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ABSTRACT

Promoting ACademic Excellence in Mathematics and Science for Workers of the 21st Century (PACE) was a consortium project made up of Indiana University Northwest, the Gary Community Schools, and the Merrillville Community Schools. The focus of this project was to prepare teachers and curricula for Tech Prep mathematics and science courses for the two school districts. The courses and course units prepared by the project are intended to promote the Core 40 Competencies of the Indiana Department of Education for High School courses. This document contains units for chemistry that advocate hands-on, application-based learning and present the basic concepts of chemistry associated with the substances that make up the environment and with the changes these substances undergo. Units include: (1) Chemistry Basic Skills; (2) Water; (3) Air and Climate; (4) Chemical Resources; (5) Organic Chemistry; (6) Petroleum; (7) Nuclear Chemistry; and (8) Chemical Industry. Contains an average Atomic Mass activity. (JRH)

Chemistry

an Applied Approach

Kenneth J. Schoon • Clyde A. Wiles
Editors

PACE Promoting Academic Excellence In Mathematics, Science & Technology for Workers of the 21st Century.

Gary Community School Corporation
Merrillville Community School Corporation
Indiana University Northwest

Chemistry
An Applied Approach

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PACE

Promoting ACademic Excellence in Mathematics and Science for Workers of the 21st Century

PACE was a consortium project of Indiana University Northwest, the Gary Community Schools, and the Merrillville Community Schools. It was supported by funds from the three institutions and by Eisenhower grants from the Indiana Higher Education Commission.

The focus of the project was to prepare teachers and curricula for Tech Prep mathematics and science courses for the two school districts. The effort took place over 1994 - 1996 and involved more than 70 teachers from seven High Schools. The Director of the project was Dr. Clyde A. Wiles, and the Associate Director, Dr. Kenneth J. Schoon, both of Indiana University Northwest.

Part of the effort was the developing of units and course outlines for use in the first two years of a High School Tech Prep program. Individual schools and faculty will be using these materials in a variety of ways from being a course guide to being a supplement to an already existing program.

We have taken the position that Tech Prep is not a program for the academically deficient. Rather it is an applied approach to curriculum that has the goal of promoting competencies recommended by the State of Indiana for non-remedial high school courses, and which does so in a learning environment that emphasizes applications. We would like students to find within these course materials and instructional approaches immediate and obvious responses to the questions: "What does this look like?" and, "Why would anyone want to know?"

These courses and course units then are intended to promote Core 40 Competencies of the Indiana Department of Education for High School courses. For mathematics, we viewed this as beginning with Algebra One and for science beginning with Biology. The Pre-Algebra course is not a Core 40 course, but does maintain the applied perspective.

Our efforts have had to accommodate to several factors. First there is an Indiana mandate that all high schools have a Tech Prep curriculum that targets the academic and school-to-work needs of the middle 50% of the high school student population. There are on the other hand, persistent beliefs of counselors, teachers, administrators, students, and parents that something called "tech" anything, is just another name for a program intended for "at risk" students who are not expected to acquire competencies at a level that would enable them to pursue post secondary schooling at the college or university level. These beliefs are often supported by admission policies at some universities. We have, therefore, attempted to position Tech Prep courses as courses that meet exactly the same Core 40 competencies (as defined by the Indiana Department of Education) as are to be met by college prep courses of the same name, but to do so in applications-based and problem-centered approaches.

Clyde Wiles, Director
Kenneth Schoon, Associate Director

Division of Education
Indiana University Northwest
Gary, Indiana
May, 1997

Chemistry
An Applied Approach

Introduction

Prerequisites: 1st Year Algebra and 1 Year of Science or Permission by Instructor (Recommend for students who pass these classes with a C or better)

Grade Level: 10-12 (or permission of Instructor)

This course presents the basic concepts of chemistry associated with the substances making up our environment and with the changes these substances undergo. Much emphasis is placed on experimentation and observation. The major environmental topics covered are Water, Chemical Resources, Petroleum, Industry, Air and Climate, and Nuclear Chemistry. As these units are taught, an integration of traditional concepts will be emphasized. These concepts include atomic structure, chemical formulas and equations, the mole concept, periodic properties of the elements, the kinetic theory, gas laws, chemical equilibrium, and redox reactions.

The methodology of this course is hands-on, application-based learning. The ultimate outcome of the course which these competencies describe is to produce a chemically literate citizen capable of using chemistry knowledge and skills to solve real-world problems and to make personal, social, and ethical decisions.

Goals

The students will:

1 apply chemical knowledge and skills in problem solving and critical thinking.
2 analyze and interpret data to make personal, social, and ethical decisions.
3 be able to engage in scientific inquiry.
4 understand the societal roles of science and technology.
5 be able to identify careers that relate to chemistry.
6 have an understanding of the fundamental principles of chemistry.

Units

1 Chemistry Basic Skills
2 Water
3 Air and Climate
4 Chemical Resources
5 Organic Chemistry
6 Petroleum
7 Nuclear Chemistry
8 Chemical Industry

Unit 1

Chemistry

Basic Skills

Unit 1 Chemistry Basic Skills 5 Weeks

This unit will focus on basic skills of chemistry such as nomenclature, balancing equations, scientific notation, the metric system, unit analysis, the scientific method, percentages, conservation of mass, and density. This unit also includes basic laboratory procedures and proper equipment use.

Competencies

The students will be able to:

Note: All competency numbers refer to the Indiana High School Science Competencies.

- A1 formulate and test working hypotheses, choosing procedures appropriate for use in the laboratory or fieldwork. (1.1.2)
- A2 observe and describe observations accurately using appropriate language and precision. (1.2.1)
- A3 select appropriate measuring instruments and computer interfaces. (1.2.2)
- A4 develop skills in using common laboratory and field equipment and perform common laboratory techniques with care and safety. (1.2.4)
- A5 assemble and dismantle laboratory equipment. (1.2.7)
- A6 determine the properties and quantities of matter such as mass, volume, temperature, density, melting point, boiling point. (3.1.2)
- A7 use appropriate nomenclature when naming and writing formulas for elements and compounds. (3.1.5)
- A8 describe chemical changes with balanced chemical equations. (3.2.1.)
- A9 demonstrate the principles of conservation of mass through laboratory investigations. (3.2.2)

Workplace Relationships

1. These basic skills are applicable to many laboratory-based professions.

Applications

1. Use the steps of the scientific method to determine the reason for more fish in the winter at industrial warm water discharges.
2. Describe the reason that one would shake a bottle of Italian dressing before serving it.

Learning Activities / Teaching Strategies

1. Scientific Method Demonstration
2. Practice worksheets for scientific notation and percentages
3. Length and Volume Activity
4. Practice worksheets for unit analysis
5. Density of water and ethanol- 3 day activity with a math teacher and a graphing calculator
6. Density of wood/metal lab
7. Conservation of mass lab
8. Balancing equations demo/lab

Daily Lesson Plan

1. Scientific Method explanation using experiment demo.
2. Groupwork: Using scientific method, describe the steps to solving given problem.
3. Scientific notation / percentages explanation - practice worksheets
4. Quiz: Scientific method, scientific notation, percentages.
5. Metric system introduction/demo examples. Metric Mastery activity
6. Metric system review / Unit analysis - practice worksheets

7 Groupwork Unit analysis - practice worksheets
8 Metric system / unit analysis quiz. Start the Measurement Activity
9 Measurement Activity
10 Density explanation. Start Density of water and ethanol; a graphing activity
11 Density of water and ethanol
12 Density of water and ethanol
13 Density of wood/metal
14-15 Identify the 50 most common symbols and names of elements/ions and oxidation numbers/distinguish between an ionic and covalent compounds/ prefixes.
16 Naming compounds and writing formulas
17 Naming compounds and writing formulas practice
18 Naming compounds and writing formulas groupwork
19 Nomenclature Mastery Quiz
20 Conservation of Matter explanation and lab
21 Balancing equations Demo/lab
22 Balancing equations practice/groupwork
23 Balancing equations quiz
24 Unit review
25 Unit evaluation

Resources

1 Any basic Chemistry text
2 Teacher-generated handouts

Assessment Plans

Student success will be assessed through scores on homework assignments, concept quizzes, lab reports and performance, and unit evaluations.

Scientific Method Demonstration

Use a simple experiment to describe the steps of the scientific method.

For example,

Pour pop on baking soda- Ask, why does that happen?

Identify the problem: (Question) What are the bubbles made of?

Hypothesis: If the bubbles are made of carbon dioxide, then a flame will be extinguished by the gas.

Controlled experiment: Design an experiment which will test this--use a lighted candle in a beaker surrounded by baking soda - also have another lighted candle surrounded by baking soda in another beaker. Add pop to one of them and watch the flame of the candle be extinguished. Do nothing to the control candle.

Results: Discuss the results with the class

Conclusion: The hypothesis was supported by the experiment.

List of Scientific Method Problems

1. Given three types of octane rated fuels (87,89,91), determine which yields the best mileage rating.
2. Find out which beverage (soda pop) is best to use when trying to avoid consuming acidic solutions.
3. Given three antacids, determine which is most cost-effective.
4. Given three cleansers, which is most effective against grease buildup.
5. Given water-based and oil-based paint, determine which is easiest to use.

Scientific Method Quiz

Sample Questions

1. Given the following, place them in order of the steps of the scientific method starting with the question.
   a. controlled experiment
   b. results
   c. problem
   d. conclusion
   e. hypothesis

2. Why is a control used in a scientific experiment?

3. Write the following using the correct scientific notation:

   a. 0.00000687
   b. 475694830
   c. 9000
   d. 0.003000490
   e. 0.076
   f. 98000000090000000000

4. What is the percentage of males in an experimental group if there are 45 males and 16 females? What is the percentage of females?

5. If the room is filled with 4.5×10^4 liters of air and 20 % of that is oxygen, how many liters of oxygen are in the room?

Name ______________________ Date ______ Hour _____

CONVERSIONS

Calculate the following conversions using one of the three methods discussed in class. As long as you show your work, any of these three methods will be acceptable.

1. 29 cm → _________ m
2. 0.71 m → _________ cm
3. 3 km → _________ m
4. 0.5 km → _________ cm
5. 100 m → _________ km
6. 2 km → _________ mm
7. 50 mm → _________ cm
8. 45 cm → _________ mm
9. 11mm → _________ m
10. 0.469 cm → _________ mm
11. 0.9 m → _________ mm
12. 2 L → _________ cm3
13. 25 cm3 → _________ mL
14. 25 cm3 → _________ L
15. 925 mL → _________ L
16. 1893 cm3 → _________ L
17. 1000L → _________ mL
18. 9000 mL → _________ L
19. 0 .732 L → _________ cm3
20. 410 mL → _________ L

Name: ______________________________ Date ______ Hour _____

Writing Formulas and Naming Compounds

Write the formula for compounds composed of the following elements. Write each compound's names next to its formula.

1. Lithium and sulfur ____________ ____________________
2. Calcium and chlorine ____________ ____________________
3. Barium and oxygen ____________ ____________________
4. Aluminum and chlorine ____________ ____________________
5. Magnesium and bromine ____________ ____________________
6. Calcium and sulfur ____________ ____________________
7. Lead (II) and oxygen ____________ ____________________
8. Aluminum and iodine ____________ ____________________
9. Calcium and oxygen ____________ ____________________
10. Chromium (II) and chlorine ____________ ____________________
11. Sodium and chlorine ____________ ____________________
12. Aluminum and oxygen ____________ ____________________
13. Hydrogen and chlorine ____________ ____________________
14. Iron (III) and oxygen ____________ ____________________
15. Copper (I) and oxygen ____________ ____________________

Name: ______________________________ Date ______ Hour _____

Writing Formulas and Naming Compounds 2

Write the formula of the compounds which the following elements will make and **name** them:

1. Calcium and acetate ion ____________ ____________________
2. Calcium and carbonate ion ____________ ____________________
3. Ammonium and phosphate ions ____________ ____________________
4. Chromium (II) and chlorate ion ____________ ____________________
5. Copper (I) and oxygen ____________ ____________________
6. Hydrogen and sulfur ____________ ____________________
7. Sodium and sulfate ion ____________ ____________________
8. Copper (I) and chlorine ____________ ____________________
9. Silicon and oxygen ____________ ____________________
10. Chromium (III) and oxygen ____________ ____________________
11. Chromium (II) and oxygen ____________ ____________________
12. Ammonium and carbonate ion ____________ ____________________
13. Copper (II) and nitrate ion ____________ ____________________
14. Barium and carbonate ion ____________ ____________________
15. Iron (II) and acetate ion ____________ ____________________
16. Sodium and phosphate ion ____________ ____________________
17. Calcium and carbonate ion ____________ ____________________

18. Manganese (III) and oxygen ______________ ______________________
19. Strontium and oxygen ______________ ______________________
20. Gallium and fluorine ______________ ______________________
21. Carbon and sulfur ______________ ______________________
22. Sodium and sulfur ______________ ______________________
23. Aluminum and fluorine ______________ ______________________
24. Silver (I) and sulfate ion ______________ ______________________
25. Ammonium ion and acetate ion ______________ ______________________

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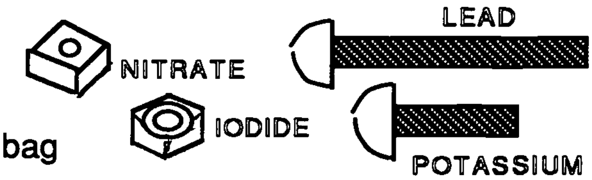
Nuts and Bolts of Balancing Equations

Purpose: To allow students to experience the production of a new compound and balancing the equation with a "hands on" approach.

Equipment: Bolts: 4 short, 2 long
Nuts: 4 hex, 4 square



Materials: $Pb(NO_3)_2$ small amount in a bag
KI small amount in bag

Remember: In balancing equations, there must be equal numbers of each type of atom on each side of the arrow.

Procedure: WEAR YOUR SAFETY GOGGLES.

1. Examine and describe the KI crystals.
2. Examine and describe the $Pb(NO_3)_2$ crystals.
3. Carefully pour the KI crystals into the bag with the $Pb(NO_3)_2$ crystals.
4. Gently rub the crystals together and observe.

Skeleton equation for the reaction: $KI + Pb(NO_3)_2 \longrightarrow PbI_2 + KNO_3$

Let us balance this equation using something we can see and manipulate.

5. Obtain a set of stove bolts and nuts from the supply table.
6. Make 1 molecule of each compound. Arrange them as they are arranged in the formula.
7. Is the formula balanced? Make needed molecules and place them appropriately until the equation is balanced.

Cleanup: Disassemble the nuts and bolts and return them to the bag and the supply table. Place the CLOSED bag of chemicals in the trash container.

Questions:

1. Write the balanced equation.
2. What is the state of the KI you used?
3. What is the state of the $Pb(NO_3)_2$ you used?
4. What is the state of the product?

Observations:

Name: ______________________________ Date: __________Hour: _____

Measuring Temperature and Mass Activity

Temperature is measured using the Kelvin scale. Degrees Kelvin are similar to degrees Celsius. To convert from degrees Celsius to Kelvin, just add 273 to the Celsius reading. When the temperature of a liquid is measured with a thermometer, the bulb of the thermometer should be in the center of the liquid. Do not allow the bulb to touch the bottom or sides of the container. When the thermometer is removed from the liquid, the column in the thermometer will soon show the temperature of the air. For this reason, take temperature readings while the thermometer is in the liquid. When measuring the temperature of hot or boiling liquids, be sure to use a thermometer that is calibrated for high temperatures. Never "shake down" a thermometer to reset it. Never use a thermometer to stir a liquid.

Temperature Prelab:
Answer the following questions and practice reading temperatures using the illustrations on the next page.

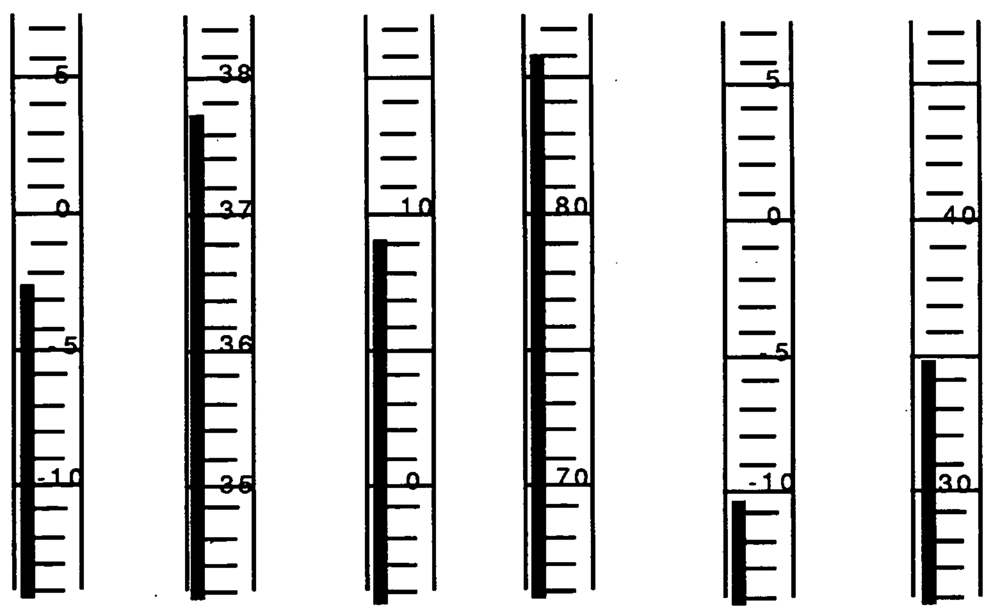
1. What tool is used to measure temperature? ______________________

2. Convert the following degrees Celsius to Kelvin:

   0 _______ 82 _______ 273 _______ 29 _______ 32 _______

3. Why should the bulb of the thermometer be left in the liquid when reading temperature?

4. What two things should you **never** do when measuring the temperature of a liquid?



A.______ B.______ C.______ D.______ E.______ F.______

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Mass is the amount of matter in an object. The SI unit of mass is the **kilogram.** The gram is used to measure small masses. The tool used to measure mass is the balance. A scale is used to measure weight. We will be using two different types of balances depending on the accuracy of measurement that we will need. The **beam balance** will be used when measuring objects that need to be accurate to the nearest tenth of a gram. The **Dial-o-gram balances** will be used when we need accuracy to the nearest 100th of a gram.

