The first of a two-book course in drafting, this manual consists of 13 topics in the following units: introduction to drafting, general safety, basic tools and lines, major equipment, applying for a job, media, lettering, reproduction, drawing sheet layout, architect's scale usage, civil engineer's scale usage, mechanical engineer's scale usage, and metric scale usage. Included in the individual instructional units are some or all of the following: performance objectives, suggested activities for teachers, information sheets, assignment sheets, job sheets, visual aids, tests, and test answers. Instructional materials in the publication are written in terms of student performance using measurable objectives and include the content necessary for employment in an entry-level drafting occupation. (MN)
BASIC DRAFTING BOOK ONE

by

Ronald Dow
Bill Hill
Bruce Yancey

Developed by

Mid America Vocational Curriculum Corporation, Inc.

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This Drafting Book One is the first volume of a series of drafting materials to be produced by the Mid America Vocational Curriculum Consortium. This book and those Drafting Books Two comprise the basics necessary to be employed in a drafting occupation. Areas of specialization such as Mechanical Drafting and Architectural Drafting are being written as supplements to be used with this book.

The success of this publication is due, in large part, to the capabilities of the personnel who worked on its development. The technical writers have numerous years of experience in both teaching and writing. Assisting them in their efforts were committees of representatives who brought with them technical expertise and experience related to the classroom and to the trade. To assure that the materials would parallel the industry environment and be accepted as a transportable basic teaching tool, other organizations and industry representatives were involved in the developmental phases of the manual. Appreciation is extended to them for their valuable contributions to the manual.

This publication is designed to assist teachers in improving instruction. As this publication is used, it is hoped that the student performance will improve and that students will be better able to assume a role in their chosen occupation. Every effort has been made to make this publication basic, valuable, and by all means usable. Three vital parts of instruction have been intentionally omitted—motivation, personalization, and individualization. These areas are left to the individual instructor who should capitalize on them only when this publication really becomes a vital part of the teaching-learning process.

Instructional materials in this publication are written in terms of student performance using measurable objectives. This is a progressive approach to teaching that accepts and augments the teaching-learning process. Criterion-related evaluation instruments are provided for uniform measurement of student progress. In addition to criterion-related information, teachers are encouraged to evaluate the other areas indicated, since the product is related at the end of each evaluation unit.

It is the sincere belief of the MAVC personnel and all those members who served on the committee that this publication will assist the students to become better prepared for the responsibilities and opportunities open to them. It is also the belief that this publication will help in the preparation of a better student. The Manuscript of this book was written.

Draft No. 2
Print No. 1

Mid America Vocational Curriculum Consortium
Base Drafting Book One is the first of two publications designed to provide the content necessary for employment in an entry level drafting occupation. Originally intended as only one volume, the separation of Base Drafting into two books was for one reason to reduce the size of the materials. The result is two books that are easier to carry and much more convenient to work with.

In a time when educational costs continue to rise, a lower priced text will be welcomed by teachers and students alike. But more than that, curriculum materials presented at such a comprehensive size will be easier to adapt to specialty programs with industry and adult education.

There has never been a MAVCC publication in which we failed to request that teachers and educators let us know how the curriculum is working out in the classroom. Teacher response to date has helped make the MAVCC format the most solid vocational technical education, and this new, comprehensive publication of Base Drafting should prove once more that as MAVCC continues to publish we also continue to listen and respond.

Ann Benson
Executive Director
Mid-Atlantic Vocational-Technical Consortium
ACKNOWLEDGMENTS

Appreciation is extended to those individuals who contributed their time and talents in the development of *Basis Drafting Book One*.

The contents of this publication were planned and reviewed by:

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USE OF THIS PUBLICATION

Instructional Units

Basic Drafting: Book One includes thirteen units. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for teachers, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the test. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help to determine:

A. The amount of material that can be covered in each class period
B. The skills which must be demonstrated
   1. Supplies needed
   2. Equipment needed
   3. Amount of practice needed
   4. Amount of class time needed for demonstrations
C. Supplementary materials such as pamphlets or filmstrips that must be ordered
D. Resource people who must be contacted

Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course, thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction, and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Following is a list of performance terms and their synonyms which may have been used in this material:

<table>
<thead>
<tr>
<th>Name</th>
<th>Identify</th>
<th>Describe</th>
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<tr>
<td>Label</td>
<td>Select</td>
<td>Define</td>
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<tr>
<td>List in writing</td>
<td>Mark</td>
<td>Discuss in writing</td>
</tr>
<tr>
<td>List orally</td>
<td>Point out</td>
<td>Discuss orally</td>
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<tr>
<td>Letter</td>
<td>Pick out</td>
<td>Interpret</td>
</tr>
<tr>
<td>Record</td>
<td>Choose</td>
<td>Tell how</td>
</tr>
<tr>
<td>Repeat</td>
<td>Locate</td>
<td>Tell what</td>
</tr>
<tr>
<td>Give</td>
<td></td>
<td>Explain</td>
</tr>
</tbody>
</table>
Order
Arrange
Sequence
List in order
Classify
Divide
Isolate
Sort

Distinguish
Discriminate

Construct
Draw
Make
Build
Design
Formulate
Reproduce
Transcribe
Reduce
Increase
Figure

Show your work
Show procedure
Perform an experiment
Perform the steps
Operate
Remove
Replace
Turn off/on
(Dis) assemble
(Dis) connect

Additional Terms Used:
Evaluate
Complete
Analyze
Calculate
Estimate
Plan
Observe
Compare
Determine
Perform
Prepared
Make
Read
Tell
Teach
Converse
Lead
State
Write

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives which will fit the material to the needs of the students and community. When teachers add objectives, they should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities for the Instructor:

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. Duties of instructors will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives and information sheet; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives in the unit. The teacher will find that the information sheets serve as an excellent guide for presenting the background knowledge necessary to develop the skill specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.
Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to and in most situations should demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for students to follow if they have missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances which might reasonably be expected from a person who has had this training.

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledge which are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Test and Evaluation

Paper pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.
TOOLS, MATERIALS, AND EQUIPMENT LIST

Standard triangles
Compass
Divider
Protractor
Irregular curve
Drafting machine parallel bar
Adjustable triangle
V track drafting machine
Elbow drafting machine
Sheet of vellum without a watermark
Nonabrasive hand eraser
Drawing pencil with soft lead
Lead holder or pencils
Lead pointer
Drawing paper or media
Pencil pointer
Paper towel or cleaning cloth
Braddock Rowe triangle
Drafting machine or parallel bar
Drawing surface
Ames type lettering guide
Scale or lettering guide
Drafting tape
Horizontal machine scale
Vertical machine scale
Scale wrench
Hex wrench
REFERENCES

A. *A Look at Service Safety* Tecumseh, Michigan, Tecumseh Products Co.


I. *Can I Get the Job?* Detroit: General Motors Public Relations Staff, 1972.


Y. *Safety Practices and Procedures in School Shops*. Division of Vocational Education/ New Jersey Department of Education.


EE. *Your Attitude Is Showing*. Austin, TX. Instructional Materials, Division of Extension/ University of Texas, 1972.
INSTRUCTIONAL/TASK ANALYSIS

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)

RELATED INFORMATION: What the Worker Should Know (Cognitive)

SECTION A--UNIT I: INTRODUCTION TO DRAFTING

1. Terms
2. Areas of specialization
3. Job descriptions
4. Advantages and disadvantages
5. Minimum qualifications
6. Important personnel traits
7. Abbreviations
8. Develop an organizational chart

UNIT II: GENERAL SAFETY

1. Terms
2. Safety responsibilities
3. Safety hazards
4. Maintaining a clean and orderly shop
5. Personal safety
6. Electrical accidents
7. Electrical tools
8. Fire triangle
9. Accidents

10. Subscribe to student safety pledge
UNIT III  BASIC TOOLS AND LINES

1. Terms
2. Standard triangles
3. Compasses
4. Dividers
5. Curves
6. Templates
7. Maintenance and care
8. Pencils
9. Types of lines
10. Widths of linework
11. Lead, plastic lead and ink
12. Draw lines on a drawing medium
13. Sharpen a compass lead
14. Divide a circle into 24 parts
15. Use a compass to draw circles and arcs
16. Use a divider
17. Measure angles with a protractor
18. Use an irregular curve to construct a curved line

UNIT IV  MAJOR EQUIPMENT

1. Terms
2. Parallel bar
3. Adjustable triangle
4. Elbow drafting machine
5. V track drafting machine
6. Maintenance and care
7. Electric erasing machine
JOB TRAINING. What the Worker Should Be Able to Do (Psychomotor)

8. Operate a parallel bar

9. Operate an adjustable triangle

10. Measure angles

11. Make adjustments to a V track drafting machine

12. Make adjustments to an elbow drafting machine

RELATED INFORMATION: What the Worker Should Know (Cognitive)

UNIT V: APPLYING FOR A JOB

1. Terms

2. Locating job openings

3. Personal interviews

4. Methods

5. Items needed

6. Write a resume

7. Write a letter of application

8. Complete an employment application form

9. Prepare a personal portfolio

10. Practice interview questions

11. Make an appointment by phone

12. Write a follow up letter

13. Evaluate a job offer

14. Compare job opportunities
JOB TRAINING: What the Worker Should Be Able to Do
(Psycho-motor)

RELATED INFORMATION: What the Worker Should Know
(Cognitive)

SECTION B--UNIT I. MEDIA

1. Terms
2. Papers
3. Paper surfaces
4. Transparentizing
5. Tracing cloth
6. Polyester drafting film
7. Scribe cost
8. Distribution of costs
9. Standard media sizes
10. Media roll sizes

11. Determine the felt side of vellum without a watermark

UNIT II. LETTERING

1. Condensed and extended
2. Boldface and lightface
3. Letter selection
4. Forming letters
5. Guidelines
6. Spacing
7. Lettering instruments

8. Select and sharpen lead
9. Operate a Braddock Rowe triangle
10. Operate an Ames type lettering guide
11. Construct vertical Gothic lettering and numerals
JOB TRAINING: What the Worker Should Be Able to Do
(Psychomotor)

12. Construct inclined Gothic lettering and numerals
13. Construct vertical lowercase Gothic lettering
14. Construct inclined lowercase Gothic lettering
15. Prepare vertical and inclined lettering exercises

UNIT III: REPRODUCTION

1. Terms
2. Blueprint machines and processes
3. Diazo dry and wet print processes
4. Erasing chemicals
5. Linework density
6. Elements of microfilming
7. Reproducibles
8. Paste up drafting
9. Appliques
10. Drawing control system
11. Storage of drawings and prints
12. Make blueline or blackline prints
13. Operate a blueline machine

UNIT IV: DRAWING SHEET LAYOUT

1. Terms
2. Types of working drawings
3. Title blocks
4. Revision blocks
5. Parts lists
6. Supplementary blocks
7. Complete a title block sheet
UNIT V: ARCHITECT'S SCALE USAGE

1. Terms
2. Architect's scale
3. Shapes of scales
4. Scale ratios
5. Interpret 1/16 and 1/32 graduations on a full size scale
6. Read architect's scale at full scale ratio 12" = 1'0"
7. Read architect's scale at scale ratio 6" = 1'0"
8. Read architect's scale at scale ratio 3" = 1'0"
9. Read architect's scale at scale ratio 1 1/2' = 1'0"
10. Measure lines

UNIT VI: CIVIL ENGINEER'S SCALE USAGE

1. Terms
2. Civil engineer's scale
3. Shapes of scales
4. Scale graduations
5. Read scale using 1" = 1'0"
6. Read scale using 1" = 20'
7. Read scale using 1" = 30'
8. Read scale using 1" = 40'
9. Read scale using 1" = 50'
10. Read scale using 1" = 60'
11. Measure lines

RELATED INFORMATION: What the Worker Should Know (Cognitive)
UNIT VII: MECHANICAL ENGINEER'S SCALE USAGE

1. Terms
2. Mechanical engineer's scale
3. Shapes of scales
4. Scale ratios
5. Read scale using ratio of 1" = 1"
6. Read scale using ratio of 1/2" = 1"
7. Read scale using ratio of 1/4" = 1"
8. Read scale using ratio of 1/8" = 1"
9. Measure lines

UNIT VIII: METRIC SCALE USAGE

1. Terms
2. Metric scale
3. Rules for usage
4. Scale graduations
5. Read scale at ratio of 1:1
6. Read scale at ratio of 1:2
7. Read scale at ratio of 1:5
8. Read scale at ratio of 1:25
9. Read scale at ratio of 1:33 1/3
10. Read scale at ratio of 1:75
11. Measure lines
INTRODUCTION TO DRAFTING
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to define drafting, select areas of specialization within the drafting profession, and name areas in which a drafter and a drawing will be evaluated. The student should also be able to develop an organizational chart for a typical engineering department. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment sheet and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to drafting with their correct definitions.
2. Write a definition of drafting.
3. Select areas of specialization in the drafting profession.
4. List industries that employ drafters.
5. Name related occupational fields that employ drafters.
6. Match job descriptions with their correct job titles.
7. Arrange in order the sequence for the completion of drafting work.
8. Match job classifications within a manufacturing structure with their correct definitions.
9. Distinguish between the advantages and disadvantages of a drafting occupation.
10. Select minimum qualifications for a drafter trainee, drafter, designer, licensed engineer, and licensed architect.
11. Select personal traits that are important for a successful drafter.
12. Select five related skills important for a successful drafter.
13. Name areas in which a drafter will be evaluated.
14. Name areas in which a drawing will always be evaluated.
15. Define the abbreviations of professional drafting organizations.
16. Name advantages enjoyed by drafters who join a professional organization.
17. Develop an organizational chart for a typical engineering department.
INTRODUCTION TO DRAFTING
UNIT I

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.
II. Provide student with information and assignment sheets.
III. Make transparencies.
IV. Discuss unit and specific objectives.
V. Discuss information and assignment sheets.
VI. Take students on a field trip to visit an industry related to drafting.
VII. Encourage students to interview a person who works as a drafter and report their findings to the class.
VIII. Discuss in detail the advantages and disadvantages of being a drafter.
IX. Invite speakers who have experience in various drafting fields to speak to the class about their jobs.
X. Provide a list of drafting vocabulary words.
XI. Discuss appropriate student organizations such as VICA.
XII. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objective sheet
   B. Information sheet
   C. Transparency masters
      1. TM 1-Types of Drafting
      2. TM 2-Drafting Industries
      3. TM 3-Typical Organizational Chart
   D. Assignment Sheet #1-Develop an Organizational Chart For a Typical Engineering Department
E. Answers to assignment sheet
F. Test
G. Answers to test

II. References:


INTRODUCTION TO DRAFTING
UNIT I

INFORMATION SHEET

I. Terms and definitions
   A. Technical—Having to do with the practical, industrial, or mechanical arts or the applied sciences
   B. Technician—A specialist in the technical details of a particular subject
   C. Engineering—The application of science and mathematics in making structures, machines, products, systems, and processes useful to humanity
   D. Craftsworker—A skilled worker who practices a trade; a specialist in an area of construction or manufacturing
   E. Cartography—The art of map making
   F. Estimating—Cataloging and pricing all materials needed to build a product

II. Definition of drafting—The process of taking the ideas, sketches and specifications of designers and engineers and preparing drawings to scale, using standard symbols and approved drafting techniques so that a product can be made

III. Areas of specialization in the drafting profession (Transparency 1)
   A. Machine
   B. Structural
   C. Piping
   D. Electrical
   E. Aircraft
   F. Architectural
   G. Pressure vessel
   H. Electronic
   I. Civil
   J. Computer graphics
   K. Sheet metal
I N F O R M A T I O N  S H E E T

IV. Industries that employ drafters (Transparency 2)
   A. Transportation industries
   B. Oil industries
   C. Construction industries
   D. Topographic industries
   E. Communications industries
   F. Pipeline industries
   G. Material fabrication industries
   H. Electrical industries
   I. Military related industries

V. Related occupational fields that employ drafters
   A. Estimating-Cost analysis
   B. Inspection-Quality control
   C. Model fabrication
   D. Surveying
   E. Engineering aid
   F. Sales-Drafting equipment and reproduction
   G. Technical illustration
   H. Cartography

VI. Job descriptions and job titles
   A. Trainee
      1. Transfers or copies drawings made by others
      2. Revises drawings working from instructions
      3. Repairs or redraws damaged drawings
   B. Junior drafter
      1. Complete and revises drawings
      2. May make simple detail and assembly drawings
C. Drafter
   1. Draws detail and assembly drawings
   2. Works with reference material
   3. Makes routine calculations
   4. Takes field notes

D. Senior drafter
   1. Handles design drafting detail assignments
   2. Exercises considerable judgment in layout
   3. Makes or reviews many calculations

E. Checker
   1. Checks all final drawings for errors
   2. Is directly responsible for errors
   3. Routes drawings through the department

F. Junior designer
   1. Works from engineering notes and specifications
   2. Does calculations
   3. Has some supervisory duties
   4. Handles complete design assignment with minimum supervision

G. Senior designer
   1. Works with engineering staff
   2. Works with mathematics, strength of materials, gear ratios, and drive systems
   3. Generally, will have a college degree in engineering or drafting technology
   4. May coordinate production deadlines, cost analysis, and generally manage the drafting department
INFORMATION SHEET

H. Chief Drafter
   1. Responsible for all drafting in a company
   2. In charge of hiring and firing
   3. Sets work schedules, company drafting standards, and work loads
   4. Responsible for budgeting and purchasing for the needs of drafting department

VII. Sequence for the completion of drafting work
   A. Preliminary design layout and rough sketches
   B. Set of working drawings with materials list and specifications
   C. Check
   D. Corrections
   E. Engineer's approval
   F. Drawing release
   G. Prints made and sent to fabricators
   H. Revisions (when necessary)

VIII. Job classifications within a manufacturing structure
   A. Engineers--Design, management
   B. Technicians--Development, drafting
   C. Craftworkers--Production, skilled trades

IX. Advantages and disadvantages of a drafting occupation
   A. Advantages
      1. Clean indoor working conditions
      2. Open job market
      3. Lots of overtime available
      4. Sense of self-satisfaction and pride
      5. Stepping stone for higher paying occupations
      6. Variety of challenging assignments
B. Disadvantages

1. Confinement to one area
2. Long hours at times of peak production
3. Responsible to both management and production
4. Rigid accountability for accuracy of work
5. Knowledge of many technical fields required
6. Very little physical exercise
7. Rigid time limits for doing work

X. Minimum qualifications for a drafter trainee, drafter, designer, licensed engineer, licensed architect

A. Drafter trainee

1. High school diploma, or be successfully working toward one
2. Course work in vocational drafting with average or better grades
3. One year of algebra and one year of geometry
4. Good character references
5. Good school attendance record

B. Drafter

1. High school diploma
2. Two or more years of vocational drafting with average or better grades
3. One year of algebra and one year of geometry
4. Good character references
5. Successful completion of an in-company training period

(NOTE: In some companies this could be as long as one year as trainee.)

C. Designer

1. Associate degree in technical area
2. Minimum five years drafting experience in a specialty area
3. Good work credentials
INFORMATION SHEET

D. Licensed Engineer
   1. Degree in engineering (five years college)
   2. Successful completion of state examination for engineering specialty area
   3. Successful completion of apprenticeship under licensed engineer

E. Architect
   1. Degree in architectural area (six years college)
   2. Successful completion of three year apprenticeship under licensed architect
   3. Successful completion of state examination

(NOTE: These minimum requirements may vary for various states and for various drafting occupations but can be considered as a general description.)

XI. Personal traits that are important for a successful drafter
   A. Listens to and follows instructions well
   B. Punctual
   C. Dependable and reliable
   D. Able to accept constructive criticism
   E. Success oriented; willingness to continue education
   F. Ability to sit quietly and work patiently at detailed work for long hours
   G. Must be able to work well with others

XII. Related skills important to become a drafter
   A. Speed
   B. Open line draughtsmanship
   C. Mechanical drawing
   D. Communication skills
   E. Accuracy
   F. Manual skills
INFORMATION SHEET

G. Ability to visualize three-dimensional objects recorded on a two-dimensional plane

H. Ability to do neat legible lettering

I. Ability to use alphabet of lines

XIII. Areas in which a drafter will be evaluated

A. Speed
B. Accuracy
C. Completeness
D. Ability to get along with others
E. Ability to work unsupervised
F. Wasted materials and man hours

XIV. Areas in which a drawing will always be evaluated

A. Accuracy
B. Linework
C. Lettering
D. Neatness
E. Dimensioning
F. Reproducibility

XV. Abbreviations of professional drafting organizations and their meanings

A. AIDD--American Institute of Design Draftsmen
B. SME--Society of Mechanical Engineers
C. SPE--Society of Professional Engineers
D. AIA--American Institute of Architects
E. NHBA--National Home Builder's Association (local association)
F. ASHRAE--American Society of Heating, Refrigerating and Air-Conditioning Engineers
Advantages enjoyed by drafters who join a professional organization

A. Helps them keep up with new trends within a specialty area

B. Allows them to maintain contacts within the industry for job openings and business trends

C. Potential library of reference materials

(NOTE: Some organizations publish standards and reference materials for their trade area.)

D. Certification credentials offered by many professional organizations

(NOTE: Many of these credentials are recognized nationally. These can be extremely important if a person wants to change localities within the United States.)
TYPES OF DRAFTING

1. Machine
2. Structural
3. Piping
4. Electrical
5. Aircraft
6. Architectural
7. Pressure Vessel
8. Electronic
9. Civil
11. Sheet Metal
DRAFTING INDUSTRIES

1. Transportation Industries
2. Oil Industries
3. Construction Industries
4. Topographic Industries
5. Communications Industries
6. Pipeline Industries
7. Material Fabrication Industries
8. Electrical Industries
9. Military Related Industries
Typical Organization Chart

Chief Drafter

Senior Designer (Engineering)
- Cost Analysis
- Design
- Technical Illustrations

Senior Drafter (Drafting)
- Jig and Fixtures
- Details
- Reproduction
- Trainee

Checker
- #1
- #2

Production Coordinator
- Welding
- Machine Shop
- Sheet Metal

Squad Leader (Junior Designer)
- Drafter #1
- Drafter #2
- Drafter #3

Squad Leader (Drafter)
- Junior Drafter #1
- Junior Drafter #2
- Junior Drafter #3
INTRODUCTION TO DRAFTING
UNIT I

ASSIGNMENT SHEET #1—DEVELOP AN ORGANIZATION CHART
FOR A TYPICAL ENGINEERING DEPARTMENT

Procedure:

1. Determine the areas of responsibility within the given department
2. Determine the job titles for the various individuals within the department
3. Prepare a block diagram sketch of the various supervisor's in the department

Example:

```
DEPT. HEAD

SENIOR ENGINEER  CHECKER  SENIOR DRAFTER
```

(NOTE: All individuals with similar responsibilities will be shown in a straight line across the chart.)
4. Continue down the chain of command on the sketch until it includes every job title within the department.

Example:

- DEPT. HEAD
  - SENIOR DRAFTER
  - CHECKER
  - SENIOR ENGINEER
    - JUNIOR DESIGNER
    - JUNIOR DESIGNER
  - DRAFTER
    - JUNIOR DRAFTER
    - TRAINEE

(NOTE: Normally, squares are used to represent positions within a department, and circles to represent positions or components not in the department.)

5. Complete the sketch with all flow lines between blocks.

(NOTE: Charts are not to scale but care must be taken to keep all squares in proportion and to allow enough room for lettering within the square.)
Problem:

Develop a sketch of an organizational chart showing the flow of authority for a typical engineering department. Refer to transparency 3. Get your sketch approved by your instructor. Use the following information:

Name of Corporation: Utility International

Personnel:

1. One Chief Drafter
2. Two Senior drafters, one in charge of drafting, one in charge of engineering
3. One Checker, who reports directly to chief drafter and is equal to senior drafters
4. Two squads of three junior drafters, one squad is in engineering
5. Two drafters who serve as squad leaders, one in engineering, one in drafting
6. Two trainees, one in engineering, one in drafting, who report directly to squad leaders
INTRODUCTION TO DRAFTING
UNIT I

ANSWERS TO ASSIGNMENT SHEET #1

ORGANIZATION CHART

CHIEF DRAFTER

SENIOR DRAFTER

DRAFTER

TRAINED

JUNIOR DRAFTER

JUNIOR DRAFTER

JUNIOR DRAFTER

CHECKER

SENIOR DRAFTER

DRAFTER

TRAINED

JUNIOR DRAFTER

JUNIOR DRAFTER

JUNIOR DRAFTER

UTILITY INTERNATIONAL CORP.
ENGINEERING DEPT.
INTRODUCTION TO DRAFTING
UNIT I

NAME

TEST

1. Match the terms on the right with their correct definitions.

   a. Cataloging and pricing all materials needed to build a product
   1. Technical

   b. The application of science and mathematics in making structures, machines, products, systems, and processes useful to humanity
   2. Engineering

   c. A skilled worker who practices a trade; a specialist in an area of construction or manufacturing
   3. Technician

   d. Having to do with the practical, industrial, or mechanical arts or the applied sciences
   4. Craftworker

   e. The art of map making
   5. Cartography

   f. A specialist in the technical details of a particular subject
   6. Estimating

2. Define drafting.

3. Select areas of specialization in the drafting profession by placing an "X" in the appropriate blanks.

   a. Piping
   b. Aircraft
   c. Political science
   d. Electronic
   e. Architectural
   f. Sheet metal
4. List six industries that employ drafters.
   a. ____________________________
   b. ____________________________
   c. ____________________________
   d. ____________________________
   e. ____________________________
   f. ____________________________

5. Name five related occupational fields that employ drafters.
   a. ____________________________
   b. ____________________________
   c. ____________________________
   d. ____________________________
   e. ____________________________

6. Match the job titles on the right with their correct descriptions.

   a. Traces or copies drawings made by others; revises drawings, working from instructions and repairs or redraws damaged drawings.

   b. Checks all final drawings for errors, is directly responsible for errors and routes drawings through the department.

   c. Handles design drafting detail assignments, exercises considerable judgment in layout and makes or reviews many calculations.

   d. Works with engineering staff; works with mathematics, strength of materials, gear ratios, and drive systems; generally, will have a college degree in engineering or drafting technology, and may coordinate production deadlines, cost analysis, and generally manage the drafting department.

   e. Works from engineering notes and specifications, does calculations, has some supervisory duties, and handles complete design assignment with minimum supervision.

   f. Responsible for all drafting in a company; in charge of hiring and firing; sets work schedules, company drafting standards, and work loads, and responsible for budgeting and purchasing for the needs of drafting department.

1. Trainee
2. Junior drafter
3. Senior drafter
4. Checker
5. Junior designer
6. Senior designer
7. Chief drafter
8. Drafter
g. Corrects and revises drawings and may make simple detail and assembly drawings

h. Draws detail and assembly drawings, works with reference material, makes routine calculations and takes field notes.

7. Arrange in order the sequence for the completion of drafting work by placing the correct sequence number in the appropriate blank.

   a. Revisions
   b. Check
   c. Preliminary design layout and rough sketches
   d. Prints made and sent to fabricators
   e. Corrections
   f. Engineer's approval
   g. Drawing release
   h. Set of working drawings with materials list and specifications

8. Match job classifications within a manufacturing structure with their correct definitions.

   a. Design, management 1. Technicians
   b. Production, skilled trades 2. Engineers
   c. Development, drafting 3. Craftworkers

9. Distinguish between advantages and disadvantages of a drafting occupation by placing an "X" by each statement that is an advantage.

   a. Clean indoor working conditions
   b. Open job market
   c. Confinement to one area
   d. Long hours at times of peak production
   e. Responsible to both management and production
   f. Variety of challenging assignments
   g. Stepping stone for higher paying occupations
   h. Rigid accountability for accuracy of work
   i. Knowledge of many technical fields required
10. Select minimum qualifications for a drafter trainee, drafter, designer, licensed engineer, and licensed architect by matching their qualifications with the job title on the right.

   a.  1) High school diploma, or be successfully working toward one
        2) Course work in vocational drafting with average or better grades
        3) One year of algebra and one year of geometry
        4) Good character references
        5) Good school attendance record

   b.  1) High school diploma
        2) Two or more years of vocational drafting
        3) Successful completion of an in-company training period

   c.  1) Associate degree in technical area
        2) Minimum five years drafting experience in a specialty area
        3) Good work credentials

   d.  1) Degree in engineering
        2) Successful completion of state examination for engineering specialty area
        3) Successful completion of apprenticeship under licensed engineer

   e.  1) Degree in architectural area
        2) Successful completion of three-year apprenticeship under licensed architect
        3) Successful completion of state examination

11. Select personal traits that are important for a successful drafter by placing an "X" in the appropriate blanks.

   a.  Listens to and follows instructions well

   b.  Ability to not listen to constructive criticism

   c.  Willingness to be satisfied with present education

   d.  Punctual

   e.  Must be able to work well with others
12. Select five related skills important for a successful drafter by placing an "X" in the appropriate blanks.

   _____ a. Speed
   _____ b. Operate machinery
   _____ c. Manual dexterity
   _____ d. Communication skills
   _____ e. Do survey work
   _____ f. Math skills
   _____ g. Operate drafting equipment correctly

13. Name five areas in which a drafter will be evaluated.

   a. ____________________________
   b. ____________________________
   c. ____________________________
   d. ____________________________
   e. ____________________________

14. Name five areas in which a drawing will always be evaluated.

   a. ____________________________
   b. ____________________________
   c. ____________________________
   d. ____________________________
   e. ____________________________

15. Define the abbreviations of the professional drafting organizations listed below.

   a. NHBA ____________________________
   b. SME ____________________________
   c. ASHRAE ____________________________
   d. AIID ____________________________
   e. AIA ____________________________
16. Name three advantages enjoyed by drafters who join a professional organization.
   a. 
   b. 
   c. 

17. Develop an organizational chart for a typical engineering department.
    (NOTE: If this activity has not been accomplished prior to the test, ask your instructor when it should be completed.)
INTRODUCTION TO DRAFTING
UNIT I

ANSWERS TO TEST

1. a. 6
   b. 2
   c. 4
   d. 1
   e. 5
   f. 3

2. The process of taking the ideas, sketches and specifications of designers and preparing drawings to scale, using standard symbols and approved drafting techniques so that a product can be made.

3. a, b, d, e, f

4. Any six of the following:
   a. Transportation industries
   b. Oil industries
   c. Construction industries
   d. Topographic industries
   e. Communications industries
   f. Pipeline industries
   g. Material fabrication industries
   h. Electrical industries
   i. Military related industries

5. Any five of the following:
   a. Estimating--Cost analysis
   b. Inspection--Quality control
   c. Model fabrication
   d. Surveying
   e. Engineering aid
   f. Sales--Drafting equipment and reproduction
   g. Technical illustration
   h. Cartography

6. a. 1   e. 5
   b. 4   f. 7
   c. 3   g. 2
   d. 6   h. 8

7. a. 8
   b. 3
   c. 1
   d. 7
   e. 4
   f. 5
   g. 6
   h. 2
8. a. 2  
b. 3  
c. 1  

9. a, b, f, g, j, l  

10. a. 3  
b. 4  
c. 1  
d. 5  
e. 2  

11. a, d, e  

12. a, c, d, f, g  

13. Any five of the following:  
   a. Speed  
   b. Accuracy  
   c. Completeness  
   d. Ability to get along with others  
   e. Ability to work unsupervised  
   f. Wasted materials and man hours  

14. Any five of the following:  
   a. Accuracy  
   b. Linework  
   c. Lettering  
   d. Neatness  
   e. Dimensioning  
   f. Reproducibility  

15. a. National Home Builder's Association  
    b. Society of Mechanical Engineers  
    c. American Society of Heating, Refrigerating and Air Conditioning Engineers  
    d. American Institute of Design Draftsmen  
    e. Society of Professional Engineers  
    f. American Institute of Architects  

16. Any three of the following:  
   a. Helps them keep up with new trends within a speciality area  
   b. Allows them to maintain contacts within the industry for job openings and business trends  
   c. Potential library of reference materials  
   d. Certification credentials offered by many professional organizations  

17. Evaluated to the satisfaction of the instructor
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to list reasons and select rules for maintaining a clean and orderly drafting classroom. The student should also be able to list ten specific rules for personal safety and describe the steps to be followed in case of an accident. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheet and by scoring 100 per cent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to general safety with their correct definitions.
2. Select safety responsibilities of school, instructor, and student.
3. Distinguish between safety hazards involving classroom environment and classroom equipment.
4. List two reasons for maintaining a clean and orderly drafting classroom.
5. List six steps in maintaining a clean and orderly shop.
7. List five potential hazards of misusing electricity.
8. List three major causes of electrical accidents.
10. Match the classes of fires to the correct definitions.
11. Label the three components of the fire triangle.
12. Match the types of fire extinguishers with their operation and the class of fires they are intended to extinguish.
13. List the two classes of fires that might be encountered in a typical drafting classroom.
14. List six steps to be followed in case of an accident in the classroom.
15. Indicate a willingness to work safely by subscribing to the student safety pledge.
GENERAL SAFETY
UNIT II

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information and assignment sheets.

III. Make transparencies.

IV. Discuss unit and specific objectives.

V. Discuss information and assignment sheets.

VI. Show a safety film.

VII. Invite fire department representative to give a talk on fire safety.

VIII. Discuss evacuation plan.

IX. Have a fire and disaster drill.

X. Have an accident victim address the class.

XI. Have a paramedic/nurse visit the class and give lecture on first aid.

XII. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet
   B. Information sheet
   C. Transparency masters

      1. TM 1--Do Not Misuse Electrical Tools
      2. TM 2--Use Trimming Shears, Paper Cutters, and Metal Straight Edges Properly and Only for Intended Purposes
      3. TM 3--Handle Sharp, Pointed Instruments With Care
      4. TM 4--Avoid Horseplay
      5. TM 5--Keep All Four Feet of Drafting Stools on Floor
      6. TM 6--Use Both Hands to Raise and Lower Drafting Table Tops
7. TM 7--Use Reproduction Equipment With Proper Care
8. TM 8--Do Not Throw Any Objects
9. TM 9--Tag Any Defective Electrical Equipment With a "Do Not Use" Tag
10. TM 10--Follow All Rules and Regulations of the School Completely
11. TM 11--Potential Results of Improper Usage of Electricity
12. TM 12--The Fire Triangle
13. TM 13--Know Your Fire Extinguisher

D. Assignment Sheet #1--Subscribe to the Student Safety Pledge
E. Test
F. Answers to test

II. References:


III. Additional materials:


B. Film: "Stop a Fire Before it Starts." 146-024, Journal Films, 909 Diversey Parkway, Chicago, IL 60614.
GENERAL SAFETY
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Safety—State or condition of being safe; freedom from danger, risk, or injury

B. Accident—Any suddenly occurring, unintentional event which causes injury or property damage

C. First aid—Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained

D. Hazard—A potential source of danger

II. Safety responsibilities of school, instructor, and student

A. School

1. Provide adequate facilities, including a classroom large enough to accommodate students without crowding

2. Provide modern, up-to-date equipment and working conditions

3. Provide adequate facilities for good lighting and temperature controls

B. Instructor

1. Provide a well-organized, progressive instructional program that challenges all students, thus eliminating free time when horseplay and unsafe acts commonly occur

2. Provide a well-planned cleanup program with individual assignments

   (NOTE: It's a good idea to rotate cleanup duties weekly.)

3. Provide adequate instruction in the safe use and proper care of all drafting and reproduction equipment

4. Provide plans for students to follow in emergency situations

5. Provide an accident reporting system which insures fast and efficient help in case of accident
INFORMATION SHEET

C. Student

1. Be responsible for own area and equipment and see that it is kept clean and in good working condition
2. Report any safety hazard to instructor immediately
3. Do not abuse or misuse any piece of equipment in the classroom
4. Conduct oneself in a manner conducive to safe practice

III. Safety hazards involving classroom environment and classroom equipment

A. Classroom environment

1. Narrow aisles
2. Poor lighting
3. Crowded conditions
4. Lack of storage area
5. Poor maintenance of facility
6. Misuse of extension cords

B. Classroom equipment

1. Desks and drafting tables with sharp corners and adjustable tops
2. Reproduction equipment (improper handling)
3. Electrical outlets and electrical equipment
4. Paper cutters and trimmers

IV. Reasons for maintaining a clean and orderly drafting classroom

A. To provide the safest working conditions possible
B. To provide working conditions as near as possible to what will be found in industry

(Note: Because many industry representatives and potential employers visit drafting programs in session, a clean and orderly classroom is an important public relations tool.)
INFORMATION SHEET

V. Steps in maintaining a clean and orderly shop
   A. Arrange desks and drafting tables to permit safe, efficient work practices and ease of cleaning
   B. Store materials and supplies in safe, secure places
   C. Keep working stations clean and free of debris
   D. Keep floors clean and free of obstacles
   E. Have sufficient brooms, brushes, and other housekeeping equipment readily available
   F. Develop procedures for cleanup and follow them on a daily basis

VI. Specific rules for personal safety in the drafting classroom
   A. Do not misuse electrical tools (Transparency 1).
      (NOTE: Report all electrical failures immediately.)
   B. Use trimming shears, paper cutters and metal straight edges only for intended purposes (Transparency 2)
      (NOTE: Do not remove guard from paper cutter.)
   C. Handle sharp, pointed instruments with care (Transparency 3)
      (NOTE: Never throw a compass or a divider.)
   D. Avoid horseplay (Transparency 4)
      (NOTE: More accidents result from horseplay than any other single cause.)
   E. Keep all four feet of drafting stools on the floor (Transparency 5)
      (NOTE: Leaning back and tilting a drafting stool is a dangerous practice.)
   F. Use both hands to raise and lower drafting table tops (Transparency 6)
      (NOTE: Be prepared to hold table top as control rod knobs are loosened.)
   G. Use reproduction equipment with proper care and only after instruction in its use and with the instructor's permission to use it (Transparency 7).
      (NOTE: Means must be provided for eyewash equipment.)
H. Do not throw any object (Transparency 8)

I. Tag any defective electrical equipment with a "Do Not Use" tag and turn it in to instructor (Transparency 9)

J. Follow all rules and regulations of the school (Transparency 10)

VII. Potential hazards of misusing electricity (Transparency 11)

A. Electrical shock
B. Ruined equipment
C. Fire
D. Hospitalization
E. Death

VIII. Major causes of electrical accidents

A. Carelessness
B. Poor equipment maintenance
C. Equipment not grounded properly

IX. Safety rules for using electrical tools

A. Use three wire, grounded equipment
   (NOTE: Never cut ground prong from a plug.)
B. Use proper size electrical cord
C. Do not use frayed or damaged cords
D. Stand on dry nonconductive surfaces

X. Classes of fires

A. Class A--Fires that occur in ordinary combustible materials
   Examples: Paper, wood, rags, and rubbish
B. Class B--Fires that occur with flammable liquids
   Examples: Gasoline, oil, grease, paints, and thinners
C. Class C--Fires that occur in or near electrical equipment
   Examples: Motors, switchboards, and electrical wiring

D. Class D--Fires that occur with combustible metals
   Example: Magnesium

XI. Components of the fire triangle (Transparency 12)

A. Fuel- Any combustible material
B. Heat- Enough to raise the fuel to its ignition temperature
C. Oxygen- Necessary to sustain combustion

(NOTE: To produce fire these three elements are necessary and must be present at the same time. If any one of the three is missing, a fire cannot be started. With the removal of any one of them, the fire will be extinguished.)

XII. Types of fire extinguishers, their method of operation, and the classes of fires they are intended to extinguish (Transparency 13)

A. Pressurized water- Operates usually by squeezing a handle or trigger, used on Class A fires
B. Soda acid- Operates by turning extinguisher upside down, used on Class A fires
C. Carbon dioxide (CO₂)- Operates usually by squeezing handle or trigger; used on Class B and C fires
D. Dry chemical- Operates usually by squeezing a handle, trigger, or lever, used on Class B, C, and D fires
   (NOTE: On Class D fires, dry sand is as effective as any dry chemical other than Purple X. The cost of the Purple X chemical places it out of reach of most shops.)
E. Foam- Operates by turning extinguisher upside down, used on Class A and B fires

XIII. Classes of fires that might be encountered in a typical drafting classroom

A. Class A
B. Class C
INFORMATION SHEET

XIV. Steps to be followed in case of an accident in the classroom

A. All accidents and injuries will be reported to the instructor no matter how minor they may seem

B. First aid will be administered if needed
   (NOTE: Check with local school policy.)

C. Student will be taken to school nurse

D. Student's parent or guardian will be notified if school nurse requires student to see a physician

E. Investigation of the accident will take place to determine the cause of the accident and ways to prevent the same accident from happening again

F. Accident report form will be filled out by instructor
Do Not Misuse Electrical Tools
Use Trimming Shears, Paper Cutters, and Metal Straight Edges Properly and Only for Intended Purposes
Handle Sharp Pointed Instruments with Care
Avoid Horseplay
Keep All Four Feet of Drafting Stools on Floor
Use Both Hands to Raise and Lower Drafting Table Tops
Use Reproduction Equipment with Proper Care

Correct

Incorrect
Do Not Throw Any Objects
Tag Any Defective Electrical Equipment with a "Do Not Use" Tag
Follow All Rules and Regulations of the School Completely
Potential Results of Improper Usage of Electricity

Never Become Part of the Circuit

Never Use Electrical Tools Beyond Their Rated Capacity
The Fire Triangle

To produce fire, three things must be present at the same time.