Follow these steps when using a **beam balance**:

1. Slide all riders back to the zero point. Check to see that the pointer swings freely along the scale. The beam should swing an equal distance above and below the zero point. **After checking with your teacher,** use the adjustment screw to obtain an equal swing of the beams. You should "zero" the balance each time you use it.
2. **Never** put hot objects directly on the pan. Air currents developing around the hot object may cause massing errors.
3. **Never** pour chemicals directly on the balance pan. Dry chemicals should be placed on paper or in a glass container. Liquid chemicals should be massed in glass containers.
4. Place the object to be massed on the pan and move the riders along the beams beginning with the largest mass first. If the beams are notched, make sure all riders are in a notch before you take a reading. Remember, the swing should be an equal distance above and below the zero point on the scale.
5. The mass of the object will be the sum of the masses indicated on the beams, as shown below. Subtract the mass of the container from the total mass reading, if necessary.

Answer the following questions and fill in the masses of the practice objects.

1. What is mass?

2. What tool is used to measure mass?

3. What unit of mass is used if you are measuring a small mass?

4. What are the two things that you should never do when reading the mass of an object?

Read the masses on the balances of your lab practice that your teacher has set up for you. Write your answers here:

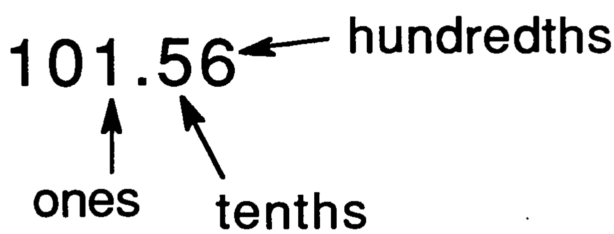
The mass of object A is ________________

The mass of object B is ________________

The mass of object C is ________________

Follow these steps to use a **Dial-O-Gram balance:**

1. Follow the same safety procedures that you followed for using the beam balance.
2. After making sure that all riders and the dial are on zero, carefully check the swing arm to see that it is on zero. If not, **have your teacher check it.**
3. Carefully place the mass on the pan. Use the riders, starting with the largest, to slowly balance the mass. When the smallest rider change will not balance the mass, slowly turn the dial until the mass is balanced.
4. Starting again with the largest rider, start writing down the mass. When you get to the dial you should be on the ones, tenths, and hundredths places. (See diagram below)



5. The ones place is any large number **on the dial** that has completely passed the zero place on the dial holder.
6. The tenths place is any part of the large number **on the dial** that has completely passed the zero place on the dial holder.
7. The hundredths place is a little bit harder. Look at the lines marked 0-.10 on the dial holder. Choose the line **on the dial** that lines up best with one of the lines on the dial holder. The line on the dial holder that lines up the best is the hundredths place. (It would be either .00, .01, .02, .03, .04, .05, .06, .07, .08, .09, or .10.)

Name: ______________________ Date: __________ Hour: _____

Temperature and Mass Activity

Measure the temperature of the following:

A. The Air ____________

B. Liquid A ____________

C. Liquid B ____________

D. Liquid C ____________

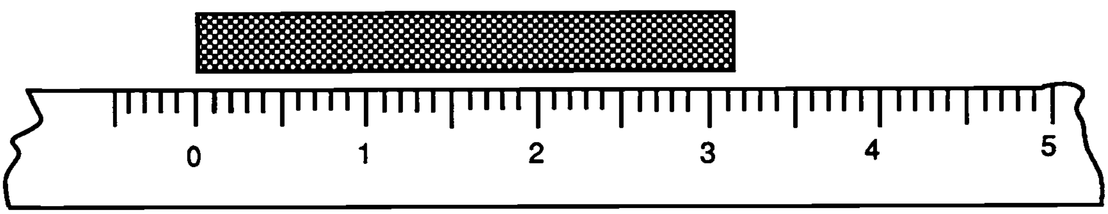
Take the mass of the following using the two types of balances:

	Beam Balance	Dial-O-Gram
A. Your pencil	____________	____________
B. A pen	____________	____________
C. Block A	____________	____________
D. Block B	____________	____________
E. Block C	____________	____________
F. A piece of paper	____________	____________

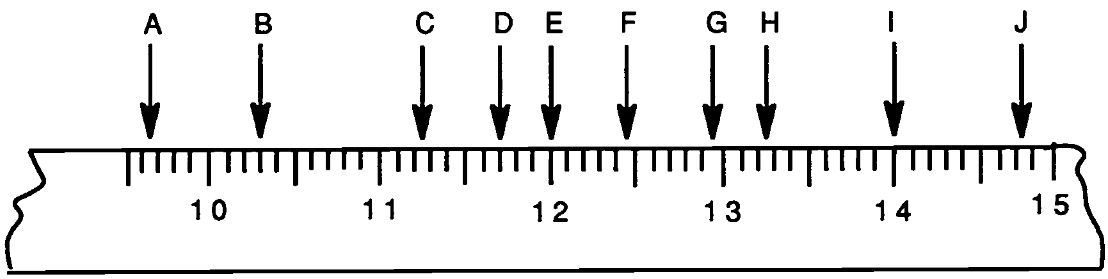
Name:______________________________ Date:__________ Hour:____

Length and Volume Activity

Length: In scientific measurement, length is the distance between two points. The SI unit of length is the **meter**. Metric rulers and meter sticks are used to measure length. Because we are no longer using the English System, 1/2, 3/4, and other fractions of an inch are not to be used. We will be using decimals to indicate a partial meter. All measurements must have both a number and a unit. Using the metric ruler below for example, the measurement of the rectangle below is 3.14 cm long. We know that it is in centimeters because the ruler is marked in centimeters. The "4" is an estimated number. The rectangle does not stop exactly at the 3.1 mark so we "guesstimate" how far it extends into the distance between the 3.1 mark and the 3.2 mark. The rectangle extends almost half way into this distance but not quite half way. So the length of this rectangle is 3.14cm. If the rectangle had extended half way into the distance between 3.1 and 3.2, it would have measured 3.15 cm.



Practice measuring length by determining the lengths <u>from zero</u> indicated by the arrows below:



A____________ D____________ G____________ J____________

B____________ E____________ H____________

C____________ F____________ I ____________

Measuring the length of long objects

During this part of the activity, you will be moving about the room. You need to do this quietly. You also need to be sure not to touch the walls. I realize the sometimes it is difficult to measure the height of a wall without touching it but, it can be done if you are careful.

Measure and record the following lengths using a meter stick:

	Meters	Centimeters
Length of a lab table	____________	____________
Width of a lab table	____________	____________
Height of your lab partner	____________	____________
Height of the ceiling (near a wall but not touching the wall)	____________	____________
Length of your book	____________	____________
Height of a lab table	____________	____________

Measure the following thick lines using a metric ruler. Record your measurement on the line that you measured.

A ____________

B ________________________

C ________________

D ______

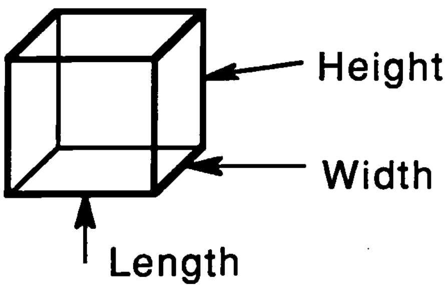
E ______________________________

F ____

Volume: The amount of space that an object occupies is called volume. There are several ways to determine the volume of an object.

A. If the object is a **regularly shaped solid**, you can determine the volume by measuring the length, width, and height and multiplying these three values together. This equation is: Volume = length x width x height or L x W x H

Sometimes it is difficult to tell which side is the length, which is the height, etc. Use the following diagram to help you:



Which side you choose for which value does not matter as long as you measure all three of the different sides.

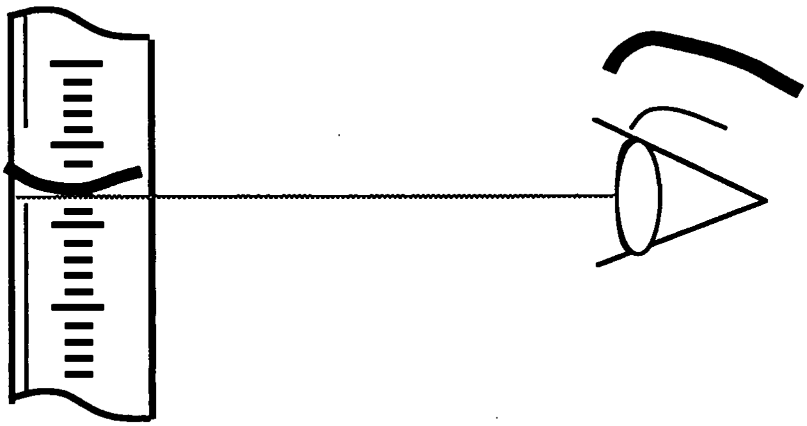
Now measure the three values on the blocks provided using your metric ruler. Be sure not to write on these blocks. Also practice calculating the volume of the blocks.

	Length	Width	Height	Volume
Block A	________	________	________	________
Block B	________	________	________	________
Block C	________	________	________	________

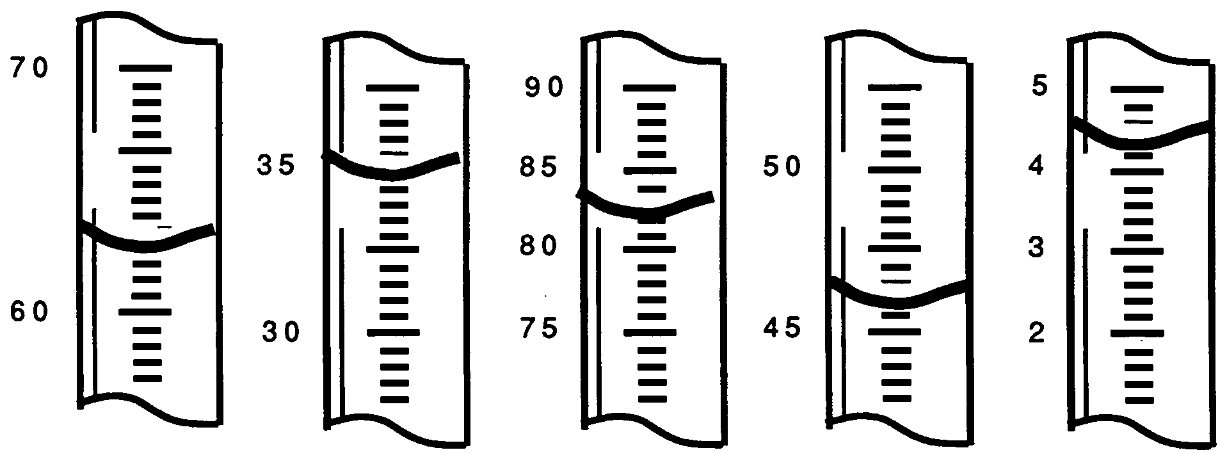
B. If the object is a liquid, you will use a graduated cylinder to determine its volume. The surface of liquids in glass cylinders is often curved. This curved surface is called the meniscus. Most of the liquids you will measure will have a concave mensicus. View the meniscus along a horizontal line of sight. Set the cylinder on the lab table and lower yourself until you are even with the meniscus. If you hold the cylinder while you are reading it, you will not get an accurate reading because you may not hold it level.

(Continued on next page)

See the picure below. Do not try to make a reading looking up or down at the meniscus. Always read a concave meniscus from the bottom of the curve. This gives the most precise volume in a glass container.



Practice Measuring volume using the graduated cylinders below:



A ________ B ________ C ________ D ________ E ________

Now go to the lab stations that are set up in your classroom. Read the volumes on the graduated cylinders. Be careful not to spill the liquids. **Do not pour out the liquids when you are finished.**

A ________ D ________ G ________

B ________ E ________ H ________

C ________ F ________ I ________

Name ______________________________ Date __________Hour ____

DENSITY LAB

Measure (to the nearest 0 .1 cm.) the length, width, and height of the blocks.

- Measure to the nearest 0.01 g.
- Work only with your assigned partner.
- Work only with those blocks that are in your lab area.
- Make sure that the blocks are returned to their original positions.
- Your area will be inspected when you complete this lab.
- Be sure to record each group of blocks in the proper data table.

After you have shown these measurements to your teacher, get a balance, measure (to the nearest 0.01 g.), and record the masses of the blocks. Compute the densities.

- Show all of your work on the back! Calculations: V= lxwxh D=m/V

Using your powers of observation, hypothesize which type of block will have the highest density. Also, which type of block will have the lowest density?

Pine blocks:

	LENGTH (cm)	WIDTH (cm)	HEIGHT (cm)	MASS (g)	VOLUME(mL)	DENSITY(g/ml)
A						
B						
C						

Poplar blocks:

	LENGTH (cm)	WIDTH (cm)	HEIGHT (cm)	MASS (g)	VOLUME(mL)	DENSITY(g/ml)
A						
B						
C						

Red oak blocks:

	LENGTH (cm)	WIDTH (cm)	HEIGHT (cm)	MASS (g)	VOLUME(mL)	DENSITY(g/ml)
A						
B						
C						

Answer the following using complete sentences.

1. Do all of the blocks of the same type of wood have about the same density? ________

   Why do you think this?

2. Which type of wood has the greatest density? ________
   Why do you think this?

3. Which type of wood has the least density? ________
   Why do you think this?

4. Why do the different sizes of the same type of wood have about the same density?

   Why do you think that these values would be slightly different?

5. If I have a chocolate bar of density 2.7 g/cm^3, and I cut it in half, what would be the value of the density of each remaining piece?

6. Was your hypothesis of which type of block was most and least dense supported?

Be prepared to graph and analyze this data.

Density of Liquids and Solids

Combined Math Science Lesson from Merrillville High School

This lesson was devised to combine competencies from the mathematics and science areas in order to give the students the reinforcement necessary for the transference of information between disciplines. It was written by four high school educators, two each from mathematics and science. This process was supported by a mini-grant from the Lake County Technical Preparation Initiative.

Mathematics competencies which will be introduced or enhanced by this project are:

- 4.7 sketch a reasonable graph for a given relationship.
- 4.8 interpret a graph representing a real world situation.
- 4.9 use graphing technology to explore the graphs of functions.
- 5.1 determine if data are behaving in a linear fashion.
- 5.5 find the slope of a non-vertical line given the graph of a line.
- 5.6 describe the slope in a real world linear relationship using real world terms.
- 5.7 write the slope-intercept form of an equation of a line.
- 5.9 write the equation of a line which models a set of real data.
- 5.10 use the line which models real data to make predictions.

Chemistry competencies which will be introduced or enhanced by this project are:

- 1.2.2 select appropriate measuring instruments and computer interfaces.
- 1.2.3 analyze observations and experimentally collected data.
- 1.3.1 organize and present data in the form of functional relationships, when appropriate.
- 1.3.2 extrapolate functional relationships beyond actual observations and interpolate between observations.
- 1.4.1 translate data into tables and graphs.
- 1.4.2 interpret data presented in tables and graphs.
- 1.4.3 describe mathematical relationships in a qualitative manner.
- 3.1.3 determine the properties and quantities of matter such as mass, volume, and density.

Daily Lesson Plan

In this lesson, an Applied Math class will be working in conjunction with a ChemCom class in an experiment dealing with density. Two math students will be paired with two science students.

Day 1: Applied Math: Students will watch a 10 minute video which demonstrates the density experiment, then will design a lesson where they learn to operate a TI-81 graphing calculator.

ChemCom: Students will watch a ten minute video which demonstrates the density experiment. The students will then complete the density experiment working in pairs.

Day 2: Applied Math: Each pair of students will graph a set of collected data from an assigned pair of science students using the TI-81 graphing calculator.

ChemCom: These students will continue to work with their partners and, using a pencil and graphing paper, construct a curve for the data collected from the experiment.

Day 3: Two math students working with two science students will compare and evaluate the two types of graphs. (The students will be divided equally between the two teachers.)

Day 4: A team of one math and one science student completes a density experiment using solids. They graph the results either using a graphing calculator or by hand. After finding the densities of the respective solids, the students will identify the solids by using a *Handbook of Chemistry*. (The students will be divided equally between the two teachers.)

Calculator Lab
Entering and Sorting Data
Linear Regression Line

By the end of this lesson, you should have the following set of data loaded and graphed in the graphing calculator with the following requirements:

Data should be sorted by the x coordinate.
Graph should use the full screen with a "best fit" line drawn.
Use the trace features to come up with values for the x
coordinates: 7,5.5,8.2.

Data points are: (4, 6.2), (2, 3), (6, 9.3), (3, 4.45), (10.3, 14)

The instructions for completing these tasks on the calculator are in the manual in sections 7-2 through 7-8. You should focus on:

Enter Data
xsort
Linear regression line
Need to remember--use range to set graph window.

Lab 1: DENSITY

This investigation is intended to acquaint you with the mass to volume ratios of some liquids and solids. It should also show you how to correctly use a graduated cylinder for measuring volume and the balance to measure mass.

EQUIPMENT:

Steel	1 50 mL graduated cylinder
Copper	1 centigram balance
Aluminum	50 mL of ethanol (C_2H_5OH)
Brass	

PROCEDURE:

PART A

1. Take the mass of a clean dry 50 mL graduated cylinder to the nearest 0.01 g. Record this and all other data from part A in **TABLE A.**

2. Add 10mL of water to the graduated cylinder and take the mass of the cylinder and the water. Repeat using 10mL increments until you have massed 50 mL of water.

3. Dry the graduated cylinder with toweling. Repeat step 2 using ethanol instead of water. Your teacher will dispense the ethanol. When finished, do not throw the ethanol away: return it to your teacher.

4. Complete Table A.

5. The next day you will graph the mass and volume data following your teacher's directions.

TABLE A

LIQUID	Mass (Graduated Cylinder)	Mass (Cylinder and Liquid)	Mass (Liquid)	Volume (Liquid)	Mass/Volume Ratio
WATER					
ETHANOL					

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PART B (Solids)

1. Place about 30 cm^3 of water in a 50 cm^3 graduated cylinder (remember 1 cm^3 = 1 mL.) Record this and all data from Part B in **TABLE B**.