FUEL

HEAT

OXYGEN

If any one of the three is missing, a fire cannot be started or, with the removal of any one, the fire will be extinguished.
# KNOW YOUR FIRE EXTINGUISHER

<table>
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<th>TYPE EXTINGUISHER</th>
<th>WATER TYPE</th>
<th>FOAM</th>
<th>CARBON DIOXIDE</th>
<th>DRY CHEMICAL</th>
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<tr>
<td>STORED PRESSURE</td>
<td>STORED PRESSURE</td>
<td>CARTRIDGE OPERATED</td>
<td>WATER PUMP TANK</td>
<td>SODA ACID</td>
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<tr>
<td>DRY CHEMICAL</td>
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## TYPES OF FIRES

<table>
<thead>
<tr>
<th>CLASS A: WOOD, PAPER, TRASH HAVING GLOWING EMBERS</th>
<th>WATER TYPE</th>
<th>FOAM</th>
<th>CARBON DIOXIDE</th>
<th>DRY CHEMICAL</th>
</tr>
</thead>
<tbody>
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<td>YES</td>
<td>YES</td>
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<table>
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<th>CLASS B: FLAMMABLE LIQUIDS, GASOLINE, OIL, PAINT GREASE, ETC</th>
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<td>NO</td>
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<table>
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<table>
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<th>CLASS D: COMBUSTIBLE METALS</th>
<th>WATER TYPE</th>
<th>FOAM</th>
<th>CARBON DIOXIDE</th>
<th>DRY CHEMICAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>METHODS OF OPERATION</td>
<td>SQUEEZE HANDLE OR TURN VALVE</td>
<td>TURN UPSIDE DOWN AND BUMP</td>
<td>PUMP HANDLE</td>
<td>TURN UPSIDE DOWN</td>
</tr>
</tbody>
</table>

* DO NOT USE FIRE EXTINGUISHER. SMOTHER FIRE WITH DRY SAND, GRAPHITE, DIRT, OR SODA ASH.
ASSIGNMENT SHEET #1--SUBSCRIBE TO THE STUDENT SAFETY PLEDGE

STUDENT SAFETY PLEDGE FORM FOR VOCATIONAL DRAFTING

who is enrolled in Vocational Drafting, will as a part of his/her shop experience, operate machines and instruments, providing that his/her parent or guardian gives written permission.

It is understood that each student will be given proper instruction, both in the use of the equipment and in the correct safety procedures concerning it, before being allowed to operate it himself/herself. The student must assume responsibility for the following safe practices, and we therefore ask that he/she subscribe to the following safety pledge.

1. I PROMISE TO ABIDE BY ALL SAFETY RULES FOR THE SHOP AS FOLLOWS:
   a. To not misuse electrical tools
   b. To use trimming shears, paper cutters, and metal straight edges only for their intended use
   c. To handle sharp pointed instruments with care
   d. To avoid horseplay
   e. To keep all four legs of drafting stools on the floor
   f. To use both hands to raise and lower drafting table tops
   g. To use reproduction equipment with proper care and only after instruction in its use and with the instructor's permission to use it
   h. To not throw any object
   i. To tag any defective electrical equipment with a "Dq Not Use" tag and turn it in to the instructor
   j. To follow all rules and regulations of the school

2. I WILL REPORT ANY ACCIDENT TO THE TEACHER IMMEDIATELY.

   DATE ___________ STUDENT'S SIGNATURE ___________

I hereby give consent to allow my son/daughter to operate all machines and equipment necessary in carrying out the requirements of the course in which he/she is enrolled.

   DATE ___________ PARENT'S SIGNATURE ___________

(Required according to school policy)

(Note Parents are cordially invited to visit the school to inspect the Drafting Lab at any time.)
GENERAL SAFETY
UNIT II

NAME _______________________

TEST

1. Match the terms on the right with their correct definitions.

   a. Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained
   _____ 1. Safety

   b. State or condition of being safe, freedom from danger, risk, or injury
   _____ 2. Accident

   c. Any suddenly occurring, unintentional event which causes injury or proper damage
   _____ 3. First aid

   d. A potential source of danger
   _____ 4. Hazard

2. Select safety responsibilities of the school, instructor, and student by placing in the appropriate blanks an "S" to indicate school responsibilities, an "I" to indicate instructor responsibilities, and an "X" to indicate student responsibilities.

   a. Provide adequate facilities, including a classroom large enough to accommodate students without crowding
   _____ S

   b. Be responsible for own area and equipment and see that it is kept in good working condition
   _____ I

   c. Conduct oneself in a manner conducive to safe practice
   _____ X

   d. Provide a well-organized, progressive, instructional program that challenges all students, thus eliminating free time when horseplay and unsafe acts commonly occur
   _____ S

   e. Provide plans for students to follow in emergency situations
   _____ S

   f. Provide adequate facilities for good lighting and temperature controls
   _____ I

   g. Do not abuse or misuse any piece of equipment in the classroom
   _____ S

   h. Provide adequate instruction in the safe use and proper care of all drafting and reproduction equipment
   _____ S
1. Provide a well-planned cleanup program with individual assignments.
2. Report any safety hazard to instructor immediately.
3. Provide modern, up-to-date equipment and working conditions.
4. Provide an accident reporting system which insures fast and efficient help in case of accident.

3. Distinguish between safety hazards involving classroom environment and classroom equipment by placing an "X" by all statements concerning classroom equipment:
   a. Desks and drafting tables with sharp corners and adjustable tops
   b. Poor maintenance of facility
   c. Electrical outlets and electrical equipment
   d. Lack of storage area
   e. Poor lighting
   f. Paper cutters and trimmers
   g. Crowded conditions
   h. Reproduction equipment
   i. Narrow aisles

5. Major reasons for maintaining a clean and orderly drafting classroom

6. Steps in maintaining a clean and orderly shop

7. ______
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   a. 
   b. 
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   g. 
   h. 
   i. 
   j.

7. List five potential hazards of misusing electricity.
   a. 
   b. 
   c. 
   d. 
   e. 

8. List three major causes of electrical accidents.
   a. 
   b. 
   c. 

   a. 
   b. 
   c. 
   d.
10. Match the classes of fire on the right with their correct definitions.

a. Fires that occur with flammable liquids 1. Class A

b. Fires that occur in ordinary combustible materials 2. Class B

c. Fires that occur in or near electrical equipment 3. Class C

d. Fires that occur with combustible metals 4. Class D

11. Label the three components of the fire triangle.

12. Match the types of fire extinguishers on the right with their method of operation and the class of fires they are intended to extinguish.

a. Operates, usually by squeezing a handle or trigger; used on Class A fires 1. Soda acid

b. Operates by turning extinguisher upside down; used on Class A fires 2. Dry chemical

c. Operates, usually by squeezing handle or trigger, used on Class B and C fires 3. Foam

d. Operates, usually by squeezing a handle or trigger, used on Class B, C, and D fires 4. Pressurized water

e. Operates by turning extinguisher upside down, used on Class A and B fires 5. Carbon dioxide (CO₂)

13. List the two classes of fires that might be encountered in a typical drafting classroom.
14. List six steps to be followed in case of an accident in the classroom.

   a. 

   b. 

   c. 

   d. 

   e. 

   f. 

15. Indicate a willingness to promote classroom safety by subscribing to the student safety pledge.

   (NOTE: If this activity has not been accomplished prior to the test, ask your instructor when it should be completed.)
GENERAL SAFETY
UNIT II

ANSWERS TO TEST

1. a. 3  c. 2  
b. 1  d. 4

2. a. S  h. 1  
b. X  i. 1  
c. X  j. X  
d. I  k. S  
e. I  l. 1  
f. S  
g. X

3. a, c, f, h

4. a. To provide the safest working conditions possible  
b. To provide working conditions as near as possible to what will be found in industry

5. a. Arrange desks and drafting tables to permit safe, efficient work practices and ease of cleaning  
b. Store materials and supplies in safe, secure places  
c. Keep working stations clean and free of debris  
d. Keep floors clean and free of obstacles  
e. Have sufficient brooms, brushes, and other housekeeping equipment readily available  
f. Develop procedures for cleanup and follow them on a daily basis

6. a. Do not misuse electrical tools  
b. Use trimming shears, paper cutters and metal straight edges only for intended purposes  
c. Handle sharp, pointed instruments with care  
d. Avoid horseplay  
e. Keep all four feet of drafting stools on the floor  
f. Use both hands to raise and lower drafting table tops  
g. Use reproduction equipment with proper care and only after instruction in its use and with the instructor's permission to use it  
h. Do not throw any object  
i. Tag any defective electrical equipment with a "Do Not Use" tag and turn it in to instructor  
j. Follow all rules and regulations of the school

7 a. Electrical shock  
b. Ruined equipment  
c. Fire  
d. Hospitalization  
e. Death
2. a. Carelessness  
b. Poor equipment maintenance  
c. Equipment not grounded properly

9. a. Use three wire, grounded equipment  
b. Use proper size electrical cord  
c. Do not use frayed or damaged cords  
d. Stand on dry nonconductive surfaces

10. a. 2  
b. 1  
c. 3  
j. 4

13. a. Class A  
b. Class C

14. a. All accidents and injuries will be reported to the instructor no matter how minor they may seem  
b. First aid will be administered if needed  
c. Student will be taken to school nurse  
d. Student's parent or guardian will be notified if school nurse requires student to see a physician  
e. Investigation of the accident will take place to determine the cause of the accident and ways to prevent the same accident from happening again  
f. Accident report form will be filled out by instructor

15. Evaluated to the satisfaction of the instructor.
UNIT OBJECTIVE

After completion of this unit, the student should be able to identify basic drafting tools, demonstrate the ability to use various drafting tools and properly care for them. The student should also be able to name the types and sizes of lines, list the uses of lead, plastic lead, and ink, and relate grades of lead to their uses. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to basic tools and lines with their correct definitions.
2. Identify the angles found on the two standard triangles.
3. State the purpose for using a standard triangle.
4. List three types of compasses.
5. Identify the three types of dividers.
6. List four types of irregular curves.
7. List five types of common templates.
8. Identify tools used to erase and/or clean a drawing surface.
9. Select true statements concerning rules for maintenance and care of drafting tools and equipment.
10. Name three types of drafting pencils.
11. List the sizes of thin-lead mechanical pencils.
12. Match the types of lead with the devices used to sharpen them.
13. Identify the basic types of lines.
14. Name the 18 grades of pencil leads from hard to soft.
15. Match the general classes of leads with their uses.
16. Distinguish between the disadvantages of hard and soft leads.
17. Select suggested line widths for linework.
18. Distinguish between the advantages and disadvantages of ink, lead, and plastic lead.

19. Match lead, plastic lead, and ink with their comparable reproduction qualities.

20. Describe non-reproducible lead.

21. Draw lines on a drawing medium using lead and plastic lead.

22. Sharpen a compass lead or mechanical lead-holder lead with a conical or a wedge point.

23. Divide a circle into 24 parts of 15 by using the 30°/60° and 45° triangle.

24. Use a compass to draw circles and arcs.

25. Use a divider.

26. Measure angles with a protractor.

27. Use an irregular curve to construct a curved line.
BASIC TOOLS AND LINES
UNIT III

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information and assignment sheets.

III. Make transparencies.

IV. Discuss unit and specific objectives.

V. Discuss information and assignment sheets.

VI. Demonstrate the use of an eraser shield and eraser to erase a line.

VII. Show students media such as lead, plastic lead, ink, vellum, polyester film, wood-cased pencil, mechanical pencil, thin-lead mechanical pencil.

VIII. Discuss information and assignment sheets.

IX. Give test.

INSTRUCTIONAL MATERIAL

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters
   1. TM 1--Standard Triangles
   2. TM 2--Three Types of Compasses
   3. TM 3--Three Types of Dividers
   4. TM 4--Types of Drafting Pencils
   5. TM 5--Tools Used to Erase and/or Clean a Drawing Surface
   6. TM 6--Visible Lines and Hidden Lines
   7. TM 7--Section Lines and Center Lines
   8. TM 8--Extension, Dimension, and Leader Lines
   9. TM 9--Cutting Plane Lines and Short-Break Lines
   10. TM 10--Long-Break Lines and Phantom Lines
12. TM 11 - Pencil Lead Grades

D. Assignment Sheets

1. Assignment Sheet #1 - Draw Lines on a Drawing Medium with Hand and Plastic Lead

2. Assignment Sheet #2 - Sharpen a Compass Lead or Mechanical Leadholder Lead with a Conical or a Wedge Point

3. Assignment Sheet #3 - Divide a Circle Into 24 Parts of 15° Using The 30°/60° and 45° Triangle

4. Assignment Sheet #4 - Use a Compass to Draw Circles and Arcs

5. Assignment Sheet #5 - Use a Divider

6. Assignment Sheet #6 - Measure Angles with a Protractor

7. Assignment Sheet #7 - Use an Irregular Curve to Construct a Curved Line

E. Test

F. Assignment Sheet

II. References


BASIC TOOLS AND LINES
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Triangle--An instrument consisting of a thin, flat, right-angled piece of plastic or metal with acute angles of 45°, or 30° and 60°

B. Lettering guide--An instrument used to lay out guidelines for lettering

C. Compass--An instrument used to draw circles and arcs

D. Divider--An instrument used to transfer dimensions

E. Dusting brush--A tool used to brush loose graphite and eraser dust from a drawing

F. Erasing shield--A metal plate with various slots and openings used to protect linework when a portion of the drawing is to be erased

G. Lead pointer--A sharpening device for mechanical pencil leads

H. Mechanical lead holder--A metal holder in which leads of various hardness can be inserted

I. Scale--An instrument used to measure the length of a line

J. Dust cover--A covering used to protect drawings and equipment when not in use

K. Irregular curve--An instrument used to lay out any noncircular curve

L. Protractor--An instrument used to measure angles

M. Template--A thin, flat, plastic tool with various size openings of different shapes used to expedite the drawing of standard features

N. Cleaning pad--A loosely woven bag of ground art gum eraser used to remove loose graphite from a drawing

O. Lead cleaner--A styrofoam pad or tissue paper used to remove loose graphite from a pencil lead after it has been sharpened

P. Eraser--A device used to remove pencil lines and graphite smudges from a drawing

Q. Drafting tape--A specially prepared tape that does not harm surface of table or drawing media
INFORMATION SHEET

R Lead Made of graphite with kaolin (clay) added in varying amounts in order to make the eighteen grades from the hardest (9H) to the softest (7B)

NCTE Grade labeling varies per the manufacturer.

S Ink Composed mainly of carbon in colloidal suspension, (latex or solutions of special shellac) and gum. The fine particles of carbon give the deep, dark, black appearance to the ink, and the gum makes it quick to dry and waterproof

T Plastic lead- Composed of varying amounts of graphite with plastic

II Angles found on the two standard triangles (Transparency 1)

A 90 degree angle
B 30 degree angle
C 60 degree angle
D 45 degree angle

III Purpose of using a standard triangle To provide a straight edge for drawing vertical or inclined lines at any angle that is a multiple of 15 degrees

IV Types of compasses (Transparency 2)

A Friction
B Bow
C Beam

V Types of dividers (Transparency 3)

A Friction
B Bow
C Proportional

VI Types of irregular curves

A Ships curve
B Flexible curve
C Rule curve
D French curve
INFORMATION SHEET

VII  Types of common templates

A  Circle template
B  Ellipse template
C  Architectural template
D  Isometric ellipse template
E  Piping template
F  Structural steel shape template
G  Hex bolt head template
H  Thread template
I  Plumbing template
J  Civil template

(NOTE Many others may be added to this list.)

VIII  Tools used to erase and/or clean a drawing surface (Transparency 4)

A  Eraser
B  Eraser shield
C  Cleaning pad
D  Dusting brush
E  Electric eraser

IX  Rules for maintenance and care of drafting tools and equipment

A  Keep hands and equipment clean
B  Do not hit templates sharply
C  Keep all instruments clean and dry
D  Do not use template or scale as a straight edge for cutting tools
E  Do not use templates as an eraser shield
F  Do not hit scales and triangles on edges
G  Do not over extend compasses and dividers
H  Clean plastic tools with soap and water only
INFORMATION SHEET

I. Do not stick compass and divider points into scales and triangles

J. Never sharpen leads over drawing or table surface

X. Types of drafting pencils (Transparency 5)
   A. Wood-cased drawing pencil
   B. Mechanical pencil
   C. Thin-lead mechanical pencil
      (NOTE: Many types of thin-lead mechanical pencils are available.)

XI. Sizes of thin-lead mechanical pencils
   A. .03 mm
   B. .05 mm
   C. .07 mm
   D. .09 mm

XII. Types of lead and devices used to sharpen them
   A. Compass leads
      1. File
      2. Sandpaper pad
   B. Wood-cased drawing pencil leads Drafter’s pencil sharpener
   C. Mechanical lead-holder leads
      1. Sandpaper cone lead pointer
      2. Metal-cutter lead pointer

XIII. Basic types of lines (Transparencies 6, 7, 8, 9, and 10)
   A. Visible lines (Transparency 6)

THICK

APPROXIMATE WIDTH 030 - 038
(0.75 - 0.96 mm)
INFORMATION SHEET

B. Hidden lines (Transparency 6)

\[
\frac{1}{8} \times 0.12 \ (3.2 \text{ mm}) \quad \text{THIN} \quad 1/32 \times 0.03 \ (0.8 \text{ mm})
\]

APPROXIMATE WIDTH \(0.015 - 0.022\)
\(0.38 - 0.55 \text{ mm}\)

C. Section lines (Transparency 7)

\[
\text{THIN}
\]

APPROXIMATE WIDTH \(0.015 - 0.022\)
\(0.38 - 0.55 \text{ mm}\)

D. Center lines (Transparency 7)

\[
\frac{3}{4} \text{ to } 1 \frac{1}{2} \quad \frac{3}{4} - 1.5 \ (19 - 38 \text{ mm}) \quad \text{THIN}
\]

APPROXIMATE WIDTH \(0.015 - 0.022\)
\(0.38 - 0.55 \text{ mm}\)

E. Extension lines (Transparency 8)

\[
\text{THIN}
\]

APPROXIMATE WIDTH \(0.015 - 0.022\)
\(0.38 - 0.55 \text{ mm}\)
INFORMATION SHEET

THIN

APPROXIMATE WIDTH 0.015 - 0.022
(0.38 - 0.55 mm)

G. Leader lines (Transparency 8)

(Shoulder optional approximately
1/4", long)

THIN

APPROXIMATE WIDTH 0.015 - 0.022
(0.38 - 0.55 mm)

I. Cutting plane line (Transparency 9)

THICK

APPROXIMATE WIDTH 0.030 - 0.038
(0.75 - 0.96 mm)

1/16 0.06 (1.6 mm)

1/8 0.12 (3.2 mm)

FREEHAND

APPROXIMATE WIDTH 0.030 - 0.038
(0.75 - 0.96 mm)
INFORMATION SHEET

J. Long break lines (Transparency 10)

\[
\text{THIN} \quad \frac{3}{4} \text{ to } 1 \frac{1}{2} \quad 0.75 - 1.50 \quad (19 - 38 \text{ mm}) \\
\text{FREEHAND}
\]

APPROXIMATE WIDTH 0.015 - 0.022
(0.38 - 0.55 mm)

K. Phantom lines (Transparency 10)

\[
\text{THIN} \quad \frac{1}{8} \quad 0.12 \quad (3.2 \text{ mm}) \quad \frac{3}{4} \text{ to } 1 \frac{1}{2} \quad 0.75 - 1.50 \quad (19 - 38 \text{ mm}) \\
\]

APPROXIMATE WIDTH 0.015 - 0.022
(0.38 - 0.55 mm)

L. Stitch lines

(NOTE The stitch line is used for indicating a stitching or sewing process.)

\[
\text{THIN} \quad \frac{1}{16} \quad 0.06 \quad (1.6 \text{ mm}) \\
\]

APPROXIMATE WIDTH 0.015 - 0.022
(0.38 - 0.55)

\[
\frac{1}{64} \quad 0.016 \quad (0.35 \text{ mm}) \\
\]

(NOTE Some companies are not willing to use the new standards, therefore the hidden and stitch lines will have a medium line width.)
INFORMATION SHEET

M. Chain lines

(NOTE: The chain line is used to indicate that a surface or surface area is to receive some additional treatment specified on drawing.)

\[
\begin{array}{c|c|c}
\text{THICK} & \text{APPROXIMATE WIDTH} & \text{THICK} \\
\hline
1/8 & .12 (3.2 mm) & 3/4 to 1 1/2 \\
.75 - 1.50 & 1/16 & .06 (1.6 mm) \\
(19 - 38 mm) & & \\
\end{array}
\]

N. Border lines

\[
\begin{array}{c|c|c}
\text{THICK} & \text{APPROXIMATE WIDTH} & \text{THICK} \\
\hline
.030 - .038 & .030 - .038 & \\
(0.75 - 0.96 mm) & (0.75 - 0.96 mm) & \\
\end{array}
\]

XIV. Pencil lead grades (Transparency 11)

A. Hard

1. 9H
2. 8H
3. 7H
4. 6H
5. 5H
6. 4H
INFORMATION SHEET

B. Medium
   1. 3H
   2. 2H
   3. H
   4. F
   5. HB
   6. B

C. Soft
   1. 2B
   2. 3B
   3. 4B
   4. 5B
   5. 6B
   6. 7B

XV. Uses of leads by their general class

A. Hard leads
   1. Wherever extreme accuracy is required
   2. Guidelines for lettering
   3. Construction lines

B. Medium leads
   1. General purpose work
   2. The softer of these are used for
      a. Lettering
      b. Technical sketching
      c. Arrowheads
      d. Any freehand work on drawings
INFORMATION SHEET

3. The harder of these are used for:

a. Line work on drawings

b. The 2H and H leads are the two leads most often used on pencil drawings, which will be reproduced

Soft leads

1. Fine art drawing
2. Architectural rendering
3. Production illustration
4. Lettering

XVI Disadvantages of hard and soft leads

Disadvantages of hard leads—Use is restricted, apt to be too light

(NOTE: Humidity is sometimes a problem. On humid days the paper absorbs moisture from the atmosphere and becomes soft, it will expand and become wrinkled. When this occurs a softer lead will be needed to offset the softening of the paper. For example if the drafter has been using a 4H lead, use a 2H until the weather clears up.)

b. Disadvantages of soft leads

1. Will result in smudged, rough lines
2. Difficult to erase
3. Must be continually sharpened

Suggested line widths for linework

A. Thick

1. Visible
2. Viewing plane or cutting plane
3. Short break
4. Chain line
5. Border line

B. Thin

1. Center (symmetry line)
INFORMATION SHEET

2. Section
3. Dimension
4. Extension
5. Leader
6. Long break
7. Phantom or adjacent-part
8. Hidden line
9. Stitch line

(NOTE: To obtain a sharp line always rotate the drafting pencil slowly as you draw.)

XVIII. Advantages and disadvantages of ink, lead, and plastic lead

A. Ink

1. Advantages
   a. Reproduces a clean, dense line
   b. Does not smudge
   c. Revisions of original drawings can be made easily with no "ghost" or damage to drawing surface
   d. Ink lines are completely readable through microfilm reduction and blowback

2. Disadvantages
   a. Messy
   b. Hard to clean up
   c. Time consuming maintenance of pens

B. Lead

1. Advantages
   a. Quick
   b. Easy
INFORMATION SHEET

2. Disadvantages
   a. Smudges easily
   b. Leaves fuzzy lines after reproduction
   c. Point dulling and breaking

C Plastic lead

1. Advantages
   a. Does not smudge as easily as lead
   b. Quick

2. Disadvantages
   a. Can only be used on polyester film
   b. Point dulling and breaking
   c. Lack of adequate opacity
   d. Extremely brittle

XIX. Comparable reproduction qualities of lead, plastic lead, and ink

   A Lead Acceptable
   B Plastic lead Good
   C Ink Excellent

XX Nonreproducible lead-A lead that will not reproduce by standard reproduction machines. It is used for layout work, only

(NOTE This lead can be obtained for a wood cased drawing pencil, or for a 0.5 mm thin lead mechanical pencil.)
Standard Triangles

- 30° 90° 60°
- 45° 90° 45°
Three Types of Compasses

Beam
Connector
Pen
Point
Pencil
Extension Beam
Beam Compass

Compass, Lengthening Bar, Pen Attachment
Friction Compass

Divider or Compass
Pen
Bow Compass

Jet Bow Compass

Ratchet Bow Compass

Speed Bow Compass

Drop Spring Bow Compass
Three Types of Dividers

1. Friction Dividers

2. Bow Dividers

3. Proportional Dividers
Types of Drafting Pencils

**DRAWING PENCIL**

- Sharp Conical Point
- Grade Mark

*For General Linework and Lettering*  
*Do not sharpen this end!*

**MECHANICAL PENCIL**

- Drafting Pencil Leads
- Available in all grades

*Thin - Lead Mechanical pencil*

*Thin Leads Require no Sharpening*
Tools Used To Erase And/Or Clean A Drawing Surface

1. ERASERS
2. ERASING SHIELD
3. CLEANING PAD
4. DUSTING BRUSH
5. ELECTRIC ERASER
Visible Lines and Hidden Lines

Width and Character of Lines

Visible Line
Approximate Width 0.030 - 0.038
(0.75 - 0.96 mm)

Hidden Line
Approximate Width 0.015 - 0.022
(0.38 - 0.55 mm)
Section Lines and Center Lines

LINES

WIDTH AND CHARACTER

APPLY LINES

APPLICATIONS

THIN

SECTION LINE

APPROXIMATE WIDTH .015-.022
(0.38 - 0.55 mm)

CENTER LINE

APPROXIMATE WIDTH .015-.022
(0.38 - 0.55 mm)

3/4 to 1 1/2 .75-1.50
(19-38 mm)

1/8 .12 (3.2 mm)

1/16 .06 (1.6 mm)
Extension, Dimension, and Leader Lines

Approximate width .015 - .022
(0.38 - 0.55 mm)

Leader line
Thin approximately .010
Wide

Dimension line
(Soulder optional
Approximately 1/4" long)

Extension line
Cutting Plane Lines and Short-Break Lines

WIDTH AND CHARACTER
OF LINES

APPLIED TO

VIEWING PLANE OR
CUTTING PLANE LINES

1/16 .06 (1.6 mm)

3/4 to 1 1/2

0.75 - 1.50
(19 - 38 mm)

APPROXIMATE WIDTH .030-.038
(0.75 - 0.96 mm)

1/16 .06 (1.6 mm)

1/4 25 (6.4 mm)

SHORT BREAK LINE

THICK

FREEHAND

APPROXIMATE WIDTH .030-.038
(0.75 - 0.96 mm)
Long-Break Lines and Phantom Lines

LONG BREAK LINE
THIN
APPROXIMATE WIDTH .015-.022
(0.38 - 0.55 mm)

Phantom Line
Thin 1/16
Approximate Width .010
Line Applications

VIEWING PLANE LINE
EXTENSION LINE
DIMENSION LINE
CENTER LINE
HIDDEN LINE
B
B
BREAK LINE
CUTTING PLANE LINE
VISIBLE LINE
CENTER LINE (PATH OF MOTION)
LEADER
PHANTOM LINE
SECTION LINE
SECT A-B
VIEW B-B
Pencil Lead Grades

<table>
<thead>
<tr>
<th>Hard</th>
<th>Medium</th>
<th>Soft</th>
</tr>
</thead>
<tbody>
<tr>
<td>9H 8H 7H 6H 5H 4H</td>
<td>3H 2H H F HB B</td>
<td>2B 3B 4B 5B 6B 7B</td>
</tr>
</tbody>
</table>
BASIC TOOLS AND LINES
UNIT III

ASSIGNMENT SHEET #1--DRAW LINES ON A DRAWING MEDIUM USING GRAPHITE AND PLASTIC LEAD

Directions: Make three drawings

1. Make two drawings on a sheet of vellum, one with plastic lead and one with graphite lead (size to be determined by the instructor).

2. Make one drawing on a sheet of polyester film (size to be determined by the instructor).

3. Include the complete alphabet of lines.

4. Show variations in line width.

5. Reproduce on the print machine.
ASSIGNMENT SHEET #2 - SHARPEN A COMPASS LEAD OR MECHANICAL LEAD-HOLDER LEAD WITH A CONICAL OR A WEDGE POINT

1. Procedure

(NOTE: A properly sharpened lead, both lead holder and compass, is extremely important because a dull lead produces fuzzy, rough lines. Only a sharp lead can produce the clean, sharp, dark lines needed for proper reproduction.)

A. Sharpen a mechanical lead holder in a lead pointer (Figure 1)

1. Extend the lead approximately 1/2” out of the mechanical lead holder and insert it into the opening in the top of the lead pointer (Figure 1)

2. Rotate the lead holder in the pointer until it is sharpened into a clean, sharp point

3. Check the point by drawing a clean, sharp line on paper

(NOTE: If the point produces a fuzzy, rough line, sharpen it again.)
ASSIGNMENT SHEET #2

B. Sharpen a compass point

1. Extend the lead approximately 1/2" out of the compass and place it at a 30° angle on the sandpaper pad (Figure 2)

2. Move the compass lead back and forth over the sandpaper until it forms a smooth, wedge shaped point on a long cut (Figure 2)

3. Turn the compass lead to each side at a 30° angle on the sandpaper and make smooth side-cuts slightly shorter than the long cut on the wedge (Figure 2)

4. Check the point by drawing a clean, sharp line on paper

(NOTE: If the point produces a fuzzy, rough line, sharpen it again)

FIGURE 2

II. Problems

A. Directions: Sharpen a mechanical lead-holder lead. Follow the procedures outlined on this assignment sheet.

B. Directions: Sharpen a compass point. Follow the procedures outlined on this page.
ASSIGNMENT SHEET #3 - DIVIDE A CIRCLE INTO 24 PARTS OF 15° BY USING THE 30°/60° AND 45° TRIANGLE

I. Procedure

A. Use the established center point and center lines as a reference point from which two standard triangles can be used to find the first 15° angle (Figure 1)

B. Use one triangle to find the 30° angle next to the first 15° angle

C. Use one triangle to find the 45° angle next to the first 30° angle

D. Use one triangle to find the 60° angle next to the first 45° angle

E. Use two triangles to find the 75° angle next to the 60° angle

F. Use one triangle to find the 90° angle next to the first 75° angle

G. Continue with triangles and a parallel bar until the circle has been divided into 24 parts and each angle has been correctly labeled

FIGURE 1
II. Problem

Directions: Divide a circle into 24 parts of 15° using only standard triangles and a parallel bar following the procedure demonstrated in Figure 1.
ASSIGNMENT SHEET #4--USE A COMPASS TO DRAW CIRCLES AND ARCS

I. Procedure

(NOTE: A compass is used to draw circles or arcs that are too large or different in size from a circle template.)

A. Set the radius to be used (Figure 1-a)

(CAUTION: Do not place the compass directly on the scale because this practice could eventually damage the scale.)

B. After radius is determined, start the circle by holding the compass handle between the thumb and forefinger (Figure 1-b)

C. Set compass point at center, then use one hand to adjust the compass to the determined radius (Figure 1-c)

D. Complete the circle by rotating the compass in a clockwise direction

E. Use the scale to check accuracy of the diameter before darkening lines

FIGURE 1
II. Problems

A. Directions. Use "A" size drawing vellum with standard border and title block and divide the working space into two equal parts. Construct a 3 1/2" square centered on the left side of the working space and construct a figure like the one shown in Figure 2 in that space. Draw 1 3/4" radius arcs at A, B, C, and D, and construct small arcs so that they intersect as shown in Figure 2. Complete the problem by adding center lines.

(NOTE. Omit radius lines A, B, C, and D from finished drawing.)

B. Directions: Construct a 3 1/2" square centered on the right side of the vellum used for Problem A and construct a figure like the one shown in Figure 3 in that space. Construct a 3" circle from center point, and then construct four 1 3/4" radius arcs using corners of squares as center points. Draw an inner circle so that it intersects as shown in Figure 3, and complete the problem by adding center lines.

(NOTE. Omit radius lines A, B, C, and D from finished drawings.)
I. Procedure

(NOTE: A divider is used to transfer a dimension from one point to another or to subdivide a line into a given number of equal parts.)

A. Divide a line into a given number of equal parts

B. Set one point of the divider at one end of the line and use one hand to adjust the divider to approximately 1/3 the distance of the line (Figure 1-a)

(NOTE: Distance will change depending upon number of divisions.)

C. Swing the divider clockwise to the second point on the line (Figure 1-b)

D. Swing the divider counterclockwise to the third point on the line (Figure 1-c)

(NOTE: If spacing is too short or long, lengthen or shorten the divider spacing slightly and try again; this is a trial and error method, but a useful method to practice.)

FIGURE 1
Problem

Directions: Use "A" size vellum with standard border and title block and construct a 4" square in the center of the working space. Using Figure 2 as an example, divide lines A-D and B-C into seven equal parts locating the corners of the squares. Construct the squares and complete the figure by adding center lines.

FIGURE 2
BASIC TOOLS AND LINES
UNIT III

ASSIGNMENT SHEET #6-MEASURE ANGLES WITH A PROTRACTOR

I. Procedure

A. Place the base line or 180° line of the protractor along one leg of angle to be measured with vertex of angle at marked center point of protractor (Figure 1).

B. Starting at zero, read up the side of the protractor right or left depending on the angle being measured.

---

FIGURE 1

---
II. Problem

Directions: Measure and record the angles shown in the blanks provided.
ASSIGNMENT SHEET #7--USE AN IRREGULAR CURVE TO CONSTRUCT A CURVED LINE

I. Procedure

(NOTE: The irregular curve is used to construct noncircular arcs.)

A. Move the curve around to connect three or more given points

B. Connect these points

C. Move curve to new position using at least two points previously given

D. Extend line to join new points (Figure 1)

FIGURE 1
II. Problem

Directions: Complete the following figure using irregular curve.

FIGURE 2
BASIC TOOLS AND LINES
UNIT III

NAME

TEST

1. Match the terms on the right with their correct definitions.

   a. A metal plate with various slots and openings used to protect linework when a portion of the drawing is to be erased

   b. An instrument used to measure the length of a line

   c. A covering used to protect drawings and equipment when not in use

   d. An instrument used to lay out guidelines for lettering

   e. A sharpening device for mechanical pencil leads

   f. An instrument used to measure angles

   g. An instrument used to transfer dimensions

   h. An instrument used to draw circles and arcs

   i. An instrument consisting of a thin, flat right-angled piece of plastic or metal with acute angles of 45° or 30° and 60°

   j. A metal holder in which leads of various hardness can be inserted

   k. An instrument used to lay out any non-circular curve

   l. A thin, flat, plastic tool with various size openings of different shapes used to expedite the drawing of standard features

   m. A tool used to brush loose graphite and eraser dust from a drawing

   n. A loosely woven bag of ground art gum eraser used to remove loose graphite from a drawing

   1. Triangle

   2. Lettering guide

   3. Compass

   4. Divider

   5. Dusting brush

   6. Erasing shield

   7. Lead pointer

   8. Mechanical lead holder

   9. Scale

   10. Dust cover

   11. Irregular curve

   12. Protractor

   13. Template

   14. Cleaning pad

   15. Lead cleaner

   16. Eraser

   17. Lead

   18. Plastic lead

   19. Ink

   20. Drafting tape
o. A device used to remove pencil lines and graphite smudges from a drawing

p. A styrofoam pad or tissue paper used to remove loose graphite from a pencil lead after it has been sharpened

q. A specially prepared tape that does not harm surface of table or drawing media

r. Composed mainly of carbon in colloidal suspension and gum. The fine particles of carbon give the deep, dark, black, appearance to the ink, and the gum makes it quick to dry and waterproof

s. Made of graphite with kaoline added in varying amounts in order to make the eighteen grades from the hardest (9H) to the softest (7B)

t. Composed of varying amounts of graphite with plastic

2. Identify the angles found on the two standard triangles.
3. State the purpose for using a standard triangle.

4. List three types of compasses.
   a. 
   b. 
   c. 

5. Identify the three types of dividers.
   a. 
   b. 
   c. 

6. List four types of irregular curves.
   a. 
   b. 
   c. 
   d. 

7. List five types of common templates.
   a. 
   b. 
   c. 
   d. 
   e. 

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8. Identify tools used to erase and/or clean a drawing surface.

a. ___________

b. ___________

c. ___________

d. ___________

e. ___________

9. Select true statements concerning rules for maintenance and care of drafting tools and equipment by placing an "X" in the appropriate blanks.

_____ a. Do not bend templates sharply

_____ b. Template and scales can be used as a straight edge for cutting

_____ c. Keep all instruments clean and dry

_____ d. A circle template can be used as an eraser shield

_____ e. Do not hit scales and triangles on edges

_____ f. Compasses and dividers cannot be over extended

_____ g. Clean plastic tools with soap and water only
14. Name the 18 types of leads from hard to soft.
   a. ______ g. ______ m. ______
   b. ______ h. ______ n. ______
   c. ______ i. ______ o. ______
   d. ______ j. ______ p. ______
   e. ______ k. ______ q. ______
   f. ______ l. ______ r. ______

15. Match the general classes of leads on the right with their uses.

   a. The softer of these are used for technical sketching, arrowheads, and any freehand work on drawings
   b. Wherever extreme accuracy is required
   c. Construction lines
   d. Fine art drawing
   e. Architectural rendering
   f. General purpose work
   g. Lettering, (exclusively)
   h. Production illustration
   i. Line work on drawings
   j. Guidelines for lettering

   1. Hard leads
   2. Medium leads
   3. Soft leads
16. Distinguish between the disadvantages of hard and soft leads by placing an "H" next to the disadvantages of hard leads and an "S" next to the disadvantages of soft leads.

______ a. Will result in smudged, rough lines
______ b. Use is restricted, apt to be too light
______ c. Difficult to erase
______ d. Must be continually sharpened

17. Select line widths for linework by placing in the appropriate blanks a "TK" for thick and a "TN" for thin.

______ a. Visible
______ b. Hidden
______ c. Dimension
______ d. Long break
______ e. Leader
______ f. Section
______ g. Short-break
______ h. Extension
______ i. Phantom or adjacent-part
______ j. Stitch
______ k. Center
______ l. Viewing plane or cutting plane
______ m. Chain line
______ n. Border line

18. Distinguish between the advantages and disadvantages of ink, lead, and plastic lead by placing an "I" next to the advantages of ink, an "L" next to the advantages of lead, and a "P" next to advantages of plastic lead.

______ a. Quick and easy
______ b. Can only be used on polyester film
______ c. Extremely brittle
______ d. Does not smudge
______ e. Hard to clean up
______ f. Does not smudge as easily as lead
______ g. Leaves fuzzy lines after reproduction
______ h. Lines are completely readable through microfilm reduction and blowback
______ i. Does not smudge
______ j. Hard to clean up
______ k. Messy
______ l. Reproduces a clean, dense line
______ m. Point dulling and breaking
n. Revisions of original drawings can be made easily with no "ghost" or damage to drawing surface

o. Time consuming maintenance of pens

19. Match the reproduction on the right with their correct medium.

   a. Lead 1. Acceptable
   b. Plastic lead 2. Good
   c. Ink 3. Excellent

20. Describe nonreproducible lead:

21. Draw lines on a drawing medium using lead and plastic lead.

22. Sharpen a compass lead or mechanical lead-holder lead with a conical point and a wedge point.

23. Divide a circle into 24 parts of 15 by using the 30°/60° and 45° triangle.

24. Use a compass to draw circles and arcs.

25. Use a divider.

26. Measure angles with a protractor.

27. Use an irregular curve to construct a curved line.

(Note: If the activities in item 21-27 have not been completed prior to the test, ask your instructor when they should be completed.)
BASIC TOOLS AND LINES
UNIT III

ANSWERS TO TEST

1. a. 6  e. 7  i. 1  m. 5  q. 20
   b. 9  f. 12  j. 8  n. 14  r. 19
   c. 10  g. 4  k. 11  o. 16  s. 17
   d. 2  h. 3  l. 13  p. 15  t. 18

2. a. 90°
   b. 30°
   c. 60°
   d. 45°

3. To provide a straight edge for drawing vertical or inclined lines at any angle that is a multiple of 15 degrees.

4. a. Friction
   b. Bow
   c. Beam

5. a. Friction
   b. Bow
   c. Proportional

6. a. Ships curve
   b. Flexible curve
   c. Rule curve
   d. French curve

7. Any five of the following:
   a. Circle template
   b. Ellipse template
   c. Architectural template
   d. Isometric ellipse template
   e. Piping template
   f. Structural steel shape template
   g. Hex bolt head template
   h. Thread template
   i. Plumbing template
   j. Civil template

8. a. Eraser shield
   b. Cleaning pad
   c. Dusting brush
   d. Eraser
   e. Electric eraser

9. a, c, e, g

10. a. Wood-cased drawing pencil
     b. Mechanical pencil
     c. Thin-lead mechanical pencil
11.  
a. .03 mm  
b. .05 mm  
c. .07 mm  
d. .09 mm  

12.  
a. 1  
b. 1  
c. 2  
d. 3  
e. 3  

13.  
a. Leader line  
b. Hidden line  
c. Section line  
d. Cutting plane line  
e. Short-break line  
f. Long-break line  
g. Visible line  
h. Extension line  
i. Phantom line  
j. Center line  
k. Stitch line  
l. Dimension line  
m. Border line  
n. Chain line  

14.  
a. 9H  
b. 8H  
c. 7H  
d. 6H  
e. 5H  
f. 4H  
g. 3H  
h. 2H  
i. H  
j. F  
k. HB  
l. B  
m. 2B  
n. 3B  
o. 4B  
p. 5B  
q. 6B  
r. 7B  

15.  
a. 2  
b. 1  
c. 1  
d. 3  
e. 3  
f. 2  
g. 3  
h. 3  
i. 2  
j. 1  

16.  
a. S  
b. H  
c. S  
d. S  

17.  
a. TK  
b. TN  
c. TN  
d. TN  
e. TN  
f. TN  
g. TK  
h. TN  
i. TN  
j. TN  
k. TN  
l. TK  
m. TK  
n. TK
20. A lead that will not reproduce by standard reproduction machines. It is used for layout work, only.

21. Evaluated to the satisfaction of the instructor

22. Evaluated to the satisfaction of the instructor

23. Evaluated to the satisfaction of the instructor

24. Evaluated to the satisfaction of the instructor

25. Evaluated to the satisfaction of the instructor

26. Evaluated to the satisfaction of the instructor

27. Evaluated to the satisfaction of the instructor
MAJOR EQUIPMENT
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to operate a parallel bar, adjustable triangle and an electric eraser. The student should also be able to make adjustments to an elbow drafting machine and a V-track drafting machine. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to major equipment with the correct definitions.
2. Identify parts of a parallel bar.
3. List three advantages of a parallel bar.
4. Describe the operation of a parallel bar.
5. Describe the use of an adjustable triangle.
6. Identify the parts of an elbow drafting machine.
7. List four advantages of an elbow drafting machine.
8. Describe the operation of an elbow drafting machine.
9. Identify the parts of a V-track drafting machine.
10. List four advantages of a V-track drafting machine.
11. Describe the operation of a V-track drafting machine.
12. Select rules to remember in the maintenance and care of drafting machines.
13. List four rules related to the use and maintenance of an electric erasing machine.
14. List two factors that determine the type of electric eraser refill to use.
15. Select types of electric refills and their uses.
16. Operate a parallel bar.
17. Operate an adjustable triangle.
18. Measure angles with the protractor and vernier scale on a drafting machine.

19. Demonstrate the ability to:
   a. Make adjustments to a V-track drafting machine to install and align scales.
   b. Make adjustments to an elbow drafting machine to install and align scales.
MAJOR EQUIPMENT
UNIT IV

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.
II. Provide student with information, assignment, and job sheets.
III. Make transparencies.
IV. Discuss unit and specific objectives.
V. Discuss information, assignment, and job sheets.
VI. Demonstrate and discuss the procedures outlined in the assignment sheets.
VII. Demonstrate and discuss the procedures outlined in the job sheets.
VIII. Have students perform activities on job sheets before assignments sheets are started.
IX. Demonstrate the set-up and accuracy of a parallel bar.
X. Discuss the advantages and disadvantages of an electric erasing machine.
XI. Have vendors give demonstrations on new products.
XII. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit
   A. Objective sheet
   B. Information sheet
   C. Transparency masters
      1. TM 1-Parts of a Parallel Bar
      2. TM 2-Adjustable Triangle
      3. TM 3-Parts of an Elbow Drafting Machine
      4. TM 4-Parts of a Standard Protractor Head
      5. TM 5-Parts of a V-Track Drafting Machine
D. Assignment sheets

1. Assignment Sheet #1--Operate a Parallel Bar
2. Assignment Sheet #2--Operate an Adjustable Triangle
3. Assignment Sheet #3--Measure Angles with the Protractor and Vernier Scale on a Drafting Machine

E. Answers to assignments sheets

F. Job Sheets

1. Job Sheet #1--Make Adjustments to a V-Track Drafting Machine to Install and Align Scales
2. Job Sheet #2--Make Adjustments to an Elbow Drafting Machine to Install and Align Scales

G. Test

H. Answers to test

References:


I. Terms and definitions
   A. Horizontal--Parallel to the plane of the horizon
   B. Vertical--A line straight up and down, perpendicular to the horizontal plane
   C. Drawing media--Any type of drawing material upon which an object is graphically represented
   D. Working surface--Any surface such as a drafting board or desk used to secure drawing media
   E. Perpendicular--At a 90° angle to a given plane or line
   F. Parallel--Two lines or surfaces side by side, equal distances apart at all points
   G. Working edge--An edge used as a point of reference, such as the edge of a drawing board or T-square
   H. Ellipse--A foreshortened circle with a major and minor diameter
   I. Vernier--A measuring device consisting of a main fixed scale and a smaller graduated scale that slides to obtain fine measurements

II. Parts of a parallel bar (Transparency 1)
   A. Cable
   B. Bar
   C. Cable clamp
   D. Cable pulleys
   E. Tension bracket

III. Advantages of a parallel bar
   A. Easy to make long-horizontal lines
   B. More accurate than a T-square
   C. Very little maintenance
   D. Simple to operate
IV. Operation of a parallel bar—A parallel bar is a long flat bar similar to a T-square that has a hollow area in its middle through which cables pass. These cables work through a series of pulleys, and the ends are attached to a tension bracket. The cables allow the bar to move in a parallel motion up and down the working surface (Transparency 1)

V. Use of an adjustable triangle—An adjustable triangle is used in combination with a T-square or parallel bar to lay out lines that are not at the standard 15° increment (Transparency 2)

VI. Parts of an elbow drafting machine (Transparencies 3 and 4)

A. Clamp
B. Upper arm
C. Lower arm
D. Elbow brake
E. Standard protractor head (Transparency 4)
F. Vertical scale
G. Horizontal scale
H. Protractor
I. Handle
J. Base line wing nut
K. Index thumbpiece
L. Protractor brake wing nut
M. Chuck plate
N. Vernier plate
O. Scale chuck
P. Adjusting screw

VII. Advantages of an elbow drafting machine

A. Increases drafting output
B. Requires fewer tools to operate
C. Less expensive than parallel track machine
D. Can be aligned to any base line
E. More accurate than separate protractor instrument
F. Can be operated from any side of the drawing desk

VIII. Operation of an elbow drafting machine—An elbow drafting machine has a protractor head which can be adjusted to any angle measurement accurate to the nearest 5 minutes of a degree. The protractor head moves in any direction on the working surface. The head is mounted at the end of two arms hinged in the middle with an elbow swivel joint. This allows the drafter to make parallel lines at any angle.

IX. Parts of a V-track drafting machine (Transparencies 4 and 5)
A. Mounting clamp
B. Horizontal track
C. Vertical track
D. Standard protractor head (Transparency 4)
E. Vertical scale
F. Horizontal scale
G. Vertical motion brake
H. Horizontal motion brake
I. Protractor head pivot point

X. Advantages of a V-track drafting machine
A. Simple to operate
B. Versatile
C. Accuracy is better maintained
D. All areas of drawing board accessible
E. Few working parts

XI. Operation of a V-track drafting machine—the V-track machine has a protractor head which can be adjusted to any angle measurement accurate to the nearest 5 minutes of a degree; this protractor head moves on a vertical track which in turn moves on a horizontal track. This allows the drafter to make parallel lines in any direction.
INFORMATION SHEET

XII. Rules to remember in maintenance and care of drafting machines

A. Keep support clamps secured snugly to desk
B. Keep scales aligned and tight
   (CAUTION: Do not overtighten.)
C. Keep scales clean
D. Keep scales flat on working surface; do not lift machine by scales
E. Keep band tension adjusted properly
F. Protractor head should adjust easily
   (CAUTION: Do not force. Check protractor brake wing nut.)
G. Tighten baseline and protractor wing nuts snugly but not too tight
   (CAUTION: Do not force.)
H. Lift machine by handle to move from position to position
I. Make sure scales are never used to cut or tear paper
J. Never use scales as straight edges for cutting with a knife
K. Never store drafting machine with scales protruding over the edge of the drafting table

XIII. Rules for the use and maintenance of an electric erasing machine

A. Select correct eraser refill for media being used
B. Keep eraser moving to prevent burning a hole in drawing media and drafting surface
C. Use erasing shield to isolate area being erased
D. Be careful when plugging and unplugging eraser from an electric receptacle
E. Prevent eraser crumbs and foreign material from falling inside working mechanism
F. Hang eraser on hook or place in tray when not in use

XIV. Factors that determine type of electric eraser refill to use

A. Type of drawing
B. Type of drawing media
XV. Types of electric eraser refills and their uses

A. Dark grey—Used to erase ink
B. White—Used to erase pencil lead
C. Pink—Used to erase pencil lead
D. Green soft—Used to erase pencil lead
E. Pink soft—Used to erase pencil lead
F. Standard red—Used to erase pencil lead
G. Nu-Red—Used to erase pencil lead and used with plastic film
H. Vinyl—Used with plastic film
Parts of a Parallel Bar

- Cable
- Cable Clamp
- Cable Pulleys
- Tension Bracket
- Bar
Adjustable Triangle

NOTE: In Closed Position
Triangle forms Standard 45° Triangle
Parts of an Elbow Drafting Machine

- Upper Arm
- Elbow Brake
- Vertical Scale
- Lower Arm
- Standard Protractor Head (Transparency 4)
- Clamp
- Horizontal Scale
Parts of a Standard Protractor Head

- Adjusting Screw
- Scale Chuck
- Chuck Plate
- Vernier Plate
- Baseplate
- Protractor Brake Wing Nut
- Index Thumbpiece
- Protractor
- Wing Nut
- Base Line
- Handle
Parts of a V-Track Drafting Machine

- Vertical Track
- Vertical Motion Brake
- Horizontal Motion Brake
- Vertical Scale
- Horizontal Track
- Mounting Clamp
- Horizontal Scale
- Protractor Head
- Pivot Point
- Standard Protractor Head (Transparency 4)
MAJOR EQUIPMENT
UNIT IV

ASSIGNMENT SHEET #1--OPERATE A PARALLEL BAR

I. Procedure
   A. Loosen cable clamp as required (Figure 1)
   B. Move parallel bar to bottom limit of drawing surface
   C. Both ends of parallel bar should be in contact with tension brackets
   D. Place drawing media on working surface so that top edge of parallel bar does not catch bottom edge of drawing media
   E. Move top edge of parallel bar up and align with top edge of drawing media (Figure 2)
   F. Hold drawing media in position and tape corners to working surface
   G. Tighten cable clamp adjustment as required
   H. Move parallel bar up and down on the working surface by holding the middle of the parallel bar and lifting slightly

FIGURE 1

FIGURE 2
ASSIGNMENT SHEET #1

I. Place triangles on top edge of parallel bar (Figure 3)

FIGURE 3

J. Check working edge of bar frequently to make sure it is maintaining proper alignment with horizontal lines of drawing

K. Use pencil to draw horizontal lines (Figure 4)

L. Use pencil and triangle to draw vertical lines (Figure 5)

M. Practice slanting the pencil in the direction of travel and rotating pencil in right hand when drawing a line
II. Problems

A. Operate a parallel bar and triangles to construct the following figure.

Directions—Use "B" (11 x 17) size drawing vellum with standard border and title block. Divide the working space into two equal areas. Center in the left hand area, construct the following figure using proper techniques.

Line B-C is divided into 9 equal parts.
Line A-B is divided into 6 equal parts.

(Note: Work at keeping all object lines the same width and darkness.)
ASSIGNMENT SHEET #1

B. Operate a parallel bar and a triangle to construct the following figure.

Directions: Use the right hand area of problem "A" drawing vellum. Construct the following grid pattern using proper techniques.

(NOTE: Accuracy is a "must" for a draftsman, start now working on accuracy of spacing and keeping all corners clean and sharp.)
C. Operate a parallel bar and triangles to construct the following figure.

Directions-Use "A" size drawing vellum with standard border and title block. Construct the following figure using proper techniques. Omit all dimensions.

(NOTE: Drawing should be centered in working space by finding center of working space by crossed diagonals.)

D. Operate a parallel bar and triangles to construct the following figure.

Directions-Use "A" size drawing vellum with standard border and title block. Construct the following figure using proper techniques. Omit all dimensions.

(NOTE: Drawing should be centered in working space by finding center of working space by crossed diagonals.)
MAJOR EQUIPMENT
UNIT IV

ASSIGNMENT SHEET #2—OPERATE AN ADJUSTABLE TRIANGLE

I. Procedure

A. Set required angle on triangle by loosening adjusting knob and setting the scale (Figure 1)

B. Read numbers on lower half of scale, if required angle is greater than 45, the angle will be the actual angle made by the triangle

C. Read numbers on upper half of scale, if required angle is less than 45, the angle will be complementary to the triangle

FIGURE 1

Adjusting Knob

Reading is at 39°

Parallel Bar Blade

Note: In Closed Position
Triangle forms Standard 45° Triangle
D. Adjustable triangle can be adjusted so that the long side can serve as the base line. This changes the direction the individual lines will run (Figure 2).

(NOTE: Using long side as base allows you to construct perpendicular lines merely by sliding the triangle.)

E. Practice setting various angles and rotating triangle to get various line angles.

F. Construct parallel lines by drawing along one edge of the triangle (Figure 3).
ASSIGNMENT SHEET #2

G. Slide the triangle along working edge to new position and construct the new line (Figure 3)

FIGURE 3

Parallel Bar
ASSIGNMENT SHEET #2

II. Problem

Directions--Complete the figures below using a parallel bar and adjustable triangle.

Draw lines parallel to given line through given points

Line A-B is a ______ angle to the horizontal

Draw lines perpendicular to given line through given points

Line C-D is a ______ angle to the vertical
MAJOR EQUIPMENT
UNIT IV

ASSIGNMENT SHEET #3- MEASURE ANGLES WITH THE PROTRACTOR AND VERNIER SCALE ON A DRAFTING MACHINE

I. Procedure

A. Operation of the standard protractor head

(NOTE: The standard protractor head is divided into one degree units with a side mounted vernier scale divided into five minute readings. The protractor has 4 quarters of 90° each.)

1. Push indexing thumbpiece in and rotate head

(NOTE: Protractor will automatically lock every 15 degrees.)

2. Push indexing thumbpiece in and down

(NOTE: This procedure will lock the indexer in the open position and free the protractor head to completely rotate.)

(CAUTION: NEVER FORCE the head if it does not rotate freely; check protractor brake wing nut.)

B. Measuring angles

(NOTE: The standard protractor head is designed to read an angle to the nearest 5 minutes of a degree. Remember, there are 360° in a circle and 69 minutes in one degree.)

1. Locate the "0" on the protractor and the "0" on the vernier scale

2. Push thumb index in

3. Slide the "0" on the vernier up or down the protractor until it lines up with the degree mark needed on the protractor (Figure 1-a)

Example:

1. Assume the vernier is set at a positive (upward) angle

2. Note the reading is between 7 and 8 degrees
ASSIGNMENT SHEET #3

3. Find the 5 minute mark on the upper half of the vernier which is most closely in alignment with a degree mark

(NOTE: The correct reading is 74'0'. The procedure is the same when reading negative (downward); in this case the reading is 425'. Refer to Figure 1-b.)

C. Setting angles

1. Release the protractor brake wing nut

2. Push the index thumbpiece in and down to release the index

3. Rotate the protractor arm until the zero of the vernier is at the desired degree

4. Rotate (slowly) the protractor arm counter-clockwise until the desired minute mark on the upper half of the vernier is precisely aligned with the nearest degree mark on the protractor

5. Lock the protractor brake wing nut

(NOTE: The procedure for setting negative angles is essentially the same except the protractor head is rotated clockwise.)
ASSIGNMENT SHEET #3

II. Problem

Directions—Use "A" size drawing vellum with standard border and title block. Construct the following figure using STD protractor head with vernier scale to lay out all angles. Start at point A. Label all corners, show dimensions in table form. Measure and label closing angle (B, A, G,) and find the length of G, A to the nearest 32nd. All angles should be calculated using the deflection method illustrated in Figure 2 of the example before starting the drawing.

Example: Deflection method

1. Extend line AB beyond object giving 180° line
2. Subtract known 135° from 180° line
3. Set base line scale on 180° line
4. Set protractor head at 45°
5. Construct line B-C

FIGURE 2
A, B = 2"
B, C = 2 11/32"
C, D = 1 3/4"
D, E = 2"
E, F = 1 17/32"
F, G = 1 3/4"
G, A = ____________________  
B, A, G = ____________________

(NOTE: Required angles to draw figure have to be calculated. Use deflection method.)
Assignment Sheet #1
Evaluated to the satisfaction of the instructor.

Assignment Sheet #2
Line A-B = 25° angle
Line C-D = 48° angle

Assignment Sheet #3
G;A = 3 5/16
BAG = 84° 30'
MAJOR EQUIPMENT
UNIT IV

JOB SHEET #1--MAKE ADJUSTMENTS TO A V-TRACK DRAFTING MACHINE TO INSTALL AND ALIGN SCALES

I. Tools and equipment
   A. V-track drafting machine
   B. Drawing surface
   C. Horizontal machine scale
   D. Vertical machine scale
   E. Scale wrench
   F. Hex wrench
   G. Pencil
   H. Drawing media

II. Procedure
   A. Insert scales
      1. Tighten flathead chuck plate screws on both vertical and horizontal scales
         (CAUTION: Do not overtighten plastic scales!!)
      2. Place scales flat on working surface in line with scale chucks on protractor and firmly press, do not drive, the chuck plate on the scale into the chuck
         (CAUTION: Do not bend scales as you apply pressure.)
JOB SHEET #1

B. Remove scales - Release scales by means of a scale wrench

(NOTE: With the pin side of the wrench downward, slip the wrench over the panhead screw and turn clockwise, pressing the curved part of wrench against end of scale chuck. Figure 1)

C. Align scales

1. Install scales
   a. Tighten flathead screws on each chuck plate
   b. Insert scales in base plate, and press them firmly into place
   c. Loosen the panhead screw on horizontal scale, and set scale near the center of its angular range of adjustment
   d. Tighten panhead screw on horizontal scale

2. Align horizontal scale
   a. Draw a reference line parallel to the horizontal track by:
      1) Locking the vertical brake and releasing the horizontal brake
      2) Placing pencil point at zero on the horizontal scale and moving pencil and protractor head together laterally along the board

   (NOTE: Merely drawing the pencil along the scale will not assure a line parallel to the horizontal track.)
JOB SHEET #1

b. Release the base line wing nut and bring the horizontal scale parallel to the reference line (Figure 2)

![Base Line Wing Nut](image1)

![Chuck-Plate Lock-Screws](image2)

![Horizontal Scale](image3)

![Reference Line](image4)

![Chuck Plate](image5)

FIGURE 2

c. Tighten the base line wing nut

3. Align vertical scale
   a. Index the head 90 degrees clockwise (Figure 3)

![Reference Line](image6)

![Vertical Scale](image7)

b. Loosen panhead screw on vertical scale

c. Adjust vertical scale to the reference line
d. Tighten panhead screw on vertical scale

e. Index the head 90 degrees counter-clockwise so that horizontal scale is parallel with reference line

(NOTE: This setting is extremely important and should be checked periodically.)
JOB SHEET #2

C. Align scales

1. Install scales
   a. Tighten flathead screws on each chuck plate
   b. Insert scales in base plate and press them firmly into place

   (NOTE: See Procedure step A-2.)

2. Align horizontal scale
   a. Loosen the panhead screw on horizontal scale, and set scale near the center of its angular range of adjustment
   b. Tighten panhead screw on horizontal scale
   c. Loosen bottom line wing nut and set horizontal scale parallel to bottom of drawing surface
   d. Tighten bottom line wing nut
   e. Draw a light reference line the length of horizontal scale

3. Align vertical scale
   a. Index the head 90° clockwise
   b. Loosen the panhead screw on vertical scale and bring the vertical scale parallel to the reference line (Figure 2)

FIGURE 2

Reference Line

Vertical Scale
C. Align scales

1. Install scales
   a. Tighten flathead screws on each chuck plate
   b. Insert scales in base plate and press them firmly into place
      (NOTE: See Procedure step A-2.)

2. Align horizontal scale
   a. Loosen the panhead screw on horizontal scale, and set scale near the center of its angular range of adjustment
   b. Tighten panhead screw on horizontal scale
   c. Loosen base line wing nut and set horizontal scale parallel to bottom of drawing surface
   d. Tighten base line wing nut
   e. Draw a light reference line the length of horizontal scale

3. Align vertical scale
   a. Index the head 90° clockwise
   b. Loosen the panhead screw on vertical scale and bring the vertical scale parallel to the reference line (Figure 2)

FIGURE 2
MATCH THE TERMS ON THE RIGHT TO THE CORRECT DEFINITIONS

1. Match the terms on the right to the correct definitions:
   a. At a 90° angle to a given plane or line
   b. Any surface such as a drafting board or desk used to secure drawing media
   c. Two lines or surfaces side by side, equal distances apart at all points
   d. An edge used as a point of reference, such as the edge of a drawing board or T square
   e. Parallel to the plane of the horizon
   f. Any type of drawing material upon which an object is graphically represented
   g. A line straight up and down, perpendicular to the horizontal plane
   h. A measuring device consisting of a smaller main fixed scale and a smaller graduated scale that slides to obtain fine measurements
   i. A foreshortened circle with a major and minor diameter

2. Identify the parts of a parallel bar by placing the correct number to the left of its corresponding name:
   a. Bar
   b. Cable pulleys
   c. Cable clamp
   d. Tension bracket
   e. Cable
2. List the advantages of a parallel bar.

4. Describe the operation of a parallel bar.

5. Describe the use of an adjustable triangle.

6. Identify the parts of an elbow drafting machine by placing the correct number to the left of its corresponding name.

   a. Elbow brake
   b. Upper arm
   c. Clamp
   d. Horizontal scale
   e. Vertical scale
   f. Protractor
   g. Adjusting screw
   h. Scale chuck
   i. Vennier plate
   j. Chuck plate
   k. Protractor brake wing nut
   l. Index thumbpiece
   m. Base line wing nut
   n. Handle
   o. Standard protractor head
   p. Lower arm

   1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16.
7. List four advantages of an elbow drafting machine.

   a. ____________________________________________
   b. ____________________________________________
   c. ____________________________________________
   d. ____________________________________________

8. Describe the operation of an elbow drafting machine.

9. Identify the parts of a V-track drafting machine by placing the correct number to the left of its corresponding name.

   _____ a. Horizontal motion brake  _____ i. Vertical motion brake
   _____ b. Handle  _____ j. Chuck plate
   _____ c. Scale chuck  _____ k. Chuck plate
   _____ d. Mounting clamp  _____ l. Base line wing nut
   _____ e. Horizontal track  _____ m. Protractor brake wing nut
   _____ f. Vertical track  _____ n. Vernier plate
   _____ g. Standard protractor head  _____ o. Protractor
   _____ h. Vertical scale  _____ p. Index thumbpiece
   _____ i. Horizontal scale  _____ q. Baseplate
   _____ j. Protractor head pivot point  _____ s. Adjusting screw
10. List four advantages of a V-track drafting machine.
   a. 
   b. 
   c. 
   d. 

11. Describe how a V-track drafting machine operates.

12. Select rules to remember concerning maintenance and care of drafting machines by placing an "X" in the appropriate blanks.
   
   a. Keep scales aligned and tight  
   b. Scales can be used as straight edge for exacto knife  
   c. Scales do not need to be kept clean  
   d. Tighten baseline and protractor wing nuts snugly but not too tight  
   e. Store drafting machine with scales over the edge of the drafting table out of the way  
   f. Lift and move drafting machine by the scales  
   g. Protractor heads are hard to adjust, force if necessary  
   h. Keep band tension adjusted properly  
   i. Keep support clamps loose when not in use 

13. List four rules related to the use and maintenance of an electric erasing machine.
   a.  
   b.  
   c.  
   d.  

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14. List two factors that determine the type of electric eraser refill to use.
   a. ____________________________________________
   b. ____________________________________________

15. Select types of electric refills and their uses by placing an "X" in the blank by the refill used only to erase pencil marks.
   _____ a. Dark grey
   _____ b. White
   _____ c. Pink
   _____ d. Green soft
   _____ e. Pink soft
   _____ f. Standard red
   _____ g. Nu-Red
   _____ h. Vinyl

16. Operate a parallel bar.

17. Operate an adjustable triangle.

18. Measure angles with the protractor and vernier scale on a drafting machine.

19. Demonstrate the ability to:
   a. Make adjustments to a V-track drafting machine to install and align scales.
   b. Make adjustments to an elbow drafting machine to install and align scales.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)
MAJOR EQUIPMENT  
UNIT IV  

ANSWERS TO TEST

1. a. 5  
b. 4  
c. 6  
d. 7  
e. 1  
f. 3  
g. 2  
h. 9  
i. 8  

2. a. 5  
b. 3  
c. 2  
d. 4  

e. 1  

3. Any three of the following:
   a. Easy to make long horizontal lines  
b. More accurate than a T-square  
c. Very little maintenance  
d. Simple to operate

4. A parallel bar is a long flat bar similar to a T-square that has a hollow area in its middle through which cables pass. These cables work through a series of pulleys, and the ends are attached to a tension bracket. The cables allow the bar to move in a parallel motion up and down the working surface.

5. An adjustable triangle is used in combination with a T-square or parallel bar to lay out lines that are not at the standard 15° increment.

6. Parts of an elbow drafting machine
   a. 13  
b. 10  
c. 9  
d. 8  
e. 11  
f. 2  
g. 1  
h. 3  
i. 15

7. Any four of the following:
   a. Increases drafting output  
b. Requires fewer tools to operate  
c. Less expensive than parallel track machine  
d. Can be aligned to any base line  
e. More accurate than separate protractor instrument  
f. Can be operated from any side of the drawing desk
8. An elbow drafting machine has a protractor head which can be adjusted to any angle to make parallel lines at any angle. The protractor head moves in any direction of the working surface. The head is mounted on the end of two arms hinged in the middle with an elbow swivel joint. This allows the draftsman to make parallel lines at any angle.

9. a. 16
   b. 2
   c. 3
   d. 7
   e. 13
   f. 12
   g. 17
   h. 11
   i. 15
   j. 14
   k. 6
   l. 8
   m. 4
   n. 9
   o. 1
   p. 5
   q. 10
   r. 18

10. Any four of the following:
   a. Simple to operate
   b. Versatile
   c. Accuracy is better maintained
   d. Few working parts
   e. All areas of drawing board accessible

11. The V-track machine has a protractor head which can be adjusted to any angle to make parallel lines in any direction. The protractor head moves on a vertical track which in turn moves on a horizontal track to make parallel lines at any angle.

12. a, d, h

13. Any four of the following:
   a. Select correct eraser refill for media being used
   b. Keep eraser moving to prevent making a hole in the medium and drafting surface
   c. Use erasing shield to isolate area being erased
   d. Be careful when plugging and unplugging eraser from an electric receptacle
   e. Prevent eraser crumbs and foreign material from falling into working mechanism
   f. Hang eraser on hook or place in tray when not in use

14. a. Type of linework
    b. Type of drawing media

15. b, c, d, e, f

16. Evaluated to the satisfaction of the instructor

17. Evaluated to the satisfaction of the instructor

18. Evaluated to the satisfaction of the instructor
APPLYING FOR A JOB
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to locate a job opening, make a formal application, and effectively interview for a job. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with applying for a job with the correct definitions.
2. Select means of locating job openings.
3. List three methods of applying for a job.
4. Select personal attributes or attitudes an employer looks for during a personal interview.
5. Select six items which an applicant may need to prepare when applying for a job.
6. Select guidelines to follow when participating in a job interview.
7. Write a resume.
8. Write a letter of application for a drafting job.
9. Complete an employment application form for a job as a drafter.
10. Prepare a personal portfolio.
11. Practice interview questions.
12. Make an appointment by phone for a drafting job interview.
13. Write a follow-up letter or make a follow-up phone call after interviewing for a drafting job.
14. Evaluate a drafting job offer.
15. Compare job opportunities.
APPLYING FOR A JOB
UNIT V

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information and assignment sheets.

III. Make transparencies.

IV. Discuss unit and specific objectives.

V. Discuss information and assignment sheets.

VI. Invite an Industry personnel manager to discuss "What to look for on application letters, resumes, employment application forms, and follow-up devices" and "How do equal opportunity and affirmative action affect my hiring procedures?"

VII Obtain actual letters of application and resumes, both good and bad examples, and discuss each with students.

VIII. Use a panel of employers to talk about things they look for in a prospective employee.

IX. Use video tape to record student practice interviews.

(NOTE: Although not as effective, an audio tape recorder can also be used.)

X. Have students critique their taped interviews.

XI Give test

INSTRUCTIONAL MATERIALS

A. Objective sheet

B. Information sheet

C. Transparency masters
   1. TM 1--Attitudes
   2. TM 2--Appropriate Dress
   3. TM 3--Take Time to be on Time
Assignment sheets

1. Assignment Sheet #1 Write a Resume

2. Assignment Sheet #2 Write a Letter of Application for a Drafting Job

3. Assignment Sheet #3 Complete Employment Application for Job as a Drafter

4. Assignment Sheet #4 Prepare a Personal Portfolio

5. Assignment Sheet #5 Practice Interview Questions

6. Assignment Sheet #6 Make an Appointment by Phone for a Drafting Job Interview

7. Assignment Sheet #7 Write a Follow-up Letter and Make Phone Call after Interviewing for a Drafting Job

8. Assignment Sheet #8 Evaluate a Drafting Job Interview

9. Assignment Sheet #9 Compare Job Opportunities

Appendix

Answers to test

Useful references


5. How to Get the Job? Denver: General Press

6. Merlo, Margaret. How to Get the Best Job. Women's Education Curriculum Development

7. interviewing Women, Undergraduate Women's Commission, 1974

8. job Attitude as an asset, Austin: Extension, University of Texas, 1972


TERMS AND DEFINITIONS

A. Award - Recognition received for outstanding achievement

B. Extracurricular activities - Clubs, organizations, and social or church groups in which one participates

Examples: VICA, AIDD

C. Fringe benefits - Extras provided by an employer, such as paid vacations, sick leave, and insurance protection

D. Qualifications - Experience, education, and physical characteristics which suit a person to a job

E. Resume - Brief, typed summary of one's qualifications and experience that is used in applying for a job

F. Vocational preparation - Any vocational courses and skills one has learned in school or through work experience

G. Interview - Meeting of employer and job applicant for purpose of evaluation and questioning

H. Application form - Printed form on which job applicants record information about their personal history, job history, job experience, education, and references

I. Blind ad - Classified advertising that does not identify the advertiser

(NOTE: Applicant is asked to send a letter of application and resume to a post office box number or to call a certain number.)

J. Help wanted ad - Classified advertisement telling what kind of job is available and what the qualifications are

K. Employment/situation wanted ad - Classified advertisement placed by individuals seeking employment and telling what their qualifications are

L. Employment agency - Business that is designed to help individuals find employment

M. Portfolio - A grouping of samples of an individual's work

N. Legible - Capable of being read; clear
INFORMATION SHEET

0. Equal opportunity employer: "Employer who is making a special effort to assure that no form of discrimination is practiced.

Examples: Age, sex, race, creed

II. Means of locating job openings

A. Classified ads
   1. Newspapers
   2. Magazines

B. Employment offices
   1. State and federal labor offices
   2. Private

(NOTE: A fee is charged by most private agencies.)

C. Local labor union business office

D. School officials
   1. Teacher
   2. Counselor
   3. Principal
   4. Placement officer

E. Current workers in the drafting field

III. Methods of applying for a job

A. Letter
B. Telephone
C. In person

IV. Personal attributes or attitudes an employer looks for during a personal interview (Transparency 1)

A. Enthusiasm and interest

(NOTE: This includes taking pride in your work and being willing to do more than your share when needed.)
INFORMATION SHEET

B. Dedication and dependability
   (NOTE: This involves good work habits which include regular attendance and being on time. It also means you should readily follow directions.)

C. Alertness, quickness of mind
   (NOTE: You should always look for unsafe situations that could injure workers or damage property, and you should constantly look for more efficient working practices.)

D. Honesty and integrity
   (NOTE: Employees should give truthful information both to customers and to their employer.)

E. Desire to work

F. Ability to work with others

G. Desire to improve one's self
   (NOTE: Good employees always look for ways to increase their knowledge; this benefits both the employer and employee.)

V. Items which applicant may need to prepare when applying for a job (Assignment Sheets #1, #2, #3 and #6)

A. Resume
B. Letter of application
C. Application form
D. Aptitude test
E. Portfolio
F. Follow up letter

VI. Guidelines to follow when participating in a job interview (Transparencies 2 and 3)

A. Preparing for the interview
   1. Wear appropriate clothing and shoes
      (NOTE: Dress better for the interview than you would for a day on the job. This includes well coordinated clothing and avoid the wearing of sneakers, sandals, or hats.)
INFORMATION SHEET

2. Be well-groomed and neat

(NOTE: For a woman, this means neat hair and appropriate jewelry. For a man, neatly trimmed hair and beard, if he wears one.)

3. Take an ink pen, several copies of your resume, and all information concerning social security number, references, names and addresses, dates employed, and dates you attended school.

4. Go alone, do not take parents or friends.

5. Do not be late.

(NOTE: Allow adequate time to complete a job application form.)

6. Find out facts about the interviewer ahead of time.

(NOTE: Obtain this information from the receptionist.)

a. Name

(NOTE: Make sure you have the correct pronunciation.)

b. Title

7. Know facts about the business

a. Name

b. Kind of business

c. Products and services

d. How old the company is and where the plants, offices, or stores are located.

(NOTE: This information may be hard to obtain. Be observant in waiting room. Ask receptionist for brochure on company.)

B. Meeting the receptionist/secretary

1. Smile.

2. Introduce yourself, stating that you have an appointment.

   Example: "Good morning, I am Terry. McKracken and I am applying for job as a cashier. I have a 10:00 appointment with Mr. Smith."

3. Follow receptionist's instructions.

4. Wait patiently.
INFORMATION SHEET

C. Starting the interview

1. Smile
2. Listen carefully
3. Enter with poise
4. Greet the interviewer by name
5. Shake hands firmly
6. Introduce yourself
7. State purpose of call
8. Be seated only at interviewer's invitation
9. Do not show signs of nervousness
   (NOTE: If you do not know where to put your hands, leave them on your lap and keep them still.)
10. Do not place personal things on interviewer's desk
11. Do not smoke or chew gum
12. Look alert; look interested and enthusiastic
   (NOTE: Words such as Mr., Mrs., Miss, Ms., thank you, please, and sir never go out of style.)

D. Answering questions clearly

1. Do not interrupt
2. Anticipate questions that might be asked and volunteer proper information
   a. Explain yes and no answers
   b. Avoid criticisms of former employers or competitors
   c. Do not talk about personal problems
   d. Show copies of your work if applicable
   (NOTE: Never go on a drafting job interview without taking several drawings. Good lettering should appear on application.)
INFORMATION SHEET

e. Answer all questions honestly

Examples: "The thing I liked least about my last job was that I was on the night shift and couldn't get home. I really wanted to be home with my family at night."

"Truthfully, my relationship with my supervisor could have been better. We seemed to have a personality conflict and never became fond of each other. However, we did manage to work together. This was my first experience like that and I surely hope it doesn't happen again."

f. Give positive answers to unfavorable questions

Examples:

Interviewer: "Your work experience doesn't seem to relate specifically to this job. Why do you feel qualified to fill this position?"

Applicant: "I understand your concern. However, my job experience is broad enough to permit me to work into this particular situation. I have done work similar to this job and I think my general work record is good enough to convince you that I would be a good employee. I would be willing to receive additional training."

g. Find a true, positive statement about your reasons for leaving previous jobs, even if you were fired

Examples: "I was laid off, but I learned from my mistakes."

"I left because they did not need as many employees during the slow season."

h. Try to mention your best qualities in relation to something concrete

Example: "I earned 75 percent of my expenses while going to school" is better than "I am a hard worker and want to get ahead."
INFORMATION SHEET

i. Be prepared for personal questions about your home life and parents' occupations

(Note: These questions are inappropriate but are sometimes asked by the interviewer.)

j. Avoid questions concerning politics, economics, religion, and other controversial subjects

k. Answer questions about career objectives using specific terms about what you would like to do in the near future in that particular field without limiting your opportunities.

Example: "I would like to work as a mechanical drafter and go to school part time; my ultimate goal is to become a mechanical engineer."

3. Look directly at interviewer

4. Speak in clear, moderate tones

5. Use correct English

(Note: Avoid swearing, slang terms, or annoying phrases like "yea," "you know," or "uhhuh.")

6. Show interest in the business; ask questions

Example:

Incorrect: "Listen, I need to know if you have any benefits."

Incorrect: "Now that you've questioned me, there are a few things that I want to know before I decide if I want to work for you."

Correct: "I wonder if you could give me some information about the benefits available to employees?"

7. Sell yourself

(Note: Never refer to yourself as just average or fair. Always look for a positive response.)

8. Give the interviewer the opportunity to mention salary and fringe benefits

9. Act enthusiastically
E. Closing the interview

1. Watch for signs that the interview is over, such as the interviewer shuffling papers and moving around in chair.

2. Ask "May I say one thing more?" or "Would you be interested in ...?" if the interview seems to be ending before all important selling points have been made.

3. Thank interviewer for his/her time.

Example: "I've enjoyed talking to you, Mr. Smith. Thank you for your time and consideration. I'm excited about this job and do hope I'm hired. Can you tell me when the position will be filled and how the applicants will be notified? (Answer) Please let me know if you need any additional information."

4. Learn from every situation even if the interviewer does not offer the position.

F. Following up the interview—Write thank you letter, call, or visit again to express interest in the job and appreciation for the opportunity to interview.
Attitudes

Enthusiasm, Interest, Dedication, Dependability, Alertness, Quickness of Mind, Honesty, Integrity, Desire to Work, Desire to Help Others, Desire to Improve One's Self
Appropriate Dress

Hair neatly trimmed and Combed?

Well-Groomed?

Conservative and Coordinated Clothing?

Shoes in Good Repair?
Take the Time to be on Time
ASSIGNMENT SHEET #1--WRITE A RESUME

Write a resume using accurate facts about yourself. Use the information below and the sample resume included in this assignment sheet as guides. A good resume should immediately give prospective employers a brief summary of your accomplishments, educational background, work experience, skills, and job objective. It is not necessary to use the exact wording and outline form used on the sample resume, but it is necessary that your resume be neat and balanced and contain all the information which might help you get a job. Keep a current copy of the resume and use it to apply for jobs.

1. Inspect several resume formats and choose one that best fits your needs or use the example included in this assignment sheet as a guide.

2. Type your resume on 8 1/2 x 11 inch white paper. Try not to exceed two pages.

3. Keep resume error free.
   (NOTE: Many employers will not consider persons who have resumes that include misspelled words and typographical errors.)

4. Use outline form.

5. Put your name prominently at the top in the upper left-hand corner. Beneath name, give full street address, city, state, zip code, telephone number with area code, and a number where messages can be accepted.
   (NOTE: Leave space at upper right for a wallet size photo.)

6. Under Personal Data include birthdate, height, weight, health, and marital status. Do not include religious and political affiliations.

7. Describe your job objective or career goal briefly.

8. Describe your educational background, giving names of schools, dates of enrollment, and diploma or degrees received.

9. List related subjects studied. Include grade averages, if favorable.

10. List student activities and awards.

11. List hobbies and extracurricular activities, if they are relevant.

12. List your past employment, starting with your most recent job. Include name of firm, mailing address, job title, starting and ending dates of employment, name of immediate supervisor; and phone number.
ASSIGNMENT SHEET #1

13. List duties of your last job.
   (NOTE: Concentrate on skills you have used. Let employer know what you can do. Remember, you have to prove your value to the business, especially if you have little experience.)

14. List three persons as character references. Include complete mailing addresses and phone numbers.
   (NOTE: Ask permission before you use anyone as a reference.)

15. List one or more jobs or work references, include people that you have actually worked for.
   (NOTE: Avoid listing relatives as a reference unless you have actually worked for them on a salary basis.)

16. Write "Confidential" at the top of the resume if you don't want your current employer to know you are looking for other employment.

17. Proofread your resume carefully and retypew if necessary. Reproduce several copies on white bond paper.
   (NOTE: Your resume's physical appearance is VERY IMPORTANT. Avoid using ditto or carbon copies. Be sure to proofread the printer's work. Always bring extra copies to interview. Leave one copy of resume with interviewer and use one as a reference when filling out the application form. You should also mail one resume with your letter of application.)
RESUME
TERRY McKRACKEN

ADDRESS:
Present: 774 E. Adams Street
YourTown, YourState 77704
(405) 311-7779
Permanent: Route #3
Anytown, YourState 77704
(405) 235-4433

PERSONAL DATA:
Age: 18
Birthdate: Jan. 21, 1963
Height: 5' 7"
Weight: 160 lbs.
Health: Excellent
Marital Status: Single
Social Security Number: 447-37-0652

JOB OBJECTIVE:
Mechanical Drafter

ULTIMATE GOAL:
Mechanical Engineer

EDUCATION:
Anytown High School, Anytown, YourState 1977-81
Progress Vo-Tech, Progressville, YourState 1981
Certificate: Drafting, Four Semesters
Grade Average: 3.5 on a 4.0 scale

RELATED SUBJECTS STUDIED:
High School
Algebra 2 semesters
Geometry - 1 semester
Basic Mechanical Drawing - 1 semester
Technical Report Writing - 1 semester

Vo-Tech School
Machine Drafting - 540 hrs.
Architectural Drafting - 270 hrs.
Piping Layout - 135 hrs.
Structural Detailing - 135 hrs.
Descriptive Geometry - 30 hrs.
Related Mathematics - 60 hrs.
Trigonometry - 30 hrs.