2. Obtain a sample of dry metal and find its mass on a balance to the nearest 0.01 g.

3. Tilt the cylinder to about a 45° angle and carefully slide the metal into the cylinder this will prevent the metal from breaking the cylinder. After the metal is at the bottom, turn it up-right and observe and record its volume in cm^3. When finished with this metal, please dry and return it.

4. Repeat step 3 for two different metals.

5. Complete TABLE B.

TABLE B

SOLID (name)	VOLUME (H_2O	VOLUME (H2O and Metal)	VOLUME (metal)	MASS (metal)	MASS/VOL RATIO

QUESTIONS:

1. If you used a 100 mL graduated cylinder, would the densities of the water and ethanol change?

2. From your graph, what would be the mass of 15 mL of water and ethanol?

3. The method used in Part B will not work for all solids. Why not?

DENSITY LAB EVALUATION

OK = 2 Not OK = 0	Very good = 4 Good = 3	Fair = 2 Poor = 1

	OK	NOT
1. What unit is represented by the vertical axis?		
2. What unit is represented by the horizontal axis?		
3. What mass does 15 mL of water have?		
4. What is the density of the liquid?		
5. What is the slope of this line?		

	V.GOOD	GOOD	FAIR	POOR
6. Describe the graph.				
7. Compare the slope of the line to the density of the liquid.				
8. If you used 100 mL graduated cylinders for the experiment, what effect would that have on the density?				

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Investigating a Bunsen Burner

In this experiment, we will see how a Bunsen burner works and how it can be adjusted.

1. You should have the following items at your work area:
   - Bunsen burner
   - matches
   - 50-mL beaker
   - Al metal wire

2. Compare the Bunsen burner to the figure in your book. Can you locate all the parts? If not, ask someone in your lab group or your teacher.

3. Close the air vents and connect the burner to the source of gas.

4. Light the burner by using the following procedure: Light the match. Turn on the source of gas. Bring the lighted match horizontally over to the burner so that the flame touches the metal at the top.

5. On your data sheet, sketch the shape of the flame and label its color.

6. Hold the beaker with the tongs and slowly put it into the flame. Then carefully set the beaker on the bench-top to cool. When cool, examine the outside of the beaker. Describe what you think happened on your data sheet.

7. Gradually open the air vents at the bottom of the burner.

8. Sketch the shape of the flame and label its color on your data sheet.

Explanation:

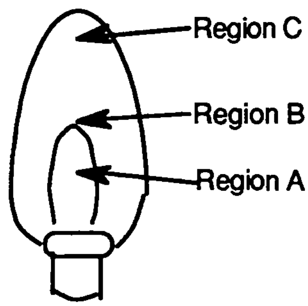
When the vents at the bottom of the burner are open, the gas rising in the burner draws air (21% oxygen) into the vents. The air mixes with the gas and the gas burns with a hotter flame.

$$CH_4\ (g) + 2\ O_2\ (g) \longrightarrow CO_2\ (g) + 2H_2O\ (g)$$

When the vents are closed, incomplete burning results in glowing carbon particles, called soot.

$$CH_4\ (g) + 2\ O_2\ (g) \longrightarrow C(s) + 2H_2O\ (g)$$

9. You should be able to identify three regions in the burner flame as shown in the figure below. Label these regions on your sketch on your data table of the flame with the vents open.



10. We will now see how the temperature of the flame varies in the various regions. This will be done by placing metal wires into the flame and seeing if they melt. The wires used are:

aluminum	melting temperature =	600^{o} C
copper	melting temperature =	1080^{o} C
iron	melting temperature =	1540^{o} C

11. Fold the aluminum wire in half. Using tongs to hold the ends, put the folded end of the aluminum wire into region A of the flame. Does it melt? Record the result in the table on your data sheet. Now put the folded end of the wire in region B. Does it melt? Enter your results in the data table . Move the wire to region C. Record whether or not it melts.

12. Repeat Step #11 with the copper wires and the iron wire. Write your observations in the table.

13. By studying your observations, you can decide which is the hottest part of the flame. Indicate your choice on the data table. Check to see if you are correct with your teacher.

14. Close the air vents at the base of the burner. Test the flame with the wires to determine the approximate temperature of the flame by observing which wires melt (Al, Cu, Fe) and referring to their melting points listed.

15. Turn off the gas. Clean your area and prepare to return to the classroom.

Name: ______________________ Date: __________ Hour: ____

Data Table:

Sketch the flame with vents closed	What is the black on the beaker? Where did it come from?
Sketch the flame with vents open	Does Wire Melt? (see table below) Which region is hottest? ________

Does Wire Melt?

Wire + M.P.	Region A	B	
Al 660			
Cu 1080			
Fe 1540			

Which region is hottest? ________

Graphing Data Practice

Graph the following data on the graph paper provided. If you feel that the lines are too close together, you can use your own graph paper. Be sure to include titles, units, and increments.

Data Set 1

Ave. Grade %	Week of semester
95	1
90	3
82	5
85	7
87	9
72	11
68	13
75	15

Data Set 2

Distance traveled (in kilometers)	Time (in minutes)
1	0.5
1	0.5
22	2
52	3
52	4
95	7
154	9

1. Graph the data in Data Set 1 for the grades of students as the year progresses.

   Answer the following questions under your graph:
   A. What would the average grade % be at week 6?
   B. Looking at the trend of grades, would the grade % at week 17 be higher or lower than 75?

2. Graph the data in Data Set 2 for the speed of a car on a trip to Indianapolis.

   Answer the following questions under your graph:
   A. What would the distance be after 6 minutes?
   B. (Bonus) Explain why the distance is the same for minutes 3 and 4.

3. Graph the datain Data Set 3 for the acceleration of a toy car down a ramp. (Use a whole side of graph paper for this graph.)

Data Set 3

Speed (m/s)	time (seconds)
0	0
2	1
4	2
6	3
8	4
10	5
10	6
10	7
9	8
8	9
6	10
2	11
0	12

Answer the following questions under your graph:
A. Looking at the trend, what would the speed be at time of 13 seconds?
B. What was the car doing between 0 and 5 seconds?
C. What was the car doing between 7 and 12 seconds?

Graphing Data Quiz
(DO NOT WRITE ON THIS SHEET)

Graph the following data. Be sure to fill half the page for each graph.
You will put 4 graphs on one sheet of graph paper.
Neatness and accuracy count!!! (Use pencil.) Include all titles and units. Use rulers!!!

1. Graph the following data for a rolling basketball:

Distance (meters)	Time (sec)
0	0
3	1
6	2
8	3
13	4
15	5

Answer the following questions under your graph:
A. What would the distance be in 10 seconds?
B. What would the time be at 10 meters?
C. What type of graph is this?

2. Graph the following data for the density of wood:

Mass (grams)	Volume (mL)
2.5	2.0
4.0	3.0
5.2	4.0
6.4	5.0
7.6	6.0
10.3	8.0

Answer the following questions under your graph:
A. What is the mass if the volume is 6.5 ml?
B. What is the volume if the mass is 8.0 g?
C. What is the density at the point when the volume is 6.0 ml?

3. Graph the following data for the pressure of oxygen:

Pressure (Atm.)	Volume (mL)
32	10
33	8
34	7
35	6
36	5
37	4

Answer the following questions under your graph:
A. What is the volume if the pressure is 32.5 atm?
B. Looking at the trend of the graph, would the volume of 38 atm be less than or greater than 4 mL?

4. Graph the following data for the activity of bass in Monroe Lake:

Activity (movement)	Number of bass
101	25
102	27
103	31
105	34
108	36
110	38

Answer the following questions under your graph:
A. What would the number of bass be if the movement was 106?
B. What would the movement be if the number of bass was 32?

Each graph is worth 15 points. Check them carefully!!!

Unit 2

Water

Unit 2 Water 6 Weeks

This unit will cover basic water concepts such as water usage, global water allocation, chemistry of water, solubility, water purification, and the societal impact due to the importance of water. Labs will focus on the water purification processes, water quality testing, and its solubility.

Competencies

The students will be able to:

B1 identify and pose meaningful answerable scientific questions. (1.1.1)
B2 formulate and test working hypotheses, choosing procedures appropriate for use in the laboratory or fieldwork. (1.1.2)
B3 analyze observations and experimentally collected data. (1.2.3)
B4 translate data into tables and graphs. (1.4.1)
B5 interpret data presented in tables and graphs. (1.4.2)
B6 formulate explanations to accommodate known phenomena and principles. (1.5.4)
B7 recognize that science is only one source of information to address societal issues. (2.1.1)
B8 identify the capabilities and limitations of science as it applies to societal issues. (2.1.2)
B9 understand the implication of science in making personal decisions. (2.2.2)
B10 differentiate among pure substances, solutions, and heterogeneous mixtures based on physical properties. (3.1.1)
B11 describe solutions in terms of their degree of saturation. (3.1.4a)
B12 describe solutions in appropriate concentration units. (3.1.4b)

Workplace Relationships

1. Work with sanitation department with the Environmental Protection Agency
2. Work for a water softener company
3. Water quality specialist for the Department of Natural Resources
4. Fish tank water quality specialist
5. Pool water quality specialist
6. Landfill ground water monitoring
7. Irrigation for farms
8. Fish hatchery water quality
9. Industrial waste water manager
10. Community water quality manager

Applications

1. Given the evidence of a large fish kill, propose four questions which could be investigated to determine the cause of such a large fish kill.
2. Students considering the purchase of bottled water because they claim the tap water "tastes funny" will bring in and test samples of both bottled and tap water to compare the dissolved solids such as chloride ions, calcium ions, and iron ions in each.

Learning Activities / Teaching Strategies

1. "Foul water," p. 8-10 in *Chem Com*
2. Water usage survey
3. Surface tension demos and activities (Water drops on a penny, floating paper clip)
4. Solutions video (20 minutes)
5. Household mixtures lab (ex. salad dressing, milk, brass, bottle of air, etc.)
6. Mixtures lab, p. 25-26 in *Chem Com*
7. Water testing, pp. 32-35 in *Chem Com*

8 Solubility graph interpretation exercises
9 "Graphing dissolved oxygen levels of Riverwood," pp. 48-51 in *Chem Com*
10 Solvents lab, p. 60-61 in *Chem Com*
11 Water softening lab, pp. 65-67 in *Chem Com*
12 Mock Riverwood Town Council review

Resources

1 Heikkinen, Henry, (Ed.). (1988). *Chem Com* (2nd Ed.), Dubuque, Iowa: Kendall-Hunt Publishing Co.
2 Teacher-generated handouts
3 Community speakers (ex. water treatment specialist)

Assessment Plans

Student success will be assessed through scores on homework assignments, concept quizzes, lab reports and performance, and unit evaluations.

Daily Lesson Plan

1 Riverwood introduction/ discussion Foul water pre-lab activity
2 "Foul water lab," p. 8-10
3 Foul water post-lab. Water usage survey introduction/explanation
4 Discuss results of water usage survey/General water usage and global water allocation assignment summary, p. 19 1-7
5 Riverwood continued discussion/ Physical properties of water (density, boiling point, freezing point, surface tension)
6 Surface tension activities/explorations
7 Solution video/ Mixtures demo-explanation
8 Mixtures lab
9 Quiz over physical properties of water and mixture concepts
10 Molecular view of water/use models/ice/snowflakes/polarity assignment, p. 29 "Your Turn" 1-3
11 Continue molecular view of water atoms/molecular structure.
12 Water quality testing lab/testing for ions
13 Continue water quality testing lab assignment summary, p. 37 1-8.
14 Solubility terminology and graphs/demos. Assignment "Your Turn," pp. 41-42 1-4
15 Solution concentration/percentages/demos. Assignment "Your Turn," pp. 43-44 1-4
16 Quiz Solubility and solution concentration
17 Gas solubility discussion and demos/ Dissolved oxygen dry lab, pp. 48-51
18-19 Dissolved oxygen dry lab, pp. 48-51
20 Acid contamination/pH discussion/demos. Assignment "Your Turn," p. 54 1-10
21 Dissolving ionic compounds and Heavy metals discussion/demos, EPA table 12, p. 58. Class discussion of questions 106 p. 58-59 on EPA limits
22 Solvent lab, p. 60-61
23 Assignment 1-10 summary, p. 61-62; prepare for quiz.
24 Quiz Gas solubility/Acid contamination/Heavy metals
25 Natural water purification/filtration/Pre-lab water purification
26 Water purification lab, pp. 65-67
27 Municipal water purification discussion. Assignment summary, p. 75 1-3
28 Water purification speaker/ Mock Riverwood Town Council Review
29 Mock Riverwood Town Council Review
30 Review
31 Unit Evaluation

Name: ______________________________ Date: _____ Hour: ______

Mixtures Lab

Purpose: You will be able to distinguish between a suspension and a colloid.

Background: A mixture is two or more substances **physically** combined. This is different from a compound in that a compound is two or more elements **chemically** combined in a fixed ratio. Mixtures are separated into two types: suspensions and colloids.

1. What is a colloid?

2. What is a suspension?

Procedure

1. Fill a small jar half full of water from the faucet on the end of the lab tables. Add one spoonful of soil to this jar.
2. Tighten the lid and shake the jar vigorously.
3. Describe the contents of the jar in your data table after they have been shaken. Allow the jar to stand for five minutes. Where are the soil particles after five minutes? Describe the contents of the jar on your answer sheet after this 5 minutes.
4. Pour the liquid through a filter using the procedure that was described by your teacher. Describe the fluid in the filter and the liquid that has passed through into the beaker. What kind of mixture is the soil and water? Explain your answer.
5. Add one drop of iodine solution to a beaker containing 10 mL of water. Record your observations.
6. Put a small amount of cornstarch in the beaker. Record your observations on your data table.
7. Put the same amount of cornstarch into a second jar containing 10 mL of water. Mix the cornstarch and water by shaking. Record the appearance of the liquid on your data table.
8. Filter the cornstarch solution and record the appearance of the fluid in the beaker after filtering.
9. Add one drop of iodine solution to the filtered liquid. Record your observations. What kind of mixture is cornstarch and water? Explain your answer.
10. Clean up your area as directed. Leave the area cleaner than when you arrived.

Mixtures Lab Questions

1. What happens to the particles of a suspension after they are allowed to sit?

2. What happens to the particles of a colloid after they are allowed to sit?

3. What types of particles are bigger? Those in a colloid or in a suspension?

4. What is cornstarch and water? A mixture or a compound? Explain your answer.

5. What lab technique did you learn during this lab?

Data Table:

Substance	Appearance of mixture after shaking	Appearance of mixture after standing 5 minutes	Observation of fluid after filtering	Colloid or suspension?
Soil Water				
Starch Water				

Describe the appearance of iodine water:

Describe the appearance of iodine in starch water:

Name ______________________ Date _______ Hour ______

Forming Solutions Data Sheet

Solute/Solvent	Did it dissolve?	Observations	Type of Solution
Table salt / water			
Mineral oil / water			
Ethanol / water			
Sugar/ water			
Table salt / ethanol			
Mineral oil /			
Sugar / ethanol			

Preparation of Acid-Base Test Paper

Many flowers and berries contain chemicals which have one color in an acid solution such as vinegar and a different color in a basic solution, such as a mixture of baking soda and water. In this activity you will make a piece of acid-base test paper. You will be able to take it home and test liquids in your kitchen.

1. Gather the following equipment:
   250-mL beaker
   four pieces of filter paper (12 cm diameter)
   tongs
   paper towel
   dropping pipet
   a set of pH buffers 2,4,6,7,8,10, and 12 (one per group)

2. Obtain about 50 mL of colored juice in a 250 mL beaker. Record at the top of TABLE 1 the name(s) of the colored material used. We will complete the table after the paper is dry.

Table 1

Plant material used:	Color of Acid-Base Indicator Paper
pH = 2 Strongly Acidic	
pH = 4 Acid	
pH = 6 Weakly Acid	
pH = 7 Neutral	
pH = 8 Weakly Basic	
pH = 10 Basic	
pH = 12 Strongly Basic	

3. Using a pencil, write your name on each of the four pieces of filter paper.

4. Turn the hot plate on to a low setting, about 3, and evaporate about two-thirds of the colored alcohol solution, leaving about 17 mL in the beaker.

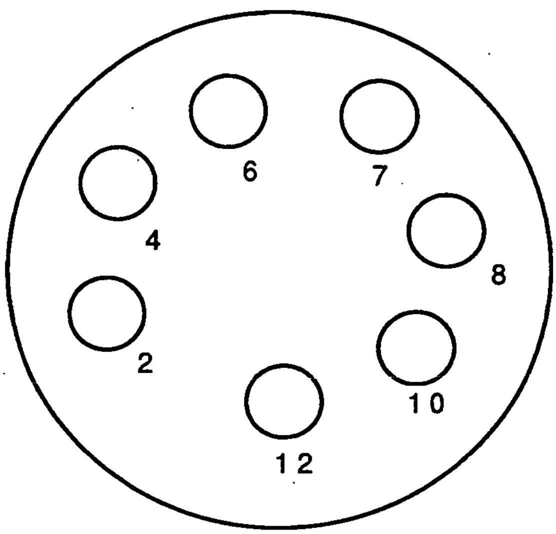
5. Once the evaporation of the alcohol is finished, use tongs to remove the hot beaker from the hot plate and allow it to cool.

6. With the side with your name on it facing down, place the pieces of filter paper on a large sheet of shelf paper or paper towel. Use a dropping pipet to place 1-2 drops of colored alcohol solution in a pattern like that shown below on each piece of filter paper. Discard the remaining colored solution in the sink.

7. When the paper is dry, place a drop of pH= 2 buffer on one piece of the acid-base test paper that you have made. Set the other three pieces of filter paper aside. You will use these later. Write the number 2 on the filter paper near the spot so you can remember which buffer goes with each spot. In Table #1, record the color of the wet spot on the test paper.

8. On the *same piece of filter paper*, repeat step #7 using each of the other buffer solutions (pH = 4,6,7,8,10,12). This will be your **calibrated piece of acid-base test paper.**

Put everything away and clean your area using the proper procedures.



Acid-Base Properties of Household Solutions

In this activity you will test household solutions to find out if they are acidic, neutral or basic. You will use the test paper that you have prepared and samples of household chemicals in dropper bottles (one set per group).

1. Test some or all of the different household products with your acid-base test paper. Compare the colors your test paper turns to your calibrated piece you prepared earlier. Record your results below in TABLE #2.