STUDENT ACTIVITIES
President, Senior Class
President, VICA
Treasurer, Baptist Youth Fellowship Organization
Drafting contest, Second Place State, Fifth Place National
ASSIGNMENT SHEET #1

WORK EXPERIENCE

Name: John Farmer Machine
714 E. Maple Ave
Your Town, Your State 77704
(405) 555-2000

Job Title: Drafter Trainee
Dates: June 1, 1981 to Aug 15, 1981

Supervisor: Mr. John Farmer

Duties: Run blueprints
File drawings
Delivery and Pick-up
Trace old drawings
Clean up office
Help take measurements in the field

CHARACTER REFERENCES:

1. Mr. Sammy Davis (918) 555-2552
   Vocational Drafting Instructor
   Progress Vo Tech
   Progressville, Your State 77703

2. Mr. John Farmer (918) 555-3333
   Friend and Neighbor
   7/2 E. Adams Street
   Your Town, Your State 77703

3. Mrs. Jerry Smith (918) 555-1000
   Youth Director, Parkview Baptist Church
   11 Fellowship Circle
   Andrew, Your State 77702

WORK REFERENCES (with permission):

Mr. Bill Bates (405) 562-7212
Production Superintendent
Jack Bowings Construction
612 W. Oak
Your Town, Your State 77704
APPLYING FOR A JOB
UNIT V

ASSIGNMENT SHEET #2: WRITE A LETTER OF APPLICATION FOR A DRAFTING JOB

The application letter is a sales technique to tell the employer how your abilities will be useful to the business. The letter should specify your qualifications while the resume gives general background information.

Cut a help-wanted ad for a drafting job from the classified ad section of the local paper. Write an application letter to accompany the resume you prepared in Assignment Sheet #1. Use the following information and the sample letter as a guide.

(NOTE: If you cannot type, it is recommended that you locate someone to type your letters for you. Make sure you have a good typewriter available.)

1. Use acceptable form and appearance
   a. Type neatly and accurately
   b. Write on only one side of the paper
   c. Avoid smudges and typographical errors
   d. Use 8 1/2" x 11" white bond paper
      (NOTE: Do not use personal or fancy paper.)
   e. Spell, capitalize, and punctuate correctly
   f. Include employer’s full name, title, and address
   g. Include your full name and address with zip code on the letter
   h. Retain a copy for further reference

2. Include proper information
   a. Write to a specific person
      (NOTE: Find out the name of the personnel manager/employer you want to reach and the correct title. When in doubt, write to the top person who will refer your resume to the right party. Use TO WHOM IT MAY CONCERN if answering a blind ad.)
   b. Avoid excessive use of the pronoun "I"
   c. Be brief; do not repeat information in the resume
      1) State the position for which you are applying
      2) Avoid needless details
ASSIGNMENT SHEET #2

3) Cover all points requested in the advertisement in exactly the order in which they were asked.

(NOTE: Some prospective employers make it a point of testing the applicant's ability to follow directions.)

d) State reason for interest in job.

(NOTE: Employers look for people who look for future advancement opportunities rather than just a paycheck.)

e) Refer briefly to the main points in the attached resume.

f) Mention that persons listed on the resume have given their permission to serve as references.

g) Request interview at employer's convenience.

1) Tell where you can be reached.

2) Enclose self addressed envelope and resume.

3) Say you will phone next week.

3 Be original in your approach—Attract attention in opening paragraph.

Examples:

Dear Mr. Money:

My experience as a drafter would be of interest to you.

Dear Ms. Owner:

Mr. Co-worker informed me that you are in need of a person who can be a drafter trainee. I believe that my experience and training have taught me how to handle these duties efficiently and accurately.

4) End the letter properly.

(NOTE: Sincerely yours or Very truly yours is appropriate.)

5) Use permanent address for the return address and make sure to include the current date.

6) Staple letter to resume as it may be circulated to several departments and otherwise become detached.
ASSIGNMENT SHEET #2

7. Follow up and phone for an appointment a week later

(NOTE: Don't be surprised if the resume has been referred to another department. Remember, they are in business and you may not get immediate attention, especially if you sent a blind letter. Be persistent until you reach the right person and ask for a convenient date to set up an interview.)

8. Keep in touch regarding possible openings now and in the future

(NOTE: The "job hunt" may take several weeks or even months! It's important to keep your contacts alive without being a nuisance.)
Mr. John Jones  
Personnel Director  
B & H Designers  
Yourtown, Yourstate 77704

Dear Mr. Jones:

Please consider me for the drafting job that you advertised in the Daily Chronicle.

The skills I have learned in my vocational drafting courses should qualify me for this job. I have had experience in all of the basic skills required by the drafting trade, including the safe use of surveying instruments.

I will graduate from technical school in May, and I would like to become a drafter. A more complete description of my qualifications is given in the enclosed resume.

I would appreciate the opportunity to come and talk over this job opportunity at your convenience. I can be reached by telephone at 405-235-4433 after 3:30 or at the above address.

Sincerely yours,

Terry McKracken

Encl
APPLYING FOR A JOB
UNIT V

ASSIGNMENT SHEET #3-COMPLETE EMPLOYMENT APPLICATION
FORM FOR A JOB AS A DRAFTER

Complete the following application form using the guidelines below. Use information corresponding to the classified ad and to your letter of application. Use information about yourself from your resume.

(NOTE: Although each business uses its own form, general rules of preparation apply to any form.)

1. Be prepared
   a. Take a good ink pen with you
   b. Take copies of resume

2. Look over entire form before starting to write, do not hurry

3. Follow directions
   a. Note whether information is to be printed or handwritten
      (NOTE: Many drafting firms have drafting applicants letter an application so it can be evaluated.)
   b. Complete all directions

4. Write or print clearly, neatly, and legibly

5. Answer briefly

6. Be honest

7. Answer all questions
   (NOTE: If questions do not apply to you, write Not Applicable or NA in the space to show that you did not overlook the question.)

8. Include complete information, use resume

9. Recheck application when finished

10. Avoid cross-outs and obvious erasure marks

11. Do not list any restrictions to the geographical area in which you would work unless you absolutely will not consider other geographical areas

12. Use the word "open" for questions about minimum salary since most employers pay standardized rates and will not negotiate on this

13. Make copy of application, if possible
ASSIGNMENT SHEET #4: PREPARE A PERSONAL PORTFOLIO

A portfolio is a group of samples of a person's work. Such work is then made available to a prospective employer at the time of an interview so that he/she can see examples of the quality work that you do.

Prepare your personal portfolio for use in a job application. Be sure to remember the following:

1. Select a wide variety of work

   (NOTE: A job may require many different kinds of skills. A wide variety of samples will help the employer to see that you are qualified to do more than just one job.)

2. Select samples of your best work

   (NOTE: To use samples of less than quality work would defeat the purpose of the portfolio. Show only samples of good work.)

3. Place your identification on all pieces included in the portfolio

   (NOTE: An employer may choose to compare the work of various prospective employees.)

4. Place all samples in some type of a case or covering

   (NOTE: This is essential to protect the samples while being moved to new locations. Be sure to put your name on the outside.)
ASSIGNMENT SHEET #5--PRACTICE INTERVIEW QUESTIONS

The following are some additional questions which might be asked when applying for various jobs. Keep the assignment sheet to review before going on any actual interview.

(NOTE: Questions about your personal life may not legally be asked. In fact, it is illegal for an employer to ask your maiden name or your father's surname if you are a female applicant; your marital status; who lives with you; the church you attend or the name of your spiritual leader; how many children you have, their ages, or who will care for them while you are at work; whether you own or rent your residence; whether you have ever had your wages garnished; and whether you have ever been arrested. However, many interviewers, particularly in smaller businesses, may ask such questions. Whether or not you choose to answer the questions depends on how much you want the job.)

How would you answer the following questions? Why do you think each question might be asked?

1. Where do you go to school? When will you graduate?
2. Do you (did you) earn any of your own expense money while in school?
3. Why did you leave your previous job(s)?
4. What did you like best and what did you like least about your classes?
   (NOTE: This could be asked about teachers, jobs, or employers.)
5. What books have you read lately? What are your favorite magazines?
6. Are you in good health?
7. What do you expect to be doing five or ten years from now? What is your chosen field of work?
8. At what salary do you expect to start?
9. What are some of your special abilities? What skills do you possess? What tools or equipment can you operate?
10. How would you rate your training for this job? Very good? Fair?
11. What personal characteristics do you think are needed to succeed in your vocation?
ASSIGNMENT SHEET #5

12. In what area do you need the most improvement?

13. Do you like to work with other people or do you work best alone?

14. Do you have any questions you want to ask us?

15. Do you think your extracurricular activities were worth the time you devoted to them?

16. How could you contribute to our organization? Why should we hire you?

17. Tell us about your family and any plans for marriage or further education.

   (NOTE: REMEMBER: Legally, you do not have to answer this question. However, it is a good idea to prepare an answer in case such a question is asked.)

   Examples:  "My family includes a younger sister and my parents, with whom I live. My plans for marriage are undecided at this time, and I'm hoping that the experience gained by being an employee of your company will help me to decide about furthering my education."

   rather than

   "Quite frankly, I regard this information as personal and choose not to answer."

18. For what other jobs have you applied?

19. Do you have any military obligations to fulfill?

20. Give us an example of a project you finished under pressure.

21. May we write or call your last employer?

22. How many people have you supervised at work or through organizations of which you are a member?

23. How do you feel about the progress you have made salary-wise?

24. Would you be able to work all day Saturday and Sunday?

25. If you could start school (or work) over again what would you do differently?

26. What is your school attendance record?

27. Have you done the best school work of which you are capable?
28. Do you require attention? Does criticism disturb you?
   (NOTE: These questions are usually asked in a more subtle and indirect way.)
29. What motivates you?
30. Would you be willing to relocate?
31. What size city do you prefer?
32. Have you saved any money?
33. Define cooperation.
34. What job with our company would you choose if you were entirely free to do so?
35. How do you feel about working overtime?

REMEMBER: YOU NEVER GET A SECOND CHANCE TO MAKE A GOOD FIRST IMPRESSION!!! GETTING A JOB IS A JOB!!!
APPLYING FOR A JOB
UNIT V

ASSIGNMENT SHEET #13—MAKE AN APPOINTMENT BY PHONE
FOR A DRAFTING JOB INTERVIEW

Making an appointment by phone does two things. First, it shows that you are interested in saving the employer's time. Second, it shows that you are thoughtful for asking what would be the best time for you to see the employer.

1. Steps in making an appointment by phone
   a. Plan what you are going to say before you call
   b. State your name and reason for calling
      Example: "Hello, this is Terry McKracken. I'm calling about your ad in last night's paper for a drafter. May I have an appointment for an interview?"
   c. Ask when would be the best time for you to come for the interview
   d. Record the day, time, and place of the interview
   e. Thank the receptionist for the help

2. Things to remember when calling for an appointment
   a. Keep the receptionist on your side; the receptionist is there to help you
      (NOTE: The receptionist is sometimes asked to evaluate the applicant.)
   b. Do not ask over the phone how much the job pays
      (NOTE: Some questions about the nature of the job may be appropriate.)
   c. Be polite and courteous
      (NOTE: Remember that this call is the first contact you may have with the firm. Make that first impression a good one.)
   d. Ask if you should pick up an application blank or if they would like to send it to you before the interview

Now that you have read about the correct way to arrange for a job interview, role play a situation where you make an appointment by phone. Use the checklist on the next page to evaluate your performance.
ASSIGNMENT SHEET #6

<table>
<thead>
<tr>
<th>Question</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was prepared before calling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not have to stammer to find the right words</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identified self immediately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stated reasons for calling immediately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asked the best time for an appointment with employer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Was courteous and friendly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asked about picking up application blank or having application blank sent prior to interview</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thanked the receptionist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Made record of the interview date, hour, and place</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPLYING FOR A JOB
UNIT V

ASSIGNMENT SHEET #7 - WRITE A FOLLOW-UP LETTER OR MAKE A FOLLOW-UP PHONE CALL AFTER INTERVIEW FOR A DRAFTING JOB

It is sometimes helpful to return to a business and check again on possible job openings. This is often done about a week after the first interview. This short casual visit accomplishes two things. It helps the interviewer remember you, and it shows that you have a sincere interest in working for that company.

However, it is not always possible to have this type of informal atmosphere when applying for a job. In which case, it is always proper to send a follow-up letter or make a follow-up telephone call.

PART A

Write a follow-up letter thanking the employer for the interview. Use any form you wish or follow the format of the sample follow-up letter included in the assignment sheet.

1. Make sure your letter meets the following standards
   a. Typed or written perfectly
   b. Clean, neat, and attractively arranged on the page
   c. Free from spelling, punctuation, and grammatical errors
   d. Sent within a day or two after the interview

2. Include the following points in your follow-up letter
   a. Expression of appreciation for interviewer's time and interest
   b. Summary of your qualifications and interest in position
   c. Your name, address, and phone number (to make it easier for the employer to contact you)

3. Make this last bid for the job a prime example of your excellent work habits; make the letter clean, neat, and well-worded

PART B

Role play a follow-up telephone call using the guidelines below.

1. Make sure you include the following information
   a. Your name
   b. Date of your interview
   c. Position for which you were interviewed
ASSIGNMENT SHEET #7

2. Ask whether a decision has been made

Example: Incorrect: "Hello, Mr. Jones. This is Terry McKracken. You told me you would let me know about the job, but I haven't heard anything from you. Why haven't you called me?"

Incorrect: "This is Terry McKracken. Did I get the job?"

Correct: "Hello, Mr. Jones. This is Terry McKracken. I interviewed with you on June 30th for the position of a drafter. Have you made a decision on my application yet?"

3. If someone has already been hired, thank the interviewer for considering you but express continued interest in working for the company

Example: Incorrect: "Oh well, that's my luck. Thanks anyway."

Incorrect: "I didn't want to work for your company anyway."

Correct: "I am sorry I was not hired. Thank you for at least considering my application. I am still interested in working for the company and would appreciate you keeping my application on file."
Route #3
Anytown, Yourstate 77702
July 1, 1980

Mr. John Jones
Personnel Director
B & H Designers
Box 19
Yourtown, Yourstate 77704

Dear Mr. Jones:

Thank you for interviewing me for the job of drafter trainee with your company. I feel that working for B & H Designers would be enjoyable and that I could do the general drafting work that the job requires. I hope that I will have the opportunity to prove my worth.

The application form you gave me is enclosed.

I will be available for work May 15. You may call me at my home after 3:30 p.m. The number is 405-235-4433.

Sincerely yours,

Terry McKracken

Encl.

(Note Be sure to sign your letter.)
APPLYING FOR A JOB
UNIT V

ASSIGNMENT SHEET #8- EVALUATE A DRAFTING JOB OFFER

Instead of saying "yes" or "no" on the spot to a job offer, express your gratitude in a warm and friendly manner, and then ask if you may have time to consider the opportunity you have been offered. Few reputable employers will deny you a reasonable time to be certain before agreeing to take a job.

Avoid getting stuck with a job that's wrong for you by using the following checklist to evaluate the job offer.

THE JOB

Do I clearly understand the nature of the work and is it what I want to do? Are my responsibilities reflected in the job title?

If this isn't my dream job, can it be a stepping stone as I acquire the skills and experience needed for advancement?

Is the background I'm building so narrow that I will have difficulty transferring it to another employer?

Will I be able to make any decisions affecting my work? Do I care?

If I need more training and will the company pay for it?

Will overtime be necessary or available?

Will I be able to leave all thought of the job behind at day's end? If not, do I care?

Will I have to travel or relocate?

Is the job permanent or temporary?

Is permanent, is there reasonable job security?

Does this job require union membership?

THE COMPANY

Is the firm too large and heavy with rules for my personality?

Is the firm too small to offer room for advancement or impressive credentials for a future resume?
ASSIGNMENT SHEET #8

Does the firm have a healthy financial position and is it a growing organization?

Is there a high turnover of personnel, and if so, why?

Does the firm promote from within the ranks or turn to outsiders to fill supervisory jobs?

Have I met the person who would be my immediate supervisor?

Does the supervisor seem like the sort of person with whom I could get along?

Do co-workers appear to be my kind of people?

Is the company's location convenient?

What is the firm's reputation for fair treatment of employees?

Is a written personnel statement available that covers vacations, sick leave, cause for dismissal, and so forth?

FINANCIAL REWARDS...

Do the earnings meet my minimum needs? Are there automatic cost-of-living increases?

What is the method of payment: salary, hourly wage?

Are raises based on merit, length of service, formal exams?

What fringe benefits are given: health insurance, free parking, discount privileges, and others?

WHEN TO SAY NO...

Should you always turn down an offer that doesn't measure up?

That depends on several questions. How desperately do you need to earn money? How competitive is the field you hope to enter, and would it be best to get your foot in the door any way you can? How valuable is the experience you'll gain? There are times when it is wise to accept a job which is not perfect in your eyes.

On the other hand, it could be best to refuse the offer.
When you are offered a job or are changing jobs there are many factors to weigh before taking the position. Some of these include:

1. What is your take-home pay?
2. What are the benefits which accompany the job?
3. How much will it cost to actually be at work each day?
4. Would the job be satisfying to you?
5. How would the job meet your needs and aspirations?

WHAT'S MY TAKE-HOME PAY?

Salaries and wages are often quoted by employers as gross earnings. Gross earnings are used because tax deductions vary due to the number of dependents, the amount of earnings, and other information.

Optional benefits and deductions offered by an employer also differ. It is generally advisable to ask what programs are available for enrollment as these can affect the actual money you receive on pay day.
WHAT OTHER BENEFITS DO I GET FROM THIS JOB?

Some benefits associated with working are not always visible. Often some of these overlooked benefits are paid for in part by your employer. At the time of the interview or when considering a position ask about:

Employer's contributions for your protection which may include:

1. Health insurance
2. Unemployment compensation
3. Clothing and safety garments
4. Medical facilities and health tests
5. Pensions
6. Travel insurance (covering mishaps when traveling on business)
7. Educational programs or reimbursement for courses related to job
8. Sick leave with pay
9. Paid vacations and holidays

WHAT WILL IT COST TO WORK AT THIS JOB?

Frequently, we often overlook the costs which are associated with being employed. It may be of value to calculate estimated weekly expenses before you make a decision about a job.

Estimate weekly expenses for:

- Transportation (parking, bus fares) $_______
- Lunches (or cost of food eaten away from home, including soft drinks and coffee) $_______
- Clothing (including cleaning) $_______
- Child care for working parent $_______
- Gifts for other employees $_______
- Special uniforms, materials, or equipment for job $_______
- Other $_______
- TOTAL $_______
WHAT IS IMPORTANT TO ME IN A JOB?

Take-home pay and benefits may be only part of what you want from a job. Think through other things you consider important in a job.

What are some of the most rewarding things you’ve felt about any job you’ve ever had?

1. ____________________________
2. ____________________________
3. ____________________________

How might you rate these in order of what’s important to you?

[ ] Job security (little chance you’ll be released from the job)
[ ] Opportunity for advancement
[ ] Recognition for your work
[ ] Good wages
[ ] Opportunity to learn and use your ideas
[ ] Flexible working hours
[ ] Long vacations
[ ] Pleasant working conditions
[ ] Interesting work
[ ] Friendly co-workers
[ ] Travel
[ ] Other, such as ____________________________

ARE YOU READY TO DECIDE????

Take all the information you have gathered and summarize it below and on the next page to reach a decision about whether you want the job or not.

1. Would the job be satisfying to you? Why/why not?

________________________________________________________________________

________________________________________________________________________
ASSIGNMENT SHEET #9

2. What are the benefits which accompany the job?

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

3. How much will it cost to actually be at work each day?

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

4. How would the job meet your needs and aspirations?

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

5. I estimate my take-home pay to be $__________.

6. I estimate my expenses related to working to be $__________.

7. I would most enjoy the following about this job.

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

8. I estimate my job benefits to be worth $__________.
1. Match the terms on the right to the correct definitions

   a. Brief, typed summary of one's qualifications and experience that is used in applying for a job

   b. Extras provided by an employer, such as paid vacations, sick leave, and insurance protection

   c. Recognition received for outstanding achievement

   d. Experience, education, and physical characteristics which suit a person to a job

   e. Any vocational courses and skills one has learned in high school or through work experience

   f. Clubs, organizations, and social or church groups in which one participates

   g. A grouping of samples of an individual's work

   h. Meeting of employer and job applicant for purpose of evaluation and questioning

   i. Printed form on which job applicants record information about their personal history, job history, job experience, education, and references

   j. Business that is designed to help individuals find employment

   k. Classified advertising that does not identify the advertiser

   l. Classified advertisement placed by individuals seeking employment and telling what their qualifications are

   1. Award

   2. Interview

   3. Extracurricular activities

   4. Fringe benefits

   5. Application form

   6. Qualifications

   7. Resume

   8. Portfolio

   9. Vocational preparation

   10. Employment agency

   11. Equal opportunity employer

   12. Blind ad

   13. Help wanted ad

   14. Legible

   15. Employment situation wanted ad
2. Select means of locating job openings by placing an "X" in the appropriate blanks.

   a. School officials
   b. Parents
   c. Employment offices
   d. Local labor union business office
   e. Waiting to be called
   f. Classified ads

3. List three methods of applying for a job.

   a. __________________________
   b. __________________________
   c. __________________________

4. Select personal attributes or attitudes an employer looks for during a personal interview by placing an "X" in the appropriate blanks.

   a. Alertness, quickness of mind
   b. Long wavy hair
   c. Dedication and dependability
   d. Enthusiasm and interest
   e. New car
   f. Honesty and integrity
   g. Desire to work
   h. Beard
   i. Flashy clothes
I. Desire to help others

k. Desire to improve one's self

l. Ability to work well with others

5. Select items which an applicant may need to prepare when applying for a job by placing an "X" in the appropriate blanks.

   a. Written critique of company
   b. Letter of application
   c. Birth certificate
   d. Resume
   e. Portfolio
   f. Application form
   g. Follow-up letter

6. Select guidelines to follow when participating in a job interview by placing an "X" in the appropriate blanks.

   a. Take parents or friends with you to job interview
   b. Know facts about the business
   c. Start the interview with a smile and greet the interviewer by name
   d. Place personal things, such as coat, hat, or purse, on interviewer's desk
   e. Criticize former employers or competitors when applicable
   f. State that you are willing to start at the beginning salary
   g. Answer all questions honestly
   h. Ask questions about politics, economics, religion, and other controversial subjects
   i. Look directly at interviewer
   j. Do not ask questions or show interest in the business
   k. Don't bother to take a pencil or pen with you
   l. Thank interviewer for his/her time
   m. Write thank you letter, call, or visit again to express interest in the job and appreciation for the opportunity to interview
7. Write a resume.
8. Write a letter of application for a drafting job.
9. Complete employment application form for a job as a drafter.
10. Prepare a personal portfolio.
11. Practice interview questions.
12. Make an appointment by phone for a drafter job interview.
13. Write a follow-up letter or make a follow-up phone call after interviewing for a drafter job.
14. Evaluate a drafting job offer.
15. Compare job opportunities.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)
APPLYING FOR A JOB
UNIT V

ANSWERS TO TEST

1. a. 7 i. 5
   b. 4 j. 10
   c. 1 k. 12
   d. 6 l. 15
   e. 9 m. 13
   f. 3 n. 14
   g. 8 o. 11
   h. 2

2. a, c, d, f

3. a. Letter
   b. Telephone
   c. In person

4. a, c, d, f, g, j, k, l

5. b, d, e, f, g

6. b, c, g, i, k, l, m

7.-15. Evaluated to the satisfaction of the instructor
UNIT OBJECTIVE

After completion of this unit, the student should be able to relate media to its composition and uses, list standard sheet and roll sizes, and demonstrate the ability to determine the felt side of vellum. This knowledge will be evidenced by correctly performing the procedures outlined in the job sheet and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to media with their correct definitions.
2. Match types of papers with their characteristics and uses.
3. Match types of papers with their compositions.
4. Describe two major problems with papers and their causes.
5. Match characteristics of paper surfaces with their correct definitions.
6. Match methods and characteristics of transparentizing with their correct definitions.
7. Select true statements concerning the composition and characteristics of tracing cloth.
8. Select true statements concerning the composition and characteristics of polyester drafting film.
9. Define scribe coat composition and scribe coat technique.
10. Complete a pie chart showing the distribution of costs for a drawing.
11. Classify standard media sheet sizes into the standard or alternate system by letter and dimension.
12. Arrange in order the suggested sequence for remembering standard media sheet sizes.
13. Complete a chart showing metric drawing sheet sizes and the nearest standard sizes.
14. List three basic widths and lengths of media roll sizes.
15. Select true statements concerning methods of determining the felt side of vellum with and without watermarks.
16. Demonstrate the ability to determine the felt side of vellum without a watermark.
SUGGESTED ACTIVITIES

I. Provide student with objective sheet.
II. Provide student with information and job sheets.
III. Make transparencies.
IV. Discuss unit and specific objectives.
V. Discuss information sheet.
VI. Discuss job sheet.
VII. Show students different types of media that might be used.
VIII. Show examples of different ways that various media are used.
IX. Invite a resource person from industry to relate to the students about the costs involved in drafting and how the dollar is divided.
X. Invite a vendor to bring samples of various media to class.
XI. Give test.

INSTRUCTIONAL MATERIALS

I Included in this unit:

A. Objective sheet
B. Information sheet
C. Transparency masters
   1. TM #1 - The Cost of a Drawing
   2. TM #2 - Sheet Sizes
D. Job Sheet #1 - Determine the Felt Side of Vellum Without a Watermark
E. Test
F. Answers to test
References


I. Terms and definitions
   
   A. Media—Material upon which drawings are made

      Examples: Drawing paper or detail paper, tracing paper, vellum, tracing cloth, and polyester film

   B. Ream—500 sheets of media material

   C. Accelerated aging—Laboratory method for speeding up the deterioration of a material in order to estimate its long-time storage and use characteristics

   D. Erasing quality—The ability of media to withstand a normal amount of erasing without losing its lead, plastic lead, or ink taking characteristics to a noticeable degree

   E. Tooth—Degree of pencild and ink receptivity on the surface of tracing media

      (NOTE: Tooth is applied to cloth or film (matte) through a coating operation; in paper, it is usually the natural formation of the fibers on the surface of the finished product in a predetermined formation.)

   F. Transparent—The property of transmitting or allowing light to pass through

   G. Translucent—Transmitting and diffusing light so that objects beyond cannot be seen clearly

   H. Opaque—The property of not allowing light to pass through

   I. Ghosting—A smudged area or image on a reproduction copy of a drawing caused by a damaged surface due to erasing or mishandling of the original

   J. Matte side—The drawing side of polyester film produced by a process that coats the polyester surface in such a way that drawing materials will more readily adhere to it

      (NOTE: It is sometimes applied to both sides of polyester film.)

   K. Felt—Substance used to adhere and mat together

   L. Web—The continuous long sheet formed as paper is processed through a papermaking machine

   M. Watermark—A marking in paper which is visible when the paper is held up to the light
II Types of papers, their characteristics, and uses

A Drawing paper A heavy paper whose smooth side is used for ink work, the rough side used for pencil work, it cannot be reproduced by blueprinting or similar processes.

B Detail paper A heavy paper whose smooth side is used for ink work, the rough side used for pencil work, it cannot be reproduced by blueprinting or similar processes.

C Tracing paper A thin, untreated, translucent paper used for ink or pencil work, it can be reproduced by blueprinting or similar processes.

(NOTE: Tracing paper and natural tracing paper have similar characteristics and uses.)

D Vellum A tracing paper that has been treated with a transparentizing agent, it can be reproduced by blueprinting or similar processes.

III Types of papers and their compositions

A Sulfite 100 percent wood pulp base stock paper containing no;.

B Ray A colorless cotton paper containing very small amounts of wood fiber.

(NOTE: Paper with 100 percent content is the best paper used.)

IV MAIN problems with papers and their causes

A Belly The humping (loss of dimensionality) occurs in the center area of a sheet or web of material usually caused by an area of absorption of moisture between the center and the edges of the material.

B Edge ripple The humping of the edges of a sheet or web of material usually caused by moisture absorption creating expansion, causes where the center of the material fails to expand an equal amount.

V Characteristics of paper surfaces and their definition

A Two sided Reference to the fact that a paper has two sides and a no side which produces surfaces with different qualities.

B Felt side The side of the paper where the fibers of the paper is pressed through a paper making machine.

(NOTE: This side usually presents the water mark or emblem.)

C Wire side The side of the paper where the fibers of the paper is pressed through a paper making machine.

(NOTE: This side usually presents the water mark or emblem.)
D. With the grain—The grain produced in the direction of flow as a sheet passes through a paper-making machine

(Note: It is usually along the length or longest dimension of the sheet.)

E. Cross grain—Across the width of a sheet

F. Closed formation—Formation of fibers in a sheet so that they give a uniform appearance

G. Open formation—Formation of fibers in a sheet so that they give a mottled appearance

H. Mottled—Giving the appearance of uneven arrangement of fiber spacing

VI. Methods and characteristics of transparentizing and their definitions

A. Transparentizing—The treatment of paper or tracing cloth with oils, waxes, or resins to achieve a high degree of translucency

B. Solid transparentizer—A solid resin whose permanent nature will not leach or lose its translucency

C. Mobile transparentizer—A nonsolid resin, oil, or wax that will migrate and usually leach on contact with any absorbent material

(Note: This is sometimes called a nonsolid transparentizer.)

D. Nonhydroscopic transparentizer—A permanent, synthetic resin which makes tracing paper water resistant and inhibits the tendency of media to curl

E. Leaching—The tendency of a transparentizer to be removed from tracing paper by migration from a media to another material

F. Pin holes—Fiber ends that have become completely transparentized or particles of man-made fibers that give tracing paper the appearance of having tiny holes in it

VII. Composition and characteristics of tracing cloth

A. Made from a fabric that has undergone a transparentizing process

B. Usually made of a muslin fabric sized with a starch compound and plastic to provide a good working surface for pencil or ink

(Note: Although sometimes referred to as "linen," tracing cloth is actually made from cotton)

C. Tracing cloths made especially for pencil are available
INFORMATION SHEET

D The dull side of the cloth is used for drawing.

E Important drawings that must be stored for long periods of time are placed on tracing cloth because it is strong and durable and will last many years without deteriorating.

VIII Composition and characteristics of polyester drafting film

A Usually made by bonding a matte surface to one or both sides of a clear polyester sheet to form a tough, translucent drafting medium.

B Reacts very little to temperature or humidity changes because of its dimensional stability.

C Will retain stability even after much erasing.

D Is almost impossible to tear.

E Is moisture resistant.

F Dull or matte side should be used for drawing when one side of the film has a matte finish.

G Should be cleaned with a moist paper towel or lint free cloth prior to use.

**NOTE**: Polyester film is sometimes called "Mylar," which is a registered trademark of Dupont.

X Some notation conventions and scribble or scribe techniques

A Scriber (also made of the same materials coated fiberglass cloth and a heavy plastic sheet) to form a dimensionally stable material suitable for scribing.

B Scribbling is a technique using a scribe (stylus) to form lines into a scribble coat surface instead of drawing them with pencil or ink.

**NOTE**: Do not confuse scribbling technique with "scribing," which refers to a technique used while the surface of a medium with a pencil or pen.

XII Special aspects for airbrush (freehand) mark

A Proper sketch or outline.

B Exact and precise evaluation costs.

C Watercolor and ink pens and markers.

D Ink, water or watercolor markers.
XI. Letters and dimensions of standard media sheet sizes (Transparency 2)

A. Standard system

1. Size A- 8 1/2" x 11"
2. Size B- 11" x 17"
3. Size C- 17" x 22"
4. Size D- 22" x 34"
5. Size E- 34" x 44"

(NOTE: Use of the standard sheet size of 8 1/2" x 11" and its multiples permits filing in standard files.)

B. Alternate system

(NOTE: Use of the alternate sheet size of 9" x 12" and its multiples is common in the automobile industry because of the advantage of larger drawing areas.)

1. Size A- 9" x 12"
2. Size B- 12" x 18"
3. Size C- 18" x 24"
4. Size D- 24" x 36"
5. Size E- 36" x 48"

(NOTE: Roll sizes are also classified. From small to large, these receive a designation of G, H, J, or K.)

XII. Steps in remembering standard media sheet sizes

A. Memorize the first size in each system

Example

In the standard system, the first size is 8 1/2" x 11"; in the alternate system, the first size is 9" x 12"

8 1/2 x 11 9 x 12

B. The second number of each preceding sheet size becomes the first number of each succeeding sheet size

Example

In the standard system, the 11" in the first sheet size becomes the first number in the succeeding 11" x 17" size, and in the alternate system, the 12" in the first sheet size becomes the first number in the 12" x 18" size

11 x 17 12 x 18
INFORMATION SHEET

Doubling the first number of each preceding sheet size gives the correct dimension for the second number of each succeeding sheet size.

**Example:**
- In the standard system, the 8 1/2" in the first sheet size is doubled to give the 17" which is the second dimension in the 11" x 17" size, and in the alternate system, the 9" dimension is doubled to give 18" which is the second dimension in the 12" x 18" size.

8 1/2 x 2 = 17 or 11 x 17

9 x 2 = 18 or 12 x 18

XIII Metric drawing sheet sizes and nearest standard sizes (American)

<table>
<thead>
<tr>
<th>Size</th>
<th>Millimeters</th>
<th>Inches</th>
<th>Nearest Standard Size American</th>
</tr>
</thead>
<tbody>
<tr>
<td>A6</td>
<td>105 x 148</td>
<td>4.13 x 5.43</td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td>148 x 210</td>
<td>5.43 x 8.27</td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>210 x 297</td>
<td>8.27 x 11.69</td>
<td>A</td>
</tr>
<tr>
<td>A3</td>
<td>297 x 420</td>
<td>11.69 x 16.54</td>
<td>B</td>
</tr>
<tr>
<td>A2</td>
<td>420 x 594</td>
<td>16.54 x 23.39</td>
<td>C</td>
</tr>
<tr>
<td>A1</td>
<td>594 x 841</td>
<td>23.39 x 33.11</td>
<td>D</td>
</tr>
<tr>
<td>A0</td>
<td>841 x 1,189</td>
<td>31.11 x 46.81</td>
<td>E</td>
</tr>
<tr>
<td>2A0</td>
<td>1,189 x 1,682</td>
<td>6.81 x 56.22</td>
<td></td>
</tr>
<tr>
<td>4A0</td>
<td>1,682 x 2,378</td>
<td>56.22 x 93.67</td>
<td></td>
</tr>
</tbody>
</table>

215
INFORMATION SHEET

XIV. Basic widths and lengths of media bulk roll sizes

A. Width
   1. 24" (610 mm)
   2. 30" (762 mm)
   3. 36" (914 mm)
   4. 42" (1,067 mm)

B. Length
   1. 20 yards (18,288 mm)
   2. 50 yards (45,720 mm)
   3. 100 yards (91,440 mm)

XV. Methods of determining the felt side of vellum with and without watermarks

A. Visually inspect for a straight forward watermark
   (NOTE: A backward watermark would indicate the wire side.)

B. If there is no watermark, look for a printed label inside the package or roll; label up indicates the felt side

C. If there is no watermark, visually inspect or feel the paper for smoothness because the felt side is always smooth

D. If there is no watermark, gently turn one corner of the paper over and lightly draw with soft lead a line onto each side of the paper, then erase the lines with a nonabrasive hand eraser; the side that erases easiest and leaves the least amount of ghosting is the felt side (see Job Sheet #1)
The Cost of a Drawing

$.65 Goes to Labor
(Drafter Salaries)

$.01 Goes for Tools & Materials

$.05 Goes for Reproduction Costs

$.29 Goes to Engineering Costs
Sheet Sizes

A SIZE

B SIZE

C SIZE

D SIZE
Microfilm alignment arrowheads located midway between sheet edges on all 4 sides

E SIZE

Round corners optional on all sizes

8½ x 11 or 9 x 12

11 x 17 or 12 x 18

17 x 22 or 18 x 24

22 x 34 or 24 x 36

34 x 44 or 36 x 48

Number Block Upper Left

Usually imaginary lines for zone usage

1

2

3

4

5

6

7

8

G

F

E

D

C

B

A
JOB SHEET #1: DETERMINE THE FELT SIDE OF VELLUM WITHOUT A WATERMARK

I. Tools and equipment
   A. Sheet of vellum without a watermark
   B. Nonabrasive hand eraser
   C. Drawing pencil with soft lead

II. Procedure
   A. Gently turn a corner of the vellum over until the backside forms a surface with the side that is up (Figure 1)

   ![Figure 1](image)

   B. With soft lead, gently draw a line across the paper at a point where the backside and the up side intersect (Figure 2)

   ![Figure 2](image)

   C. Erase the lines, paying careful attention to which line erases the easiest and leaves the least amount of ghosting, this will be the felt side of the vellum
1. Match the terms on the right with the correct definitions.

   a. Material upon which drawings are made
   b. A marking in paper which is visible when the paper is held up to the light
   c. 500 sheets of media material
   d. The continuous long sheet formed as paper is processed through a papermaking machine
   e. Laboratory method for speeding up the deterioration of a material in order to estimate its long-time storage and use characteristics
   f. Substance used to adhere and mat together
   g. The ability of media to withstand a normal amount of erasing without losing its lead, plastic lead, or ink taking characteristics to a noticeable degree
   h. The drawing side of polyester film produced by a process that coats the polyester surface in such a way that drawing materials will more readily adhere to it
   i. Degree of pencil and ink receptivity on the surface of tracing media
   j. The property of transmitting or allowing light to pass through
   k. Transmitting and diffusing light so that objects beyond cannot be seen clearly
   l. The property of not allowing light to pass through
   m. A smudged area or image on a reproduction copy of a drawing caused by a damaged area due to a tear, or a handling of the original

1. Transparent
2. Tooth
3. Erasing quality
4. Accelerated aging
5. Ream
6. Media
7. Translucent
8. Opaque
9. Ghosting
10. Matte side
11. Felt
12. Web
13. Watermark
5. Match the types of paper on the right with the correct characteristics and uses.

   a. A thin, untreated, translucent paper used for ink or pencil work, it can be reproduced by blueprinting or similar processes.
   1. Drawing paper
   2. Detail paper
   3. Tracing paper
   4. Vellum

   b. A heavy paper whose smooth side is used for ink work, the rough side used for pencil work; it cannot be reproduced by blueprinting or similar processes.

   c. A tracing paper that has been treated with a transparentizing agent; it can be reproduced by blueprinting or similar processes.

3. Match the types of paper on the right with their compositions.

   a. A cloth base paper containing various amounts of wood fiber.
   1. Rag
   2. Sulphite

   b. 100 percent wood pulp base stack paper containing no rag

4. Describe two major problems with papers and their causes.

   a. Relly

   b. Edge-ripple

5. Match the characteristics of paper surfaces on the right with their definitions.

   a. Across the width of a sheet
   1. Two sided

   b. The side of the paper which is up when the paper is processed through a paper-making machine
   2. Felt side

   c. Giving the appearance of uneven arrangement of fiber spacing
   3. Wire side

   d. Reference to the fact that all paper has a felt side and a wire side which produces surfaces with different qualities
   4. With the grain

   e. Formation of fibers in a sheet so that they give a mottled appearance
   5. Cross grain

   f. Formation of fibers in a sheet so that they give a uniform appearance
   6. Closed formation

   7. Open formation

   8. Mottled
6. Match the methods and characteristics of transparentizing on the right with their definitions.

   a. The tendency of a transparentizer to be removed from tracing paper by migration from a media to another material
   b. A solid resin whose permanent nature will not leach or lose its translucency
   c. A nonsolid resin, oil, or wax that will migrate and usually leach on contact with any absorbent material
   d. The treatment of paper or tracing cloth with oils, waxes, or resins to achieve a high degree of translucency
   e. Fiber ends that have become completely transparentized or particles of man-made fibers that give tracing paper the appearance of having tiny holes in it
   f. A permanent, synthetic resin which makes tracing paper water resistant and inhibits the tendency of media to curl

7. Select the true statements concerning the composition and characteristics of tracing cloth by placing an "X" in the appropriate blanks.

   a. Tracing cloths made especially for pencil are available
   b. Made from a fabric that has not undergone a transparentizing process
   c. The shiny side of the cloth is used for drawing
   d. Usually made of a muslin fabric sized with a starch compound and plastic to provide a good working surface for pencil or ink
   e. Important drawings that must be stored for long periods of time are placed on tracing cloth because it is strong and durable and will last many years without deteriorating
8. Select the true statements concerning the composition and characteristics of polyester drafting film by placing an "X" in the appropriate blanks.

   __ a. Will retain stability even after much erasing
   __ b. Is almost impossible to tear
   __ c. Is not moisture resistant
   __ d. Dull or matte side should be used for drawing when one side of the film has a matte finish
   __ e. Should be cleaned with a dry paper towel or lint-free cloth prior to use
   __ f. Usually made by bonding a matte surface to one or both sides of a clear polyester sheet to form a tough, translucent drafting medium
   __ g. Reacts to temperature or humidity changes because of its dimensional stability

9. Define scribe coat composition and scribe coat technique

10. Complete a pie chart showing the distribution of costs for a drawing.

11. Classify the following standard media sheet sizes as either in the standard or alternate system by placing a "S" to the left of the standard and an "A" to the left of those in the alternate system.