Table #2

SAMPLE	Estimated pH	Color of Paper after Tested	Acidic, Basic or Neutral
Tap Water			
Distilled Water			
Bubble- Up			
Vinegar			
Window Cleaner			
Baking Soda			
Lemon Juice			
Detergent			

2. You might take your acid-base test paper home and test other solutions around you house. (What do you think the pH is of the coffee or tea your parents may drink? Or how about the water in a swimming pool?)

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ACID/ BASE TITRATION

Thus far we have known the concentrations of each of the solutions involved in the experiment. What if we do not know one of the concentrations of the solutions being used? How could we find the missing concentration?

To determine this concentration, chemists working in industry and research use what is called volumetric analysis. Volumetric analysis is the process in which you accurately find the volume of one solution which will react with a carefully measured amount of another solution. The method used to do this is called titration.

In this experiment, you will determine the concentration of a base by titrating it with an accurately known concentration and volume of an acid solution which you made in an earlier activity. In the next part, you will titrate a solid acid with the base of known concentration and volume of the base from the first part.

Equipment:

ringstand
2 50 ml. burets
2 100 ml. beakers
phenolphthalein indicator
solid acid 1-5
buret clamp
250 ml. Erlenmeyer flask
base solutions A, B, C, D
acid solution HCl 0.15M

Procedure A:

1. Rinse two 50 ml. burets with tap water.
2. Into one of the 100 ml. beakers pour enough of the 0.15M HCl to fill the buret. Pour enough of the base that you have chosen into the other 100 ml. beaker to fill the other 50 ml. buret.
3. Choose one of the bases labeled A, B, C, or D. Your partner must choose a different lettered base.
4. As you face the ringstand and buret clamp, the buret on the left should contain the acid and the one on the right the base. (REMEMBER A B)
5. Rinse the buret on the left with about 10 ml. of the acid and then fill it to the top.
6. Repeat step 4 with the other 50 ml. buret and the base.
7. Remove the air from the tip of each of the burets catching the solutions in their respective 100 ml. beakers. **Start with each buret reading 0.0 ml.**
8. Rinse the Erlenmeyer flask with some tap water. Add approximately 10 to 20 ml. of distilled water. You do not have to measure this amount.
9. Add 3 or 4 drops of pheolphthalein to the flask. (Note the readings of the burets.) Add exactly 10.0 ml. of the 0.15M HCl to the flask.
10. Begin to titrate with the base by slowly adding it to the acid solution. Continue to add the base until one drop of the base turns the solution a faint pink. **Be careful not to go too fast or you will go beyond the end poi**Make sure the solution stays pink for at least 30 seconds. (NOTE: ONE OR TWO DROPS OF HCl SHOULD TURN THE SOLUTION CLEAR AGAIN.)
11. Rinse out the flask with tap water and repeat steps 8, 9, and 10. The number of ml. of the base NaOH should be very close.

DO THE FOLLOWING CALCULATIONS BEFORE GOING ON TO PART B (SHOW YOUR WORK)

1. Calculate the number of moles of HCl used in each titration. For example, if you used 10.0 ml. of 0.4M HCl, you would have:

$$10 \text{ mL HCl} \times \frac{0.4 \text{ moles}}{1 \text{ l}} \times \frac{1 \text{ l}}{1000 \text{ mL}} = 0.0004 \text{ moles}$$

2. Write the equation for the reaction in this experiment. Remember that the reactants are HCl and NaOH. Calculate the number of moles of NaOH needed to react with the calculated moles of HCl that you started with.
3. The number of moles of NaOH calculated in question 2 is contained in the volume of NaOH that you titrated in step 10 in the procedure. Knowing that the units for concentration or molarity are moles per liter, calculate the concentration of the NaOH. **Use the average of the two numbers you obtained from the titrations.**

Procedure B:

1. Prepare only one 50 ml. buret per instructions in step 1 Part A.
2. Rinse and fill the buret with the base you used in Part A. You calculated its concentration in calculation number 2.
3. Pick one of the solid acids (1-5). Your partner must use the same number also. Measure the mass of a piece of weighing paper. To this mass add 0.50 g of solid acid. Add the solid acid from the bottle until the arm of the balance swings up. Rebalance the arm and record the mass. **THERE IS NO NEED TO GET EXACTLY 0.50 g.**
4. Clean and rinse the Erlenmeyer flask with tap water. Add approximately 20 to 30 ml. of distilled water and add the solid acid. Swirl the solution to get as much of the acid to dissolve as possible. Rinse down the sides with distilled water to get any of the acid off the sides of the flask. **Put in 3 or 4 drops of phenolphthalein and swirl.**
5. Titrate with the standardized NaOH from Part A. Make sure the faint pink color lasts for at least 60 seconds. During that time, keep swirling the solution. If the color fades away, add more of the base until it stays for the full 60 seconds.
6. Rinse out the flask with tap water. Your partner can now titrate his/her solid acid.

CALCULATIONS FOR PART B: (SHOW YOUR WORK)

1. From Part A, you know the concentration of NaOH. Calculate the number of moles of NaOH used to titrate the solid acid.
2. Calculate the moles of hydrogen or hydronium ions that were contained in the 0.50 g sample of the solid acid.
3. Calculate the molecular mass of the solid acid. Remember the units for molecular mass are grams per mole.

ACID/BASE TITRATION DATA TABLE:

PART A:

1. Letter of base used.	
2. mL if 0.15 M HCl used (1)	
3. mL of unknown NaOH titrated (1)	
4. mL of 0.15 M HCl used (2)	
5. mL of unknown base titrated (2)	
6. Concentration of NaOH (1)	
7. Concentration of NaOH (2)	
8. Average concentration of NaOH	

PART B:

9. Number of unknown solid acid	
10. Mass of the solid acid	
11. Molecular mass of the solid acid	

QUESTIONS:

1. When the end point of the titration is reached, what does this indicate about the reaction between the acid and the base?

2. How many milliliters of 0.030M NaOH will exactly neutralize 20.0 ml. of 0.50M H_2SO_4?

3. How many milliliters of 0.200M HNO_3 will completely neutralize 30.0 ml. of a 0.71 M solution of KOH?

Acids, Bases, and Indicators Lab

You can express the acidity of a solution by using a pH scale. The pH of a solution is a measure of the concentration of the hydronium ions in that solution. The pH scale ranges in value from 0 to 14. Acids have pH values less than 7. Bases have pH values greater than 7. A neutral solution has a pH value of 7.0.

The pH of a solution can be determined by using an indicator. An indicator is usually an organic compound that changes color at a certain pH value. A universal indicator is a mixture of indicators that can be used to determine a wide range of pH values.

Objectives: In this experiment you will:

A. investigate how a universal indicator is affected by acidic and basic solutions, and
B. determine the pH of several common liquids.

Equipment:

goggles
well microplate
plastic microtip pipet
sheet of white paper
universal indicator
sodium hydroxide solution, NaOH
hydrochloric acid solution, HCl
distilled water

samples of common liquids (lemon juice, tap water, lemon-lime soda, vinegar, detergent, and baking soda)

CAUTION: NaOH and HCl solution are corrosive. The universal indicator can cause stains. Avoid contacting these solutions with your skin or clothing.

PROCEDURE:

Part A - Preparing the color scale

1. Wear your goggles during this experiment. An apron is optional.
2. Place the well microplate on a piece of paper on a flat surface. Have the numbers on the paper lined up with the rows and column on the plate.
3. Using the microtip pipet, add 9 drops of distilled water to each of the well **A2-A6** and **B1-B5**.
4. Use the pipet to add 10 drops of hydrochloric acid, HCl to well **A1**. Rinse the pipet with distilled water.
5. Use the pipet to add 10 drops of sodium hydroxide, NaOH to well **B6**. Rinse the pipet with distilled water.
6. Use the pipet to transfer one drop of hydrochloric acid solution from well **A1** to well **A2**. Return any solution remaining in the pipet to well **A1**, making sure the pipet is empty. Mix the contents of well **A2** by drawing the solution into the pipet and then returning it to well **A2.**
7. Using the pipet, transfer one drop of the solution in well **A2** to well **A3**. Return any solution remaining in the pipet to well **A2.** Mix the contents of well **A3** by drawing

the solution into the pipet and then returning it to the well.

8. Repeat step 7 for wells **A3, A4, and A5**. Rinse the pipet with distilled water.
9. Use the pipet to transfer one drop of sodium hydroxide solution from well **B6** to well **B5**. Return any sodium hydroxide solution remaining in the pipet to well **B6**. Mix the contents of well **B5** by drawing the solution into the pipet and then returning it to well **B5.**
10. Using the pipet, transfer 1 drop of the solution in well **B5** to well **B4**. Return any solution remaining in the pipet to well **B5**. Mix the contents of well **B4** by drawing the solution into the pipet and then returning it to the well.
11. Repeat step 10 for wells **B4, B3, and B2**. Do not transfer solution from well **B2** to well **B1.** Well **B1** will contain only distilled water. Rinse the pipet with distilled water.
12. Use the pipet to add 1 drop of universal indicator to each of the wells **A1-A6, and B1-B6.** Rinse the pipet with distilled water.
13. Observe the solutions in each well. Record the color of the solution in each well in the table on the Data and Observations sheet.

Part B - Determining the pH of solutions

1. Use the bottle and dropper to place 9 drops of lemon juice in well **D1**. Rinse the pipet with distilled water.
2. Place 9 drops of tap water in well **D2** and 9 drops of lemon-lime soda in well **D3.**
3. Place 9 drops of vinegar in well **D4**, 9 drops of detergent in well **D5**, and 9 drops of the baking soda solution in well **D6**.
4. Using the pipet, add 1 drop of the universal indicator to each of the wells **D1-D6.**
5. Observe the solution in each well. Record the name of the solution and its color in the appropriate table on your Data and Observation sheet.

Analysis:

1. By adding 1 drop of hydrochloric acid solution in well **A1** to the 9 drops of water in well **A2**, the concentration of the hydrochloric acid in well A2 was reduced to 1/10 that of well **A1**. With each dilution in wells **A1-A6**, you reduced the concentration of the acid from one well to the next by 1/10. Likewise, by diluting the sodium hydroxide solution, the concentration of the sodium hydroxide solution is decreased by 1/10 from well **B6-B1**. Because of these dilutions, the pH value of the solution in each of the wells **A1-A6** will be the same as the number of the well. For example, the pH of well **A3** is 3. For wells **B1-B6** the pH will be equal to the well number + 6. For example well **B1** has a pH of 7.
2. The color of the solution in wells **A1-A6 and B1-B6** can be used to determine the pH of other solutions that are tested with the universal indicator. You can determine the pH of a solution by comparing its color with the color of the solution in wells **A1-A6 and B1-B6**. Determine the pH values of the solutions that you tested in Part B of the procedure. Record your pH values on the appropriate table on your Data and Observation Sheet.

Name ______________________ **Hour** ______ **Date** _______

Acids, Bases, and Indicators Lab

Questions:

1. What are the pH values of acids and of bases?

2. Classify the solutions that you tested in Part B as acids or bases.

3. What is a universal indicator?

4. Distilled water is neutral. What is its pH value?

   What color will water appear if tested with the universal indicator solution?

Data and Observations:

Well	A1	A2	A3	A4	A5	A6
Color						
Well	B1	B2	B3	B4	B5	B6
Color						

Solution	Color	pH

Comparing the Effectiveness of Several Antacids

Your stomach normally contains hydrochloric acid. Some people take drugs known as antacids when they feel discomfort due to too much acid in the stomach. Antacids contain a base. The base neutralizes some of the acid.

When a base neutralizes an acid, hydroxide ions from the base combine with hydrogen ions from the acid. Water is formed. The chemical equation is:

$$OH^- + H^+ \longrightarrow H_2O$$

Another product is formed as well when an acid and base neutralize each other. For example, suppose HCl in the stomach is neutralized by an antacid containing magnesium hydroxide, $Mg(OH)_2$. The complete chemical equation is:

$$2HCl + Mg(OH)_2 \qquad 2H_2O + MgCl_2$$

The product magnesium chloride, $MgCl_2$, is formed from the positive ion Mg^{+2} of the base and the negative ion Cl^- of the acid. This kind of compound is known as a salt. Salts are always formed from the positive ion of a base and the negative ion of an acid. A salt usually contains a metal and a nonmetal.

Antacid products can be compared by testing how much acid they can neutralize. In this investigation, you will mix several antacid tablets with water and a colored chemical called an indicator. The indicator changes color depending on whether an acid or base is present. Then you will add acid to the solution to determine how much acid can be neutralized by the antacid tablet.

Materials:

1M HCl	100-mL beaker	medicine dropper
antacid tablets	graduated cylinder	goggles
distilled water	250mL Erlenmeyer flask	
indicator	pestle and crucible	

Purpose:

To compare the effectiveness of antacid products and to practice titrations.

Procedure:

1. Put on safety goggles.
2. Obtain a sample of an antacid tablet. Record the brand name and active ingredients for your tablet in the table provided.
3. Put 100mL of distilled water in each of the clean, dry Erlenmeyer flasks. Dissolve the tablet in the water. If you are using a chewable tablet, crush it using the pestle and crucible. (Some tablets may not dissolve completely.)
4. Put a sheet of white paper under the flask. Add about 10 drops of indicator into the flask.
5. Use a medicine dropper in the bottle of HCl to add the HCl to the flask.

   SAFETY NOTE: Do not get any HCl on your skin or clothing. If you do, wash with plenty of water. Wipe up any spills with paper towels.

   Add five drops at a time, then swirl the contents of the flask.
6. **Keep track of the number of drops of HCl that you add to the flask.** At some point, adding drops of HCl will cause brief changes in color that will disappear after the solution is swirled. At that point, add only one drop at a time swirling the solution after each drop.
7. Stop adding acid when the solution color change stays after swirling. At this point, the antacid tablet cannot neutralize any more acid.
8. Record the number of drops of acid added. Also record the results and antacid data reported by other groups in the class. If more than one group tested each antacid, then average the results.
9. Clean your area so that it is neater than when you started. Wait for further instructions.

Name ______________________________ Date ____________ Hour _____

Antacid Comparison

(Turn in this page only)

Antacid Brand	Active ingredients	Inactive ingredients	Drops of HCl added

Observations:

Questions:

1. What active ingredients are in the brand tested?

2. Do some antacids contains inactive ingredients? If so, what are they?

3. Which antacid tablet neutralized the most acid?

   What active ingredient(s) does it contain?

4. Which antacid tablet neutralized the least acid?

   What active ingredient(s) does it contain?

5. What factors could account for any differences you observed in the acid-neutralizing capacities of the antacids tested?

Bubble-Up Gas in Solution Demonstration

Through this class demonstration, students will discover that both pressure and temperature affect the solubility of gas (amount of gas) in a solution. Students will observe this by listening to and comparing the amount of "woosh" when opening warm and cold bottles of soda water. They will also observe and compare the amount of bubbling in cold, warm, and agitated soda water. Also, they will use stretched balloons to collect and compare the amount of gas released from soda water at different temperatures and level of disturbance.

The student will be able to explain how pressure and temperature affect the solubility of gas in a solution.

Materials:

3 clear plastic cups	3 bowls or pans or 500 mL beaker
3 stretched balloons	Straw or coffee stirrer
Hot water	6 bottles of soda water
Ice	-- 2 room temp. and 4 cold

Use clear soda water or pop in clear bottles with labels peeled off to make observation easier. Label the bottles "warm" or "cold."

Which do you prefer, a freshly opened bottle of soda or one that has been opened and has been setting around for awhile? Why? What do we mean when we say that a bottle or glass of soda has "gone flat"?

Procedure #1: Observe 2 unopened bottles of soda water (1 cold, 1 warm) for bubbles. Open the bottles and observe each again. Record your comparisons on the DATA and OBSERVATION SHEET.

Discussion Questions

Did you notice anything the same or different about the liquid in the 2 bottles before opening?

Did you notice anything the same or different about the liquid in the 2 bottles after opening?

What caused the "woosh" when we opened each bottle?

What happened in the liquid as a result of this pressure change?

Where do you think the bubbles are coming from?

What do you think the bubbles might be?

Which bubbled more... the warm or cold soda water?

Why do you think the bubbles are forming and coming to the top?

Explanation

We have all been in large close crowds of different types. One type has everyone standing and watching some presentation. Another type is a large crowd that is moving about like at a fair or exhibition. Which is easier to move through? I'm sure you've found an already moving crowd easier to move through. This same concept applies to gas molecules. As we already know, the molecules and atoms of substances are always moving. The warmer the substance, the more they are moving. Hence, it is easier for the gas molecules to move through warm soda and form bubbles than in the cold soda. Therefore, the gas molecules which were held in both liquids by the extra pressure in both warm and cold soda had an easier time escaping from the warm soda than from the cold soda. Thus, we saw more bubbles coming from the warm soda than the cold.

Procedure #2: Label the 3 clear plastic cups A, B, and C. Add 1/3 of the soda from the cold bottle to each of the 3 cups. Leave cup A as your control. Place some hot water in a bowl to a depth somewhat less than the depth of soda in cup B (so it won't tip over). Set cup B into the warm water (2-3 minutes). Stir the soda in cup C briskly (2-3 minutes). Record your observations on the table of the DATA & OBSERVATION SHEET.

Discussion Questions

How did the bubbling in B and C compare to the bubbling in A while doing the activity?
How does the bubbling in B and C compare to the bubbling in A after a period of time?
Which solution is best at keeping its gas?
What factors cause the rate of bubbling in soda water to increase? (There are 3.)

Procedure #3: Observe the 4 remaining bottles for bubbling. Label the warm bottle, A, and the 3 cold bottles, B, C, and D. Have 4 pairs of students open all 4 bottles in succession on a given signal (one after the other) and place a stretched balloon over the neck of each bottle. (One student would hold the bottle as steady as possible while the other opens it and puts on the balloon. All should listen for any difference in the "woosh" sound made by each.)

Allow A and B to set quietly. Place C in a pan of hot water. Hold the balloon tightly on D and shake it vigorously. Record your observations and comparisons on the DATA and OBSERVATION SHEET.

Discussion Questions

How did the amount of bubbling compare before opening?
Which had the greater "woosh" when opened... cold or warm?
Which bottle had the most gas released? How do you know?
Which bottle had the least gas released? How do you know?
Which bottle would be the most "bubbly" to drink and enjoy?
How do most people usually prepare soda to drink and enjoy?
Decreasing the pressure decreased the solubility of the gas in the liquid.
What do you think increasing the pressure would do to the solubility of a gas in a liquid?