   __ a. Size A  9" x 12"
   __ b. Size C  17" x 22"
   __ c. Size E  34" x 44"
   __ d. Size B  12" x 18"
   __ e. Size A  8 1/2" x 11"
12. Arrange in order the suggested sequence for remembering standard media sheet sizes by placing a "1" to the left of the first step and proceed through the remaining steps.

   a. The second number of each preceding sheet size becomes the first number of each succeeding sheet size.
   b. Memorize the first size in each system.
   c. Doubling the first number of each preceding sheet size gives the correct dimension for the second number of each succeeding sheet size.

13. Complete the following chart showing metric drawing sheet sizes and the nearest standard sizes.

<table>
<thead>
<tr>
<th>Size</th>
<th>Millimeters</th>
<th>Inches</th>
<th>Nearest Standard Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>210 x 297</td>
<td>8.27 x 11.69</td>
<td>f.</td>
</tr>
<tr>
<td>b.</td>
<td>297 x 420</td>
<td>11.69 x 16.54</td>
<td>g.</td>
</tr>
<tr>
<td>c.</td>
<td>420 x 594</td>
<td>16.54 x 23.39</td>
<td>h.</td>
</tr>
<tr>
<td>d.</td>
<td>594 x 841</td>
<td>23.39 x 33.11</td>
<td>i.</td>
</tr>
<tr>
<td>e.</td>
<td>841 x 1,189</td>
<td>33.11 x 46.81</td>
<td>j.</td>
</tr>
</tbody>
</table>

14. List three basic widths and lengths of media roll sizes.

   a. Widths
      1) ________________
      2) ________________
      3) ________________
The statements concerning methods of determining the felt side of vellum with or without watermarks by placing an "X" in the appropriate blanks.

a. Visually inspect for a straight forward watermark

b. If there is no watermark, visually inspect or feel the paper for smoothness because the felt side is always smooth

c. If there is no watermark, look for a printed label inside the package or roll; label down indicates the felt side

1. Rate the ability to determine the felt side of vellum without a watermark.

2. If the test has not been accomplished prior to the test, ask your instructor to complete it.
ANSWERS TO TEST

1. a. 6  f. 11  k. 7
   b. 13  g. 3  l. 8
   c. 5  h. 10  m. 9
   d. 12  i. 2
   e. 4  j. 1

2. a. 3
   b. 1 and 2
   c. 4

3. a. 1
   b. 2

4. Descriptions should include:
   a. Belly--The bagging (loss of dimensional stability) near the center area of a sheet or web of material usually caused by an uneven absorption of moisture between the center and the edges of the material.
   b. Edge-ripple--The rippling of the edges of a sheet of material usually caused by moisture absorption creating expansion along the edges when the center of the material fails to expand an equal amount.

5. a. 5     e. 7
   b. 2     f. 6
   c. 8     g. 4
   d. 1     h. 3

6. a. 2     d. 6
   b. 5     e. 1
   c. 4     f. 3

7. a, d, e

8. a, b, d, f

9. Definition should include.
   a. Scribe coat is made of thin aluminum sheets, coated fiberglass cloth, and a heavy plastic sheet to form a dimensionally stable material suitable for scribing.
   b. Scribing is a technique using a scribe to form lines into a scribe coat surface instead of drawing them with pencil or ink.
10. a. One cent goes for tools and materials costs
   b. Five cents goes for reproduction costs
   c. Twenty five cents goes for engineering costs
   d. Sixty five cents goes for drafting costs

11. a. A
    b. S
    c. S
    d. A
    e. S

12. a. 2
    b. 1
    c. 3

13. a. A
    b. A
    c. A
    d. A
    e. A

14. Widths (any three of the following):
   1) 24"
   2) 30"
   3) 36"
   4) 42"

15. a. b

16. Execution to the satisfaction of the instructor
LETTERING
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to list the reasons for neat lettering, the procedure for forming letters, and the use of guidelines and the instruments for making them. The student should also be able to relate paper size to proper lettering height and draw both lower-case and upper-case vertical and inclined Gothic letters. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Differentiate between condensed and extended letters.
2. Differentiate between boldface and lightface letters.
3. Select true statements concerning reasons and rules for neat lettering.
5. Select true statements concerning the procedure for forming letters.
6. Select true statements concerning the rules for left-handed drafters.
7. Select the purposes of guidelines.
8. Select true statements concerning rules for making guidelines.
10. Select basic rules for learning to letter.
11. Select true statements concerning rules for spacing.
12. Distinguish between suggested leads used for lettering and for constructing guidelines.
13. List types of line guides used for laying out guidelines for lettering.
14. Arrange in order the suggested steps in using a Braddock Rowe triangle.
15. Arrange in order the suggested steps in using an Ames type lettering guide.
16. Match the name of lettering instruments with the correct description.

17. Select true statements concerning rules for different types of lettering.

18. Complete a chart showing recommended lettering height in relation to paper size.

19. Identify common problems in lettering uniformity.

20. Discuss common problems in lettering stability.

21. Demonstrate the ability to:
   
a. Select and sharpen lead correctly.
   
b. Operate a Braddock Rowe triangle to construct guidelines.
   
c. Operate an Ames type lettering guide to construct guidelines.
   
d. Construct vertical Gothic lettering and numerals.
   
e. Construct inclined Gothic lettering and numerals.
   
f. Construct vertical lower-case Gothic lettering.
   
g. Construct inclined lower-case Gothic lettering.
   
h. Prepare vertical and inclined lettering exercises.
LETTERING
UNIT II

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information and assignment sheets.

III. Make transparencies.

IV. Discuss unit and specific objectives.

V. Discuss information sheet.

VI. Discuss the procedures outlined in the assignment sheets.

VII. Use file drawings to demonstrate to the class examples of correct and incorrect lettering.

VIII. Show lettering templates that may be used in drafting.

IX. Demonstrate the use of different types of lettering instruments.

X. Demonstrate the use of the Braddock Rowe triangle, Ames type lettering guide and parallelograph.

XI. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Condensed and Extended Lettering

2. TM 2--Rules for Making Guidelines

3. TM 3--Steps in Using a Braddock Rowe Triangle

4. TM 4--Steps in Using an Ames Type Lettering Guide

5. TM 5--Types of Lettering Instruments

6. TM 6--Types of Lettering Instruments (Continued)
7. TM 7 - Types of Lettering Instruments (Continued)
8. TM 8 - Vertical Gothic Lettering
9. TM 9 - Inclined Gothic Lettering
10. TM 10 - Vertical Gothic Lower-Case Lettering
11. TM 11 - Inclined Gothic Lower-Case Lettering
12. TM 12 - Inclined Lettering Uniformity
13. TM 13 - Vertical Lettering Uniformity

D. Assignment sheets

1. Assignment Sheet #1 - Select and Sharpen Lead Correctly
2. Assignment Sheet #2 - Operate a Braddock Rowe Triangle to Construct Guidelines
3. Assignment Sheet #3 - Operate an Ames Type Lettering Guide to Construct Guidelines
4. Assignment Sheet #4 - Construct Vertical Gothic Lettering and Numerals
5. Assignment Sheet #5 - Construct Inclined Gothic Lettering and Numerals
6. Assignment Sheet #6 - Construct Vertical Lower-Case Gothic Lettering
7. Assignment Sheet #7 - Construct Inclined Lower-Case Gothic Lettering
8. Assignment Sheet #8 - Prepare Vertical and Inclined Lettering Exercises

F. Test

F. Answers to Test

II References:


LETTERING
UNIT II

INFORMATION SHEET

I. Condensed and extended letters (Transparency 1)
   A. Condensed--Letters that are narrower and spaced closer together than normal
      (NOTE: Condensed letters may sometimes be referred to as compressed letters.)
   B. Extended--Letters that are wider than normal

II. Boldface and lightface letters (Transparency 1)
   A. Boldface--Letters made up of heavy components
   B. Lightface--Letters made up of thin components

III. Reasons and rules for neat lettering
   A. Since approximately 20% of a drafter's time is used in lettering, neat lettering conserves time and money for the individual and the company
   B. Lettering can greatly affect the overall appearance of a drawing
   C. Most drawings are reproduced, therefore, the lettering must be done with neatness, accuracy, speed, legibility, and be a dense black
   D. The letters must be formed very carefully and not crowded together or they will run together when reproduced
   E. When additions or revisions are made to a drawing, the original style of lettering should be matched

IV. Guidelines for letter selection
   A. For machine drawings, upper case (capital) letters are used and may be vertical or inclined
      (NOTE: Vertical and inclined letters should never be mixed on the same drawing.)
   B. For topographic drawings or maps, lower case letters are used for notes
      (NOTE: Vertical letters are a little more legible than slant letters; however, they are more difficult to draw.)
V. Procedure for forming letters

A. The vertical or inclined strokes of letters are usually formed by finger movement.

B. The horizontal strokes of letters are made by a movement of the hand and wrist alone with a very slight finger movement.

C. Ovals of the letters are formed by a movement of the hand and fingers together.

D. The forearm should be at a 90° angle to the area to be lettered, and rest on the drawing board for all lettering movements.

VI. Rules for left-handed drafters

A. The left-handed drafter should follow a system of strokes that will involve pulling the pen or pencil instead of pushing it.
   (Note: Pushing the pen or pencil tends to dig into the paper.)

B. Vertical and inclined strokes should be done from top to bottom.

C. Movement on horizontal strokes should be done from right to left.
   (Note: When lettering, a left-hander should normally take a position exactly opposite that of a right-hander; the left-handers that letter with a hooked wrist have more difficulty and must adopt a system that seems best for their own particular habits.)

VII. Purposes of guidelines

A. To keep letters exactly the same height.

B. To keep letters spaced properly.

C. To keep letters positioned in the same direction.

D. To improve the overall composition of lettered information.

VIII. Lettering machines (Transparency, etc.)

A. Line should be uniform and corners squared with care to avoid surface

B. Horizontal lines should be made with the aid of a lettering guide.

C. Lettering should be reproducible.

D. Lettering guidelines should be accurately spaced.

E. Lettering should be neat and uniform, and of good design.

F. Lettering should be recognizable and legible.
INFORMATION SHEET

IX. Reasons for using Gothic single-stroke vertical and inclined lettering
A. Saves time in production
B. Easy to read and provides drawing consistency
C. Students learn to use it faster
D. Cost of drawings is reduced

X. Basic rules for learning to letter
(Note: When lettering, select a comfortable position either sitting or standing.)
A. Learn the shapes
B. Learn the strokes
C. Learn the rules of spacing
D. Learn to practice with a determination to improve
E. Master one letter at a time

XI. Rules for spacing
A. Spacing between letters is determined by the area between two letters (0.06" or 1.5 mm), not just the distance between two letters
B. The spacing of words is attained by using an imaginary letter "O" as a spacer
C. The spacing between two sentences is attained by using an imaginary double letter "OO" as a spacer
D. The space between two numerals separated by a decimal point (4.1) should be a minimum of 2/3 the height of the numerals
E. The space between lines of lettering should be a minimum of 1/2 the height of the lettering and a maximum of the same height as the lettering
F. Notes must be placed horizontally on the drawing
(Note: To identify separate notes, at least double the height of the character is used.)
G. Use underline lettering only when special emphasis is needed
(Note: The underline should be a minimum of 0.06" (1.5mm) below the lettering.)
INFORMATION SHEET

H. The division line in a common fraction should be parallel to the direction the dimension reads and the numerator and denominator of a fraction should be separated by a 0.06" (1.5mm) space.

RIGHT
\[
\frac{5}{8} \\
\frac{1}{4} \\
\frac{1}{2} \\
\frac{18}{64}
\]

WRONG
\[
\frac{5}{8} \\
\frac{1}{4} \\
\frac{1}{2} \\
\frac{18}{64}
\]

I. A diagonal line is permissible only when fractions are placed in lists, tables, or notes.

J. Each numeral in a fraction should be the same height as a whole number.

XII. Suggested leads

A. Lettering
   1. HB
   2. F
   3. H
   4. 2H

B. Constructing guidelines
   1. 4H
   2. 5H
   3. 6H
INFORMATION SHEET

4. Non-reproducible blue
   (NOTE: Guidelines should be light enough so that when a drawing is held at arms length they cannot be seen.)

XIII. Types of line guides used in laying out guidelines for lettering
   A. Braddock Rowe triangle
   B. Ames type lettering guide
   C. Parallelograph

XIV. Steps in using a Braddock Rowe triangle (Transparency 3)
   A. Align and secure paper to drawing surface with drafting tape on each corner
   B. Place Braddock Rowe triangle against top edge of drafting machine or parallel bar
   C. Select letter height which is expressed in 1/32 (3/32 through 8/32)
   D. Sharpen lead
   E. Place pencil in appropriate holes for height of letter required and move triangle across horizontal blade
   F. When lettering uppercase letters, omit the middle guideline which is used for lowercase letters
   G. Construct guidelines vertically by using vertical blade or a triangle
   H. Incline guidelines by using a 68° notch on the Braddock Rowe triangle

XV. Steps in using an Ames type lettering guide (Transparency 4)
   A. Align and secure paper to drawing surface with drafting tape on each corner
   B. Place Ames type lettering guide against top edge of drafting machine or parallel bar
   C. Select appropriate letter height which is expressed in 1/32 and can be selected by rotation of the circular selector
   D. Sharpen lead
   E. Place lead in appropriate holes for height of letter required and move Ames type lettering guide across top edge of blade in a smooth, light motion
   F. When lettering uppercase letters, omit the middle guideline which is used for lowercase letters
INFORMATION SHEET

G. Construct guidelines vertically by using vertical blade or triangle

H. Incline guidelines by using the 68° slope on the Ames type lettering guide

XVI Description of lettering instruments

A. Leroy lettering instrument—An instrument consisting of a template, a scribe, and an inking pen (Transparency 5)

(NOTE: A guide pin follows grooved letters in a template, and the ink point moves on the paper. Various sizes and styles of guides are available.)

B. Varigraph—A device for making a wide variety of either single stroke or "built-up" letters (Transparency 6)

(NOTE: Angle of letters, size, and height of letters can be changed by adjustments on the body of the scriber.)

C. Letterguide—An instrument much like the varigraph (but simpler) which also makes a large variety of styles and sizes of letters (Transparency 6)

(NOTE: It also operates with a guide pin moving in the grooved letters of the template while the pen, which is mounted on the adjustable arm, makes the letters in outline.)

D. Varityper—An instrument which uses a one-time carbon ribbon and has a near-standard typewriter keyboard with an open ended carriage (Transparency 6)

(NOTE: This allows it to receive various size drawings. Hundreds of instantly changeable typefaces are available for the varityper.)

E. Template—A thin, flat sheet of plastic with letters cut through the sheet (Transparency 6)

(NOTE: A pin is inserted into the groove and moved back and forth to form the shape of the letter. Spacing of individual letters must be done virtually.)

F. Lettering machine—A machine that produces "Type on tape" (Transparency 7)

(NOTE: Bold black letters come out of a transparent tape that can be attached directly to the surface of a drawing. Type dies for the machine are easily interchangeable and come in four popular type styles and six type sizes ranging from 8 to 30 point.)
XVII. Rules concerning different types of lettering

A. Vertical Gothic (Transparency 8)

1. The number 1 and letter I have no width.
2. The width of the letter W is 1 1/3 times its height.
3. Letters that are equal in height and width are A, M, O, Q, T, V, X, Y.
4. All other letters not noted above have a width 5/6 their height.
5. All numerals except the numeral one have a width 5/6 their height.
6. If the center area of the following letters is placed at midheight of the line, it appears to be below center; therefore, these strokes are placed slightly above the center point of these letters: B, E, F, and H.
7. When the heights vary on upper case letters, the small upper case letters are to be 2/3 to 4/5 the height of the large upper case lettering.

Example: LETTERING

8. Lettering is not writing but freehand drawing, and the six fundamental strokes of freehand drawing are used in lettering.

Examples:

- Vertical
- Inclined

B. Inclined Gothic (Transparency 9)

1. The same rules for letter sizes and spacing that apply in vertical lettering apply in inclined lettering.
2. Circular parts of letters should be made elliptical by having the major axis inclined at a 45° angle to the horizontal so they will appear to slant properly to the right.
INFORMATION SHEET

3. The letters A, V, W, X, and Y have sloping sides and are difficult to make unless an imaginary inclined center line is used and the letter is drawn symmetrically around it.

(NOTE: This method is a good one for beginning drafters to practice.)

C. Vertical Gothic lower-case (Transparency 10)

1. The shapes of vertical lower-case lettering are based on the circle, circular arc, and straight line.

(NOTE: There are some variations.)

2. The third stroke of the e is slightly above midheight of the letter.

3. The horizontal strokes of the f and t are placed on the waist line, and are an equal distance from stroke number 1.

4. On the letters h, m, n, and r, the curved strokes intersect the first stroke at roughly 2/3 the distance from the base line to the waist line.

5. On the letters g, j, and y, the descenders form a curve tangent to the drop line.

6. The letters p and q terminate without curves on the drop line.

7. When upper case and lower case letters are used, the lower case letter should be 2/3 the height of the uppercase letter.

(NOTE: An exception to this rule is lettering for microfilm.)

8. On lower-case letters, the ascending or descending stems are equal in length to the height of the capitals.

D. Inclined Gothic lower-case (Transparency 11)

1. The same rules for letter sizes and spacing that apply in vertical lettering apply in inclined lettering.

2. Circular parts of letters should be made elliptical by having the major axis inclined at a 45° angle to the horizontal so they will appear to slant properly to the right.

3. The letters c, o, s, v, w, x, and z have the same form as their corresponding capitals.
XVIII. Paper size and lettering standards

A. Paper size and letter height

<table>
<thead>
<tr>
<th>Standard U.S. Paper Size</th>
<th>Metric Paper Size</th>
<th>Recommended Lettering Height</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Millimeters</td>
<td>Decimals (Inches)</td>
</tr>
<tr>
<td>A</td>
<td>A4</td>
<td>3.2</td>
</tr>
<tr>
<td>B</td>
<td>A3</td>
<td>3.2</td>
</tr>
<tr>
<td>C</td>
<td>A2</td>
<td>4.0</td>
</tr>
<tr>
<td>D</td>
<td>A1</td>
<td>4.8</td>
</tr>
<tr>
<td>E</td>
<td>A0</td>
<td>4.8</td>
</tr>
</tbody>
</table>

(NOTE: The larger the drawing size the larger the lettering required.)

XIX. Common problems in lettering uniformity (Transparencies 12 and 13)

A. Letters are not uniform in height
B. Letters are not inclined or vertically uniform
C. Letters are not uniform in stroke thickness
D. Areas are not uniform between letters
E. Style of letters is not uniform
F. Areas are not uniform between words

XX. Common problems in lettering stability (Transparencies 12 and 13)

A. On some letters, if the top portion is the same width as the bottom, the letters appear to be top heavy
B. If the center area of certain letters is placed at midheight to the line, it appears to be below center, therefore these strokes are placed slightly above the center point of the letters B, E, F, and H
Condensed and Extended Lettering

CONDENSED LETTERS
EXTENDED LETTERS

Vertical

Condensed Letters
Extended Letters

Inclined

BOLDFACE LIGHTFACE

Boldface and Lightface Letters
Rules for Making Guidelines

Step A

Step B

Step C

Step D

Step E

Step F

Step G
Steps in Using a Braddock Rowe Triangle
Steps in Using an Ames Type Lettering Guide
Types of Lettering Instruments

Leroy Lettering Instrument

Pen

Scriber

Template

ABCDEFGHJKLMNPQRSTUVWXYZ
Types of Lettering Instruments

b. Varigraph, Italic Model Headwriter

Varigraph, Inc.

VariTyper Corporation

d. Vari Typer Office Composing Machine, Model 660

c. Letterguide

e. Template
Types of Lettering Instruments

Lettering Machine
(Note--Available in either Manual or Electric)
Vertical Gothic Lettering

ABCDE
JIKLMNOPQRSTUVWXYZ
0123456789
Inclined Gothic Lettering

A B C D E F G H I
J K L M N O P Q R
S T U V W X Y Z &

1 2 3 4 5 6 7 8 9 0
Vertical Gothic Lower Case Lettering

dabcdefghij

mnopqrstuvwxyz
Inclined Gothic Lower Case Lettering

a b c d e f g h i j k l m n o
p q r s t u v w x y z
Inclined Lettering Uniformity

*UNIFORM*

**A** Letters not uniform in height

**UNIFORM**

**B** Letters are not uniformly inclined

**UNIFORM**

**C** Letters not uniform in stroke thickness

**UNIFORM**

**D** Areas are not uniform between letters

**UNIFORM**

**E** Style of letters is not uniform

**GOOD LETTERINGS SHOULD BE UNIFORM**

**F** Areas are not uniform between words

**UNIFORM**

**G** Uniform lettering

Lettering Stability

**TOP-HEAVY LETTERS**

**CORRECT LETTERS**
Vertical Lettering Uniformity

A. Letters not uniform in height

B. Letters are not vertically uniform

C. Letters not uniform in stroke thickness

D. Areas are not uniform between letters

E. Style of letters is not uniform

F. Areas are not uniform between words

G. Uniform lettering

Good letterings should be uniform

Lettering Stability

Top-heavy letters: D G E K S X Z 2 3 5 8

Correct letters: D G E K S X Z 2 3 5 8
LETTERING
UNIT II

ASSIGNMENT SHEET #1--SELECT AND SHARPEN LEAD CORRECTLY

I. Tools and equipment
   A. Lead holder or pencil
   B. Lead pointer
   C. Drawing paper or media
   D. Pencil pointer
   E. Paper towel or cleaning cloth
   F. Styrofoam point cleaner or tissue

II. Procedure
   A. Select correct lead weight
   B. Sharpen lead to correct point
   C. After lead has been sharpened correctly, remove excess graphite from pencil using styrofoam point cleaner or tissue

   (NOTE: This will prevent lead from smudging drawing.)

Pencil

Lead Holder
LETTERING
UNIT II

ASSIGNMENT SHEET #2-OPERATE A BRADDOCK ROWE TRIANGLE TO CONSTRUCT GUIDELINES

I. Tools and equipment
   A. Braddock Rowe triangle
   B. Drafting machine or parallel bar
   C. Lead holder
   D. Drawing media
   E. Drawing surface

II. Procedure (Transparency 3)
   A. Align and secure paper to drawing surface with drafting tape on each corner
   B. Place Braddock Rowe triangle against top edge of machine or bar
   C. Select letter height which is expressed in 1/32 (3/32 through 8/32 are indicated on the triangle)
   D. Sharpen lead
   E. Place pencil in appropriate holes for height of letter required and move triangle across horizontal blade
   F. Omit the middle guideline which is used for lowercase letters when lettering uppercase letters

(NOTE: Guidelines may be constructed vertically by using vertical blade or triangle.)
LETTERING
UNIT II

ASSIGNMENT SHEET #3: OPERATE AN AMES TYPE LETTERING GUIDE TO CONSTRUCT GUIDELINES

I. Tools and equipment
   A. Ames type lettering guide
   B. Drafting machine or parallel bar
   C. Lead holder
   D. Drawing media
   E. Drawing surface

II. Procedure (Transparency 4)
   A. Align and secure paper drawing surface with drafting tape on each corner
   B. Place Ames type lettering guide against top edge of machine or bar
   C. Select appropriate letter height which is expressed in 1/32
      (NOTE: It can be selected by rotation of the circular selector.)
   D. Sharpen lead
   E. Place lead in appropriate holes for height of letter required and move Ames type lettering guide across top edge of blade in a smooth light motion
   F. Omit the middle guideline which is used for lowercase letters when lettering uppercase letters
      (NOTE: Guidelines may be constructed vertically by using vertical blade or triangle.)
Diagram of the procedure:

- Step A
- Step B
- Step C
- Step D
- Step E
- Step F

ASSIGNMENT SHEET 72
LETTERING
UNIT II

ASSIGNMENT SHEET #4: CONSTRUCT VERTICAL GOTHIC LETTERING AND NUMERALS

I Tool and equipment
A. Lead holder or pencil
B. Drafting tape
C. Drawing surface
D. Scale or lettering guide
E. Drafting machine or parallel bar
F. Pencil pointer

II. Procedure (Transparency 8)
A. Secure lettering exercise paper to surface with tape
B. Prepare point of lead for lettering
C. Hold lead holder in correct position
D. Study forms and strokes of letters and numerals shown in diagram
E. Copy letters and numerals on guidelines
   (NOTE: Use proper form and stroke techniques.)

III. Diagram of the procedure
A. Obtain A size drawing media
ASSIGNMENT SHEET #4

B. Prepare point of lead

(NOTE. Point should be dulled slightly to give desired width of letter elements.)

C. Use correct lead position

(NOTE. Use an even pressure and rotate the lead in the fingers after every few strokes to get uniform lines.)

D. Study form of letters

(NOTE. Trace over letters to learn strokes of each letter and numeral.)

AB cD EFGHIJKL MNOPQR Sss TUu VW XYZ 123 45 67 89 0
ASSIGNMENT SHEET #4

E. Construct guidelines

(NOTE: Space 1/4" apart and copy letters and numerals shown in step D. Use space below for lettering exercise.)
LETTERING
UNIT II

ASSIGNMENT SHEET #5-CONSTRUCT INCLINED GOThic LETTERING AND NUMERALS

Tools and equipment
A. Lead holder or pencil
B. Drafting tape
C. Drawing surface
D. Scale or lettering guide
E. Drafting machine or parallel bar
F. Pencil pointer

II. Procedure (Transparency 9)
A. Secure lettering exercise paper to drawing surface with tape
B. Prepare point of lead for lettering
C. Hold lead holder in correct position
D. Study forms and strokes of letters and numerals shown in diagram
E. Copy letters and numerals on guidelines
   (NOTE: Use proper form and stroke techniques.)

III. Diagram of the procedure
A. Obtain A size drawing media
ASSIGNMENT SHEET #5

B. Prepare point of lead

(NOTE: Point should be dulled slightly to give desired width of letter elements.)

C. Use correct pencil position

(NOTE: Use even pressure or rotate lead in fingers after every few strokes to get uniform lines.)

D. Study form of letters

(NOTE: Trace over letters to learn strokes of each letter and numeral.)

ABCDEFGHI
JKLMNOPQR
STUWXYZ

1234567890
ASSIGNMENT SHEET #5

E. Construct guidelines

(NOTE: Space 1/4" apart and copy letters and numerals shown in step D. Use space below for lettering exercise.)
ASSIGNMENT SHEET #6-CONSTRUCT VERTICAL LOWER-CASE GOTHIC LETTERING

I. Tools and equipment
   A. Lead holder or pencil
   B. Drafting tape
   C. Drawing surface
   D. Scale or lettering guide
   E. Drafting machine or parallel bar
   F. Pencil pointer

II. Procedure (Transparency 10)
   A. Secure lettering exercise paper to drawing surface with tape
   B. Prepare point of lead for lettering
   C. Hold lead holder in correct position
   D. Study forms and strokes of letters and numerals shown in diagram
   E. Copy letters and numerals on guidelines using proper form and stroke techniques

III. Diagram of the procedure
   A. Obtain A size drawing media
ASSIGNMENT SHEET #6

B. Prepare point of lead

(NOTE: Point should be dulled slightly to give desired width of letter elements)

C. Use correct pencil position

(NOTE: Use an even pressure and rotate the lead in the fingers after every few strokes to get uniform lines.)

D. Study form of letters

(NOTE: Trace over letters to learn strokes of each letter and numeral)

a b c d e f g h i j k l
m n o p q r s t u v w x y z
ASSIGNMENT SHEET #6

E. Construct guidelines

(NOTE: Space 1/4" apart and copy letters and numerals shown in step D. Use space below for lettering exercise.)
LETTERING
UNIT II

ASSIGNMENT SHEET #7--CONSTRUCT INCLINED LOWER-CASE GOTHIC LETTERING

I. Tools and equipment
   A. Lead holder or pencil
   B. Drafting tape
   C. Drawing surface
   D. Scale or lettering guide
   E. Drafting machine or parallel bar
   F. Pencil pointer

II. Procedure (Transparency 11)
   A. Secure lettering exercise paper to drawing surface with tape
   B. Prepare point of lead for lettering
   C. Hold lead holder in correct position
   D. Study forms and strokes of letters and numerals shown in diagram
   E. Copy letters and numerals on guidelines using proper form and stroke techniques

III. Diagram of the procedure
   A. Obtain A size drawing media
ASSIGNMENT SHEET #7

B. Prepare point of lead

(NOTE: Point should be dulled slightly to give desired width of letter elements.)

C. Use correct pencil position

(NOTE: Use an even pressure and rotate the lead in the fingers after every few strokes to get uniform lines)

D. Study form of letters

(NOTE: Trace over letters to learn strokes of each letter and numeral.)

a b c d e f g h i j k l m n o p q r s t u v w x y z
ASSIGNMENT SHEET #7

E. Construct guidelines

(NOTE: Space 1/4" apart and copy letters and numerals shown in step D. Use space below for lettering exercise.)
LETTERING
UNIT II

ASSIGNMENT SHEET #8-PREPARE VERTICAL AND INCLINED LETTERING EXERCISES

I. Tools and equipment
   A. Lead holder or pencil
   B. Drafting tape
   C. Drawing surface
   D. Scale or lettering guide
   E. Drafting machine or parallel bar
   F. Pencil pointer

II. Procedure
   A. Complete vertical lettering exercise—uppercase
      1. Secure A size drawing media to drawing surface and lay out sheet as shown in diagram
      2. Use proper form and strokes to complete exercise of vertical letters and numerals as assigned by instructor
      3. Use A size media with 1/2" borders; use guidelines as shown
   B. Complete inclined lettering exercise—uppercase
      1. Secure A size drawing media to drawing surface and lay out sheet as shown in diagram
      2. Use proper form and strokes to complete exercise of inclined letters and numerals as assigned by instructor
      3. Use A size media with 1/2" borders; use guidelines as shown
III. Diagram of the procedure

A. Vertical lettering

B. Inclined lettering
LETTERING
UNIT II

NAME ____________________________

TEST

1. Differentiate between condensed and extended letters by placing an "X" to the left of the description of extended letters.
   a. Letters that are narrower and spaced closer together than normal
   b. Letters that are wider than normal

2. Differentiate between boldface and lightface letters by placing an "X" to the left of the description of lightface letters.
   a. Letters made up of thin components
   b. Letters made up of heavy components

3. Select true statements concerning the reasons and rules for neat lettering by placing an "X" in the appropriate blanks.
   a. Since approximately 60% of the drafter's time is used in lettering, both time and money are saved by the individual or company
   b. Lettering can greatly affect the overall appearance of a drawing
   c. Although letters must be formed very carefully, skill should be used to letter as much as possible in a limited space
   d. When additions or revisions are made to a drawing, the original style of lettering should be matched
   e. Most drawings are reproduced, therefore, the lettering must be done with neatness, accuracy, speed, legibility, and be a dense black

   a. ____________________________
   b. ____________________________

5. Select true statements concerning the procedures for forming letters by placing an "X" in the appropriate blanks.
   a. Ovals of the letters are formed by a movement of the hand and fingers together
   b. The forearm should be at a 90° angle to the area to be lettered, and rest on the drawing board for all lettering movements
The vertical or inclined strokes of letters are usually formed by finger and wrist movement.

The horizontal strokes of lettering are made by a movement of the hand at the wrist along with a very slight finger movement.

6. Select true statements concerning rules for left-handed drafters by placing an "X" in the appropriate blanks.

   a. Vertical and inclined strokes should be done from top to bottom
   b. Movement on horizontal strokes should be done from left to right
   c. The left-handed drafter should follow a system of strokes that will involve pulling the pen or pencil instead of pushing it

7. Select from the following list the purposes of guidelines by placing an "X" in the appropriate blanks.

   a. To keep letters spaced properly
   b. To improve the overall composition of lettered information
   c. To keep letters exactly the same width
   d. To maintain correctness in drawing illustrations
   e. To keep letters exactly the same height
   f. To keep letters positioned in the same direction

8. Select true statements concerning rules for making guidelines by placing an "X" in the appropriate blanks.

   a. Make vertical guidelines with the aid of a lettering guide
   b. Align paper and secure corners with tape to working surface
   c. Horizontal guidelines should be accurately spaced
   d. Although guidelines are often useful, they are not necessary when a Brad-dock Rowe triangle is used
   e. Guidelines should not reproduce

9. List three reasons for using Gothic single stroke vertical and inclined lettering:

   a. 
   b. 
   c. 

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10. Select from the following list basic rules for learning to letter by placing an "X" in the appropriate blanks.

   a. Learn the strokes
   b. Master groups of five letters at a time
   c. Master one letter at a time
   d. Learn the shapes
   e. Learn the rules of spacing
   f. Learn the sizes
   g. Learn to practice with a determination to improve

11. Select true statements concerning rules for spacing by placing an "X" in the appropriate blanks.

   a. The spacing of words is attained by using an imaginary letter "O" as a spacer
   b. Notes must be placed vertically on the drawing
   c. Use underline lettering only when special emphasis is needed
   d. The division line in a common fraction should be parallel to the direction the dimension reads and the numerator and denominator of a fraction should be separated by a 0.06" space
   e. The spacing between two sentences should always be 1/4"
   f. Spacing between letters is determined by the area between two letters, not just the distance between two letters
   g. Each numeral in a fraction should be the same width as a whole number

12. Distinguish between suggested leads for lettering and those used for constructing guidelines by placing an "X" to the left of those used in lettering.

   a. Non-reproducible blue
   b. H
   c. 2H
   d. 4H
   e. 5H
   f. 6H
   g. F
   h. HB
13. List three types of line guides used for laying out guidelines for lettering.
   a. _________________________________
   b. _________________________________
   c. _________________________________

14. Arrange in order the suggested steps in using a Braddock Rowe triangle by placing a "1" to the left of the first step and continue through all steps.
   a. Sharpen lead
   b. Select letter height which is expressed in 1/32
   c. Align and secure paper to drawing surface with drafting tape on each corner
   d. When lettering uppercase letters, omit the middle guideline which is used for lowercase letters
   e. Incline guidelines by using a 68° notch on the Braddock Rowe triangle
   f. Place pencil in appropriate holes for height of letter required and move triangle across horizontal blade
   g. Place Braddock Rowe triangle against top edge of drafting machine or parallel bar
   h. Construct guidelines vertically by using vertical blade or a triangle

15. Arrange in order the suggested steps in using an Ames type lettering guide by placing a "1" to the left of the first step and continue through all steps.
   a. Place Ames type lettering guide against top edge of drafting machine or parallel bar
   b. Sharpen lead
   c. Incline guidelines by using the 68° slope on the Ames type lettering guide
   d. Align and secure paper to drawing surface with drafting tape on each corner
   e. Construct guidelines vertically by using vertical blade or triangle
   f. When lettering uppercase letters, omit the middle guideline which is used for lowercase letters
   g. Select appropriate letter height which is expressed in 1/32 and can be selected by rotation of the circular selector
   h. Place lead in appropriate holes for height of letter required and move Ames type lettering guide across top edge of blade in a smooth, light, motion
16. Match the names of the lettering instrument on the right with the correct description.

   a. A machine that produces "Type on tape"  
    1. Letterguide
   b. An instrument consisting of a template, a scriber, and an inking pen  
    2. Varityper
   c. A thin, flat sheet of plastic with letters cut through the sheet  
    3. Lettering machine
   d. An instrument which uses a one-time carbon ribbon and has a near-standard typewriter keyboard with an open ended carriage  
    4. Template
   e. An instrument much like the varigraph which also makes a large variety of styles and sizes of letters  
    5. Leroy lettering instrument
   f. A device for making a wide variety of either single stroke or "built-up" letters  
    6. Varigraph

17. Select true statements concerning rules for different types of lettering by placing an "X" in the appropriate blanks.

   a. In vertical Gothic lettering the number 1 and letter I have no width  
       X
   b. In vertical Gothic lettering all numerals except the number one have a width equal to their height  
       X
   c. The same rules for letter sizes and spacing that apply in vertical lettering apply in inclined lettering  
       X
   d. In inclined Gothic lettering, the letters A, V, W, X, and Y have sloping sides and are difficult to make unless an imaginary inclined center line is used and the letter is drawn symmetrically around it  
       X
   e. In vertical Gothic lower-case lettering, the letters p and g terminate without curves on the waist line
       X
   f. The shapes of vertical Gothic lower-case lettering are based on the circle, circular arc, and the straight line  
    
   g. In inclined Gothic lower-case lettering, the letters c, o, s, v, w, x, and z have the same form as their corresponding capitals  
    
   X
18. Complete the following chart showing recommended lettering height in relation to paper size.

<table>
<thead>
<tr>
<th>Standard U.S. Paper Size</th>
<th>Metric Paper Size</th>
<th>Recommended Lettering Height</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Millimeters</td>
</tr>
<tr>
<td>a. __________</td>
<td>f. __________</td>
<td>3.2</td>
</tr>
<tr>
<td>b. __________</td>
<td>g. __________</td>
<td>3.2</td>
</tr>
<tr>
<td>c. __________</td>
<td>h. __________</td>
<td>4.0</td>
</tr>
<tr>
<td>d. __________</td>
<td>i. __________</td>
<td>4.8</td>
</tr>
<tr>
<td>e. __________</td>
<td>j. __________</td>
<td>4.8</td>
</tr>
</tbody>
</table>

19. Identify common problems in lettering uniformity by stating the problems under each of the following examples.

a. GOOD LETTERING SHOULD UNIFORM BE UNIFORM

b. UNIFORM

c. UNIFORM

d. UNIFORM

e. Uniform

20. Discuss two common problems in lettering stability.

a.

b.

21. Demonstrate the ability to:

da. Select and sharpen lead correctly.

b. Operate a Braddock Rowe triangle to construct guidelines.

c. Operate an Ames type lettering guide to construct guidelines.

d. Construct vertical Gothic lettering and numerals.
LETTERING
UNIT II

ANSWERS TO TEST

1. b
2. a
3. b, d, e
4. a. For machine drawings, upper case letters are used and may be vertical or inclined
   b. For topographic drawings or maps, lower case letters are used for notes
5. a, b, d
6. a, c
7. a, b, e, f
8. b, c, e
9. Any three of the following:
   a. Saves time in production
   b. Easy to read and provides drawing consistency
   c. Students learn to use it faster
   d. Cost of drawings is reduced
10. a, c, d, e, g
11. a, c, d, f
12. b, c, g, h
13. a. Braddock Rowe triangle
    b. Ames type lettering guide
    c. Parallelograph
14. a 4  e. 8
    b. 3  f. 5
    c. 1  g. 2
    d. 6  h. 7
15. a 2  e. 7
    b. 4  f. 6
    c. 8  g. 3
    d. 1  h. 5
16. a 3  d. 2
    b 5  e. 1
    c 4  f. 6
17. a, c, d, f, g
18. a. A  
   b. B  
   c. C  
   d. D  
   e. E
   f. A4  
   g. A3  
   h. A2  
   i. A1  
   j. A0

19. a. Areas are not uniform between words  
   b. Areas are not uniform between letters  
   c. Letters are not uniform in height  
   d. Letters are not inclined or vertically uniform  
   e. Style of letters is not uniform  
   f. Letters are not uniform in stroke thickness

20. Discussion should include:  
   a. On some letters, if the top portion is the same width as the bottom, the letters appear to be top heavy  
   b. If the center area of certain letters is placed at midheight to the line, it appears to be below center; therefore, these strokes are placed slightly above the center point of the letters B, E, F, and H

21. Performance skills evaluated to the satisfaction of the instructor
UNIT OBJECTIVE

After completion of this unit, the student should be able to list the materials and processes involved in blueprinting and other reproduction activities in drafting. The student should also be able to list materials and processes in microfilming and operate reproduction equipment. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment and job sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to reproduction with their correct definitions.
2. Distinguish between two types of blueprint machines.
3. Select true statements concerning the uses of the blueprint process.
4. List two advantages and two disadvantages of blueprints.
5. Match materials, equipment, and characteristics of diazo dry and wet processes with their correct definitions.
6. Select true statements concerning important factors in the diazo dry print process.
7. List advantages of the diazo dry print process.
8. Select true statements concerning the diazo wet print process and its advantages.
9. List common problems in the diazo dry print process and how to correct them.
10. Select true statements concerning how to safely use erasing chemicals in diazo processing.
11. Discuss the need for correct linework density and how to test for it.
12. Match basic elements of microfilming with their correct definitions.
13. List suggestions for preparing drawings to be microfilmed.
14. Select true statements concerning the advantages of microfilm.
15. Describe the purpose and method for making reproducibles from existing drawings.
16. Select true statements concerning the uses and procedures for paste-up drafting.
17. Select true statements concerning the characteristics of appliques.
18. Arrange in order the steps in using transfer appliques.
19. Arrange in order the steps in using cutout appliques.
20. List elements of a proper drawing control system.
21. List ways a proper drawing control system benefits a drafting organization.
22. Discuss correct storage of drawings and prints.
23. Discuss the proper distribution of completed drawings.
24. Demonstrate the ability to:
   a. Make blueline or blackline prints.
   b. Operate a blueline machine.
REPRODUCTION
UNIT III

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.
II. Provide student with information, assignment, and job sheets.
III. Make transparencies.
IV. Discuss unit and specific objectives.
V. Discuss information sheet.
VI. Discuss the procedures outlined in the assignment and job sheets.
VII. Discuss with the class the safety precautions required when using chemicals in various reproduction processes.
VIII. Have examples available of materials reproduced by methods other than blue-printing or the diazo processes such as Thermo-Fax or Verifax.
IX. Demonstrate how to operate a print machine.
X. Demonstrate how to clean a print machine.
XI. Discuss other types of reproduction methods.
XII. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objective sheet
   B. Information sheet
   C. Transparency masters
      1. TM 1--Reproduction Processes
      2. TM 2--Blueprint Process
      3. TM 3--Dry Print Process
      4. TM 4--Moist Print Process
      5. TM 5--Fourth Generation Reproduction
      6. TM 6--Microfilm System from Original Drawing to Distribution of Prints or Aperture Cards
Assignment Sheet #1 Make Blueline or Blackline Prints

Job Sheet #1 Operate a Blueline Machine

Text

Answers to text

References


6. Vocational, Curriculum Development and Research Center Basic Drafting Lafayette, Louisiana 71457 State of Louisiana Vocational Curriculum Development and Research Center, revised 1979
REPRODUCTION
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Drawing reproduction--Making copies from completed drawings (Transparency 1)

B. Back curl--The curl of paper toward the uncoated side

C. Face curl--The curl of paper toward the coated side

D. Silk screening--Stenciling through a silk screen to form an image

E. Brownprint process--Reproduction method using light-sensitive iron and silver salts which will produce a negative sepia image from a positive master

F. Composite print--Print made by combining the parts of two or more masters

G. Contact print--Print made by placing a master or an original in contact with light-sensitive material while exposure is being made

H. Contrast--The difference between the image and background areas of a print

I. Core--Tube on which print paper, film, sepia, or other material is wound

J. Density--The darkness of an image (linework or lettering) area

K. Developer--Chemical agent used for treating an exposed light-sensitive material to make the image visible to the eye

L. Development--Any process used for rendering an image visible

M. Discoloration--Yellowing or other color changes of white areas on prints

N. Double coated stock--Duplicating material which has a sensitized layer on each side

O. Double feed--Improper feeding of two sheets of duplicating paper instead of one

P. Eradicator--Chemical solution containing acid designed to bleach out unwanted portions of a print
INFORMATION SHEET

G. Exposure: Time period that light of a given intensity has been allowed to act on light-sensitive material.

H. Fading: Loss in density of an image.

I. Master: Any original to be duplicated.

J. Positive: An image on materials such as paper or film on which light tones appear light and dark tones appear dark when copied from a pencil or ink drawing.

K. Negative: An image on materials such as paper or film where the background is dense black and the fine image appears clear (film) or white (paper).

L. Overlay: A group of transparent or translucent prints normally used to form a composite.

M. With the grain: The direction in which most of the paper fibers are oriented, usually in the direction of the longest dimension of the sheet.

N. Autopositive: A print or intermediate made on paper or foil by means of a positive to positive silver type emulsion.

O. Blueprint process: A wet process of drawing reproduction using light, water, and chemicals (Transparency). The original drawing serves as the negative.

NOTE: Basically a photographic process, the original drawing serves as the positive.

P. Blueprinting machine: A machine which combines exposure, washing, and drying in one continuous operation.

NOTE: After the paper has been exposed for the proper length of time, it is often subject to a developing bath or a fixing bath, or to a fixing bath and washing in a separate washer.

Q. Continuous blueprint machine: A machine in which the sheets are fed continuously for exposure only, then washed in a separate washer.
C. Best results are obtained when the original tracing is drawn in ink on cloth or vellum, and pencil drawings linework and lettering are jet black.

D. Corrections and changes can be made on blueprints with an alkaline solution of adequate strength to destroy the blue background compound; a caustic soda solution of 1.5 percent is normally used.

(NOTE: When a blueprint machine is not available, prints can be made by exposing the drawing and print paper to sunlight while they are held tightly together under a piece of glass, or in a device called a sun frame.)

IV. Advantages and disadvantages of blueprints

A. Advantages
   1. They do not soil easily
   2. They do not fade easily
   3. They are readily subject to field changes

B. Disadvantages
   1. Preparation of print is time consuming
   2. Much space is required for processing

V. Materials, equipment, and characteristics of diazo dry and wet processes

A. Diazo dry print process--A dry process of reproduction that uses ultraviolet light, (carbon arc, mercury vapor lamp, or, if necessary, sunlight) and is developed by ammonia vapors as an alkaline agent (Transparency 3)

B. Diazo wet print process--A wet process of reproduction that uses ultraviolet light and is developed by a liquid developer or activator fluid (Transparency 4)

C. Activator fluid--A liquid used in the diazo wet process which causes the image line to form when brought into contact with the unexposed portion of the diazo sensitized material

D. Printing speed--A media's passage of actinic light which in turn affects the speed of the media's print making ability through conventional exposure equipment

(NOTE: Printing speed is also the rate of speed at which light-sensitive material is exposed, normally expressed in feet per minute of printer operation.)

E. Diazo paper--A reproduction paper which depends on the light-sensitivity of the diazo compound (photosensitive Diazonium salt) used during manufacturing
INFORMATION SHEET

F. Filing aging - The change in appearance of a diazo print in storage not exposed to light.

G. Film positive - Film base which carries a positive image, often a photographic material which it necessary can serve as master for diazo-type prints.

H. Printer section - Area of print machine used to expose light sensitive materials.

I. Developer section - Area of print machine used to develop light sensitive materials.

J. Shelf life - Time period before deterioration renders a sensitized material unusable.

K. Reproducible - Item capable of being used as a master for making prints.

L. Sensitized - A reproduction material coated with a light sensitive compound.

M. Intermediate - The translucent reproduction made on vellum, cloth, or foil made from an original drawing and used in place of the original for making other prints.

(Note: Sometimes the original is placed on the intermediate paper upside down so the drafter can draw on the side of the paper away from the dye lines. A typical use of copies occurs in architectural work when several copies are made of the basic floor plan of a building, the copies are then used for framing, plumbing, heating, ventilating and air conditioning, electrical, and reflected ceiling work.)

N. Polyester film - Diazo sensitized transparent cellulose acetates.

(Note: Polyester film is sometimes referred to as foil.)

O. Diazo color film - Diazo sensitized material for use with the diazo dry process to produce audiovisual aides.

VI. Important factors in the diazo dry print process

A. The process depends on the transmission of light through the original for the reproduction of positive prints.

B. Subject matter may be pen, pencil, typewritten, or printed matter, or any opaque image.

C. No negative step is involved; positives are used to obtain positive prints.

(Note: To remove the ammonia odor from the print, feed the print into the printer section with the back of the print next to the warm glass cylinder surrounding the lamp.)
VII. Advantages of the diazo dry print process
A. Sensitized materials can be handled under normal indoor illumination
B. Prints may have black, blue, or red lines on a white background depending upon which paper is used
C. Prints can be worked on easily with pen, crayon, or pencil
D. Intermediates can be made of the original to save wear on the original, these intermediates can be made on special paper (sepia), cloth, or foil
E. Changes can be made to intermediates with correction fluid

VIII. Diazo wet print process and its advantages
A. It is similar to the diazo dry process except paper is fed through a special developer which dampens the coated side of the paper with developing solution
B. Prints may have black, red, brown, or blue lines on a white background simply by selecting the appropriate paper

(NOTE: These prints along with diazo dry prints have largely replaced the more burdensome blueprint process.)

IX. Common problems in diazo dry print processing and how to correct them
A. Print with a green tint Ammonia may be too cold or too old or tubes controlling ammonia flow may be clogged, need cleaning, or flow adjusted
B. Print with streaking on it - Ammonia flow is excessive and needs to be adjusted

X. How to safely use erasing chemicals in diazo processing
A. Eradicator for sepia intermediates is a one-step method, but the eradicator contains acid and application should be made with care
B. Erasing-fluid for foils is a two-step method involving application of a first fluid containing hydrochloric acid

(NOTE: This reacts with the metallic silver in the sheet to produce a white salt of silver.)
C. The second step in erasing foils involves application of a fluid containing thiourea which dissolves the silver salt

(NOTE: The silver salt must be completely dissolved or it will re-appear as a yellow stain when exposed to light)
INFORMATION SHEET

D. After the second fluid is applied on foil, it should be washed to remove any residual chemicals.

(CAUTION: Prolonged skin contact or ingestion of erasing chemicals is dangerous. In case of skin contact, the chemicals should be flushed thoroughly with water. In case of ingestion, a doctor should be consulted immediately.)

XI. The need for correct linework density and how to test for it

A. In order for a drawing to reproduce properly the linework and lettering must be opaque and dense black because work that is not opaque will not print clearly.

B. To determine if linework and lettering are opaque and dense black, simply hold the drawing near a source of light.

XII. Basic elements of microfilming and their definitions

A. Microfilm-A roll of film bearing a photographic record.

(NOTE: Available sizes of microfilm are 16 mm, 35 mm, 70 mm, and 105 mm. 16 mm and 35 mm film are usually mounted in aperture cards or jackets, and 70 mm and 105 mm frames are generally stored in envelopes.)

B. Microfiche-A sheet of microfilm containing rows of micro images of drawings.

C. Aperture card-A computer card with a rectangular hole capable of holding a single frame of microfilm.

D. Jacket-Made of clear thin plastic and has channels for short strips of microfilm usually available for 16 or 35 mm.

E. Blowback-A print that has been enlarged from a micro-image (Transparency 5).

(NOTE: The blowback made from a microfilm or aperture card of an original drawing is a first generation print. A blowback made of this first generation print would then be a second generation print. The term "generation" is used to express quality required of the drawing being microfilmed. Fourth generation quality must be present in the original drawing to make all notes, dimensions, and linework clearly readable on the fourth generation print.)

F. Film copy-An enlarged print on paper, cloth, or foil made from a microfilm or aperture card.

(NOTE: Enlargements can be made by photographic, microstatite, or photopolymer methods.)
SUGGESTIONS FOR PREPARING DRAWINGS TO BE MICROFILMED

A. Check linework and lettering for uniformity and density

B. All lines of the same type must be the same width

C. Ink lines produce the best results on microfilm

   (NOTE: Ink lines are sharper, blacker and have more density than pencil lines. They also dry flat so there is less reflection.)

D. Experimentation should be done with various pencils, inks, and vellums

E. Lettering must be large enough to reduce photographically and then be enlarged without loss of clarity

Example: Some companies establish lettering height standards for microfilm; one such standard is as follows for 35 mm microfilm:

<table>
<thead>
<tr>
<th>Standard U.S. Paper Size</th>
<th>Metric Paper Size</th>
<th>Recommended Lettering Height</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Millimeters</td>
</tr>
<tr>
<td>A</td>
<td>A4</td>
<td>3.2</td>
</tr>
<tr>
<td>B</td>
<td>A3</td>
<td>3.2</td>
</tr>
<tr>
<td>C</td>
<td>A2</td>
<td>4.0</td>
</tr>
<tr>
<td>D</td>
<td>A1</td>
<td>4.8</td>
</tr>
<tr>
<td>E</td>
<td>A0</td>
<td>4.8</td>
</tr>
</tbody>
</table>

   (NOTE: The larger the drawing size the larger the lettering required.)

F. The letters must be formed very carefully and not crowded or they will run together when reduced

G. When lines of lettering are used, the space between the lines should be a minimum of one-half the height of the letters with more space between paragraphs

H. If lettering is typed on, care must be used to produce a dense, uniform, and solid letter

   (NOTE: Ribbons with too much ink smear, and worn ribbons, type, and typewriter platens produce a poor letter; carbon ribbons usually work best.)

I. Exercise care when erasing because all smears and dirt will show on the microfilm

   (NOTE: If a portion of the drawing is cut away and replaced with new material, the material should be of the same type and match the original background.)
INFORMATION SHEET

J. Keep drawing covered when not working on it; when working on the drawing, cover areas not needed, use a draftsman's brush and dry cleaning pad, and keep perspiration from hands and arms off the drawing.

K. Drawings that are to be microfilmed should be stored flat.

(NOTE. After drawings have been rolled or made from rolled stock they are difficult to flatten.)

L. Do not use the original drawing for reference; if a print is needed it should be made from the microfilm.

XIV Advantages of microfilm (Transparency 6)

A. Used where large numbers of drawings are involved.

B. Used to store drawing duplications in a small amount of filing space.

C. Used to duplicate copies for security purposes.

Examples: Burglary, vandalism, fire.

D. Aperture cards may be viewed in a reader, a full-size print may be made from a reader-printer unit when produced through a C size.

E. Aperture cards are basically the same as cards used in electronic computers; equipment is capable of sorting, filing, and retrieving these cards.

F. Duplicate aperture cards and drawing reproductions to any desired size may be produced on specialized equipment.

G. Microfilm drawings may be sent to another office at less expense than standard prints.

XV Purpose and method for making reproducibles from existing drawings.

A. Purpose—Used when a new drawing can be made from an existing drawing with only minor changes.

B. Method

1. Make transparent or translucent print of the original drawing.

2. Remove unwanted information from an old print and then add new information.

(NOTE. A problem may be encountered when old drawings do not conform with the newest drafting standards.)
XVI. Uses and procedures for paste-up drafting

A. Uses

1. With new designs, some features may be repetitive; therefore, paste-up drafting is possible

2. A major advantage of paste-up drafting is that it reduces drawing and rechecking time

B. Procedures

1. Make transparent or translucent print of the original drawing

2. Cut out needed existing drawings, charts, notes, or drawing forms

3. Arrange information on a clear acetate sheet using the correct size and proper arrangement

4. Tape pieces to the acetate sheet with transparent tape

5. Make a transparent or translucent print to form a new original

6. Remove pieces from the acetate sheet, discard used transparent tape, and remove transparent tape residue from the drawing pieces and acetate sheet

7. Store drawing pieces and acetate sheet for future use

8. Add additional drawings, dimensions, and notes

XVII. Characteristics of appliques

A. Appliques are overlays which are pressure-sensitive and printed on blank, transparent, or translucent sheets with adhesive backing

B. Time is saved when notes, symbols, shapes, or parts are used repeatedly

(Note: The mat surface on appliques will accept pencil or ink lines, and can be used in a typewriter.)

C. Appliques can be used for long notes which can be typed faster than they can be lettered, or for making changes or corrections to drawings or lists

D. Appliques are used extensively in industry, mostly in the piping and electronics areas

E. Appliques are available in two types, transfer and cutout
INFORMATION SHEET

XVIII. Steps in using transfer appliques

A. Remove the carrier from the image sheet
B. Place the image in the proper position on the drawing
C. Rub over the image to be transferred with a blunt object or a burnishing tool
D. Lift the transfer image carefully so the image will remain on the drawing
E. Place the carrier sheet over the image and rub or reburnish it again

(NOTE: Transfers sometimes crack with age or come off on the glass cylinder of a print machine, but they can be secured with transparent tape if tape is free of fingerprints and the tape dispenser ends are removed.)

XIX. Steps in using cutout appliques

A. Position the image in the correct location on the drawing and lightly mark reference points on the drawing
B. Lift the image and remove the backing material on the applique
C. Reposition the image in the correct place on the drawing and lightly rub or burnish it
D. Use a razor knife to cut away unwanted material from around the image
   (NOTE: Use caution with a razor knife so the media surface will not be cut; backing material should be used.)
E. Reburnish the area

XX. Elements of a proper drawing control system

A. Drawing numbers
B. Proper methods of filing
C. Microfilming
D. Security files
E. Print making and print distribution control

XXI. Ways a proper drawing control system benefits a drafting organization

A. Allows the person in charge to know the status of a drawing at all times
INFORMATION SHEET

B. Minimizes the possibility that an original drawing will be damaged from being handled for printing, changes, or checking.

C. Controls the distribution of prints to the appropriate people.

XXII. Correct storage of drawings and prints

A. Drawings may be stored in large, flat file drawers or hung vertically in a cabinet or a free-standing file.

B. Prints may be folded and filed in standard office file cabinets, or extra large prints can be rolled and stored in cabinets, tubes, or tubes in cabinets.

XXIII. Proper distribution of completed drawings

A. Whether prints or intermediates, copies should be made for distribution.

B. The original should NEVER be sent but...
Reproduction Processes

REPRODUCTION PROCESSES

PHOTOCHEMICAL

SPECIAL

MECHANICAL

TRANSMITTED LIGHT (CONTACT)
1. VANDYKE
2. BLUEPRINT
3. DIAZO, MOIST
4. DIAZO, DRY
5. PHOTOGRAPHIC CONTACT PRINT

REFLECTED LIGHT (PROJECTION)
1. PHOTOGRAPHIC REFLEX PRINT
2. PHOTOSTAT
3. MICROFILM

PRINTING
1. LITHOGRAPHY
2. PHOTOGRAVURE
3. LETTERPRESS

DUPLICATING
1. MIMEOGRAPH
2. HECTOGRAPH
3. TYPEWRITER
Blueprint Process

1. Tracing
   - Sensitized Paper
2. Light
3. Water Rinse
4. Drying

CONTACT
EXPOSURE
WATER WASH
POTASSIUM DICHROMATE BATH
WATER RINSE
DRYING
Dry Print Process

CONTACT

Sensitized Paper

EXPOSURE

DEVELOPING WITH AMMONIA VAPORS
Moist Print Process

1. Moist Print Process

2. Tracing

3. Sensitized Paper

4. EXPOSURE

5. CONTACT

6. LIQUID DEVELOPER
Fourth Generation Reproduction

ORIGINAL DRAWING

MASTER INTERMEDIATE OR MICROFILM

FIRST GENERATION REPRODUCTION MADE FROM MASTER INTERMEDIATE

SECOND GENERATION REPRODUCTION MADE FROM REVISION OF FIRST GENERATION REPRODUCTION (PRINT)

THIRD GENERATION REPRODUCTION MADE FROM REVISION OF SECOND GENERATION REPRODUCTION (PRINT)

FOURTH GENERATION REPRODUCTION MADE FROM REVISION OF THIRD GENERATION REPRODUCTION (PRINT)
Microfilm System from Original Drawing to Distribution of Prints or Aperture Cards

ORIGINAL DRAWING

CAMERA PROCESSOR

INSPECTION FOR MICROFILM QUALITY

ELECTRONIC ACCOUNTING MACHINE PUNCHING IDENTIFYING INFORMATION IN CARD

CARD DUPLICATOR

TO STORAGE

DUPLICATE CARDS

ELECTRONIC ACCOUNTING MACHINE CARD SORT

FOR DISTRIBUTION

READER-PRINTER

DISTRIBUTION OF PRINTS

REVISION AND UPDATING
ASSIGNMENT SHEET #1--MAKE BLUELINES OR BLACKLINES PRINTS

Directions: Make blueline or blackline prints of several drawings done to this date using either a diazo dry process machine or a diazo wet process machine.

(NOTE: Instructor may wish to have some drawings reproduced on intermediates such as sepia or foil.)
JOB SHEET #1--OPERATE A BLUELINE MACHINE

I. Tools and equipment
   A. Machine as selected by instructor
   B. Safety gear as specified by instructor
      (NOTE: Before doing any of the following remove all rings, loose jewelry, and if necessary tie back hair.)

II. Procedure
   A. Start up
      1. Remove cover
      2. Turn on exhaust fan
      3. Turn on ammonia pump BEFORE turning machine on
      4. Turn from off to blower-dryer motors and wait approximately 5 seconds
      5. Turn from blower dryer motors to heaters and wait approximately 5 seconds
      6. Turn from heaters to lamp
      7. Be sure switch is set to forward
      8. Set ammonia control at approximately 15 drops per minute
      9. Set speed control and wait approximately 15 minutes for machine to warm up
   B. Make blueline
   C. Shut down
      1. Turn ammonia flow switch off GENTLY
      2. Turn switch from lamp to heaters and wait approximately 5 seconds
      3. Turn from heaters to blower dryer motors and wait approximately 5 seconds
      4. Turn from blower dryer motors to off
      5. After machine has turned off, turn off the ammonia pump
JOB SHEET #1

6. Turn off exhaust fan

7. Cover machine

(NOTE: Ask instructor to verify how the machine in the drafting department works.)
1. Match the terms on the right to the correct definitions.

   a. Chemical solution containing acid designed to bleach out unwanted portions of a print
   b. Improper feeding of two sheets of duplicating paper instead of one
   c. Duplicating material which has a sensitized layer on each side
   d. Yellowing or other color changes of white areas on prints
   e. Any process used for rendering an image visible
   f. Chemical agent used for treating an exposed light-sensitive material to make the image visible to the eye
   g. The darkness of an image area
   h. Tube on which print paper, film, sepia, or other material is wound
   i. The difference between the image and background areas of a print
   j. Print made by placing a master or an original in contact with light-sensitive material while exposure is being made
   k. Print made by combining the parts of two or more masters
   l. Reproduction method using light-sensitive iron and silver salts which will produce a negative sepia image from a positive master
   m. Stenciling through a silk screen to form an image

   1. Autopositive
   2. Overlay
   3. Positive
   4. Fading
   5. Eradicator
   6. Double coated stock
   7. Development
   8. Density
   9. Contrast
   10. Composite print
   11. Silk screening
   12. Back curl
   13. Drawing reproduction
n. The curl of paper toward the coated side

o. The curl of paper toward the uncoated side

p. Making copies from completed drawings

q. A print or intermediate made on paper or foil by means of a positive to positive silver-type emulsion

r. The direction in which most of the paper fibers are oriented, usually in the direction of the longest dimension of the sheet

s. A group of transparent or translucent prints normally used to form a composite

t. An image on materials such as paper or film where the background is dense black and the line image appears clear or white

u. An image on materials such as paper or film on which light tones appear light and dark tones appear dark when copied from a pencil or ink original

v. Any original to be duplicated

w. Loss in density of an image

x. Time period that light of a given intensity has been allowed to act on light-sensitive materials

y. A wet process of drawing reproduction using light, water, and chemicals

2. Distinguish between the two types of blueprint machines by placing an "X" to the left of the description of a continuous blueprint machine.

a. A machine in which the sheets are fed through for exposure only, then worked in a separate washer

b. A machine which combines exposure, washing, and drying in one continuous operation
3. Select true statements concerning the uses of the blueprint process by placing an "X" in the appropriate blanks.

a. Of several reproduction processes in use, blueprinting is the newest

b. Best results are obtained when the original tracing is drawn in ink on cloth or vellum, and pencil drawings linework and lettering is jet black

c. The coated side of the paper, when fresh, is a light greenish yellow color

d. Corrections and changes cannot be made on blueprints

4. List two advantages and two disadvantages of blueprints.

a. Advantages

1) ___________
2) ___________

b. Disadvantages

1) ___________
2) ___________

5. Match the materials, equipment, and characteristics of diazo dry and wet processes on the right with the correct definitions.

- a. Diazo sensitized material for use with the diazo dry process to produce audiovisual aides

- b. Diazo-sensitized transparent cellulose acetates

- c. The translucent reproduction made on vellum, cloth, or foil made from an original drawing and used in place of the original for making other prints

- d. A reproduction material coated with a light-sensitive compound

- e. Item capable of being used as a master for making prints

- f. Time period before deterioration renders a sensitized material unusable

- g. Area of print machine used to develop light-sensitive materials

1. Diazo dry print process
2. Diazo paper
3. Diazo wet print process
4. Printing speed
5. Activator fluid
6. Diazo color film
7. File aging
1394. 

**h.** Area of print machine used to expose light-sensitive materials

**i.** Film base which carries a positive image, often a photographic material which, if necessary, can serve as master for diazo-type prints

**j.** The change in appearance of a diazo print in storage not exposed to light

**k.** A reproduction paper which depends on the light-sensitivity of the diazo compound used during manufacturing

**l.** A media's passage of actinic light which in turn affects the speed of the media's print making ability through conventional exposure equipment

**m.** A liquid used in the diazo wet process which causes the image line to form when brought into contact with the unexposed portion of the diazo sensitized material

**n.** A wet process of reproduction that uses ultraviolet light and is developed by a liquid developer or activator fluid

**o.** A dry process of reproduction that uses ultraviolet light and is developed by ammonia vapors as an alkaline agent

6. Select the true statements concerning important factors in the diazo dry print process by placing an "X" in the appropriate blanks.

- a. The process depends upon the transmission of light through the original for the reproduction of positive prints
- b. Subject matter may be pen, pencil, typewritten, or printed matter, or any opaque image
- c. Only negative steps are involved in the process

7. List three advantages of the diazo dry print process.

a.

b.

c.
8. Select true statements concerning the diazo wet print process and its advantages by placing an "X" in the appropriate blanks.

   a. Prints may have only black or blue lines on a white background by selecting the appropriate paper. 
   b. It is similar to the diazo dry process except paper is fed through a special developer which dampens the coated side of the paper with developing solution.

9. List two common problems in the diazo dry print process and how to correct them.
   a. __________________________
   b. __________________________

10. Select true statements concerning how to safely use erasing chemicals in diazo processing by placing an "X" in the appropriate blanks.

   a. Eradicator for sepia intermediates is a one-step method, but the eradicator contains acid and application should be made with care.
   b. Erasing fluid for foils is a two-step method involving application of a first fluid containing acetic acid.
   c. After the second fluid is applied on foil, it should be washed to remove any residual chemicals.

11. Discuss the need for correct linework density and how to test for it.

12. Match the basic elements of microfilming on the right to the correct definitions.

   a. A print that has been enlarged from a micro-image
   b. An enlarged print on paper, cloth, or foil made from a microfilm image or aperture card
   c. A sheet of microfilm containing several rows of micro-images of drawings
   d. Made of clear thin plastic and has channels for short strips of microfilm usually available for 16 or 35 mm

   1. Microfilm
   2. Microfiche
   3. Aperature card
   4. Jacket
   5. Blowback
   6. Hard copy
140-B

13. List five suggestions for preparing drawings to be microfilmed.
   a. ______________________________________
   b. ______________________________________
   c. ______________________________________
   d. ______________________________________
   e. ______________________________________

14. Select true statements concerning the advantages of microfilm by placing an "X" in the appropriate blanks.
   a. Used to store drawing duplications in a small amount of filing space
   b. Duplicate aperture cards and drawing reproductions to any desired size may be produced on specialized equipment
   c. Used where small numbers of drawings are involved
   d. Postage requirements are higher for microfilm when sending to another office becomes necessary
   e. Used where large numbers of drawings are involved

15. Describe the purpose and method for making reproducibles from existing drawings.
16. Select true statements concerning the uses and procedures for paste-up drafting by placing an "X" in the appropriate blanks.

   ___ a. With new designs, most features may not be repetitive; therefore, paste-up drafting is possible
   ___ b. A major disadvantage of paste-up drafting is that it increases drawing and rechecking time
   ___ c. Make transparent or translucent print of the original drawing
   ___ d. Arrange information on a clear acetate sheet using the correct size and proper arrangement
   ___ e. Tape pieces to the acetate sheet with opaque tape
   ___ f. Make a transparent or translucent print to form a new original
   ___ g. Store pieces attached to the acetate sheet
   ___ h. Add additional drawings, dimensions, and notes

17. Select true statements concerning the characteristics of appliques by placing an "X" in the appropriate blanks.

   ___ a. Appliques are overlays which are pressure-sensitive and printed on blank, transparent, or translucent sheets with adhesive backing
   ___ b. Use of appliques increases time needed to work with notes, symbols, and shapes
   ___ c. Appliques can be used for long notes which can be typed faster than they can be lettered, or for making changes or corrections to drawings or lists
   ___ d. Appliques are more practical for home use than they are for industry
   ___ e. Only one type of applique, the transfer, is available

18. Arrange in order the following steps in using transfer appliques by placing the number "1" to the left of the first step, "2" to the left of the second step and continue through all steps.

   ___ a. Lift the transfer image carefully so the image will remain on the drawing
   ___ b. Remove the carrier from the image sheet
   ___ c. Place the carrier sheet over the image and rub or reburnish it again
   ___ d. Rub over the image to be transferred with a blunt object or a burnishing tool
   ___ e. Place the image in the proper position on the drawing
19. Arrange in order the following steps in using cutout appliques by placing the number "1" to the left of the first step, "2" to the left of the second step, and continue through all steps:

a. Lift the image and remove the backing material on the applique.

b. Reposition the image in the correct place on the drawing and lightly rub or burnish it.

c. Repaint the area.

d. Position the image in the correct location on the drawing and lightly mark reference points on the drawing.

Use a razor knife to cut away unwanted material from around the image.

20. List three elements of a proper drawing control system:

   1. 
   2. 
   3. 

21. List three ways a proper drawing control system benefits a drafting organization:

   1. 
   2. 
   3. 

22. Discuss correct storage of drawing and prints.

23. Discuss the proper distribution of completed drawings.
24. Demonstrate the ability to:
   a. Make blueline or blackline prints.
   b. Operate a blueline machine.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)
REPRODUCTION
UNIT III

ANSWERS TO TEST

1. a. 5  
   b. 20  
   c. 6  
   d. 19  
   e. 7  
   f. 18  
   g. 8  
   h. 17  
   i. 9  
   j. 16  
   k. 10  
   l. 15  
   m. 11  
   n. 14  
   o. 12  
   p. 13  
   q. 1  
   r. 24  
   s. 2  
   t. 23  
   u. 3  
   v. 22  
   w. 4  
   x. 21  
   y. 25

2. b
3. b, c
4. a. Advantages (any two of the following)
   1) They do not soil easily
   2) They do not fade easily
   3) They are readily subject to field changes
   
   b. Disadvantages
   1) Preparation of print is time consuming
   2) Much space is required for processing

5. a. 6  
   b. 8  
   c. 10  
   d. 12  
   e. 14  
   f. 15  
   g. 13  
   h. 11  
   i. 9  
   j. 7  
   k. 2  
   l. 4  
   m. 5  
   n. 3  
   o. 1

6. a, b
7. Any three of the following
   
   a. Sensitized materials can be handled under normal indoor illumination
   b. Prints may have black, blue, or red lines on a white background depending upon which paper is used
   c. Prints can be worked on easily with pen, crayon, or pencil
   d. Intermediates can be made of the original to save wear on the original, these intermediates can be made on special paper, cloth, or foil
   e. Changes can be made to intermediates with correction fluid

8. b

9. a. Print with a green tint—Ammonia may be too cold or too old or tubes controlling ammonia flow may be clogged, need cleaning, or ammonia flow adjusted
   b. Print with streaking on it—Ammonia flow is excessive and needs to be adjusted

10. a, c
11. Discussion should include:

a. In order for a drawing to reproduce properly, the linework and lettering must be opaque and dense black because work that is not opaque will not print clearly.

b. To determine if linework and lettering are opaque and dense black, simply hold the drawing near a source of light.

c. 6  d. 4

d. 5  e. 1

e. 2  f. 3

12. Any five of the following:

a. Check linework and lettering for uniformity and density.

b. All lines of the same type must be the same width.

c. Ink lines produce the best results on microfilm.

d. Experimentation should be done with various pencils, inks, and vellums.

e. Lettering must be large enough to reduce photographically and then be enlarged without loss of clarity.

f. The letters must be formed very carefully and not crowded or they will run together when reduced.

g. When lines of lettering are used, the space between the lines should be a minimum of one half the height of the letters with more space between paragraphs.

h. If lettering is typed on, care must be used to produce a dense, uniform and solid letter.

i. Exercise care when erasing because all smears and dirt will show on the microfilm.

j. Keep drawing covered when not working on it, when working on the drawing, cover area not needed, use a drafter's brush and try cleaning pad, and keep perspiration from hands and arms off the drawing.

k. Drawings that are to be microfilmed should be stored flat.

l. Do not use the original drawing for reference, if a print is needed it should be made from the microfilm.

13. Discussion should include:

a. Preparing when a new drawing can be made from an existing drawing with only minor changes.

b. Reproduction:

1. Make a transparent or translucent print of the original drawing.
2. Remove unneeded information from the old print and then add new information.

14. 9

15. Discussion should include:

a. 4  b. 3

b. 5  c. 1
19. a. 2     d. 1
    b. 3     e. 4
    c. 5

20. Any three of the following:
    a. Drawing numbers
    b. Proper methods of filing
    c. Microfilming
    d. Security files
    e. Print making and print distribution control

21. a. Allows the person in charge to know the status of a drawing at all times
    b. Minimizes the possibility that an original drawing will be damaged from being handled for printing, changes, or checking
    c. Controls the distribution of prints to the appropriate people

22. Discussion should include:
    a. Drawings may be stored in large, flat file drawers or hung vertically in a cabinet or a free-standing file
    b. Prints may be folded and filed in standard office file cabinets, or extra large prints can be rolled and stored in cabinets, tubes, or tubes in cabinets

23. Discussion should include:
    a. Whether prints or intermediates, copies should be made for distribution
    b. The original should NEVER be sent out

24. Evaluated to the satisfaction of the instructor.
UNIT OBJECTIVE

After completion of this unit, the student should be able to select items of information required on a correct drawing sheet layout and the items in working drawings that are checked for accuracy. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheet and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to a drawing sheet layout with their correct definitions.
2. Match types of working drawings with their correct definitions.
3. Match other types of drawings with their correct definitions.
4. Select basic information needed on a drawing.
5. Select information found in a title block.
6. Select information found in a revision block.
7. Select information found in a parts list.
8. Select information found in supplementary blocks.
9. Demonstrate the ability to complete a title block sheet.
DRAWING SHEET LAYOUT
UNIT IV

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information and assignment sheets.

III. Make transparencies.

IV. Discuss unit and specific objectives.

V. Discuss information sheet.

VI. Discuss the procedures outlined in the assignment sheet.

VII. Use file drawings to demonstrate to the class the location of various information blocks and areas on a set of working drawings.

VIII. Invite a checker from a local drafting or architectural firm to speak to the class concerning techniques used in checking drawings.

IX. Using information from various companies, have students complete several title blocks.

X. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters
   1. TM 1-Sheet Sizes
   2. TM 2-Parts List
   3. TM 3-Title Blocks
   4. TM 4-Title Blocks (Continued)
   5. TM 5-Revision Blocks

D. Assignment Sheet #1-Complete a Title Block Sheet
I. Terms and definitions

A. Drawing - Graphic and lettered information on an original media surface (NOTE: A drawing is sometimes referred to as a plate.)

B. Zones - The areas on the border of a drawing sheet used for locating specific points by the coordinate point system (Transparency 1)

(CASTE: On a complicated drawing, if there is a revision to be made which would be difficult to locate, use zones to determine the revision quickly and accurately.)

C. Revision - A correction made on a drawing to reflect a needed change

D. Title block location - Should be located in the lower right corner of the drawing layout

(NOTE: Some companies may move the location.)

E. Revision block location - Should be located in the upper right corner of the drawing layout

(NOTE: Some companies may move the location.)

F. Parts list (list of materials or bill of materials) location - Should be located in the lower right corner above the title block (Transparency 2)

(NOTE: If additional parts lists are needed they should be located left of or adjacent to the original parts list.)

G. Supplementary block location - Should be located in the same respective location on all drawings, usually to the left of the title block

H. Drawing number locations - Should be located in the lower right corner of the title block and in at least one other location

I. Microfilm alignment - Arrowheads placed in the margins of a drawing to aid in the alignment of drawings to be microfilmed (Transparency 1)

J. Change order - An approved engineering change on an existing drawing

II. Types of working drawings and their definitions

A. Working drawing - A drawing needed to manufacture, build, assemble, or install any unit, component, or structure

(NOTE: The drawing must have size and shape descriptions, specifications for the materials to be used, the finish, and completeness of the project.)
INFORMATION SHEET

B Detailed drawing - The complete size, material, and specification description of an individual part

C Subassembly drawing - A description of how several parts fit together in one unit

D Assembly drawing - A description of how several subassemblies and details make up a larger unit

E Installation drawing - A description of how an object fits into its working position

F Set of working drawings - A number of working drawings bound together to do a complete project or job

III. Other types of drawings and their definitions

A. Process drawings - Drawings of only one step in a production or manufacturing assembly which enable a machine operator to set up equipment for a single operation

   Examples: Drilling, punching holes, milling a surface

B. Layout drawings - Drawings used in the development of experimental or prototype designs

   (NOTE: They appear to be assembly drawings; however, layout drawings are used in the early developmental stages of a product and assembly drawings are for the final fabrication process)

C. Checking drawings or check set - Drawings which are carefully checked for accuracy before they are sent into the field or into the shop for fabrication

   (NOTE: Checking should be done by a drafter who is not working on the drawing, or by the project engineer or architect, chief drafter, or the checker, depending on the company structure)

IV. Basic information needed on a drawing:

   A. Date
   B. Material number
   C. Drawing number
   D...
   E.
   F.
   G.
INFORMATION SHEET

G. Revision block
H. List of materials
I. Tolerance
J. Approval signature

V. Information found in a title block (Transparencies 3 and 4)
A. Company name and address or manufacturer's (code identification) number
   (NOTE: The manufacturer's number may be referred to as the FSCM. This stands for the Federal Supply Code for Manufacturers.)
B. Drawing (plate) name
C. Drawing (plate) number
D. Drafter's name
E. Date drafter completed drawing
F. Checker's name
G. Date checker completed checking functions
H. Approval signatures
I. Issue date
J. Contract numbers
K. Approval by someone in another company
   (NOTE: Used only when a contractor-subcontractor situation exists.)
L. Scale
M. Letter designation of drawing size if necessary
N. Estimated or actual weight of the item
   (NOTE: This may not be required.)
O. Drawing sheet number
   (NOTE: This is included only if needed.)
INFORMATION SHEET

VI Information found in a revision block (Transparency 5)
A. Revision number
B. Description or identification
C. Date
D. Approval
E. Zone
   (NOTE: The zone may not be needed.)
F. Reason for revision
   (NOTE: This may not be necessary)

VII Information found in a parts list (Transparency 2)
A. Writer's name
B. Approval signature
C. Checker's name
D. Date
E. Assembly list number
F. Description of the assembly
G. Page number of the total parts lists
H. Account number if needed for billing purposes
I. Name of item
J. Item number of subassembly
K. Quantity needed
L. Description of subassembly
M. Part number of subassembly
N. Letter designation of drawing size
   (NOTE: This may not be necessary)
O. Name and other information about the vendor if part is purchased from another company
VIII. Information found in supplementary blocks

A. Information covering notes on dimensioning and tolerances
B. Material
C. Usage and general notes
D. Treatment
E. Finish
Sheet Sizes

A SIZE
8½" x 11" or 9" x 12"

B SIZE
11" x 17" or 12" x 18"

C SIZE
17 x 22 or 18 x 24

D SIZE
22 x 34 or 24 x 36

E SIZE
34 x 44 or 36 x 48

ROUND CORNERS OPTIONAL ON ALL SIZES

Number Block in Upper Left Corner

MICROFILM ALIGNMENT ARROWHEADS LOCATED MIDWAY BETWEEN SHEET EDGES ON ALL 4 SIDES

USUALLY IMAGINARY LINES FOR ZONE USAGE
# Parts List

<table>
<thead>
<tr>
<th>LIST NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>WRITTEN BY:</th>
<th>APPROVED BY:</th>
<th>VERIFIED BY:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PAGE OF</th>
<th>ACCOUNT NO.</th>
<th>REQUIRED FOR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>QTY.</th>
<th>DESCRIPTION</th>
<th>PART NO.</th>
<th>Dwg NO.</th>
<th>VENDOR NO.</th>
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<thead>
<tr>
<th>DATE:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>
Title Blocks

NOTE: ALL DIMENSIONS ARE IN INCHES.
Title Blocks
(Continued)

TITLE BLOCK FOR D, E, F, H, J, AND K SIZES
NOTE: ALL DIMENSIONS ARE IN INCHES.
### Revision Blocks

<table>
<thead>
<tr>
<th>ZONE</th>
<th>REV</th>
<th>DESCRIPTION</th>
<th>DATE</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Dimensions
- .50
- .38
- 5.50
- .88
- 1.00

**NOTE:** ALL DIMENSIONS ARE IN INCHES
ASSIGNMENT SHEET #1--COMPLETE A TITLE BLOCK SHEET

I. Tools and equipment
   A. Pencil
   B. Drawing sheet
   C. Parallel bar or drafting machine

II. Procedure
   A. Tape sheet to drawing surface
   B. Select correct pencil
   C. Compile title block data
   D. Letter in information in its proper place

III. Diagram of the procedure

(Note: Instructor should select an appropriate title block to use in this class and give instructions on filling it out.)