Bubble-up Gas in a Solution

Part I

Observations of unopened and opened bottles of soda water:

Part II

Cup	Soda Condition	Observation and comparison of bubbling
A	Control	
B	Heated	
C	Stirred	

Part III

Bottle	Soda Condition	Observation of balloon size
A	Room Temp.	
B	Cold	
C	Cold and shaken	
D	Cold and heated	

Most soft drinks contain dissolved CO_2. If you shake and then open it, the soft drink may "shoot" into the air. Explain why this happens.

Would this be more likely to happen with a shaken bottle of cold soda or warm soda? Explain why you think this happens.

Application Questions:

Can you think of ways people try to keep the gas in soda water to keep it from going flat?

Some people use pump up bottles to save soda pop. How would this help?

In cold area where there are long cold spells and lakes and ponds are frozen over, people sometimes drill holes in the ice and run hoses down to the bottom and bubble air through the water. What good would this do?

Can you think of other devices to keep air or put air into liquids?

How do aerators help in aquariums?

Decorative fountains and ponds in shopping malls always have water squirting up or tumbling over waterfalls. Why do you think this is done?

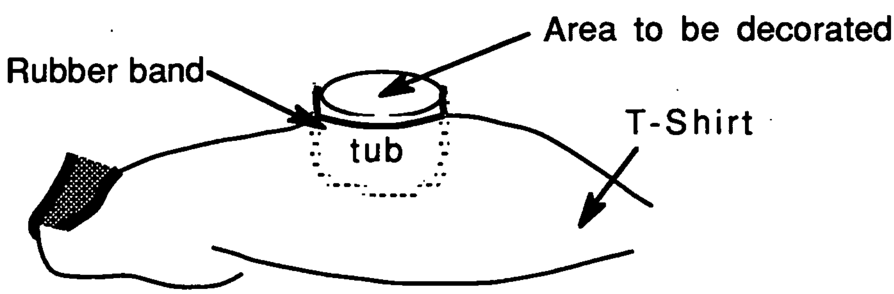
Name:______________________________ Date: __________ Hour: ____

T-Shirt Chromatography Lab

This activity uses a separation technique, radial chromatography, to create a decorative pattern on T-shirts. Radial chromatography is a process in which the solvent spreads out in a radial pattern, carrying the different ink pigments with it to varying degrees. In this activity, permanent-ink pens are used because their pigments are not water-soluble. Thus, permanent ink produces patterns that will not easily run or wash out of the T-shirt. What kind of solvent do you think we'll need to use with these permanent pens? Now, see if you can use chromatography to transform a plain white T-shirt into a colorful one.

A. Making your pattern:

1. Gather the following materials:
   a plain white T-shirt
   an assortment of permanent pens (one set per group)
   a plastic tub
   a 250-mL beaker with isopropyl alcohol in it
   a plastic pipette
   a rubber band
2. Using a permanent marker, write your initials on the hem or tag of your shirt.
3. Place the plastic tub upright inside the T-shirt under the area you want to decorate. Pull a rubber band over the T-shirt and around the tub. Gently pull down on the shirt along the outside of the rubber band to draw up any slack in the fabric.



4. Choose one of the permanent markers and on the fabric in the center of the tub, make 5 or 6 little dots in a circle that is about the size of a quarter. The dots should be as small and as concentrated as possible.
5. If multi-colored pattern is desired, choose other markers and use them to make dots in between the first ones. **(Remember to recap the pens after use!!!)**

B. Developing your pattern:

6. Pick up your plastic pipette and fill it with isopropyl alcohol by squeezing the pipette while it is in the beaker of alcohol, and then releasing the squeeze without letting go of the pipette.
7. Hold the pipette over the center of the circle of dots on the T-shirt. Slowly squeeze the bulb to release a few drops of the alcohol onto the T-shirt in the center of your design.
8. Watch as the alcohol spreads out in a circle or oval as you squeeze out more and more. As the alcohol passes the dots, it will start to spread them out radially. **Note that if you become impatient and add more alcohol to other parts of the pattern, the resulting design will not be nearly as nice.**

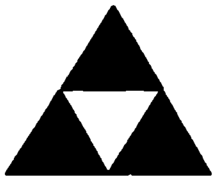
9. When the pattern has gotten as large as you want it (but no larger than the rim of the tub), stop squeezing out the alcohol, and put the pipette aside.

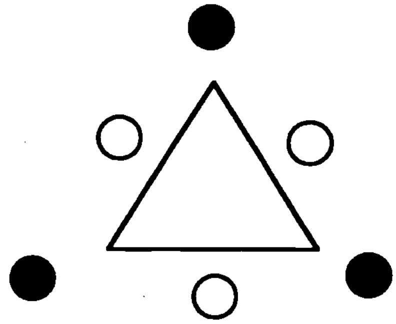
C. Making more designs:

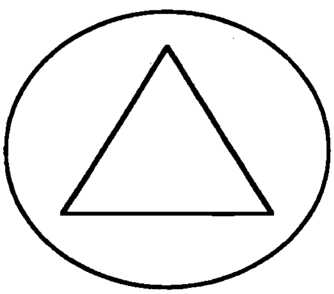
10. If you want to make more designs, carefully take off the rubber band and move the tub to a different area of the shirt (away from the one that is still wet). Try to keep the wet part of the shirt away from dry parts if you don't want to color to bleed (use paper towels as a shield, if you wish).
11. Repeat sections A and B above to make additional designs as time allows. If you want some ideas for patterns that make interesting designs after they develop, look at the next page. Experiment with making different-sized dots or arranging them in different sized circles. It is best to use dots, and place them near the center of the tub. Try making patterns with a variety of colors and sizes.
12. When you are finished with your patterns, put the shirt on a metal hanger near the front of the lab and allow the T-shirt to dry completely before taking it home.
13. Pour the isopropyl alcohol into the sink and rinse out the beaker and pipette. Make sure that your area is cleaner than you found it!!!

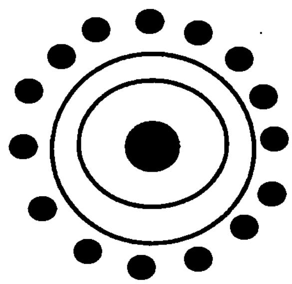
D. At home:

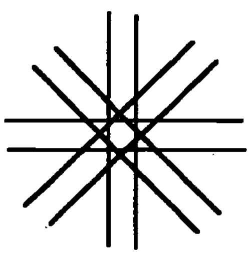
1. When the T-shirt is *completely* dry, iron it to help set the patterns. Do not apply a hot iron to a T-shirt that still has traces of alcohol on it. Fading occurs with repeated washing; some of the lighter shades will disappear completely. To help minimize fading, wash the T-shirt in cold water only.
2. If you want to make your chromatography pattern more permanent, treat it using Rit ®DESIGN-IT® dye binder (available at discount and fabric stores) as described below:
   a. Put a piece of waxed paper inside the T-shirt under the pattern to be treated. Using a small (about 3/4 to 1 inch wide) foam rubber paint applicator, apply a thin layer of Rit ® DESIGN-IT® (without dilution) onto the radial pattern.
   b. Allow it to dry for one hour.
   c. Heat treat with an iron as described on the DESIGN-IT® container. Before proceeding with the heat treatment, test the temperature of the iron on an old T-shirt to make certain that it is not so hot that the T-shirt fabric will scorch.

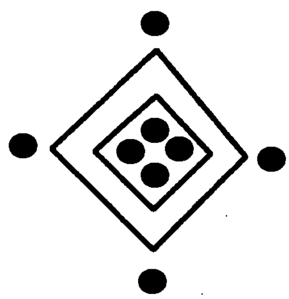












Unit 3

Air and Climate

Unit 3 Air and Climate 6 Weeks

This unit examines the physical and chemical properties of gases that make up our atmosphere. It evaluates the economic, environmental, and personal impact of commercial uses of gases and a description of some of the vital functions of atmospheric gases. This also unit provides insight on how to predict the effects on animal and plant life of industrial and agricultural activities that produce atmospheric pollutants .In addition, the issues that affect global warning and the greenhouse effect are discussed.

Competencies

The students will be able to:

C1 Observe and describe observations accurately using appropriate language and precision. (1.2.1)
C2 Develop skills in using common laboratory and field equipment and perform common laboratory techniques. (1.2.4)
C3 Select appropriate measuring instruments in computer interfaces. (1.2.2)
C4 Organize and present data in the form of functional relationships, when appropriate. (1.3.1)
C5 Interpret and translate data into tables and graphs. (1.4.1 and 1.4.2)
C6 Describe mathematical relationships in a qualitative manner. (1.4.3)
C7 Explain that science is only one source of information to address societal issues. (2.1.1)
C8 Identify the capabilities and limitations of science as it applies to social issues. (2.1.2)
C9 Apply scientific knowledge in making personal decisions. (2.2.2)
C10 List careers that require or involve science. (2.3.1)
C11 Cite examples of how science and technology can establish useful connection between natural and designed worlds. (2.2.1)
C12 Use kinetic molecular theory to explain changes in gas volumes, pressure and temperature. (3.3.4)

Workplace Relationships

1 Aircraft Mechanic: Skills are acquired on the job. The mechanic adjusts various pressure gauges and maintains various mechanical equipment on the aircraft.
2 Meteorologist: A college degree is required. The meteorologist studies weather and atmospheric systems. He/She reports the weather and uses various instruments that measure weather factors.
3 Respiratory Technician: This job requires a license or certification. Health care workers use various instruments to monitor respiration gases in patients.
4 Biomedical Technician: The job requires specialized training. The technician maintains equipment for a local clinic or hospital.
5 Power Plant Operator: The job requires a technical degree. The operator will monitor day to day operations of the plant.
6 Gas Lab Technician: Skills are acquired on the job. The technician must check gas samples at various sites for quality.
7 Robotics Technician: Requires a two-year degree program in a technical school. The job requires a knowledge of pneumatic and hydraulic systems.
8 Gas Delivery Driver: High School diploma is needed. Must transport cylinders of gas to customers. Driver must have a knowledge of gas properties.
9 Auto Emissions Technician: A high school diploma is needed. Skills are acquired on the job. Technicians will attach /operate various pollution control equipment in order to monitor exhaust fumes from automobiles.
10 Environmental Technician: An associate degree is required. Technicians will acquire

skills at the work place. The job requires the technician to help local industries comply with increased environmental regulations.

11 Occupational Safety and Health Technician: An associates degree in occupational safety and health is required. The technician must monitor workplace hazards, keep records of safety violations, corrective measures, and spills and assist in safety training for all employees.

12 Hazardous Materials Technician: A technical degree is required. The technician monitors, analyzes, and cleans up chemical spills.

13 Emergency Medical Technician: Emergency medical training certification is needed. Technicians will monitor injured clients for vital life signs and administer oxygen for breathing purposes.

Applications

1 Pros and cons for developing an airport/shopping mall that is adjacent to a natural wildlife preserve.
2 Pros and cons of burning leaves in the residential area.
3 Buying tires: Comparing the price of tires and their size.
4 Decorating Committee: Deciding whether to fill balloons with compressed air or helium.

Learning Activities / Teaching Strategies

1 20 Questions T-F test on pages 341-342/ Demo-discussions (See teacher's manual)
2 The Atmosphere Lab (Gas collecting/gas testing lab), p. 346-351
3 Air pressure demos
4 Chem quandaries, pp. 357-358, etc.
5 Boyle's Law computer interface
6 "Temperature vs. Volume" Activity, pp. 362-363
7 Absolute temperature video and graphing activity
8 Reflectivity Demo
9 Carbon Dioxide Level Lab, pp. 380-382
10 Lab demo on cleansing air, pp. 392 (See teacher's manual p. 199-200)
11 Acid Rain lab, pp. 399-400

Resources

1. Heikkinen, Henry, (Ed.), *Chem Com* (2nd Ed.), Dubuque, Iowa: Kendall-Hunt Publishing Co.,1988.
2. Any basic Chemistry book

Assessment Plans

Student success will be assessed through scores on homework assignments, concept quizzes, lab reports and performance, and unit evaluations.

Daily Lesson Plan

1 20 Questions T-F test on pp. 341-342/ Demo-discussions (See teacher's manual)
2 Continue demo/discussions
3 Breath of Life discussion Group Assignment "Your Turn" pp. 343-344 1-4
4 Group Assignment summary, p. 345 1-4
5 Start The Atmosphere Lab: Gas collection
6 The Atmosphere Lab: Gas testing
7 Troposphere/Avogadro's law/Molar volume discussion. Assignment "Your Turn," p. 354 1 - 3
8 Graphing exercise pp. 355-356 temperature vs altitude, pressure vs. altitude.
9 Quiz

10 Air pressure discussion/demos and chemquandary
11 Boyle's law discussion and prelab
12 Boyle's law lab computer interface. Assignment "Your Turn," pp. 361-362 1-4
13 Charles' law discussion/Ideal gases Absolute zero video and graphing activity
14 Temperature/Volume Lab
15 Chemquandary, p. 365 1-4. Assignment "Your Turn," pp. 365-366 1-5
Homework: Summary questions, pp. 368-369, 1-8
16 Quiz
17 Atmosphere and Climate discussion
18 Groupwork "Your Turn," p. 375 1-6. Graphing Carbon Dioxide levels p. 379
19 Carbon Dioxide Level lab, pp. 380-381
20 Ozone discussion and Assignment summary, p. 384 1-9
21 Quiz
22 Pollution discussion/ Assignment questions relating to table, pp. 386-387.
23 Lab demo on cleansing air
24 Acid Rain lab, pp. 399-400
25 "Your Turn," p. 401 1-2. Summary, pp. 401-402 1-12
26 Review
27 Unit evaluation

MOLAR RATIOS USING MASS AND VOLUME

Avogadro's hypothesis tells us that equal volumes of gas measured at the same temperature and pressure contain an equal number of particles.

Solids and gases are often contained in the same experiment. The mass of the solid can be found on a balance, but to find the mass of a gas is a little more difficult. Chemists usually measure the volume of a gas, then convert the volume to mass. Using this idea, the chemist must know the relationship between the molar mass and the molar volume. Avogadro's hypothesis is this relationship. Your measurements will be observed at room temperature and pressure. You will then convert to standard conditions, STP, to finish the experiment.

In this experiment, you will investigate the importance of Avogadro's hypothesis.

EQUIPMENT:

- 400 mL beaker
- One hole rubber stopper
- 50 mL gas measuring tube
- Thermometer
- Barometer
- Pair of Calipers
- 2000 mL graduated cylinder
- Clamp
- Ring stand
- Piece of Copper Wire
- Piece of Magnesium

PROCEDURE:

1. When you go into the laboratory, take a 600 mL beaker and fill it three/fourths full with tap water. This will allow the water to stand and come to room temperature.
2. While you are waiting for the water to come to room temperature, take a piece of magnesium metal and find its length to the nearest 0.01 cm with a pair of calipers. **Record this length.**
3. Prepare the ring stand and clamp to hold the gas measuring tube.
4. Take the copper metal and put it through the hole in the stopper. On the end of the copper that will be inside the tube, make a cage-like structure (teacher's instructions). Wrap the magnesium metal around the cage, but make sure it is not wound around too tightly. Make sure the magnesium and the copper will go inside the gas measuring tube.
5. Invert the tube and add approximately 10 mL of HCl.
6. Slowly fill the tube to the top with the tap water from the beaker from STEP 1.
7. Insert the rubber stopper with the copper and magnesium into the gas measuring tube.
8. Put your index finger over the hole in the stopper and place the tube right side up and into the 400 mL beaker. When the hole is below the surface of the water, release your finger. No air should have gotten in the tube. (If in doubt, ask your teacher.)
9. The reaction will not start immediately, for the HCl has to diffuse down to the magnesium. When the reaction is complete, gently tap the gas collecting tube with your finger to release any trapped gas. Note the column of gas in the tube.

10. Place your index finger over the hole in the rubber stopper while your partner undoes the clamp to the tube. Keep your finger over the hole and take the tube to the nearest sink and place it in a filled 2000 mL graduated cylinder. Remember: do not release your finger until the stopper is below the surface of the water.
11. Move the tube up or down until the level of the water in the tube is the same as the level of water in the graduated cylinder. Record this volume.
12. Record the temperature of the room, the barometric pressure in cm of Hg, and the mass of 1.00 meters of magnesium metal.

DATA:

The table is left out for you to construct and fill out.

CALCULATIONS:

1. Calculate the mass of magnesium metal, using the mass per meter given to you by your teacher. Hint: 5 cm = 0.05 meter
2. Calculate the moles of magnesium.
3. Calculate the partial pressure of the hydrogen gas in the hydrogen gas water mixture. Remember that $P_{total} = P_{H2O} + P_{H2}$
4. You know the volume of hydrogen gas at the corrected pressure, (calculation #3), and at room temperature. Now calculate the volume of hydrogen gas at STP.
5. You now know the volume of the hydrogen gas at STP. Use this information to calculate the volume of hydrogen gas which would be produced if one mole of magnesium were reacted with an excess of HCl.

QUESTIONS:

1. Write the balanced equation for the reaction in this experiment. If the water was boiled away, the white residue remaining would be magnesium chloride. Also show the molar relationship between the magnesium and the hydrogen gas.
2. From this experiment you should be able to predict the volume that one mole of hydrogen gas would occupy at STP. What is this volume?
3. Calculate the volume of hydrogen gas and the mass of magnesium chloride that would be produced if 2.43 g of Mg reacted with an excess amount of HCl.

Balloon lab

Problem: How is the volume of air affected by changing temperature?

Hypothesis: (Answer the question: What do you think will happen when the balloon is heated and when it is cooled?)

Procedure:

1. Measure the room temperature and record it in your data table .

2. Use only the balloons that are assigned to you.

3. Use string to measure the circumference (the distance around) of each balloon at room temperature. For later use, place an ink dot where the string went around each balloon. Then use a meter stick to measure the length of the string. Record this circumference on your data table.

4. The volume of the balloon is equal to the cube of the circumference divided by 59.

$$V = c^3/59$$

5. Place one balloon in ice water for 5 minutes. Measure and record the temperature of the ice water.

6. Remove the balloon and **quickly** use the string to measure the new circumference, using the ink dot as a guide.

7. Place the balloon over the steam from the beaker of boiling water for 5 minutes. **CAUTION:** *Steam causes burns.* Measure and record the temperature of the steam.

8. Remove the balloon and **quickly** use the string to measure the new circumference, using the ink dot as a guide.

9. Clean your area making it cleaner than when you started.

Name ______________________ Date ____________ Hour ______

Balloon lab data and observations

Hypothesis: ____

____

STATE	TEMPERATURE	CIRCUMFERENCE	VOLUME
ROOM			
HOT			
COLD			

1. Using the temperatures and volumes in your data table, make a line graph. What is the relationship between the temperature and volume of a gas?

2. Using the trends that you see on your graph, was your hypothesis supported? Why or why not?

3. Your graph should suggest a straight line. If you extended the line to zero volume, to what temperature would it correspond? (See page 206 for a hint.)

4. Using the kinetic theory, explain how the movements of air particles inside each balloon are causing the volume to change.

5. Aerosol cans often bear the warning "Do not incinerate, contents under pressure." How can you apply what you have seen in this activity to explain this caution?

Unit 4

Chemical Resources

Unit 4 Conserving Chemical Resources 4 Weeks

This unit is intended to give students some insight into the worldwide problem of limited chemical resources. As the Earth's human population has grown, demand for chemical resources such as metal ores and fossil fuels has increased. Our developing technology has provided us a more comfortable way of life, but we face decreasing reserves of resources and increasing disposal problems associated with large quantities of "waste" materials. These related trends generate a host of economic, environmental, and political issues.

Chemical concepts covered in this unit include equation balancing, properties and reactivities of metals, and the periodic table; there is particular emphasis on copper as a resource, along with recycling and reusing resources. We must consider resource conservation strategies if we are to maintain a high standard of living. For some resources this means maximizing use/reuse (multiple use of a manufactured object for the same or similar purpose). For others, recycling or substitution is more feasible. For many resources a combination of these conservation strategies is desirable. In any case all three options require knowledge of the properties and behavior of matter.

If students are not already familiar with chemical reference books, while using this unit they should be exposed to one or more of the following: the CRC *Handbook of Chemistry and Physics,* Lange's *Handbook of Chemistry,* the *Merck Index*, the McGraw-Hill *Encyclopedia of Science and Technology* , and similar sources.

Competencies

The students will be able to:

- D1 develop skills in using common laboratory and field equipment and perform common laboratory techniques with care and safety. (1.2.4)
- D2 analyze observations and experimentally collected data. (1.2.3)
- D3 understand how both science and technology establish useful connections between the natural and designed worlds. (2.2.1)
- D4 use the processes of scientific inquiry to analyze issues in the natural world. (2.2.3)
- D5 demonstrate the principles of conservation of mass through laboratory investigations. (3.2.2)

Workplace Relationships

1. Conservation scientists dating coins and identifying artifacts.
2. Potters using raw materials in the firing processes to produce ceramics.
3. Fire fighters using chemicals to control fires.
4. Waste management engineers recycling materials.
5. Blacksmiths treating metals to produce products.
6. Power plant operators operating fuel-and-ash-handling systems.
7. Environmental and chemical analysis technicians checking and monitoring air quality and water quality.
8. Gas analysis technicians taking samples of gases for component analysis, adjusting pressure and temperature indicators, and calculating relative densities, testing for hydrogen sulfide gas, and calculating volumetric rates and heating values.
9. Air pollution control technicians installing, operating and repairing air-sampling equipment, taking readings of wind speed, humidity, and temperature.
10. Aquatic chemists collecting samples from natural water bodies, industrial wastes, or other water sources to perform physical and chemical tests in the field and in the laboratory; measuring pH samples of small lakes .

11 Soil conservation technicians assisting farmers, ranchers, and other landowners to prevent soil erosion.

12 Forest technicians protecting wildlife by patrolling forests and keeping records of over harvesting and clear-cutting.

*An associate degree is required for the technician positions.
B. S. degree is required for chemists and conservation scientists.

Applications

1 Edison Power Company knows that the lignite deposit they've leased next to the power plant site is limited. It will be used up someday. The company needs to know how long it can depend upon this lignite as a fuel. Scientists called geophysicists have estimated the amount of lignite at the site has a bed that contains 240 million tons of coal. The plant will burn about 6 million tons of coal each year.

a How long will the mine be able to provide the fuel required by the power plant? Perform the calculations.
b Do you think that the coal will last long enough for the plant's electricity production to pay for the investment?
c What information might you need to answer this question?

2 Charles De Mann is an automotive mechanic and garage owner. About ten percent of his automotive business is air-conditioning repair. When he repairs air-conditioning systems, he usually has to release the used freon into the atmosphere. Charles knows that freon is one of the gases that interacts with ozone. He doesn't like the idea of letting the freon out into the air.

There's a device on the market that would allow the used freon to be reused. Charles would like to buy such a device, but the price tag is $3,OOO. Putting in new freon costs only about $8.OO to $1O.OO per car. It would take him about ten years to recover the cost of a freon cleaner. The Environmental Protection Agency may require garage owners to use it someday. There are thousands of mechanics like Charles all over the country.

a What could be done to encourage auto mechanics like Charles to buy and use freon filtering systems and to stop putting used freon into the atmosphere?
b Should Charles pass the cost of the cleaner on to his customers?
c Would you be willing to pay more for air-conditioning repair in order to ensure that the used freon is not released into the air?

Learning Activities / Teaching Strategies

1 "Chemquandary: A Penny for Your Thoughts," *Chem Com* , p. 88. This is a motivational strategy for the unit. Laboratory Activity 1.
2 "Striking it Rich," *Chem Com,* pp 89-91. This lab is to generate student interest in the chemistry of metallic resources; to introduce the "why" of the unit.
3 Cooperative Learning Group Discussions on problems we face with natural resources, *CORD*: Natural Resources, 1990. This is intended to show application of chemistry in the natural world.
4 "Demonstration: Using Up a Metal," *Chem Com,* pp. 94-95. This demonstrates copper being "used up" by the action of nitric acid which will reinforce the concept of conservation of matter.
5 Cooperative Learning Group Pre-Lab Discussion on the differences between physical and chemical properties.
6 Field studies at USX Gary Works: Processing steel. This allows students to see how science is

interfaced with technology; how natural resources are used.

7 "Laboratory Activity 2: Metal Reactivities," *Chem Com,* pp. 113-115.

8 "Laboratory Activity 3: Metal, Nonmetal?" *Chem Com*, pp. 105-107. In this lab, students will learn how to distinguish metallic from nonmetallic elements after examining their properties.

9 Reading Assignment on the development process of the Periodic Table, *Chem Com*, pp. 107-108. Students will be involved in activities that simulate the historical paths leading to the periodic table as a way to organize knowledge.

10 Video: *Natural Resources* by CORD, 1990. This video is divided into separate programs: An Introduction to Natural Resources, Fossil Fuels, Problem Solving, Using Natural Resources and the Summary.

11 Group projects on developing alternative groupings of 20 elements based on atomic masses, melting points, boiling points, numbers of oxygen atoms in their oxide compounds, and the numbers of chlorine atoms in their chloride compounds. Data cards containing selected chemical and physical properties of 20 elements are required for this activity.

12 Pure and Applied Chemistry decision to renumber the family designations, and the naming of new elements.

13 Optional chemquandaries:
   a) Necessity is the mother of collection (and recycling).
   b) Provide support for the statement: Waste is a human concept; in nature nothing is wasted.

14 Guest presenters to discuss careers that relate to chemistry.

Resources

1 Keith Michael Shea (1993). *Chem Com Chemistry in the Community*, 2nd ed. Dubuque, Iowa: Kendall /Hunt Publishing Co.

2 Alan C. Kousen and John J. Roper (199O). *Applications in Biology /Chemistry,* 1st ed., Waco, Texas: Center for Occupational Research and Development. (CORD)

3 *Merrill Chemistry*, Glencoe, 1993.

4 *Modern Chemistry*, Holt, Rinehart & Winston, 1993.

5 "The Fascinating World of Trash." *National Geographic,* April 1983, 424-457. Waste disposal and recycling (video).

6 "Element X" and "Family Resemblance," *ChemMatters,* Dec. 1987.

7 "The Wild World of Compost." *National Geographic*, August 1980, 273-284. Recycling.

8 "The Disposal of Wastes in the Ocean."*Scientific American,* August 1974, 10-25.

9 "Storing Up Trouble: Hazardous Wastes." *National Geographic,* March 1985, 318-351.

10 "Aluminum, the Magic Metal"*National Geographic* , August 1978, 186-211

11 "The Miracle Metal-Platinum."*National Geographic*, November, 1983.

Assessment Plans

1 Laboratory reports
2 Concept maps
3 Group Project
4 Laboratory skills assessment
5 Portfolios for the Tech Prep Chemistry Course
6 Weekly quizzes
7 Unit test

Daily Lesson Plan

1	Classwork	Chem Quandary, p. 88; Discuss pp. 86-87; Video Part 1: "Natural Resources;" Introduce Concept Mapping; Discuss Applications
2	Laboratory	Striking It Rich, pp. 89-91
3	Homework	Read pp. 91-95, 102-105
4	Evaluation	Quiz
5	Classroom	Review pp. 102; Discuss pp. 104-105; Introduce Group Project; Group Discussion; Problems
6	Laboratory	Metal / Nonmetal, pp. 105-107
7	Homework	Chem Quandary Read pp. 107-108
8	Evaluation	Quiz
9	Classroom	Discuss pp. 112-113, Review Video Part 2: "Natural Resources;" Construct Concept Map, Field Study
10	Laboratory	Teacher Demonstration: Using Up A Metal pp. 94-95
11	Homework	Read pp. 115-119
12	Evaluation	Quiz
13	Classroom	Career Information; Group Discussion; Review, Presenters, Chem Quandary A and B
14	Laboratory	Metal Reactivities, pp 113-115.
15	Homework	Read pp. 122-127; Read pp. 127-130
16	Evaluation	Quiz
17	Classroom	Discussions; Video Part 3: "Natural Resources," Review Unit, Do Applications; Presentation of Group Projects
18	Laboratory	Graph Data from Lab; Write Lab Reports
19	Homework	Work on Group Projects; Read pp. 132-133; 135-143; 144-146; Putting It All Together
20	Evaluation	Unit Exam

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Families of Elements - Nonmetals

PURPOSE: The purpose of this lab is to investigate the chemical properties of elements from a family of nonmetals. We will explore their reactivities and predict the properties of other elements in the family. Since all of the halogens have the same number of electrons in their outer energy level, their chemical properties should be similar. We are looking for the similarities of the reactivity of the members of the halogen family with silver nitrate. A similarity in reactivity would be presented by the production of a gas, the release of heat or the formation of a precipitate. Each element would react in the SAME way. You are looking for a **general** similarity. Even though these elements are in the same family and are expected to react similarly, they are individuals. This individuality results in some slight differences. Remember this when you are looking for the **general** similarity.

MATERIALS:

graduated cylinder	solutions of:
test tube rack	sodium bromide
goggles	sodium chloride
apron (optional)	sodium iodide
3 test tubes	dropper bottle with silver nitrate solution, $AgNO_3$

PROCEDURE:

1. Write the chemical formulae for sodium bromide, sodium chloride, and sodium iodide on your data sheet.
2. Look at the periodic table. On your data sheet, record the names and symbols of the members of the halogen family in Group 17.
3. Label three test tubes A, B, and C.
4. Counting the number of drops, add about 5 mL of sodium chloride to a graduated cylinder. Write this number of drops on your data sheet.
5. Pour the sodium chloride into tube A.
6. Add about 3-4 drops of AgNO3 to tube A. Record your observations on your data sheet. **CAUTION: SILVER NITRATE SOLUTION CAN STAIN YOUR HANDS AND CLOTHING.**
7. Make a hypothesis (an educated guess) about the reactions of the halogen family with AgNO3. Record your hypothesis on your data sheet.
8. Using the same number of drops as before, add about 5 mL of sodium bromide to tube B.
9. Using the same number of drops as before, add about 5 mL of sodium iodide to tube C.
10. Use the solution in tubes B and C to test your hypothesis. Record your observation on your data sheet.
11. Dispose of the liquids as instructed. Clean your hardware and put everything away. Make sure you area is cleaner than it was when you started.
12. Wait for further instructions.

QUESTIONS:

1. Define a chemical property.
2. Describe a chemical property of the halogen family.
3. When you look at a periodic table, the halogen family is labeled Group 17. What does this tell you about the number of outer electrons?
4. Was your hypothesis supported by the reactions that took place in tubes B and C? Explain your answer.
5. What would be your hypothesis for the reaction of fluorine with silver nitrate? Why?
6. What are the formulae of the products of the reactions that took place in tubes A, B, and C?
7. A new element is found and placed in the Noble Gases family. The Noble Gases are nonreactive. How would you expect this new element to react with hydrogen and why?

Name ______________________ Date __________ Hour _____

NONMETAL LAB DATA SHEET

1. Formula of sodium chloride

2. Formula of sodium bromide

3. Formula of sodium iodide

4. Record the symbols and names of the members of the halogen family.

    A.

    B.

    C.

    D.

    E.

5. Number of drops that equals 5 mL:

6. Hypothesis:

    How will sodium bromide and sodium iodide react with $AgNO_3$?

Tube	Solution	Observations
A	Sodium chloride	
B	Sodium Bromide	
C	Sodium Iodide	

Periodic Table Activity

Obtain a blank Periodic Table.

Label the Groups and Periods. (Use their numbers. You will name them later.)

Write the Atomic number, symbol, name, and average atomic mass in each box.

> You will need to write neatly. This is the Periodic Table you will be using on the test. It might be a good idea to **start** with pencil. You only get one Periodic Table. Make sure that you go over your pencil markings with a pen because as you outline, the colors may smear the pencil.

Outline the Alkali Metals with yellow.

Outline the Alkali Earth Metals with green.

Outline the Transition Elements with light blue.

Outline the boxes of the metalloids with orange.

Outline the Halogens with pink.

Outline the inert gases with purple.

Make a key for these colors at the bottom of your sheet.

COPPER TO "SILVER" TO "GOLD"

In this experiment, copper metal will be plated with zinc metal, giving it a silvery appearance. Then, the zinc-coated copper will be heated so that an alloy of copper and zinc forms. This alloy is called brass and has the appearance of gold.

Materials

3 pennies (1982 or older)
eraser
Bunsen burner
matches
tongs
paper towels
100-mL beaker
zinc
Sodium hydroxide
evaporating dish
goggles

1. Put on your goggles. It is extremely important that during this lab you are wearing your goggles at all times!!!
2. To clean the pennies, rub them between you fingers or use the eraser on the end of your pencil.
3. Coat-plate your pennies using the following procedure (ONLY ONE COAT-PLATE APPARATUS SHOULD BE SET UP FOR EACH SIDE OF A LAB TABLE): Fill an evaporating dish approximately 1/2 full of Sodium hydroxide. Pour a small amount zinc into the dish and heat **slowly** until boiling. Only two pennies for each person will be coated with zinc. Place the pennies in the dish and turn over for uniform plating. The pennies should be **carefully** removed from the dish with tongs and washed in cold water.
4. Each person should now have two "silver" pennies. Set one aside with the copper penny.
5. Fill a 100-mL beaker with cold water.
6. Light the Bunsen burner.
7. Pick up the "silver" penny by the edges with tongs, and heat it gently on both sides in the Bunsen burner flame until the surface of the penny turns uniformly golden. **DO NOT OVERHEAT!!!**
8. **QUICKLY** drop the "gold" penny into cold water to cool before handling it.
9. Your penny collection now consists of a copper penny, a "silver" penny, and a "gold" penny.

Name:______________________________ Date: ________ Hour: ______

HEAT TREATMENT OF IRON

In this experiment, we will investigate the effects of heat-treating on the properties of iron. In the process, we will construct a hook which can be used for supporting Christmas decorations.

1. Gather the following equipment:
   4 bobby pins (one used for comparison -you won't do anything to it, one for annealing, one for hardening, and one for tempering)
   500mL of cold water in a 1-L beaker
   Bunsen burner
   matches
   tongs
2. Examine one of the bobby pins. Try bending it. How easily does it bend? Is it springy (does it return to its original shape after bending)?
3. Light the Bunsen burner using the proper lighting procedure.
4. Grasp the open end of the bobby pin with your fingers or tongs, and hold the bent end in the hottest part of the Bunsen burner flame. As the pin heats up and glows red, pull the ends apart to bend it straight and then remove it from the flame. **CAUTION!! HOT!!**
   Put the hot pin in a safe place to cool. Repeat this procedure with the other two pins.
5. Holding the straightened pin in the middle with tongs, heat the *entire* wire to a glowing red-hot temperature. Let it cool slowly in a safe place. Repeat this with the other two pins.

Explanation: Heating to a red-hot temperature causes the metal atoms to move faster and more freely. This is why it is easier to bend the iron when it is red-hot. By allowing the iron to *cool slowly*, more perfect crystals of iron are formed. This process is called *annealing*, "to make soft." The more perfect the crystal of a metal, the easier it is to bend the metals: The metal atoms can slide over one another.

6. When the wires have cooled, bend them into hooks. Do the wires bend more easily now after they have been heated? Are they as springy as they were before?
7. Place the beaker of water next to the Bunsen burner. Holding one of the hooks with tongs, heat it to a glowing red-hot temperature in the flame of the Bunsen burner. Drop the hook into the beaker of water to cool it quickly. Repeat this with the other hook.

Explanation: When the red-hot fast moving atoms of iron ore are cooled quickly, they don't have enough time to form into large ordered crystals. This results in defects separating many small crystal groupings. The iron, which is now hard and brittle is said to be *hardened*. This iron is useful for making knives.

8. Remove one of the hooks from the water. Try bending it. Does it bend as easily as before?
9. Carefully remove the other hook from the water. Grasp it with the tongs and hold it high above the Bunsen burner. Slowly lower it toward the top part of the flame. Heat it **slowly** in this cool part of the flame until an iridescent blue coating forms on the hook. It must not be heated to a glowing red, so keep it out of the hottest region of the flame. Allow the hook to cool slowly in a safe place.

Explanation: The process of gently warming is called *tempering*. It removes the brittleness and returns the flexibility to the hardened iron. The crystalline structure of tempered iron is between the more perfect crystals of annealed iron and the messy structure of hardened iron.