Pictured on Transparencies 3 and 4 are samples of title blocks. Devise one of your own or select one shown.
DRAWING SHEET LAYOUT
UNIT IV

NAME ______________________

TEST

1. Match the terms on the right with their correct definitions.

   a. Graphic and lettered information on an original media surface
   b. A correction made on a drawing to reflect a needed change
   c. Should be located in the upper right corner of the drawing layout
   d. Should be located in the same respective location on all drawings, usually to the left of the title block
   e. Arrowheads placed in the margins of the drawing to aid in the alignment of drawings to be microfilmed
   f. An approved engineering change on an existing drawing
   g. Should be located in the lower right corner of the title block and in at least one other location
   h. Should be located in the lower right corner above the title block
   i. Should be located in the lower right corner of the drawing layout
   j. The areas on the border of a drawing sheet used for locating specific points by the coordinate point system

2. Match the types of working drawings on the right with the correct definitions.

   a. The complete size, material, and specification description of an individual part
   b. A drawing needed to manufacturer, build, assemble, or install any unit, component, or structure
   c. A number of working drawings bound together to do a complete project or job

   1. Change order
   2. Microfilm alignment
   3. Drawing
   4. Zones
   5. Drawing number locations
   6. Supplementary block location
   7. Revision
   8. Title block location
   9. Revision block location
   10. Parts list

   1. Subassembly drawing
   2. Assembly drawing
   3. Set of working drawings
172-8

___ d. A description of how an object fits into its working position
___ e. A description of how several subassemblies and details make up a larger unit
___ f. A description of how several parts fit together in one unit

3. Match the other types of drawings on the right with their correct definitions.
   ___ a. Drawings which are carefully checked for accuracy before they are sent into the field or into the shop for fabrication
   ___ b. Drawings used in the development of experimental or prototype designs
   ___ c. Drawings of only one step in a production or manufacturing assembly which enable a machine operator to set up equipment for a single operation

4. Select the basic information needed on a drawing by placing an "X" in the appropriate blanks.
   ___ a. Drawing media
   ___ b. Scale
   ___ c. Company name and address
   ___ d. Revision block
   ___ e. Notes
   ___ f. Approval signature
   ___ g. List of materials
   ___ h. Drafter
   ___ i. Final check
   ___ j. Drawing number
   ___ k. Revision number
   ___ l. Tolerance
   ___ m. Issue date
   ___ n. Drawing name
   ___ o. Date
   ___ p. Contract numbers
5. Select the information found in the title block by placing an "X" in the appropriate blanks.

   __ a. Material
   __ b. Drawing name
   __ c. Drafter's name
   __ d. Part number
   __ e. Checker's name
   __ f. Approval signatures
   __ g. Contract numbers
   __ h. Approval by someone in another company
   __ i. Quantity needed
   __ j. Issue date
   __ k. Date checker completed checking functions
   __ l. Date drafter completed drawing
   __ m. Description subassembly
   __ n. Drawing number
   __ o. Company name and address of manufacturer's number

6. Select the information found in the revision block by placing an "X" in the appropriate blanks.

   __ a. Date
   __ b. Tolerance
   __ c. Approval
   __ d. Zone
   __ e. Reason for revision
   __ f. Description or identification
   __ g. Checker's name
   __ h. Revision number
   __ i. List of materials
7. Select information found in a parts list by placing an "X" in the appropriate blanks.
   a. Part number of subassembly
   b. Quantity needed
   c. Name of item
   d. Zone
   e. Page number of the total parts list
   f. Assembly list number
   g. Tolerance
   h. Checker's name
   i. Writer's name
   j. Approval signature
   k. Date
   l. Description of the assembly
   m. Treatment
   n. Account number if needed for billing purposes
   o. Item number of subassembly
   p. Description of subassembly
   q. Letter designation of drawing size

8. Select information found in supplementary blocks by placing an "X" in the appropriate blanks.
   a. Finish
   b. Treatment
   c. Quantity needed
   d. Material
   e. Information covering notes on dimensioning and tolerances
   f. Usage and general notes
   g. Checker's name

9. Demonstrate the ability to complete a title block sheet.
   (NOTE: If this activity has not been accomplished prior to the test, ask your instructor when it should be completed.)
DRAWING SHEET LAYOUT
UNIT IV

ANSWERS TO TEST

1. a. 3 f. 1
   b. 7 g. 5
   c. 9 h. 10
   d. 6 i. 8
   e. 2 j. 4

2. a. 5 d. 6
   b. 4 e. 2
   c. 3 f. 1

3. a. 2
   b. 3
   c. 1

4. b, c, d, f, g, h, j, l, n, o

5. b, c, e, f, g, h, j, k, l, n, o

6. a, c, d, e, f, h

7. a, b, c, e, f, h, i, j, k, l, n, o, p, q

8. a, b, d, e, f

9. Evaluated to the satisfaction of the instructor
ARCHITECT'S SCALE USAGE  
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe an architect's scale, list the seven scale ratios found on an architect's scale, and read an architect's scale at various ratios. The student should also be able to measure lines accurately using various scale ratios. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to architect's scale usage with their correct definitions.
2. Describe an architect's scale.
3. State the purpose for using a scale.
4. Identify five basic shapes of scales.
5. List seven scale ratios found on an architect's scale.
7. Interpret 1/16, 1/8, and 1/4 graduations on a full size scale.
8. Calculate and locate 1/32" graduations on a full size scale.
9. Read the architect's scale at full scale ratio 12" = 1'-0".
10. Read the architect's scale at the scale ratio 6" = 1'-0".
11. Read the architect's scale at the scale ratio 3" = 1'-0".
12. Read the architect's scale at the scale ratio 1 1/2" = 1'-0".
13. Read the architect's scale at the scale ratio 1/4" = 1'-0".
14. Demonstrate the ability to:
   a. Interpret 1/16 and 1/32 graduations on a full size scale.
   b. Read the architect's scale at full scale ratio 12" = 1'-0".
   c. Read the architect's scale at the scale ratio 6" = 1'-0".
d. Read the architect's scale at the scale ratio 3" = 1'. 0".
e. Read the architect's scale at the scale ratio 1 1/2" = 1'. 0".
f. Measure lines accurately with various scale ratios on an architect's scale.
ARCHITECT'S SCALE USAGE
UNIT V

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.
II. Provide student with information and assignment sheets.
III. Make transparencies.
IV. Discuss unit and specific objectives.
V. Discuss information and assignment sheets.
VI. Develop a display of all types of measuring rules, tapes, scales, and related items used in various machine and building trades. Include all five types of scales used in a drafting room. Discuss this display in depth with students.
VII. Explain why scaling should not be completed on blueprint copies.
VIII. Use unit test as a pre-test to determine prior knowledge of the architect's scale usage.
IX. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objective sheet
   B. Information sheet
   C. Transparency masters
      1. TM 1- Architect's Scale
      2. TM 2- Graduations on a Rule
      3. TM 3- Measurements at Scale of 12" = 1'-0" (Full-size)
      4. TM 4- Measurements at Scale of 6" = 1'-0" (Half-size)
      5. TM 5- Measurements at Scale of 3" = 1'-0" (1/4 size)
      6. TM 6- Measurements at Scale of 1 1/2" = 1'-0" (1/8 size)
      7. TM 7- Measurements at Scale of 1/4" = 1'-0" (1/48 size)
Assignment Sheets

1. Assignment Sheet #1: Interpret 1/16 and 1/32 Graduations on a Full Size Metal Rule

2. Assignment Sheet #2: Read the Architect's Scale at Full Scale Ratio 12" = 1' 0"

3. Assignment Sheet #3: Read the Architect's Scale at the Scale Ratio 6" = 1' 0"

4. Assignment Sheet #4: Read the Architect's Scale at the Scale Ratio 3" = 1' 0"

5. Assignment Sheet #5: Read the Architect's Scale at the Scale Ratio 1 1/2" = 1' 0"

6. Assignment Sheet #6: Measure Lines Accurately with Various Scale Ratios on an Architect's Scale

Assignment sheets

Text

References


Spencer, William J. Drafting Technology and Practice. Peoria, IL 61615: A. Bennett Co., Inc., 1973
ARCHITECT'S SCALE USAGE
UNIT V
INFORMATION SHEET

I. Terms and definitions
   A. Actual size--An object's dimensions, the size it actually is in completed form
   B. Scale--An instrument used as a standard of reference when drawing an object to a proportional size
   C. Draw to scale--Drawing an object at a set proportion such as half its actual size, one-fourth its actual size, or double its actual size
   D. Architecture--Dealing with the design and drawing of public and private buildings
   E. Graduations--The subdivisions in a scale unit, all of which are equal in size or length
   F. Scale ratio--A relationship between dimension values used to reduce or enlarge the size of an object so that it can be drawn to proportion
   G. Fraction--A part of a whole, such as 1/2 or 1/4
   H. Full-divided scale--A scale with the basic units subdivided throughout the length of the scale
   I. Open-divided scale--A scale with only the end unit subdivided into fractional parts
   J. NTS--Abbr. abbreviation meaning "not-to-scale"

II. Description of architect's scale--Scale used primarily for drawings of buildings, piping systems, and other large structures which must be drawn to a reduced scale to fit on a standard sheet size; it has one full-size scale and ten reduced-size scales (Transparency 1)

   (NOTE: In all of the reduced scales, the major divisions represent feet, and their subdivisions represent inches and fractions thereof. Thus 3/4" scale means 3/4 inch = 1 foot, NOT 3/4 inch = 1 inch.)

III. Purpose of using a scale to draw--Enables objects which are too large or too small to be drawn to actual size, or be drawn with a standard point of reference controlling the relative size of each part
IV. Basic shapes of scales

A. Triangular

B. Four-bevel

C. One bevel

D. Two-bevel

E. Opposite bevel

V. Scale ratios found on architect's scale

A. 12" = 1' 0" Full size
B. 6" = 1' 0" Half size
C. 3" = 1' 0" 1/4 size
D. 1½ 2" = 1' 0" 1/8 size
E. 1" = 1' 0" 1:12 size
F. 3½" = 1' 0" 1/16 size
G. 1½" = 1' 0" 1/24 size
H. 3½" = 1' 0" 1/32 size
INFORMATION SHEET

I. $1/4'' = 1' : 0'' - 1/48$ size
J. $3/16'' = 1' : 0'' - 1/64$ size
K. $1/8'' = 1' : 0'' - 1/96$ size
L. $3/32'' = 1' : 0'' - 1/128$ size

VI. Rules for correct scale usage
A. Select proper scale ratio.
B. Scale should lay flat on the surface being measured.
C. Scale should be parallel with or on line being measured.
D. Do not stick compass or divider points into scale.
E. Edge of the scale should be protected to prevent damage to its graduation marks.
F. A short dash should be made rather than a point to mark a distance.
G. If a series of measurements are to be made on full size scale, do not move scale for each measurement.
   (NOTE: Set off measurements with scale in one position.)
H. Make sure that the line of sight does not create an optical illusion.
   (NOTE: This could result in an incorrect measurement.)

VII. How to Interpret $1/16''$, $1/8''$ $1/4''$ and $1/2''$ graduations on a full size scale (Transparency 2).
A. Full scale ($12''$ represents $1' : 0''$)
   1. Sixteen one-sixteenths ($16/16$) = one inch ($1''$)
   
   2. Eight one-eighths $8/8$ = one inch ($1''$); two one-sixteenths ($2/16$) = one-eighth inch ($1/8''$)
1. Four one fourths (4/4) = one inch (1"")

2. One one sixteenth (1/16) = one fourth inch (1/4"")

3. Two one eighths (2/8) = one inch (1"")

4. Eight one sixteenths (8/16) = one half inch (1/2"")

5. For 1/32" increments there are two 1/32" in one 1/16" and two 1/8" in one 1/4"

B. Dimensions are read in this order:
   1. Feet marked thus (')
   2. Inches marked thus ("")
   3. Fractions of an inch (1/4, 1/2, etc.)

   (NOTE: When measuring less than 12 inches, use the symbol "". Over 12 inches should be symbolized in feet or "feet plus inches as in 1' 3".")

VIII. How to calculate and locate 1/32"gradations on a tape

A. For 1/32" increments there are two 1/32" in one 1/16"

B. Subtract 1/32" from the reading to be worked with to find the nearest 1/16".

C. Add 1/32" to the reading before working to find the nearest 1/16".

D. Find the lower "feet" and lower 1/32" to 1/8" measure and approximate the center between the two.
INFORMATION SHEET

E. Mark this approximate center by making a short dash with a sharp light lead and observe reading

Example: The reading wanted is 11/32".

1. Subtract 1/32" which gives 10/32 or 5/16"
2. Add 1/32" which gives 12/32 or 3/8"
3. Locate 5/16 and 3/8 and approximate center

4. Mark approximate 11/32" point

IX. Read the architect's scale at full scale ratio 12" = 1'-0"

(NOTE: Measurement is made by reading directly from full size scale in inches and fractions.) (Transparency 3)

Example: If the reading wanted is 2 13/16", start at "0" and determine how many full inches are between 0 and the point being measured; there are 2. Next, determine how many 1/16" units are between the last full inch and the point being measured; there are 13 1/16" units and the measurement is 2 13/16"
INFORMATION SHEET

X. Read the architect's scale at the scale ratio 6" : 1'-0" (Transparency 4)

A. When measuring a given line at half size, use the full size scale, and multiply the full size dimension by 2

B. When laying out or drawing a line at half size, use the full size scale, and divide the full size dimension by 2 to obtain line length.

Example: The reading is 2 3/16" and the full size scale measures 1 13/32", so multiply 1 13/32" by 2 giving 2 13/16", the measurement is 2 13/16" at half size because at half size, each 1/16" unit will represent 1/8".

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XI. Read the architect's scale at the scale ratio 3" : 1'-0" (Transparency 5)

A. When measuring a given line at 3" : 1'-0", use the quarter size scale marked with a "3"

B. The subdivided unit to the right of zero represents one foot (12") compressed to actually 3" in length, and it is divided into inches, then half inches, quarter inches, and finally eighth inches.

Example: If the reading is 1'-9 1/4", lay the scale so that the 3" = 1'-0" scale lays parallel to the line being measured, then determine how many full feet to the left of zero the line extends (in this example it is 1'-0") set the 1'-0" mark at the left end of the line being measured and refer to the right of the zero in the subdivided scale and find the number of inches and fractions (in this example it is 9 1/4") so the reading is 1'-9 1/4".

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XII. Read the architect's scale at the scale ratio 1 1/2" = 1'-0" (Transparency 6)

A. When measuring a given line, at 1 1/2" = 1'-0" use the 1/8 size scale marked with a "1 1/2"

B. The subdivided unit to the left of zero represents one foot (12") compressed to actually 1 1/2" in length, and is divided into inches, half inches, and quarter inches

C. Measure full feet to the right of the zero and measure anything less than 12" in the subdivided unit to the left of zero

Example: If the reading is 2'-7 3/4", lay the scale so that the 1 1/2" scale lays parallel to the line being measured; determine how many full feet to the right of zero the line extends (in this example it is 2'-0") then set the 2'-0" mark at the right end of the line being measured and refer to the left of the zero in the subdivided scale area for the inches and fractions (in this example it is 7 3/4") so the total length is 2'-7 3/4"

XIII. Read the architect's scale at the scale ratio 1/4" = 1'-0" (Transparency 7)

A. When measuring a given line at 1/4" = 1'-0", use the 1/48 size scale marked with a 1/4"

B. The subdivided portion to the right of zero represents one foot (12") compressed to actually 1/4" in length, and is divided into inches
C. Measure full feet to the left of zero and measure anything less than 12" in the subdivided unit to the right of zero.

Example: If the reading is 23' 8", lay the scale so that the 1/4" = 1' 0" scale lays parallel to the line being measured, determine how many full feet to the left of zero the line extends (in this example it is 23' 0"").

(NOTE: Be sure you don't pick up the wrong numbers from the 1' 8" 1' 0" scale that is in between the 1/4" = 1' 0" numbers.)

Set the 23' 0" mark at the left end of the line being measured and refer to the right of the zero in the subdivided scale area for the inches and fractions (in this example it is 8"").
Architect’s Scale

This is how the Architect’s Scale should look.
Graduations on a Scale

Halves

Quarters

Eighths

Sixteenths

Thirty-Seconds

Graduations Applied to a Rule
Measurements at Scale of 12" = 1'-0"
(Full Size)
Measurements at Scale of 6" = 1'-0"

(Half-Size)
Measurements at Scale of 3" = 1' 0"
(Quarter-Size)
Measurements at Scale of $1\frac{1}{2}'' = 1\text{-}0''$

($\frac{1}{8}$ Size)
Measurements at Scale of $\frac{1}{4}'' = 1'-0''$
($\frac{1}{48}$ Size)
ARCHITECT’S SCALE USAGE
UNIT V

ASSIGNMENT SHEET #1—INTERPRET 1/16 AND 1/32 GRADUATIONS
ON A FULL SIZE METAL RULE

Directions: Read the measurements shown below at full size by reading from end of rule at left to points indicated by extension lines.

1. [Diagram of measurement]
   Reading: __________

2. [Diagram of measurement]
   Reading: __________

3. [Diagram of measurement]
   Reading: __________

4. [Diagram of measurement]
   Reading: __________

5. [Diagram of measurement]
   Reading: __________

6. [Diagram of measurement]
   Reading: __________
ARCHITECT'S SCALE USAGE
UNIT V

ASSIGNMENT SHEET #2--READ THE ARCHITECT'S SCALE AT FULL SCALE RATIO 12" = 1' 0"

Directions: Read the measurements shown below at full scale by reading the distance from "0" at left to points indicated on the scale with letters.

1. A =
2. B =
3. C =
4. D =
5. E =
6. F =
7. G =
8. H =
ARCHITECT'S SCALE USAGE
UNIT V

ASSIGNMENT SHEET #3-READ THE ARCHITECT'S SCALE AT THE SCALE RATIO 6" = 1'-0"

Directions: Read the measurements shown below at half scale by reading the distance from "0" at left to points indicated on the scale with letters.

1. A =
2. B =
3. C =
4. D =
5. E =
6. F =
7. G =
8. H =
ARCHITECT’S SCALE USAGE
UNIT V

ASSIGNMENT SHEET #4—READ THE ARCHITECT’S SCALE
AT THE SCALE RATIO 3” = 1′-0”

Directions: Read the measurements shown below at half scale by reading the distance from "0" at left to points indicated on the scale with letters.

1. A =
2. B =
3. C =
4. D =
5. E =
6. F =
7. G =
8. H =
ARCHITECT'S SCALE USAGE
UNIT V

ASSIGNMENT SHEET #5--READ THE ARCHITECT'S SCALE
AT THE SCALE RATIO 1 1/2" = 1'-0"

Directions: Read measurements shown below at half scale by reading the distance from "0" at right to points indicated on the scale with letters.

1. A =
2. B =
3. C =
4. D =
5. E =
6. F =
7. G =
ARCHITECT'S SCALE USAGE
UNIT V

ASSIGNMENT SHEET #6—MEASURE LINES ACCURATELY WITH VARIOUS SCALE RATIOS ON AN ARCHITECT'S SCALE

Directions: Measure the lines A through J to the scale heading each column in the table. Print the scale readings in the appropriate space in the table.

Example: Measure line A to the scale 3/32" = 1'. 0". A reading of 63'. 6" is obtained. This dimension is printed under the 3/32" = 1'. 0" column and opposite the letter A. Use guide lines for 1/8" lettering.

(NOTE: Readings must be accurate or they will be considered wrong, and lettering must be neat and correct.)

| A |  
|---|---
| B |  
| C |  
| D |  
| E |  
| F |  
| G |  
| H |  
| I |  
| J |  

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## ASSIGNMENT SHEET #6

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<th>LINE</th>
<th>(\frac{3}{32})&quot; = 1(\frac{1}{2})&quot;</th>
<th>(\frac{1}{8})&quot; = 1(\frac{1}{2})&quot;</th>
<th>(\frac{1}{4})&quot; = 1(\frac{1}{2})&quot;</th>
<th>(\frac{3}{8})&quot; = 1(\frac{1}{2})&quot;</th>
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<th>(3)&quot; = 1(\frac{1}{2})&quot;</th>
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</tbody>
</table>
ARCHITECT’S SCALE USAGE
UNIT V

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1
1. 3 3/16"
2. 3 15/16"
3. 2 5/16"
4. 4 3/8"
5. 3 9/16"
6. 3 31/32"
7. 3 14/32" or 7/16"
8. 4 5/32"
9. 3 8/32" or 1/4"
10. 4 15/32"

Assignment Sheet #2
1. A = 1 1/8"
2. B = 1 3/4"
3. C = 2 3/16"
4. D = 2 9/16"
5. E = 2 13/16"
6. F = 11 1/4"
7. G = 11 3/4"
8. H = 11 15/16"
Assignment Sheet #3

1. $A = 2\, 1/4''$
2. $B = 3\, 1/2''$
3. $C = 4\, 3/8''$
4. $D = 5\, 18''$
5. $E = 5\, 5/8''$
6. $F = 22\, 1/2''$ or $1'' 10\, 1/2''$
7. $G = 23\, 1/2''$ or $1'' 11\, 1/2''$
8. $H = 23\, 7/8''$ or $1'' 11\, 7/8''$

Assignment Sheet #4

1. $A = 1''$
2. $B = 1\, 1/2''$
3. $C = 2''$
4. $D = 3''$
5. $E = 3\, 3/4''$
6. $F = 6''$
7. $G = 8\, 1/4''$
8. $H = 9''$

Assignment Sheet #5

1. $A = 1''$
2. $B = 1\, 3/4''$
3. $C = 3''$
4. $D = 6\, 1/2''$
5. $E = 8\, 1/4''$
6. $F = 11''$
7. $G = 12''$ or $1'' 0''$
<table>
<thead>
<tr>
<th>LINE</th>
<th>3/32&quot; = 0.1&quot;</th>
<th>1/8&quot; = 0.125&quot;</th>
<th>1/4&quot; = 0.25&quot;</th>
<th>3/8&quot; = 0.375&quot;</th>
<th>1/2&quot; = 0.5&quot;</th>
<th>1 1/2&quot; = 1.5&quot;</th>
<th>3&quot; = 1.5&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>64'-10&quot;</td>
<td>48'-8&quot;</td>
<td>24'-4&quot;</td>
<td>16'-2¼&quot;</td>
<td>12'-2&quot;</td>
<td>4'-0½&quot;</td>
<td>2'-0½&quot;</td>
</tr>
<tr>
<td>B</td>
<td>51'-6&quot;</td>
<td>38'-5&quot;</td>
<td>19'-4&quot;</td>
<td>12'-10½&quot;</td>
<td>9'-7¼&quot;</td>
<td>3'-2½&quot;</td>
<td>1'-7¼&quot;</td>
</tr>
<tr>
<td>C</td>
<td>42'-5&quot;</td>
<td>31'-10&quot;</td>
<td>15'-11&quot;</td>
<td>10'-7¼&quot;</td>
<td>7'-11¼&quot;</td>
<td>2'-7¼&quot;</td>
<td>1'-3¼&quot;</td>
</tr>
<tr>
<td>D</td>
<td>47'-0&quot;</td>
<td>35'-2¼&quot;</td>
<td>17'-7½&quot;</td>
<td>11'-8¼&quot;</td>
<td>8'-9½&quot;</td>
<td>2'-11¼&quot;</td>
<td>1'-5½&quot;</td>
</tr>
<tr>
<td>E</td>
<td>57'-11&quot;</td>
<td>43'-5&quot;</td>
<td>21'-9&quot;</td>
<td>14'-5¼&quot;</td>
<td>10'-10½&quot;</td>
<td>3'-7¼&quot;</td>
<td>1'-8¼&quot;</td>
</tr>
<tr>
<td>F</td>
<td>36'-7&quot;</td>
<td>27'-5&quot;</td>
<td>13'-8¼&quot;</td>
<td>9'-1¼&quot;</td>
<td>6'-10¼&quot;</td>
<td>2'-3¼&quot;</td>
<td>1'-1¼&quot;</td>
</tr>
<tr>
<td>G</td>
<td>24'-7&quot;</td>
<td>18'-5&quot;</td>
<td>9'-3&quot;</td>
<td>6'-1¼&quot;</td>
<td>4'-7½&quot;</td>
<td>1'-7&quot;</td>
<td>0'-9¼&quot;</td>
</tr>
<tr>
<td>H</td>
<td>14'-4&quot;</td>
<td>10'-9&quot;</td>
<td>5'-4½&quot;</td>
<td>3'-7&quot;</td>
<td>2'-8¼&quot;</td>
<td>0'-10½&quot;</td>
<td>0'-5¼&quot;</td>
</tr>
<tr>
<td>I</td>
<td>7'-9&quot;</td>
<td>5'-10&quot;</td>
<td>2'-11&quot;</td>
<td>1'-11&quot;</td>
<td>1'-5¼&quot;</td>
<td>0'-5¼&quot;</td>
<td>0'-2¼&quot;</td>
</tr>
<tr>
<td>J</td>
<td>2'-6&quot;</td>
<td>2'-0&quot;</td>
<td>1'-0&quot;</td>
<td>0'-8&quot;</td>
<td>0'-6&quot;</td>
<td>0'-2&quot;</td>
<td>0'-1&quot;</td>
</tr>
</tbody>
</table>
1. Match the terms on the right with their correct definitions.

   a. An object's dimensions, the size it actually is in completed form
   b. An instrument used as a standard of reference when drawing an object to a proportional size
   c. Drawing an object at a set proportion such as half its actual size, one-fourth its actual size, or double its actual size
   d. Dealing with the design and drawing of public and private buildings
   e. The subdivisions in a scale unit, all of which are equal in size or length
   f. A relationship between dimensional values used to reduce or enlarge the size of an object so that it can be drawn to proportion
   g. A part of a whole, such as 1/2 or 1/4
   h. A scale with the basic units subdivided throughout the length of the scale
   i. A scale with only, the end unit subdivided into fractional parts
   j. Abbreviation meaning "not-to-scale"

   1. Graduations
   2. Open divided scale
   3. Fraction
   4. Architecture
   5. Actual size
   6. Full-divided scale
   7. NTS
   8. Scale ratio
   9. Draw to scale
   10. Scale

2. Describe an architect's scale.

3. State the purpose for using a scale.
4. Identify the five basic shapes of scales below.

a. 

b. 

c. 

d. 

e. 

5. List seven scale ratios found on an architect's scale.
   a. 
   b. 
   c. 
   d. 
   e. 
   f. 
   g. 

6. Select rules for correct scale usage by placing an "X" in the appropriate blanks.
   a. Select proper scale ratio  
   b. Scale should be at a 30° angle to the line being measured  
   c. Scales can be used as a cutting edge  
   d. Scale should lay flat on the surface being measured  
   e. A short dash should be made rather than a point to mark a distance  
   f. Stick compass or divider points into scale to set instruments  
   g. Edge of the scale should be protected to prevent damage to its graduation marks  
   h. If a series of measurements are to be made on the full size scale, do not move scale for each measurement  
   i. Make sure that the line of sight does not create an optical illusion

7. Interpret 1/16, 1/8 and 1/4 graduations on full size scale shown below:

   a. 
   b. 
   c. 
   d. 
   e. 

8. Calculate and locate 1/32” graduations on the full size scale shown below by marking each dimension with a 1/8” dash and labeling the point with the correct dimension.

a. 1 5/32”

b. 2 21/32”

c. 11 13/32”

9. Read the architect’s scale at full scale ratio 12” = 1’- 0”

a.  

b.  

c.  

10. Read the architect’s scale at the scale ratio 6” = 1’- 0”.

a.  

b.  

c.  
11. Read the architect's scale at the scale ratio 3" = 1'-0".
   a. ___   b. ___   c. ___

12. Read the architect's scale at the scale ratio 1 1/2" = 1'-0".
   a. ___
   b. ___
   c. ___

13. Read the architect's scale at the scale ratio 1/4" = 1'-0".
   a. ___
   b. ___
   c. ___
14. Demonstrate the ability to:
   a. Interpret 1/16 and 1/32 graduations on a full size scale.
   b. Read the architect's scale at full scale ratio 12" = 1'-0".
   c. Read the architect's scale at the scale ratio 6" = 1'-0".
   d. Read the architect's scale at the scale ratio 3" = 1'-0".
   e. Read the architect's scale at the scale ratio 1 1/2" = 1'-0".
   f. Measure lines accurately with various scale ratios on an architect's scale.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)
ARCHITECT'S SCALE USAGE
UNIT V

ANSWERS TO TEST

1. a. 5  f. 8
   b. 10  g. 3
   c. 9  h. 6
   d. 4  i. 2
   e. 1  j. 7

2. Description should include: scale used primarily for drawings of buildings, piping systems and other large structures which must be drawn to a reduced scale to fit on a standard sheet size; it has one full-size scale and ten reduced-size scales.

3. Enables objects which are too large or too small to be drawn to actual size, or be drawn with a standard point of reference controlling the relative size of each part.

4. a. Triangular  d. Two-bevel
    b. Four-bevel  e. Opposite-bevel
    c. One-bevel

5. Any seven of the following:
   A. 12" = 1'-0" -- Full size
   B. 6" = 1'-0" -- Half size
   C. 3" = 1'-0" -- 1/4 size
   D. 1 1/2" = 1'-0" -- 1/8 size
   E. 1" = 1'-0" -- 1/12 size
   F. 3/4" = 1'-0" -- 1/16 size
   G. 1/2" = 1'-0" -- 1/24 size
   H. 3/8" = 1'-0" -- 1/32 size
   I. 1/4" = 1'-0" -- 1/48 size
   J. 3/16" = 1'-0" -- 1/64 size
   K. 1/8" = 1'-0" -- 1/96 size
   L. 3/32" = 1'-0" -- 1/128 size
6. a, d, e, g, h, i

7. a. 10 3/4"
b. 2 13/16"
c. 1 13/32"
d. 1/16"
e. 1/8"

8.

9. a. 1 9/16"
b. 2 11/16"
c. 11 3/16"

10. a. 1"
b. 2 9/16"
c. 5 3/8"

11. a. 1' 11 1/2"
b. 1' 9 1/4"
c. 8"

12. a. 4"
b. 6 1/2"
c. 2' 6 1/2"

13. a. 3"
b. 5' 6"
c. 43' 10"

14. Evaluated to the satisfaction of the instructor
CIVIL ENGINEER'S SCALE USAGE
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe a civil engineer's scale, select rules for its correct usage, and interpret scale graduations. The student should also be able to read a civil engineer's scale in various scale ratios. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to civil engineer's scale usage with their correct definitions.
2. Describe a civil engineer's scale.
3. State the purpose for using a civil engineering scale.
4. Identify five basic shapes of scales.
5. Select rules for correct scale usage.
6. List scale divisions that are found on a civil engineer's scale.
7. Interpret scale graduations found on a civil engineer's scale.
8. Demonstrate the ability to:
   a. Read the civil engineer's scale using a scale ratio of 1" = 1' - 0".
   b. Read the civil engineer's scale using a scale ratio of 1" = 20' .
   c. Read the civil engineer's scale using a scale ratio of 1" = 30' .
   d. Read the civil engineer's scale using a scale ratio of 1" = 40' .
   e. Read the civil engineer's scale using a scale ratio of 1" = 50' .
   f. Read the civil engineer's scale using a scale ratio of 1" = 60' .
   g. Measure lines accurately with various scale ratios on a civil engineer's scale.
CIVIL ENGINEER'S SCALE USAGE
UNIT VI

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information and assignment sheets.

III. Make transparencies.

IV. Discuss unit and specific objectives.

V. Discuss information and assignment sheets.

VI. Develop a display of all types of measuring rules, tapes, scales, and related items used in various machine and building trades. Include all five types of scales used in a drafting room. Discuss this display in depth with students.

VII. Invite resource person to attend class and discuss use and types of scales.

VIII. Lead discussion on the advantages and disadvantages of different types of scales.

IX. Provide problems for the students to use in practicing using the engineer's scale.

X. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters
   1. TM 1 - Civil Engineer's Scale
   2. TM 2 - Civil Engineer's Scale (Continued)

D. Assignment sheets
   1. Assignment Sheet #1 - Read the Civil Engineer's Scale Using a Scale Ratio of 1" = 1' - 0"
   2. Assignment Sheet #2 - Read the Civil Engineer's Scale Using a Scale Ratio of 1" = 20'
3. Assignment Sheet #3--Read the Civil Engineer's Scale Using a Scale Ratio of 1" = 30'

4. Assignment Sheet #4--Read the Civil Engineer's Scale Using a Scale Ratio of 1" = 40'

5. Assignment Sheet #5--Read the Civil Engineer's Scale Using a Scale Ratio of 1" = 50'

6. Assignment Sheet #6--Read the Civil Engineer's Scale Using a Scale Ratio of 1" = 60'

7. Assignment Sheet #7--Measure Lines Appropriately with Various Scale Ratios on a Civil Engineer's Scale

E. Answers to assignment sheets

F. Test

G. Answers to test

II. References:


CIVIL ENGINEER'S SCALE USAGE
UNIT VI

INFORMATION SHEET

I. Terms and definitions

A. Actual size—An object's actual dimensions, the size it actually is in completed form

B. Scale—An instrument used as a standard of reference when drawing an object to a proportional size

C. Draw to scale—Drawing an object at some set proportion such as half its actual size, one fourth its actual size, or double its actual size

D. Civil engineering—Design and construction of public works, transportation systems, environmental systems, and other systems

E. Graduations—The subdivisions in a scale unit, all of which are equal in size or length

F. Scale ratio—A relationship between dimensional values used to reduce or enlarge the size of an object so that it can be drawn

G. Fraction—A part of a whole, such as 1/2 or 1/4

H. Full-divided scale—A scale with the basic units subdivided throughout the length of the scale

II. Description of civil engineer's scale—Scale used for civil engineering work; it is graduated in units of one inch divided into 10, 20, 30, 40, 50, and 60 parts (Transparencies 1 and 2)

(NOTE: It is used in drawing maps to scales of 1" = 50', 1" = 500', 1" = 5 miles, etc.)

III. Purpose for using a civil engineer's scale—To provide a standard of reference that is needed when drawing civil projects

(NOTE: It allows areas and objects that are too large to be drawn actual size to be drawn to a usable proportion.)
IV Basic shapes of scales

A. Triangular

B. Four bevel

C. One bevel

D. Two bevel

E. Opposite bevel
INFORMATION SHEET

D. Do not stick compass or divider points into scale

E. Protect the edge of the scale to prevent damage to its graduation marks

F. Make a short dash rather than a point to mark a distance

G. If a series of measurements are to be made on full size scale, do not move scale for each measurement, but set off measurements with scale in one position

H. Make sure that the eye's line of sight does not create an optical illusion and thus an incorrect measurement

VI. Scale divisions found on an engineer's scale

A. 10 scale-1" subdivided in 10 parts

B. 20 scale-1" subdivided in 20 parts

C. 30 scale-1" subdivided in 30 parts

D. 40 scale-1" subdivided in 40 parts

E. 50 scale-1" subdivided in 50 parts

F. 60 scale-1" subdivided in 60 parts

VII. How to interpret graduations on the civil engineer's scale

A. 1" = 1' scale ratio

1. Measurement is made by reading directly from the full size scale marked 10

2. This is a full divided scale with each inch divided into 10 units of 1/10 inch

(Note: This scale can be used for various ratios, such as 1" = 1', 1" = 10', 1" = 100', or 1" = 1,000'.)

Example. On the 1" = 1' scale ratio, each division represents 1/10 of a foot, so a line containing 10 units would be 10/10 or 1' long. On the 1" = 100' scale ratio, each division represents 1/10 of 100', so each division is 10' long.
234 B

INFORMATION SHEET

B 1" 20' scale ratio

1 Measurement is made by marking off on the scale marked 20

2 This is a full divided scale with each inch divided into 20 units of 1/20 inch

"NOTE: This scale can be used for all situations such as 1" = 20', 1" = 200', or 1" = 2000"

Example: On the 1" 20' scale diagram, each division represents 1/20 of 20' or one 100th of a foot. A 22 units long, or 22' long, line A is 22' long on the 1" 20' scale, or each division represents 1/20 of 200' on the 1" 2000' scale, or each division contains 50 units, the B is 500' long.

B

500'

A

23'

20'

500'

AF 1" = 200' LENGTH
INFORMATION SHEET

1" = 30' scale

1. Measurement is made by reading directly from the scale marked 30

2. This is a full divided scale with each inch divided into 30 units of 1/30 inch

(NOTE: This scale can be used for various ratios such as 1" = 30', 1" = 300', 1" = 3,000'.)

Example: On the 1" = 30' scale ratio, each division represents 1/30 of 30' or one foot, so since it contains 42 units, line A is 42' long; on the 1" = 300' scale ratio, each division represents 1/30 or 300' or ten feet, so since it contains 55 units, line B is 550' long

D. 1" = 40' scale ratio

1. Measurement is made by reading directly from the scale marked 40

2. This is a full divided scale with each inch divided into 40 units of 1/40 inch

(NOTE: This scale can be used for various ratios such as 1" = 40', 1" = 400', or 1" = 4,000'.)

Example: On the 1" = 40' scale ratio, each division represents 1/40 of 40' or one foot, so since it contains 10 units, line A is 10' long; on the 1" = 400' scale ratio, each division represents 1/40 or 400' or ten feet, so since it contains 50 units, line B is 500' long
1. Measure the unknown length directly from the scale marked 50.

2. To obtain the unknown length, each inch divided into 50 units of 1.50

---

For the 1" : 50 scale ratio, each division represents 1/50 of an inch. Since it contains 65 units, each division is 1/65 of 1". On the 1" : 500 scale ratio, each division represents 1/500 or 0.002" per foot, so that at 1000 scale, B is 1.000" long.
F.  1" = 60' scale

1. Measurement is made by reading directly from the scale marked 60
2. This is a full divided scale with each inch divided into 60 units of 1/60 inch

(NOTE: This scale can be used for various ratios such as 1" = 60', 1" = 600', 1" = 6,000')

Example: On the 1" = 60' scale ratio, each division represents 1/60 of 60' or one foot, so since it contains 25 units, line A is 25' long. On the 1" = 600' scale ratio, each division represents 1/60 of 600' or ten feet, so since it contains 110 units, line B is 1,100' long.
Civil Engineer's Scale

Examples for Reading

This scale can be used to read

- 1.0' = 1.0"
- 10.0' = 10.0"
- 100.0' = 100.0"
Civil Engineer's Scale
(Continued)

1" = 20'

1" = 30'

1" = 40'

1" = 50'

1" = 60'
CIVIL ENGINEER'S SCALE USAGE
UNIT VI

ASSIGNMENT SHEET #1--READ THE CIVIL ENGINEER'S SCALE
USING SCALE RATIO OF 1" = 1' - 0"

Directions: Read the measurements shown below at 1" = 1' - 0" scale reading the distance from 0 at left to points indicated on the scale. Place the correct measurements in the blanks below the scale.

1. A = 
2. B = 
3. C = 
4. D = 
5. E = 
CIVIL ENGINEER'S SCALE USAGE
UNIT VI

ASSIGNMENT SHEET #2: READ THE CIVIL ENGINEER'S SCALE USING SCALE RATIO OF 1" = 20'

Directions: Read the following scale from distance at left to points indicated. Place the correct measurements in the blanks below the scale.

1. A = 
2. B = 
3. C = 

---
ASSIGNMENT SHEET #3: READ THE CIVIL ENGINEER’S SCALE USING SCALE RATIO OF 1" = 30'

Directions: Read the measurements shown below at 1" = 30' scale reading the distance from 0 at left to points indicated on the scale. Place the correct measurements in the blanks below the scale.

1. A = ____________
2. B = ____________
3. C = ____________
4. D = ____________
5. E = ____________
CIVIL ENGINEER'S SCALE USAGE
UNIT VI

ASSIGNMENT SHEET #4--READ THE CIVIL ENGINEER'S SCALE USING SCALE RATIO OF 1" = 40'

Directions: Read the measurements shown below at 1" = 40' scale reading the distance from 0 at left to points indicated on the scale. Place the correct measurements in the blanks below the scale.

1. A =
2. B =
3. C =
4. D =
5. E =
CIVIL ENGINEER'S SCALE USAGE
UNIT VI

ASSIGNMENT SHEET #5: READ THE CIVIL ENGINEER'S SCALE
USING SCALE RATIO OF 1" = 50'

Directions: Read the measurements shown below at 1" = 50' scale reading the distance
from 0 at left to points indicated on the scale. Place the correct measurements in the blanks
below the scale.

1. A = ___________________
2. B = ___________________
3. C = ___________________
4. D = ___________________
5. E = ___________________
CIVIL ENGINEER’S SCALE USAGE
UNIT VI

ASSIGNMENT SHEET #6--READ THE CIVIL ENGINEER’S SCALE
USING SCALE RATIO OF 1" = 60'

Directions: Read the measurements shown below at 1" = 60' scale reading the distance from 0 at left to points indicated on the scale. Place the correct measurements in the blanks below the scale.

1. A = ________
2. B = ________
3. C = ________
4. D = ________
5. E = ________
## ASSIGNMENT SHEET #7 - MEASURE LINES ACCURATELY WITH VARIOUS SCALE RATIOS ON A CIVIL ENGINEER'S SCALE

**Directions:** Measure the lines A through F to the scale ratio heading each column in the table. Letter the scale readings in the appropriate space in table using guidelines for 1/8" lettering.

**Example:** On a 1" = 10' scale ratio, line A would be 55' long; this figure should be lettered under the 1" = 10' column opposite letter A.