10. Try bending this hook. Is it brittle or springy?
11. Turn off the Bunsen burner and carefully clean your area.

Questions: Match the following numbers with the corresponding letters.

_____	1. A mixture of Zn and Cu	A. Hardened iron
_____	2. A mixture of Sn and Pb	B. Brass
_____	3. Zn + acid	C. Solder
_____	4. Cu^{+2} + Fe	D. Annealed iron
_____	5. Red hot Fe cooled quickly	E. Hydrogen gas
_____	6. Red hot Fe cooled slowly	F. Copper metal + Fe^{+2}

Unit 5

Organic Chemistry

Unit 5 Organic Chemistry 3 Weeks

This unit will focus on the basic concepts and information relating to Organic Chemistry, the study of carbon compounds. As the student masters the basic fundamentals of Organic Chemistry he/she will be prepared to study the following unit covering Petroleum. The unit will focus on covalent bonding, Lewis Structures, nomenclature, physical properties (boiling point, density), heats of combustion, and the graphing of data.

Competencies

The student will be able to:

- E1 analyze observations and experimentally collected data. (1.2.3)
- E2 develop skills in using common laboratory and field equipment and perform common laboratory techniques with care and safety. (1.2.4)
- E3 select and use reference materials to obtain relevant information. (1.2.5)
- E4 translate data into tables and graphs and interpret data presented in tables and graphs. (1.4.1 and 1.4.2)
- E5 interconvert formulas and names for common organic compounds. (3.5.1)
- E6 recognize common functional groups and polymers when given chemical formulas and names. (3.5.2)
- E7 infer and explain physical properties of substances (such as melting points, boiling points, and solubility) based on the strength of interparticle attractions. (3.3.8)

Workplace Relationships

1. Any company associated with the petroleum industry (exploration, refineries, and distribution).
2. Environmental Laboratories
3. Perfume / cologne
4. Cosmetics
5. Pharmaceuticals

Applications

1. Prepare a list companies and industries that depend directly upon organic compounds.
2. Prepare a list of organic compounds and their uses found in our society.

Learning Activities / Teaching Strategies

1. Students draw Lewis Structures (electron dot) for some common organic compounds and discuss covalent bonding.
2. Laboratory: Build 'ball and stick' models of common organic compounds (alkanes, alkenes, alkynes, alcohols, etc.). See Handout.
3. Analyze and construct a graph of number of carbons (1 through 10) versus alkane boiling points. The students will also extrapolate to find the boiling points for alkanes containing 11, 12, and 13 carbon atoms. *Chem Com*, pp. 166, 167, and 171.
4. Laboratory: Using ball and stick models, construct and draw isomers of Alkanes. *Chem Com*, pp. 172-173.
5. Laboratory: Using a soft drink can, candle, 3x5 card, and ring stand, the students will experiment with heat of combustion and compare the gathered data with actual data. *Chem Com*, pp. 186-189.

Resources

1. Heikkinen, Henry, (Ed.), *Chem Com* (2nd Ed.), Dubuque, Iowa: Kendall-Hunt Publishing Co.,1988.
2. Mortimer, Charles E. *Chemistry 6th Ed.* Bemont, California :Wadsworth Publishing Co., 1986.

Assessment Plans

1 Laboratory projects including lab reports
2 Examination
3 Quizzes
4 Homework
5 Cooperative work

Daily Lesson Plan

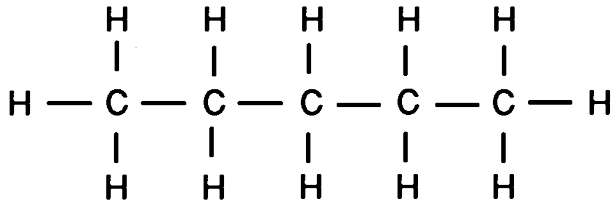
1 Provide students with a brief understanding (objectives and basic information) of Organic Chemistry. Include terminology such as hydrocarbons, alkanes, alkenes, alkynes, covalent bonding, etc. The teacher should explain the various types of formulas (empirical, structural) and draw several examples of each. Assignment: Read pp. 167-169.
2 After the teacher demonstrates some examples the students should draw Lewis Structures (electron dot) for some common organic compounds. Assignment: draw Lewis Structures for list of common compounds.
3 Collect assignment. Laboratory: Build 'ball and stick' models of common organic compounds (alkanes, alkenes, alkynes, alcohols, etc.). See Handout.
4 Continue
5 Analyze and construct a graph of number of carbons (1 through 10)versus alkane boiling points. The students will also extrapolate to find the boiling points for alkanes containing 11, 12, and 13 carbon atoms. *Chem Com*, pp. 166, 167, and 171. Assign students to answer questions 1-6 on pp. 174 and 175 to be collected on day 7.
6 Continue
7 Quiz: Terminology, Lewis Structures, and graphing. Review correct answers.
8 Laboratory: Using ball and stick models, construct and draw isomers of Alkanes. *Chem Com*, pp. 172-173.
9 Laboratory: Using a soft drink can, candle, 3x5 card, and ring stand, the students will experiment with heat of combustion and compare the gathered data with actual data. *Chem Com*, pp. 186-189.
10 Continue
11 Demonstrate the solving of problems concerning heats of combustion.
12 The students should work in groups to solve the problems on page 191, numbers 1-5. Each group should be assigned one problem to demonstrate its solving at the board.
13 Continue
14 Review the concepts and information learned in this unit. Problem solving strategies should also be reviewed.
15 Students should be given an exam covering the material in this unit.

NAME:______________________________ DATE:________HOUR:______

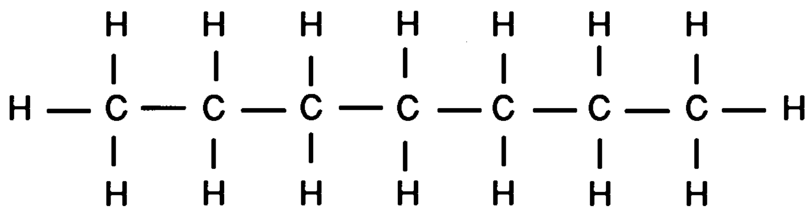
Organic Molecule Naming

Name the following molecules.

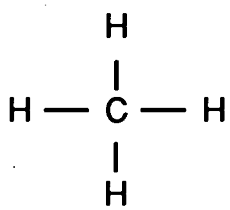
1.



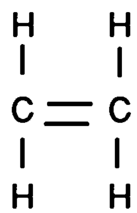
2.



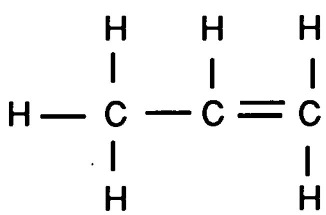
3.



4.



5.



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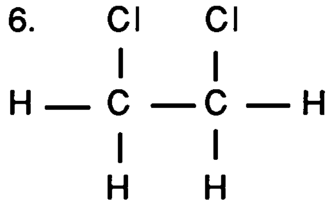
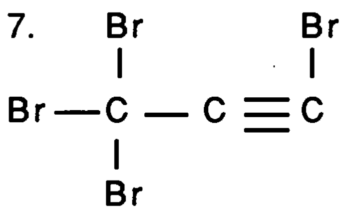
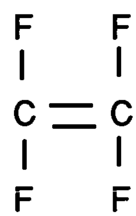


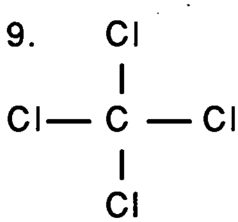
7.



8.



9.



Draw the following molecules:

10. ethene

11. propyne

12. butanol

13. 1- decene

14. 1,3-dichloropentane

15. hexane

16. cyclohexane

17. benzene

Which of the above molecules are substituted hydrocarbons?

Unit 6

Petroleum

Unit 6 Petroleum 3 Weeks

One of the largest industries in the worlds centers around petroleum; therefore, it is essential that students gain an understanding of the terminology and concepts associated with it.

Exploration, drilling and collecting, refining, and distribution are areas that one may encounter in this industry. This unit will focus on how petroleum is used for fuel as well as for building purposes. The students will study charts and graphs, interpret and graph data, and engage in problem solving schemes, such as those involving fuel efficiency.

Competencies

The student will be able to:

F1 interconvert formulas and names for common organic compounds. (3.5.1)

F2 infer and explain physical properties of substances (such as melting points, boiling points, and solubility) based on the strength of interparticle attractions. (3.3.8)

F3 recognize common functional groups and polymers when given chemical formulas and names. (3.5.2)

F4 classify chemical reactions and/or phase changes as exothermic or endothermic. (3.4.2)

Workplace Relationships

1. Any company associated with the petroleum industry (exploration, refineries, distribution).
2. Environmental Laboratories
3. Perfume / cologne
4. Cosmetics
5. Pharmaceuticals

Applications

1. How much energy is produced from the combustion of ten gallons of gasoline and how much of this thermal energy is actually used in wheel turning (mechanical energy).
2. How much organic material does it take to make one gallon of crude oil?
3. List at least 20 products produced from petroleum.

Learning Activities/Teaching Strategies

1. Prepare a list of all items which use petroleum and a separate list for those items or substances made from petroleum ('You Decide' on pp. 154-155).
2. Analyze graphs and data showing petroleum production (amounts and locations of reserves).
3. Observe a picture (drawing) of a fractionating tower showing the cracking process which converts larger hydrocarbons into the various products of petroleum (paraffin, waxes, asphalt, lubricating stocks, gas oil, kerosene, gasoline, and gas).
4. Perform a laboratory activity on viscosity and density of mineral oil, asphalt, kerosene, paraffin wax, motor oil, household lubricating oil.

Resources

Heikkinen, Henry, (Ed.), *Chem Com* (2nd Ed.), Dubuque, Iowa: Kendall-Hunt Publishing Co.,1988.

Mortimer, Charles E. *Chemistry 6th Ed.* Bemont, California : Wadsworth Publishing Co., 1986.

Assessment Plans

1 Laboratory projects including lab reports
2 Examination
3 Quizzes
4 Homework
5 Cooperative work

Daily Lesson Plan

1 As a class, orally and on the board complete the 'You Decide' on pp. 154-155. Assign the students to read page 155 and complete the summary questions on page 157, numbers 1-4.
2 Analyze graphs and data showing petroleum production (amounts and locations of reserves).
3 Observe a picture (drawing) of a fractionating tower showing the cracking process which converts larger hydrocarbons into the various products of gas.
4 Perform a laboratory activity on viscosity and density of mineral oil, asphalt, kerosene, paraffin wax, motor oil, household lubricating oil.
5 Continue laboratory experiment and discuss results.
6 Demonstrate technique of solving energy efficiency problems with automobiles. Students should solve problems on page 184-185, numbers 1-5.
7 Collect assignment and discuss results. Students should complete page 195, numbers 1-11 for homework.
8 Students should visit the autoshop and observe how an engine works. Emphasis should be on how the gasoline is used and how it is converted to mechanical energy.
9 Discuss the differences of the various grades of gasoline (octane 87, 89, 91, 93) and students should determine which is more efficient. They should determine which octane number costs the least to run an automobile. The students should be given five days to complete this assignment since it will require some outside research.
10 Discuss the alternatives to petroleum being used as a fuel.
11 Demonstrate a technique of distillation. Show the students how to write a report for an experiment in chemistry. This can best be done by using a set of computers.
12 Students should perform a distillation experiment.
13 Students should write a report for the results of the distillation experiment.
14 Collect the reports and review the concepts and information studied in this organic unit.
15 Exam

Unit 7

Nuclear Chemistry

Unit 7 Nuclear Chemistry up to 6 weeks

This Nuclear Chemistry unit confronts one of the most emotional issues in society: the use of nuclear energy. This unit traces the history and development of nuclear energy, from the discovery of radioactivity to modern day reactions and fusion. There is a strong emphasis on the benefits and risks of nuclear technologies. The nuclear accidents at Chernobyl and Three Mile Island add an element of urgency to this unit, which probes the structure of the nucleus as well as addressing the question of nuclear waste.

In defining radioactivity and nuclear chemistry the students will distinguish among physical, chemical and nuclear changes. Using the periodic table identify the radioactive elements that spontaneously emit particles. Describe the role of light, heat and electrical energies in nuclear, chemical and physical changes. Understand that certain radioactive elements emit traceable amounts of energy.

Our goal here is not to end debates on the use of nuclear energy by providing the "right" answers, but rather to provide a firm grounding in basic facts related to nuclear technology. With this knowledge the students are then able to make informed decisions about radioactivity in their lives.

Competencies

The students will be able to:

G1 Identify and pose meaningful, answerable scientific questions. (1.1.1)
G2 Observe and describe observations accurately using appropriate language and precision. (1.2.1)
G3 Analyze observations and experimentally collected data. (1.2.3)
G4 Use an electronic data base to obtain relevant information. (1.2.6)
G5 Translate data into tables and graphs. (1.4.1)
G6 Recognize that science is only one source of information to address societal issues. (2.1.1)
G7 Identify the capabilities and limitations of science as it applies to social issues. (2.1.2)
G8 Recognize that seeking answers to one question usually generates other questions. (2.1.3)
G9 Understand how both science and technology establish useful connections between the natural and designed worlds. (2.2.1)
G10 Understand the implications of science in making personal decisions. (2.2.2)
G11 Use the processes of scientific inquiry to analyze issues in the natural world. (2.2.3)
G12 Recognize that science knowledge and skills are necessary for future success, as occupations change over time and career paths evolve. (2.3.1)
G13 Distinguish among physical, chemical, and nuclear changes. (3.2.6)
G14 Recognize that certain radioactive isotopes spontaneously emit particles. (3.3.9)
G15 Recognize that certain radioactive isotopes spontaneously emit traceable amounts of energy. (3.4.4)

Workplace Relationships

1 Radiologist
2 Oncology
3 X-ray Technician
4 Radiation Therapist
5 Mammography Technician
6 Civil Engineer
7 Police officer
8 Waste Disposal (engineer)
9 Energy consultant
10 Contamination and Decontamination Specialist
11 Plant designer
12 Commercial and Residential Contractor
13 Radon Task Force
14 Consumer Food Preservation

Applications

1 Benjamin and Ilene Dover found a large number of 5 leaf clovers in their backyard. Describe what might be the cause for this discovery.
2 Describe how radioactive tracers are used to find cancer tumors.
3 Your company disposes of radioactive waste. Where are the possible places of environmentally-sound disposal?

Learning Activities / Teaching Strategies

1 Black Box Lab - The purpose of this lab is to simulate the use of indirect evidence to infer properties that cannot be perceived by all of our senses. The emphasis in this lab is on reasoning processes and how they apply to the development of the atomic structure. (Found in many chemistry lab books, *Chem Com,* p. 281)
2 Isotope Pennies - The purpose of this lab will be to simulate the isotopic nature of elements and to calculate average atomic masses using pre- and post-1982 pennies. (*Chem Com,* pp. 285-286)
3 M&M half-life graph - The objective of the lab is to demonstrate the fractional decrease in the original amounts of a radioactive material (half-life). Students will then plot the results and do a second home activity showing the similarity in half-life graphs and predict decay amounts. (*Chem Com,* pp. 299-302)
4 Simulating a Radioactive Decay Chain - The objective of this lab is to simulate a three member radioactive decay chain. To use the knowledge gained to understand some current problems related to the use of nuclear power. (*Global Science Laboratory Science,* pp. 173-175)
5 Cloud Chamber experiment - The purpose of this laboratory is to observe direct evidence of nuclear radiation and to observe evidence of probable background (cosmic) radiation. (*Global Science* Laboratory Science, pp. 167-168)
6 Alpha, Beta, and Gamma Rays demonstration - This demonstration will familiarize students with the different types of radiation, their properties and the different types of material used to shield each of these radiation sources. (*Chem Com,* pp. 291-294)
7 Video *In France It Works*, NBC, White paper late 1980's - This is a very positive look at a the uses of nuclear power as an alternative form of energy.
8 Video about the Chernobyl accident; PBS has done several documentaries. These tend to lead towards a negative perspective of nuclear power as an alternative form of energy. Both videos will allow for excellent classroom debate about the uses of nuclear energy.
9 Nuclear Phenomena Survey - Survey will be used at the beginning of the unit to test the students knowledge and understanding of nuclear science. Then during the unit the students will survey other people, compile the data and make some judgments about the need for knowledge in this area of chemistry. On the last day of the class, students will take the survey again. (*Chem Com,* pp. 273-274)
10 Chain Reaction with "You Decide" - A demonstration showing the difference between expanding and limited chain reactions. This can be used in conjunction with the videos of nuclear power plants. (*Chem Com,* pp. 310-311)
11 Potential "Benefits and Risks"; This material can be used to discuss the biological effects of ionizing radiation and the risks that you take. (DOE materials unit 3, p. 15-25 and unit 2, p. 21-29)
12 Discussion: "Why are there no Nuclear Power plants along Lake Michigan, in Indiana?"
13 Field Trips and Speakers:
    Cook Nuclear Power Plant Tour - located in Benton Harbor, Michigan
    Visit Radiology Department - local hospital
    X-ray technician speaker - local medical facility
    Radon Task Force (EPA) speaker
    Save the Dunes Council

14 Projects and Reports:
Radon testing prevention and reduction - students' home or find a volunteer in the neighborhood. (see assessment)
Nuclear Phenomena Survey - students will be asked to survey students not in chemistry, an adult born before 1950 and an adult born after 1950. (see classroom discussions)

Resources

Science, Society and America's Nuclear Waste, Department of Energy, 1991.
Chem Com: Chemistry in the Community, Kendall Hunt, 1993.
Global Science: Energy, Resources, and Environment, Kendall Hunt, 1994.
Turn Your Students Into Radon Sleuths, Roberts, Sharon. NSTA November 11, 1993.
Indiana High School Science Competencies, Indiana Department of Education, January, 1995.