<table>
<thead>
<tr>
<th></th>
<th>1&quot;=10'</th>
<th>1&quot;=20'</th>
<th>1&quot;=300'</th>
<th>1&quot;=40'</th>
<th>1&quot;=500'</th>
<th>1&quot;=60'</th>
<th>1&quot;=10 MILES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Assignment Sheet #1
1. A = .1'
2. B = 1.35'
3. C = 3'
4. D = 8.7'
5. E = 10'

Assignment Sheet #2
1. A = 20'
2. B = 60'
3. C = 70'

Assignment Sheet #3
1. A = 10'
2. B = 52'
3. C = 90'
4. D = 116'
5. E = 150'

Assignment Sheet #4
1. A = 9'
2. B = 37'
3. C = 57'
4. D = 70'
5. E = 86'
Assignment Sheet #5

1. A = 10'
2. B = 42'
3. C = 75'
4. D = 107'
5. E = 140'

Assignment Sheet #6

1. A = 12'
2. B = 72'
3. C = 90'
4. D = 117'
5. E = 141'

Assignment Sheet #7

<table>
<thead>
<tr>
<th></th>
<th>1''=10'</th>
<th>1''=20'</th>
<th>1''=300'</th>
<th>1''=40'</th>
<th>1''=500'</th>
<th>1''=60'</th>
<th>1''=10 MILES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>44'</td>
<td>88'</td>
<td>1320'</td>
<td>176'</td>
<td>2200'</td>
<td>264'</td>
<td>44 miles</td>
</tr>
<tr>
<td>B</td>
<td>37'</td>
<td>74'</td>
<td>1110'</td>
<td>148'</td>
<td>1850'</td>
<td>222'</td>
<td>37 miles</td>
</tr>
<tr>
<td>C</td>
<td>31'</td>
<td>62'</td>
<td>930'</td>
<td>124'</td>
<td>1550'</td>
<td>186'</td>
<td>31 miles</td>
</tr>
<tr>
<td>D</td>
<td>42'</td>
<td>84'</td>
<td>1260'</td>
<td>168'</td>
<td>2100'</td>
<td>252'</td>
<td>42 miles</td>
</tr>
<tr>
<td>E</td>
<td>12'</td>
<td>24'</td>
<td>360'</td>
<td>48'</td>
<td>600'</td>
<td>72'</td>
<td>12 miles</td>
</tr>
<tr>
<td>F</td>
<td>30'</td>
<td>60'</td>
<td>900'</td>
<td>120'</td>
<td>1500'</td>
<td>180'</td>
<td>30 miles</td>
</tr>
</tbody>
</table>
1. Match the terms on the right with the correct definitions.

   a. An object's actual dimensions, the size it actually is in completed form
   b. An instrument used as a standard of reference when drawing an object to a proportional size
   c. Drawing an object at some set proportion such as half its actual size, one fourth its actual size, or double its actual size
   d. Design and construction of public works, transportation systems, environmental systems, and other systems
   e. The subdivisions in a unit all of which are equal in size or length
   f. A relationship between dimensional values used to reduce or enlarge the size of an object so that it can be drawn
   g. A part of a whole, such as 1/2 or 1/4
   h. A scale with the basic units subdivided throughout the length of the scale

2. Describe a civil engineer's scale.
3. Describe the purpose for using a civil engineer's scale.

4. Identify the five shapes of scales pictured below.
   a
   ![Triangle Shape]
   b
   ![Arrow Shape]
   c
   ![Bar Shape]
   d
   ![Bar Shape]
   e
   ![Bar Shape]
5. Select the rules for correct scale usage by placing an "X" in the appropriate blanks.

   a. Select proper scale ratio
   b. Scale should be at a 30° angle to the line being measured
   c. Scales can be used as a cutting edge
   d. Scale should lay flat on the surface being measured
   e. Make a short dash rather than a point to mark a distance
   f. Stick compass or divider points into scale to set instruments
   g. Protect the edge of the scale to prevent damage to its graduation marks
   h. If a series of measurements are to be made on the full size scale, do not move scale for each measurement, but set off measurements with scale in one position
   i. Make sure that the eye’s line of sight does not create an optical illusion and thus an incorrect measurement

6. List six scale divisions that are found on a civil engineer’s scale.

   a. __________________________ d. __________________________
   b. __________________________ e. __________________________
   c. __________________________ f. __________________________

7. Interpret graduations on a civil engineer’s scale.

   a. 1” = 10’

   1) __________________________
   2) __________________________
b 1" - 20'

1)

2)

c 1" - 30'

1)

2)

d 1" - 40'

1)
e. 1" = 500'  

8. Demonstrate the ability to:

a. Read the civil engineer's scale using a scale ratio of 1" = 1' - 0".
b. Read the civil engineer's scale using a scale ratio of 1" = 20'.
c. Read the civil engineer's scale using a scale ratio of 1" = 30'.
d. Read the civil engineer's scale using a scale ratio of 1" = 40'.
e. Read the civil engineer's scale using a scale ratio of 1" = 50'.
f. Read the civil engineer's scale using a scale ratio of 1" = 60'.
g. Measure lines accurately with various scale ratios on a civil engineer's scale.

(NOTE. If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)
CIVIL ENGINEER'S SCALE USAGE
UNIT VI

ANSWERS TO TEST

1. a. 8  e. 2
    b. 3  f. 5
    c. 7  g. 1
    d. 4  h. 6

2. Description should include:
   Scale used for civil engineering work; it is graduated in units of one inch divided into 10, 20, 30, 40, 50, and 60 parts

3. To provide a standard of reference that is needed when drawing civil projects

4. a. Triangular
    b. Four-bevel
    c. One-bevel
    d. Two-bevel
    e. Opposite-bevel

5. a, d, e, g, h, i

6. a. 10 scale--1" subdivided in 10 parts
    b. 20 scale--1" subdivided in 20 parts
    c. 30 scale--1" subdivided in 30 parts
    d. 40 scale--1" subdivided in 40 parts
    e. 50 scale--1" subdivided in 50 parts
    f. 60 scale--1" subdivided in 60 parts

7. a. 1" = 10'
    1) 10'
    2) 100'
    b. 1" = 20'
    1) 10'
    2) 50'
    c. 1" = 300'
    1) 100'
    2) 500'
d  \[ 1'' = 40' \]
   1)  10'
   2)  50'

e  \[ 1'' = 500' \]
   1)  100'
   2)  1,000'

f  \[ 1'' = 60' \]
   1)  10'
   2)  100'

8. Evaluated to the satisfaction of the instructor.
MECHANICAL ENGINEER'S SCALE USAGE

UNIT VII

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe a mechanical engineer's scale and state the purpose for using one. The student should also be able to list ratios found on a mechanical engineer's scale and read the ratio scales correctly when measuring lines. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to mechanical engineer's scale usage with their correct definitions.
2. Describe a mechanical engineer's scale.
3. State the purpose for using a mechanical engineer's scale.
4. Identify five basic shapes of scales.
5. Select rules for correct scale usage.
6. List four scale ratios that are found on a mechanical engineer's scale.
7. Interpret scale graduations found on a mechanical engineer's scale.
8. Demonstrate the ability to:
   a. Read the mechanical engineer's scale at the scale ratio of 1" = 1" (Full size)
   b. Read the mechanical engineer's scale at the scale ratio of 1/2" = 1" (Half size)
   c. Read the mechanical engineer's scale at the scale ratio of 1/4" = 1" (Quarter size)
   d. Read the mechanical engineer's scale at the scale ratio of 1/8" = 1" (One-eighth size)
   e. Measure lines accurately with various scale ratios on a mechanical engineer's scale
MECHANICAL ENGINEER'S SCALE USAGE
UNIT VII

SUGGESTED ACTIVITIES

I. Provide students with objective sheet.

II. Provide students with information and assignment sheets.

III. Make transparency.

IV. Discuss unit and specific objectives.

V. Discuss information and assignment sheets.

VI. Develop a display of all types of measuring rules, tapes, scales, and related items used in various machine trades. Include all five types of scales used in a drafting room. Discuss this display in depth with students.

VII. Provide practice activities for students to use in increasing their skill with the mechanical engineer's scale.

VIII. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency Master 1 Mechanical Engineer's Scale

D. Assignment sheets

1. Assignment Sheet #1 Read the Mechanical Engineer's Scale Using a Scale Ratio of 1" = 1" (Full size)

2. Assignment Sheet #2 Read the Mechanical Engineer's Scale Using a Scale Ratio of 1/2" = 1" (Half size)

3. Assignment Sheet #3 Read the Mechanical Engineer's Scale Using a Scale Ratio of 1/4" = 1" (Quarter size)

4. Assignment Sheet #4 Read the Mechanical Engineer's Scale Using a Scale Ratio of 1/8" = 1" (One eighth size)

5. Assignment Sheet #5 Measure Lines Accurately with Various Scale Ratios on a Mechanical Engineer's Scale
References:

MECHANICAL ENGINEER'S SCALE USAGE
UNIT VII

INFORMATION SHEET

I. Terms and definitions

A. Actual size An object's actual dimensions, the size it actually is in completed form

B. Scale An instrument used as a standard of reference when drawing an object to a proportional size

C. Draw to scale Drawing an object at some set proportion such as half its actual size, one fourth its actual size, or double its actual size

D. Open divided scale A scale with only the end unit subdivided into fractional parts

E. Full divided scale A scale with the basic units subdivided throughout the length of the scale

F. Graduations The subdivisions in a scale unit, all of which are equal in size or length

G. Scale ratio A relationship between dimensional values used to reduce or enlarge the size of an object so that it can be drawn

H. Fraction A part of a whole, such as 1/2 or 1/4

II. Description of mechanical engineer's scale A scale commonly used by mechanical drafters because of its scale ratios; the mechanical engineer's scale is divided into units representing full size (1" = 1"), half size (1/2" = 1"), quarter size (1/4" = 1"), and one eighth size (1/8" = 1")

(NOTE: The mechanical engineer's scale is sometimes called a mechanical drafter's scale)

III. Purpose for using a mechanical engineer's scale To provide a standard of reference that is needed when drawing mechanical parts where the dimensions are in inches or fractions

(NOTE: It allows objects that are too large or too small to be drawn actual size to be drawn to a usable proportion.)
INFORMATION SHEET

IV  Basic shapes of scales

A  Triangle

B  Trapezoid

C  One Beeve

D  Two Beeve

E  One Flat-beeve

V  Rules for using scale shapes:

a  Shape and ratio

b  Enlarge or reduce the surface being measured

c  Percent of the numbers being fractioned

d  Do not use compass and ruler points into scale
INFORMATION SHEET

E. Protect the edge of the scale to prevent damage to its graduation marks.

F. Make a short dash rather than a point to mark a distance.

G. If a series of measurements are to be made on full size scale, do not move scale for each measurement, but set off measurements with scale in one position.

H. Make sure that the eyes' line of sight does not create an optical illusion and thus an incorrect measurement.

VI. Scale ratios found on a mechanical engineer's scale:

A. 1" = 1" -- Full size
B. 1/2" = 1" -- Half size
C. 1/4" = 1" -- Quarter size
D. 1/8" = 1" -- One-eighth size

(NOTE: On some mechanical engineer's scales you will find a 3/8" = 1" and 3/4" = 1", but these are not considered standard reduction scales.)

VII. How to interpret scale graduations found on the mechanical engineer's scale:

A. 1" = 1" (Full size) Measurement is made by reading directly from full size scale in inches and fractions.

Example: To measure the distance indicated on the scale below, start at 0 and the point being measured (in this case it is 2"), next, determine the number of 1/16" units between the last full inch and the point being measured (in this case there are thirteen 1/16" units), add the inches and the fraction, and the measurement is 2 13/16".
INFORMATION SHEET

B. 1/2" - 1" (Half size)

1. When measuring a given line on a scale ratio of 1/2" = 1", use the scale marked 1/2".

2. The subdivisions to the left of 0 represent one inch compressed to a 1/2" length in 16 units which represent 1/16"

Example. To measure the distance indicated on the scale below, lay the 1/2" scale parallel to the line being measured, then move the scale to the right until it shows only the full inches to the right of 0 (in this case it is 4"); next, read the subdivisions to the left of 0 to determine the inches and fractions of an inch (in this case it is 6/16 or 3/8") which when added to the full inches will give a reading of 4 3/8".

Unit Subdivided Into 16 Parts

---

C. 1/4" - 1" (Quarter size)

1. When measuring a given line on a scale ratio of 1/4" = 1", use the scale marked 1/4".

2. The subdivisions to the right of 0 represent one inch compressed to a 1/4" length in 8 units which represent 1/8"

Example. To measure the distance indicated on the scale below, lay the 1/4" scale parallel to the line being measured, then move the scale to the left until it shows only the full inches to the left of 0 (in this case it is 9"); next, read the subdivisions to the right of 0 to determine the inches and fractions of an inch (in this case it is 3/8") which when added to the full inches will give a reading of 9 3/8".

Unit Subdivided Into 8 Parts
INFORMATION SHEET

D. 1/8" = 1" (one-eighth size)

1. When measuring a given line on a scale ratio of 1/8" = 1", use the scale marked 1/8.

2. The subdivisions to the left of 0 represent one inch compressed to a 1/8" length in 4 units which represent 1/4".

Example:

To measure the distance indicated on the scale below, lay the 1/8 scale parallel to the line being measured, then move the scale to the right until it shows only the full inches to the right of 0 (in this case it is 18"); next, read the subdivisions to the left of 0 to determine the inches and fractions of an inch (in this case it is 3/4"), which when added to the full inches will give a reading of 18 3/4".

Unit Subdivided Into 4 Parts

[Diagram of a scale showing 18 3/4" measurement]
Mechanical Engineers Scale

1"=1" Full Scale

One-Eighth Size (1/8" =1")

16 Subdivisions in 1 st. Unit

One-Half Size (1/2"=1")

8 Subdivisions in 1 st. Unit

One-Quarter Size (1/4"=1")

An alternate form of mechanical engineer's scale is shown at right
MECHANICAL ENGINEER'S SCALE USAGE
UNIT VII

ASSIGNMENT SHEET #1--READ THE MECHANICAL ENGINEER'S SCALE USING A SCALE RATIO OF 1" = 1"

Directions: Read the measurements shown below at 1" = 1" scale (full size). Read the lengths from 0 at left of points indicated on the scale. Place the correct measurements in the blanks below the figure.

A. 
B. 
C. 
D. 
E. 

---

A. 
B. 
C. 
D. 
E. 

---
ASSIGNMENT SHEET #2 - READ THE MECHANICAL ENGINEER’S SCALE USING A SCALE RATIO OF 1/2” = 1”

Directions: Read the measurements shown below at 1/2” = 1” scale (half size). Read the full inch units from 0 to the right and the fractional units to the left. Place the correct measurements in the blanks below the figure.

A. __________________________
B. __________________________
C. __________________________
D. __________________________

NOT TO SCALE
Assignment Sheet #3 - Read the Mechanical Engineer's Scale using a scale ratio of 1/4" = 1".

Directions: Read the measurements shown below at 1/4" = 1" scale (quarter size). Read the full inch units from 0 to the left and the fractional units to the right of 0. Place the correct measurements in the blanks below the figure.

A. ________

B. ________

C. ________

D. ________
Directions: Read the measurements shown below at 1/8" = 1" scale (one-eighth size). Read the full inch units from 0 to the right and the fractional unit to the left. Place the correct measurements in the blanks below the figure.

A. ________
B. ________
C. ________
D. ________
MECHANICAL ENGINEER'S SCALE USAGE
UNIT VII

ASSIGNMENT SHEET #5-MEASURE LINES ACCURATELY WITH VARIOUS SCALE RATIOS ON A MECHANICAL ENGINEER'S SCALE

Directions: Measure the lines A through F to the scale heading each column in the table. Letter the scale readings in the appropriate space in the table.

Example: Measure Line A to the scale $1/2'' = 1''$. A reading of _____ is obtained. This dimension is lettered under the $1/2'' = 1''$ column and opposite the letter A. Use guide lines for $1/8''$ lettering.

(NOTE: Readings must be accurate or they will be considered wrong.)

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1'' = 1''$</td>
<td>$1/2'' = 1''$</td>
<td>$1/4'' = 1''$</td>
<td>$1/8'' = 1''$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MECHANICAL ENGINEER'S SCALE USAGE
UNIT VII

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1
A. 15/16"  
B. 1 7/16"  
C. 2 3/8"  
D. 10 13/16"  
E. 11 3/4"

Assignment Sheet #2
A. 9/16"  
B. 2 13/16"  
C. 3 7/8"  
D. 4 15/16"

Assignment Sheet #3
A. 3/8"  
B. 5/8"  
C. 3 5/8"  
D. 5 7/8"

Assignment Sheet #4
A. 1/2"  
B. 8 1/2"  
C. 15 3/4" or 1' - 3 3/4"  
D. 21 3/4" or 1' - 9 3/4"
Assignment Sheet #5

<table>
<thead>
<tr>
<th></th>
<th>1&quot; = 1&quot;</th>
<th>1/2&quot; = 1&quot;</th>
<th>1/4&quot; = 1&quot;</th>
<th>1/8&quot; = 1&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4 15/32&quot;</td>
<td>6 15/16&quot;</td>
<td>17 7/8&quot;</td>
<td>35 3/4&quot;</td>
</tr>
<tr>
<td>B</td>
<td>3 11/16&quot;</td>
<td>7 3/8&quot;</td>
<td>14 3/4&quot;</td>
<td>29 1/2&quot;</td>
</tr>
<tr>
<td>C</td>
<td>3 7/16&quot;</td>
<td>6 1/8&quot;</td>
<td>12 1/4&quot;</td>
<td>24 1/2&quot;</td>
</tr>
<tr>
<td>D</td>
<td>4 7 32&quot;</td>
<td>8 7/16&quot;</td>
<td>16 7/8&quot;</td>
<td>33 3/4&quot;</td>
</tr>
<tr>
<td>E</td>
<td>1 1/4&quot;</td>
<td>2 1/2&quot;</td>
<td>5&quot;</td>
<td>10&quot;</td>
</tr>
<tr>
<td>F</td>
<td>2 15/16&quot;</td>
<td>5 7/8&quot;</td>
<td>11 3/4&quot;</td>
<td>23 1/2&quot;</td>
</tr>
</tbody>
</table>
MECHANICAL ENGINEER'S SCALE USAGE
UNIT VII

NAME ____________________________

TEST:

1. Match the terms on the right with their correct definitions.

   a. An object's actual dimensions, the size it actually is in completed form
   b. An instrument used as a standard of reference when drawing an object to a proportional size
   c. Drawing an object at some set proportion such as half its actual size, one fourth its actual size, or double its actual size
   d. A scale with only the end unit subdivided into fractional parts
   e. The subdivisions in a scale unit, all of which are equal in size or length
   f. A relationship between dimensional values used to reduce or enlarge the size of an object so that it can be drawn
   g. A part of a whole, such as 1/2 or 1/4
   h. A scale with the basic units subdivided throughout the length of the scale

   1. Graduations
   2. Fraction
   3. Open-divided scale
   4. Scale
   5. Actual size
   6. Full-divided scale
   7. Scale ratio
   8. Draw to scale

2. Describe a mechanical engineer's scale.
3. State the purpose for using a mechanical engineer's scale.

4. Identify five basic shapes of scales.

   a. 
   b. 
   c. 
   d. 
   e. 

5. Select rules for correct scale usage by placing an "X" in the appropriate blanks.
   a. Select proper scale ratio
   b. Scale should be at a 30° angle to the line being measured
   c. Scales can be used as a cutting edge
d. Scale should lay flat on the surface being measured

e. Make a short dash rather than a point to mark a distance

f. Stick compass or divider points into scale to set instruments

g. Protect the edge of the scale to prevent damage to its graduation marks

h. If a series of measurements are to be made on the full size scale, do not move scale for each measurement, but set off measurements with scale in one position

i. Make sure that the eyes' line of sight does not create an optical illusion and thus an incorrect measurement

6. List four scale ratios that are found on a mechanical engineer's scale.

a.  

b.  

c.  

d.  

7. Interpret graduations on the engineer's scale.

a. 1" = 1"

![Scale Diagram]

1)  
2)  
3)  

\[ \text{Scale Diagram} \]
b. 1\frac{1}{2}'' - 1''

1) 
2) 
3) 

NOT TO SCALE

1\cdot 4'' = 1''

1) 
2) 
3) 
d. 1/8" = 1"

8. Demonstrate the ability to:

a. Read the mechanical engineer's scale at the scale ratio of 1" = 1" (Full size)

b. Read the mechanical engineer's scale at the scale ratio of 1/2" = 1" (Half size)

c. Read the mechanical engineer's scale at the scale ratio of 1/4" = 1" (Quarter size)

d. Read the mechanical engineer's scale at the scale ratio of 1/8" = 1" (One eighth size)

e. Measure lines accurately with various scale ratios on a mechanical engineer's scale (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)
MECHANICAL ENGINEER'S SCALE USAGE
UNIT VII

ANSWERS TO TEST

1. a. 5  e. 1
    b. 4  f. 7
    c. 8  g. 2
    d. 3  h. 6

2. Description should include:
   A scale commonly used by mechanical drafters because of its scale ratios; the mechanical engineer's scale is divided into units representing full size (1" = 1"), half size (1/2" = 1"), quarter size (1/4" = 1"), and one-eighth size (1/8" = 1")

3. To provide a standard of reference that is needed when drawing mechanical parts where the dimensions are in inches or fractions

4. a. Triangular
    b. Four-bevel
    c. One-bevel
    d. Two-bevel
    e. Opposite-bevel

5. a, d, e, g, h, i

6. a. 1" = 1"
    b. 1/2" = 1"
    c. 1/4" = 1"
    d. 1/8" = 1"

7. a. 1) 1 5/16"
    2) 2 3/8"
    3) 3 1/16"

    b. 1) 3/8"
    2) 2 5/8"
    3) 5 7/8"

    c. 1) 5/8"
    2) 6 3/4"
    3) 8 7/8"

    d. 1) 11 1/4"
    2) 19 1/2"

8. Evaluated to satisfaction of the instructor
METRIC SCALE USAGE
UNIT VIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe the purpose for using a metric scale and be able to list standard scale ratios to which objects can be drawn with the metric scale. The student should be able to interpret scale graduations and correctly measure lengths with the metric scale. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to metric scale usage with their correct definitions.
2. State the purpose for using a metric scale.
3. Identify basic shapes of metric scales.
4. Select rules for correct scale usage.
5. Explain a scale ratio.
6. Distinguish between a reduction scale ratio and an enlargement scale ratio.
7. Select metric scale ratios commonly used for various drafting applications.
8. List commonly used scale ratios found on triangular metric scales.
9. Interpret scale graduations on a full divided 1:1, 1:100 metric scale.
10. Interpret metric scale ratios commonly used for machine drawings.
11. Interpret metric scale ratios commonly used for architectural construction details.
12. Demonstrate the ability to:
   a. Read the metric scale at the scale ratio of 1:1.
   b. Read the metric scale at the scale ratio of 1:2.
   c. Read the metric scale at the scale ratio of 1:5.
d. Read the metric scale at the scale ratio 1:25.

e. Read the metric scale at the scale ratio 1:33 1/3.

f. Read the metric scale at the scale ratio 1:75.

g. Measure lines accurately with various scale ratios found on a metric scale.
METRIC SCALE USAGE
UNIT VIII

SUGGESTED ACTIVITIES

I. Provide students with objective sheet.

II. Provide students with information and assignment sheets.

III. Make transparencies.

IV. Discuss unit and specific objectives.

V. Discuss information and assignment sheets.

VI. Develop a display of all types of measuring rules, tapes, scales and related items used in various machine and building trades. Include all five types of scales used in a drafting room. Discuss this display in depth with students.

VII. Have students practice measuring objects in the classroom.

VIII. Use metric comparison charts in discussing the use of metric scales.

IX. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Metric Scales (Triangular)

2. TM 2--Frequently Used Metric Reduction Scales

3. TM 3--Frequently Used Metric Enlargement Scales

D. Assignment sheets

1. Assignment Sheet #1--Read the Metric Scale at the Scale Ratio of 1:1

2. Assignment Sheet #2--Read the Metric Scale at the Scale Ratio of 1:2

3. Assignment Sheet #3--Read the Metric Scale at the Scale Ratio 1:5
1. Assignment Sheet #4: Read the Metric Scale at the Scale Ratio 1:25
2. Assignment Sheet #5: Read the Metric Scale at the Scale Ratio 1:33
3. Assignment Sheet #6: Read the Metric Scale at the Scale Ratio 1:75
4. Assignment Sheet #7: Measure Lines Accurately with Various Scale Ratios Found on a Metric Scale

E. Answers to assignment sheets

F. Test

G. Answers to test

II. References:


METRIC SCALE USAGE
UNIT VIII

INFORMATION SHEET

I. Terms and definitions

A. Actual size--An object's actual dimensions, the size it actually is in completed form.

B. Scale--An instrument used as a standard of reference when drawing an object to a proportional size.

C. Draw to scale--Drawing an object at some set proportion such as half its actual size or double its actual size.

D. Graduations--The subdivisions in a scale unit, all of which are equal in size or length.

E. Scale ratio--A relationship between dimensional values used to reduce or enlarge the size of an object so that it can be drawn proportionally.

F. Open-divided scale--A scale with only the end unit subdivided into fractional parts.

G. Full-divided scale--A scale with the basic units subdivided throughout the length of the scale.

H. Metric system--A decimal system of weights and measures based on the meter and the kilogram.

I. Meter (m)--The metric system standard for linear measurement.

J. SI--The modern form of the metric system "The International System of Units".

K. Millimeter (mm)--1/1000 of a meter.
   (NOTE: This is the primary unit of measurement for engineering.)

L. Centimeter (cm)--1/100 of a meter.

M. Decimeter (dm)--1/10 of a meter.

II. Purpose for using a metric scale--To provide a standard of reference for constructing a drawing either in its actual size or larger or smaller than full size.
INFORMATION SHEET

III. Basic shapes of metric scales

A. Oval

B. Two bevel

C. Opposite Bevel

D. Four bevel

E. Triangular

IV. Rules for correct scale usage

A. Select proper scale ratio
B. Scale should lay flat on the surface being measured
C. Scale should be parallel with or on line being measured
D. Do not stick compass or divider points into scale
E. Protect the edge of the scale to prevent damage to its graduation marks
F. Make a short dash rather than a point to mark a distance
G. If a series of measurements are to be made on full size scale, do not move scale for each measurement, but set off measurements with scale in one position
H. Make sure that the eyes' line of sight does not create an optical illusion and thus an incorrect measurement
V. Explanation of a scale ratio—A ratio between the actual dimension and another dimension that will be used to represent the actual size

(NOTE: The ratio 1:1 would indicate 1 millimeter = 1 millimeter while 1:10 would indicate 1 millimeter = 10 millimeters.)

VI. Reduction and enlargement scale ratios

A. Frequently used reduction scales are 1:2, 1:3, 1:5, and 1:10

(NOTE: 1:2 means 1mm = 2mm, 1:5 means 1mm = 5mm.)

B. Frequently used enlarging scale ratios are 2:1 and 5:1

(NOTE: It is always recommended to use full-size (1:1) whenever possible.)

VII. Metric scale ratios commonly used for various drafting applications

<table>
<thead>
<tr>
<th>Metric mm:mm</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1</td>
<td>Machine drawings</td>
</tr>
<tr>
<td>1:2</td>
<td></td>
</tr>
<tr>
<td>1:3</td>
<td></td>
</tr>
<tr>
<td>1:5</td>
<td></td>
</tr>
<tr>
<td>1:10</td>
<td></td>
</tr>
<tr>
<td>1:20</td>
<td></td>
</tr>
<tr>
<td>1:25</td>
<td>Architectural construction details</td>
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<tr>
<td>1:33 1/3</td>
<td></td>
</tr>
<tr>
<td>1:75</td>
<td>Architectural plans and elevations</td>
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<tr>
<td>1:100</td>
<td>Architectural plot plans</td>
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<td>1:200</td>
<td></td>
</tr>
<tr>
<td>1:500</td>
<td></td>
</tr>
<tr>
<td>1:1250</td>
<td>Maps (civil drawings)</td>
</tr>
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<td>1:2500</td>
<td></td>
</tr>
<tr>
<td>1:10,000</td>
<td></td>
</tr>
<tr>
<td>1:50,000</td>
<td></td>
</tr>
</tbody>
</table>

VIII. Commonly used scale ratios found on triangular metric scales

A. 1:1

B. 1:2

C. 1:5

D. 1:25
INFORMATION SHEET

E. 1:33 1:3
F. 1:75

IX. How to interpret scale graduations found on a full-divided 1:1, 1:100 metric scale:

A. Many metric scales have multiple scale ratios along one edge to allow for a variety of scales to be used from a single instrument.

B. The 1:1 (full size) scale ratio is the basic scale ratio used; each subdivision is actually 1 mm in width with the calibrations numbered at 10 mm intervals.

Example: On the 1:1 scale ratio, line X in the figure below is 100 mm long, but on the 1:100 scale ratio at the bottom of the scale, line X would be 10,000 mm or 10 meters long.

X

Metric scale ratios commonly used for machine drawings:

A. 1:1 ratio (full size) has scale subdivisions 1 mm in width with calibrations numbered in 10 mm increments.

(NOTE: Some scales have subdivisions in 1.2 mm, and these should not be confused with the standard 1 mm subdivisions.)

Measurements are made by reading directly from the 1:1 scale ratio in meters (Figure 1).

Figure 1
INFORMATION SHEET

2. When read 1:10, this scale ratio is used for machine drawings, when read 1:100, this scale ratio is used for architectural drawings, and when read 1:1000, this scale ratio is used for map drawings.

B. 1:2 ratio (half size) has scale subdivisions representing 2 mm of width with calibrations numbered in 20 mm increments.
   1. Measurements are made by reading directly from the 1:2 scale ratio in millimeters (Figure 1).

2. When read 1:20, this scale ratio is used for machine drawings, when read 1:200, this scale ratio is used for architectural drawings, and when read 1:2000, this scale ratio is used for map drawings.

C. 1:5 ratio (one-fifth size) has scale subdivisions representing 5 mm of width with calibrations numbered in 100 mm increments.
   1. Measurements are made by reading directly from the 1:5 scale ratio in millimeters (Figure 2).

FIGURE 2

2. When read 1:50, this scale ratio is used for machine drawings, when read 1:500, this scale ratio is used for architectural drawings, and when read 1:5000, this scale is used for map drawings.

XI. Metric scale ratios commonly used for architectural construction details

A. 1:25 ratio has subdivisions representing 20 mm of width with calibrations numbered in 500 mm increments, and measurements are made by reading directly from the 1:25 scale in meters and millimeters (Figure 3).

B. 1:33 1/3 ratio has subdivisions representing 20 mm of width with calibrations numbered in 1000 mm increments, and measurements are made by reading directly from the 1:33 1/3 scale in millimeters (Figure 3).
C. 1:75 ratio has subdivisions representing 50 mm of width with calibrations numbered in 1000 mm (1 m) increments, and measurements are made by reading directly from the 1:75 scale in millimeters (Figure 4).
Metric Scales
(Triangular)

1:1 RATIO METRIC SCALE (Full-Size)

1:2 RATIO METRIC SCALE (Half-Size)

1:5 RATIO METRIC SCALE (One-Fifth Size)

1:25 RATIO METRIC SCALE

1:33 1/3 RATIO METRIC SCALE

1:75 RATIO METRIC SCALE
Frequently Used Metric Reduction Scales

OBJECT (1:1)

1:2

1:3

1:5

1:10
Frequently Used Metric Enlargement Scales

OBJECT (1:1)

2:1

5:1
METRIC SCALE USAGE
UNIT VIII

ASSIGNMENT SHEET #1--READ THE METRIC SCALE
AT THE SCALE RATIO OF 1:1

Directions: Read the measurements shown below at 1:1 scale ratio (full size). Read the lengths from 0 at the left side to the point indicated on the scale. Place the correct measurements in the blanks below the figure.

<table>
<thead>
<tr>
<th>a.</th>
<th>b.</th>
<th>c.</th>
<th>d.</th>
<th>e.</th>
</tr>
</thead>
</table>

[Diagram of a metric ruler with markings from 0 to 300 mm]
METRIC SCALE USAGE
UNIT VIII

ASSIGNMENT SHEET #2--READ THE METRIC SCALE
AT THE SCALE RATIO OF 1:2

Directions: Read the measurements shown below at 1:2 scale ratio (half size). Read the lengths from 0 at the left side to the point indicated on the scale. Place the correct measurements in the blanks below the figure.

a. 

b. 

c. 

d. 

e. 

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---

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METRIC SCALE USAGE
UNIT VIII

ASSIGNMENT SHEET #3-READ THE METRIC SCALE
AT THE SCALE RATIO OF 1:5

Directions: Read the measurements shown below at 1:5 ratio. Read the lengths from 0 at the left side to the point indicated on the scale. Place the correct measurements in the blanks below the figure.

a.

b.

c.

d.

e.
METRIC SCALE USAGE
UNIT VIII

ASSIGNMENT SHEET #4—READ THE METRIC SCALE
AT THE SCALE RATIO OF 1:25

Directions: Read the measurements shown below at 1:25 ratio. Read the lengths from 0 at the left to the point indicated on the scale. Place the correct measurements in the blanks below the figure.

a. 

b. 

c. 

d. 

e. 

METRIC SCALE USAGE
UNIT VIII

ASSIGNMENT SHEET #5—READ THE METRIC SCALE
AT THE SCALE RATIO OF 1:33 1/3

Directions: Read the measurements shown below at 1:33 1/3 ratio. Read the lengths from 0 at the left end to the point indicated on the scale. Place the correct measurements in the blanks below the figure.

---

a. 

b. 

c. 

d. 

e. 

---
METRIC SCALE USAGE
UNIT VIII

ASSIGNMENT SHEET #6 - READ THE METRIC SCALE
AT THE RATIO OF 1:75

Directions: Read the measurements shown below at 1:75 ratio. Read the lengths from 0 at the left end to the point indicated on the scale. Place the correct measurements in the blanks below the figure.

a. 

b. 

c. 

d. 

e. 

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METRIC SCALE USAGE
UNIT VIII

ASSIGNMENT SHEET #7-MEASURE LINES ACCURately WITH VARIOUS SCALE RATIOs FOUND ON A METRIC SCALE

Directions: Measure the lines A through F to the scale heading each column in the table. Letter the scale readings in the appropriate space in the table. Use guidelines for 1/8 lettering.

Example: Measure line A to the scale ratio 1:2 when the reading is obtained, dimension should be lettered under the 1:2 column and opposite the letter A.

<table>
<thead>
<tr>
<th></th>
<th>1:1</th>
<th>1:2</th>
<th>1:5</th>
<th>1:26</th>
<th>1:33 1/3</th>
<th>1:1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
METRIC SCALE USAGE
UNIT VIII

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1
a. 34 mm
b. 52 mm
c. 69 mm
d. 270 mm
e. 294 mm

Assignment Sheet #2
a. 30 mm
b. 56 mm
c. 460 mm
d. 518 mm
e. 550 mm

Assignment Sheet #3
a. 80 mm
b. 180 mm
c. 280 mm
d. 1300 mm
e. 1365 mm

Assignment Sheet #4
a. 680 mm
b. 1 m
c. 6 m
d. 6 m - 400 mm or 6400 mm
e. 6 m - 920 mm or 6920 mm
Assignment Sheet #5

a. 600 mm
b. 1000 mm or 1 m
c. 3 m 500 mm or 1500 mm
d. 8 m 300 mm or 8300 mm
e. 9 m 500 mm or 9500 mm

Assignment Sheet #6

a. 1 m 700 mm or 1700 mm
b. 3 m 150 mm or 3150 mm
c. 4 m 500 mm or 4500 mm
d. 19 mm or 19,000 mm
e. 20 m 300 mm or 20,300 mm

Assignment Sheet #7

<table>
<thead>
<tr>
<th></th>
<th>1:1</th>
<th>1:2</th>
<th>1:5</th>
<th>1:25</th>
<th>1:500</th>
<th>1:1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>113 mm</td>
<td>227 mm</td>
<td>566 mm</td>
<td>242.5 mm</td>
<td>318 mm</td>
<td>11,300 mm</td>
</tr>
<tr>
<td>B</td>
<td>93 mm</td>
<td>166 mm</td>
<td>466 mm</td>
<td>233 mm</td>
<td>310 mm</td>
<td>9,300 mm</td>
</tr>
<tr>
<td>C</td>
<td>77 mm</td>
<td>154 mm</td>
<td>386 mm</td>
<td>193 mm</td>
<td>257 mm</td>
<td>700 mm</td>
</tr>
<tr>
<td>D</td>
<td>107 mm</td>
<td>214 mm</td>
<td>536 mm</td>
<td>268 mm</td>
<td>356 mm</td>
<td>10,700 mm</td>
</tr>
<tr>
<td>E</td>
<td>39 mm</td>
<td>62 mm</td>
<td>150 mm</td>
<td>75 mm</td>
<td>100 mm</td>
<td>300 mm</td>
</tr>
<tr>
<td>F</td>
<td>73 mm</td>
<td>146 mm</td>
<td>364 mm</td>
<td>192 mm</td>
<td>244 mm</td>
<td>7,300 mm</td>
</tr>
</tbody>
</table>
1. Match the terms on the right with the correct definitions.

   a. An object's actual dimensions, the size it actually is in completed form
   1. Meter

   b. An instrument used as a standard of reference when drawing an object to a proportional size
   2. Open-divided scale

   c. Drawing an object at some set proportion such as half its actual size or double its actual size
   3. Graduations

   d. The subdivisions in a scale unit, all of which are equal in size or length
   4. Actual size

   e. A relationship between dimensional values used to reduce or enlarge the size of an object so that it can be drawn proportionally
   5. Draw to scale

   f. A scale with only the end unit subdivided into fractional parts
   6. Decimeter (DM)

   g. A scale with the basic units, subdivided throughout the length of the scale
   7. SI

   h. A decimal system of weights and measures based on the meter and the kilogram
   8. Full-divided scale

   i. The metric standard for linear measurement
   9. Scale ratio

   j. The modern form of the metric system "The International System of Units"
   10. Millimeter (mm)

   k. 1/1000 of a meter
   11. Scale

   l. 1/100 of a meter
   12. Metric system

   m. 1/10 of a meter
   13. Centimeter (cm)

2. State the purpose for using a metric scale.
3. Identify basic shapes of metric scales.

   a. 

   b. 

   c. 

   d. 

   e. 

4. Select rules for correct scale usage by placing an "X" in the appropriate blanks.

   a. Select proper scale ratio

   b. Scale should be at a 60° angle to the line being measured

   c. Scales can be used as a cutting edge

   d. Scale should lay flat on the surface being measured

   e. Make a short dash rather than a point to mark a distance

   f. Stick compass or divider points into scale to set instruments

   g. Protect the edge of the scale to prevent damage to its graduation marks

   h. If a series of measurements are to be made on the full size scale, do not move scale for each measurement, but set off measurements with scale in one position

   i. Make sure that the eyes' line of sight creates an optical illusion and thus an incorrect measurement
5. Explain a scale reduction ratio.

6. Distinguish between a reduction scale ratio and an enlargement scale ratio by placing an "X" by each example of a reduction scale ratio.

   a. 1:2
   b. 5:1
   c. 1:5
   d. 2:1
   e. 1:33 1/3
   f. 1:25

7. Select metric scale ratios commonly used for various drafting applications by placing an "MD" by those ratios commonly used for machine drawings, an "AD" by those ratios commonly used for architectural plans, details and plot plans, and an "M" by those ratios commonly used for maps.

   a. 1:1
   b. 1:50,000
   c. 1:3
   d. 1:500
   e. 1:10
   f. 1:2,500
   g. 1:75
   h. 1:33 1/3
   i. 1:25
   j. 1:100
   k. 1:200
   l. 1:5
   m. 1:20
   n. 1:10,000
   o. 1:2
8. List commonly used scale ratios found on metric scales.
   a. 
   b. 
   c. 
   d. 
   e. 
   f. 

9. Interpret scale graduations found on a full divided 1:1, 1:10 metric scale.

10. Interpret metric scale ratios commonly used for machine drawings.
11. Interpret scale ratios commonly used for architectural construction details.
At 1:25

a. 

b. 

c. 

12. Demonstrate the ability to:

a. Read the metric scale at the scale ratio of 1:1.

b. Read the metric scale at the scale ratio of 1:2.

c. Read the metric scale at the scale ratio of 1:5.

d. Read the metric scale at the scale ratio of 1:25.

e. Read the metric scale at the scale ratio of 1:33 1/3.

f. Read the metric scale at the scale ratio of 1:75.

q. Measure lines accurately with various scale ratios found on a metric scale.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)
METRIC SCALE USAGE
UNIT VIII

ANSWERS TO TEST

1. a. 4  g. 8
b. 11  h. 12
c. 5  i. 1
d. 3  j. 7
e. 9  k. 10
f. 2  l. 13
m. 6

2. Purpose for using a metric scale: To provide a standard of reference for constructing a
drawing either in its actual size or larger or smaller than full size

3. a. Oval
   b. Two bevel
   c. Opposite bevel
   d. Four bevel
   e. Triangular

4. a, d, e, g, h

5. Explanation should include:

   A ratio between the actual dimension and another dimension that will be used to
   represent the actual size.

6. a, c, e, f

7. a. MD  i. AD
   b. M  j. AD
   c. MD  k. AD
   d. M  l. MD
   e. MD  m. AD
   f. M  n. M
   g. AD  o. MD
   h. AD

8. 1:1
   1:2
   1:5
   1:25
   1:33 1/3
   1:75
9.

1:1 Ratio
a. 14 mm  
b. 27 mm  
c. 40 mm

1:100 Ratio
a. 1.4 m  
b. 2.7 m  
c. 4.0 m

10.

At 1:5 Ratio
a. 5 mm  
b. 175 mm  
c. 290 mm

At 1:1 Ratio
a. 1 mm  
b. 35 mm  
c. 48.5 mm

At 1:2 Ratio
a. 2 mm  
b. 35 mm  
c. 49 mm

11.

At 1:25 Ratio
a. 20 mm  
b. 500 mm  
c. 1000 mm

At 1:33 1/3 Ratio
a. 20 mm  
b. 1150 mm  
c. 1560 mm

At 1:75 Ratio
a. 350 mm  
b. 1400 mm  
c. 2600 mm

12. Evaluated to the satisfaction of the instructor