Assessment Plans

1 Plan to have an ongoing trivial pursuit game developed by the students in the class. Scavenger hunt at the power plant tour. The students will work in groups of 4 to find the answers to questions posed. These answers may be in the presentation material, the display area, or the computer programs. They should not use the tour guides as sources. (Prizes can be given based on time and completeness).
2 Written laboratory reports and laboratory practicals will be done for assessment. A practical for this unit will be given for the penny isotope. Two objects different from the pennies will be given to the students and they will have to find the ratio of the objects in a container (the objects will represent isotopes).
3 Demonstration, Discussion, Field Trips, and Speakers: Students will be assessed based on attendance and oral and written contributions. Students will need to contribute to the activity in the form of questions and written responses both individually as well as in a group.
4 Projects and Reports: The radon project will involve both school and the community. Within the first week of the unit students will be doing radon testing either in their home or somewhere in their community. The objectives will be to determine radon levels, examine the structural and geological patterns that affect the levels of radon and devise the means to measurably reduce the radon level. The students will have to report to the instructor in written and oral form.

The students will also report to and receive feedback from the people whose houses we will be testing. The students will be required to report to these residents in a manner in which the information will be understood.

Daily Lesson Plan

1 Nuclear Phenomena Survey - Compile results of student surveys and discuss the significance of this survey. Discuss the objectives of this unit and then send students out for homework to survey others in the community.
2 From the Department of Energy Units on Radioactivity have the students read Unit 3 pp. 15-25 and Unit 2 pp. 21-29. These pages discuss the "benefits and risks" of radiation. This reading can be used to add to the discussion in *Chem Com* pp. 277-280.
3 Article on Radon (several are available you need only do a short search, and maybe find something in the local newspaper). Discussion question: "Is radon found in Northwest Indiana?". Introduce Project on radon detection.
4 Finish Discussion of project assessment. Collect and discuss survey data from "Nuclear Phenomena Survey".
5 Video "In France it Works" - Have the students work on a question sheet while viewing this video (it can be tedious at times). Leave discussion for later!

6 Black Box Lab - The discovery of subatomic particles was made by indirect evidence. Have the students determine what is in a box by indirect evidence. Finish with the discussion of the structure of the atom (protons, electrons and neutrons and Rutherford's Gold Foil Experiment).
7 Finish yesterday's lecture and then introduce subatomic particles, radiation, radioactive particles a, b, and g.
8 Define an Isotope. Penny isotope lab (Hint: use envelopes as containers for the pennies)
9 Finish Penny isotope lab and do for discussion "Your Turn" pp. 287
10 Quiz : Radiation, radioactivity and atomic structure
11 Discussion of Decay Chains and Half life
12 Have the students collect the half life decay of M&Ms. The students are given 80 M&M's. They lay the M&Ms out and those that have the Ms up are the ones that have decayed. Individual data will differ from the ideal half-life curve but the class's total data will be relatively close to the ideal half-life curve.
13 Isotope Practical - In this practical you can either give the students a different mixture of pennies or come up with two other objects (example: buttons) and have them show their understanding of the lab individually. No formal lab write up should be required, just their final answer should be checked.
14 Check on radon project should collect and send samples in to the EPA soon. Review Day - Have students work in groups on summary questions and extending knowledge questions on page 290 and 306-307.
15 Quizl Isotopes, balance equations, decay series. Trivial Pursuit Game.
16 Radioactive Decay - Simulating a Radioactive Decay Chain : The objective of this lab is to simulate a three member radioactive decay chain.
17 Radioactive decay series simulating decay chains finish and discuss. (Included may be a discussion of how the half-life curve of the M&Ms is similar and different and why?)
18 Cloud Chamber Demo and discussion of artificial radioactivity.
19 Review for Test
20 Standard Paper and pencil test
21 Class discussion of chain reactions and domino effect. Homework in preparation for speaker tomorrow. Careers pp. 289 *Chem Com*
22 Speaker(s) - Invite one or two speakers in to allow the students to see that the subject of nuclear science affects everyone. Have them discuss how their jobs in nuclear science affect the students.
23 Video about the Chernobyl accident; PBS has done several documentaries. These tend to lead towards a negative perspective of nuclear power as an alternative form of energy.
24 Discussion of the pros and cons of nuclear energy, parts of a nuclear power plant, and the different types of power plants.
25 Field trip - encourage students to ask questions which broach both the positive and negative sides of nuclear chemistry.
26 Discuss the results of the EPA report on the radon detectors. Discuss possible sources.
27 Students should begin to compile a report for the homes that they tested. They should report amounts, source, risks and then discuss some of the types of remediation that can be done with the home.
28 Continue work on the report.
29 Invite the home owners in to review the students work and have the students present it to them. The home owners should then be given an assessment form to evaluate their perceptions of the effectiveness of the students' work.
30 Nuclear Phenomena Survey - Compile results of students surveys and discuss the significance of this survey. Include in the discussion how their views have changed and how each students view may be different from the others.

M & M Half Life

Purpose:

In this lab you will study a model of **radioactive decay**. Instead of atoms, you will observe M & Ms. Each candy will represent a radioactive atom. The nucleus of a radioactive atom may break down, releasing radiation. After breaking down, or decaying, a radioactive atom becomes a stable, new element. The process of radioactive decay is completely random. That is, we never know when a particular nucleus is going to decay. In this respect, radioactivity is like flipping a coin, or for that matter, an M&M.

The time required for one half of a sample of radioactive atoms to decay is called the **half-life**. In this experiment, you will determine the half-life of a sample of M&Ms. Note: After decay, radioactive M&Ms become edible!! (You can eat them.)

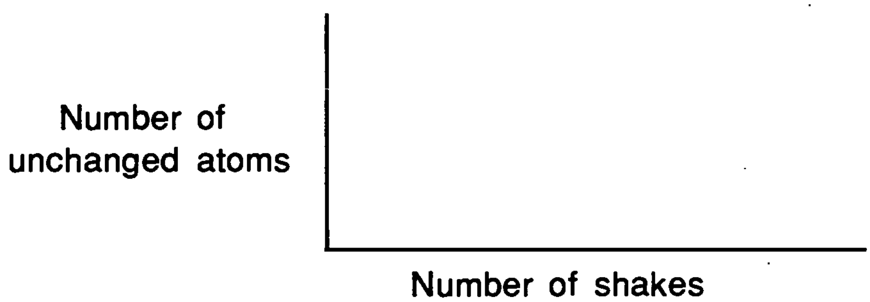
Materials:

1. bag M&M's
2. pie tins

   graph paper

Procedure:

1. Place the candies "M" side down in one tin.
2. Cover filled tin with empty tin and shake.
3. Uncover the candy-filled tin and remove all the "changed" candies (those turned "M" side up).
4. Count and record the number of "unchanged" candies remaining in the tin. **Record** this data in the chart.
5. Repeat steps 2, 3, and 4 until all candies have turned.
6. Graph the information from the chart. On the graph, draw a smooth curve in red for the data.



Name ______________________________ Date __________ Hour _____

M & M Half life

Trial	Number of unchanged M&Ms

Trial	Number of unchanged M&Ms

Questions:

1. Define half-life in your own words.

2. What was the half-life, in "shakes," of your M & M sample?

3. Which color is your favorite M&M?

Unit 8

Chemical Industry

Unit 8 The Chemical Industry 5 weeks

This unit provides students with an understanding of how chemical industries use the principles of chemistry to produce material goods and services. The function of the chemical industry is to chemically change natural materials into products that will make them more useful to society. Jobs today in this and related industries require people who have the ability to apply basic principles of chemistry. These principles include an understanding of the composition and properties of matter, changes in matter, and how energy is involved in these changes.

Students will experience, first hand, how technicians apply their basic understanding of chemical principles. Through selected laboratories, students will discover how chemical technicians perform simple chemically related tasks required in manufacturing. The student will begin by reviewing how the chemical industry helps address the basic human needs and how the chemical industry can affect their environment in both a positive and negative way.

Competencies

H1 The students will be able to use appropriate nomenclature when naming and writing formulas to identify common natural and synthetic products of Industry. (3.1.5) [nomenclature]

H2 The students will be able to use formulas and laboratory investigations to classify substances according to the presence of common anions and cations. The students will test for the following anions: phosphates, nitrates, and sulfates. The students will test for the following cations: Potassium, Ammonium, and Ferrous III. (3.1.6) [formulas]

H3 The student will describe the behavior of particles in a state of dynamic equilibrium, describing how the concentrations of the reactants and products at equilibrium are a measure of the tendency of chemical reactions to proceed from reactants to products. (3.3.3). [dynamic equilibrium]

H4 The student will describe and illustrate with the appropriate equations electron transfer in a chemical reaction and identify the substances losing and gaining electrons. (3.2.5) [Oxidation-Reduction]. The student will be able to make a voltaic cell and harness the electrical energy. [Electrochemistry]

H5 The student will be able to diagram reactants and products of chemical changes using sketches with the appropriate chemical notations (3.3.2). [diagrams reactions]

H6 The students will use the periodic table and electronegativity charts to compare attractions that atoms have for their valence electrons, and the attraction that atoms have for electrons bonded in other compounds (3.3.7). [periodic table]

H7 The student will describe solutions in appropriate concentration units such as molarity, ppm, ppb, or percentage by mass or volume. (3.1.4b) [concentrations]

H8 The student will make use of Colorimetric techniques used by analytical chemists to recognize color indicators of chemical changes as an indication of ion concentrations. The student will be able to quantify phosphate content in fertilizer samples (3.1.3). [colorimetric techniques]

H9 The students will predict how a reaction rate will be affected by changes of temperature, concentration, surface area, and use of catalysts. (3.2.4) [Thermodynamics - entropy and enthalpy].

Workplace Relationships

1 Applications in industry working with any substance. (Steel mills, refineries, auto industry, battery industry, pharmaceuticals, food industry, textiles, transportation industry, etc.)

Applications

1. Given an unknown solution, determine the ions present using proper laboratory techniques.
2. Given a raw material, research the possible consumer products made from that material.

Learning Activities / Teaching Strategies

1. Mock Community Activity (See attached description)
2. Riverwood new industry Activity, p. 474
3. Products of industry Co-op learning Activity, p. 475
4. Asset or liability Activity, pp. 476-477
5. Preparing Solutions: Molarity Calculations (See attached description)
6. Fertilizer Activity, pp. 487-490
7. Phosphate Activity, pp. 493-495
8. Thermodynamics Activity (See attached description)
9. Voltaic Cells Lab, pp. 506-509
10. Guest speaker from batteries industry
11. Electroplating Lab, pp. 512-515

Resources

Chem Com: Chemistry in the Community second edition and Teacher generated labs

Assessment Plans

Student success will be assessed through scores on homework assignments, concept quizzes, lab reports and performance, and unit evaluations.

Daily Lesson Plan

1 Introduction to Mock Community Activity/Start Mock Community Activity
2 Mock Community Activity
3 Riverwood New Industry Activity p. 474
4 Products of Industry Co-op Learning Activity. p. 475
5 Assets or liability Activity. pp. 476-477 Summary page 477 1-3
6-9 Preparing Solutions: Molarity Calculations
10 Fertilizers discussion and Start Fertilizer Activity
11 Fertilizer Activity. pp. 487-490, p. 490 1-5 questions
12 Phosphate Activity. pp. 493-495
13 Finish Phosphate Activity questions 1-5. p. 495
14 Redox discussion Assignment pp. 496-497. "Your Turn" 1-3
15 Explosives discussion Assignment pp. 503-503. "Your Turn" 1-3, and Summary pages 504-505, 1-4
16 Thermodynamics discussion/ start Thermodynamics activities
17-19 Thermodynamics Activities (See attached sheet)
20-21 Voltaic Cell Lab. pp. 506-509
22 Electrochemistry discussion/Guest speaker, "Your Turn." pp. 511-512. 1-4
23 Electroplating lab, p. 512-515
24 Summary page 518, 1-8. Review
25 Unit Exam

THE ANALYSIS OF HYDROGEN PEROXIDE SOLUTION
(from Heath *Chemistry*, 1993)

Although hydrogen peroxide occurs naturally in small quantities in dew, rain, or snow, it was first discovered in the laboratory. Hydrogen peroxide undergoes decomposition into oxygen and water according to this equation:

$$H_2O_2(l) \longrightarrow H_2O(l) + 1/2\,O_2(g)$$

This relatively unstable compound must be kept in a cool environment and away from light. For that reason, H_2O_2 is dispensed in brown bottles.

In this experiment, you will use a solution of potassium permanganate, $KMnO_4$ (aq), of known concentration to titrate a sample of H_2O_2 in an acidic solution. The results of the titration will allow you to determine the concentration of the hydrogen peroxide solution. The titration technique you will use is similar to that of acid/base titrations. However, this is a redox reaction in which electrons are transferred from one substance to another as one reactant is oxidized and another is reduced. The **unbalanced** equation for the reaction is this:

$$KMnO_4\,(aq) + H_2SO_4(aq) + H_2O_2(aq) \longrightarrow MnSO_4(aq) + K_2SO_4(aq) + H_2O(l) + O_2\,(g)$$

The indicator for the reaction equivalence point is the reactant potassium permanganate itself. Potassium permanganate is red-violet in color, and the products are all colorless. At the first indication that the reaction mixture stays pale pink, the equivalence point has been reached.

OBJECTIVES:
1. Determine the volume of KMnO4 solution required to react with a given volume of H_2O_2 of unknown molarity.
2. Calculate the molarity of the hydrogen peroxide solution.
3. Determine the percent by mass of household hydrogen peroxide and compare your result with the percent given on the bottle label.

MATERIALS:

Apparatus		Reagents
50 mL graduated cylinder	ring stand	0.10*M* $KMnO_4$
10 mL graduated cylinder	lab apron	H_2O_2
buret and buret clamp	safety goggles	1.0 *M* H_2SO_4
125 mL Erlenmeyer flask		distilled water

PRE LAB:
1. Read the introduction and procedure before you begin.
2. Answer prelab questions 1-4 on the Report Sheet.

PROCEDURE:
1. Put on your laboratory apron and **safety goggles.**
2. Clean a buret and rinse with deionized or distilled water. Fill the buret with 0.10*M* $KMnO_4$ solution.
3. Using a 10 mL graduated cylinder or pipette, add 10 mL of hydrogen peroxide solution to a 125 mL flask. Then add 50 mL of deionized or distilled water and 15 mL of 1.0 *M* sulfuric acid. Swirl the flask gently to mix.
4. Record the initial volume of $KMnO_4$ on your data table and place the flask on a sheet of white paper under the buret.
5. Titrate the hydrogen peroxide solution until the color of the solution begins to turn pale pink. When the faint pink color persists for at least 30 seconds, you have reached the end point. Record the final volume of $KMnO_4$ (aq) on your data table.
6. Before leaving the laboratory, clean up all materials and wash your hands thoroughly.

HYDROGEN PEROXIDE SOLUTION REPORT SHEET

Name ______________________________ Date _____ Hour _____

Prelab Questions:

1. Balance the equation for the reaction. Keep in mind that the basis for balancing a redox equation is that the number of electrons lost by one reactant is equal to number gained by another reactant.

2. Household 3% H_2O_2 is approximately 3 g of hydrogen peroxide per 100 g of solution or 30 g per liter of solution. What is the approximate molarity?

3. To reach the end point in the titration of a 10 mL sample of H_2O_2, 34.0 mL of 0.10*M* $KMnO_4$ are required. What is the molarity of the hydrogen peroxide sample?

4. In your own words, write the purpose of this experiment.

DATA AND OBSERVATIONS:

Final volume of KMnO4	
Initial volume of KMnO4	

CALCULATIONS:

1. Calculate the number of mL of 0.10*M* $KMnO_4$ used to titrate your sample of hydrogen peroxide.

2. How many moles of $KMnO_4$ are required to oxidize the hydrogen peroxide?

3. Use the equation you balanced in prelab question 1 to determine the moles of hydrogen peroxide that are reduced by the moles of $KMnO_4$ in calculation 2.

4. Calculate the molarity of the hydrogen peroxide solution.

5. Use your data to calculate the percent by mass of hydrogen peroxide in the solution.

ANALYSIS AND CONCLUSIONS:

1. Why is this redox titration an easy system to monitor?

2. Can you think of a way that this redox reaction can be carried out and monitored without titration?

SYNTHESIS:

1. Write the electron dot diagram for hydrogen peroxide.

Name: ________________________ Date: _____ Hour: ____

Average Atomic Mass

Objective: The student will, at the conclusion of this laboratory experience, be able to:

1. calculate the average atomic mass of an element.
2. define, orally and/or in writing, average atomic mass.
3. state the reason for the occurrence of decimal atomic masses on the Periodic Table of elements.
4. define proton, neutron, and electron and state the location of each in the atom.
5. explain what isotopes are.

Materials and equipment:

20 paper clips, standard size, metal
15 paper clips, large, metal
10 paper clips, standard size, plastic
scale, either double-pan, Dial-O-Gram or electronic
paper, pencil, calculator

Theory:

The Periodic Table of Elements represents all elements currently discovered or created.

Elements have as their basic unit of structure, the atom, which is in turn composed of two areas, the nucleus (containing positively charged protons with a mass of approximately 1 amu and neutrons, which are electrically neutral and have a mass of approximately 1 amu), and the electron cloud, which contains electrons of electrical charge -1. The electrons are taken to have negligible mass (though they in fact have a mass of 9.110×10^{-28} amu, which is 1/1860th of the actual mass of a proton.)

Together the particles in the nucleus (the protons and the neutrons) are referred to as nucleons. Recall that the relative atomic mass for both these particles is approximately 1 amu each. In nature there are different forms of the same element. In nature, elements which have the same numbers of protons but different numbers of neutrons are called isotopes. Isotopes of the same element have the same chemical properties. The mass of the element on the Periodic Table is the result of finding the isotopes, determining their weights individually, and multiplying the mass of the isotope by the abundance of that isotope in nature. The partial weights are then all added together and the result is the average atomic mass shown on the Periodic Table.

You are about to follow the procedure mentioned above, and determine the "average atomic mass" of paper clips, you Nobel Prize winner of the future, you!

Procedure:

Mass the standard size metal paper clips and record this figure. Mass the standard plastic paper clips and record this figure. Mass the large metal paper clips and record this figure. Then, write down the total number of paper clips used by you, in each size.

	Quantity	Mass

Next determine the percent of the total number of paper clips of each type. You determine any percentage by dividing the total number of an item you have into each individual item, then multiplying the result (which is equal to or less than 1) by 100. In this case you will divide the total number of paper clips you have into the number of standard metal paper clips and multiply by 100. Record the result. You then divide the total number of plastic paper clips by the total number of paper clips used and multiply by 100, then record the result. Lastly, divide the number of large metal paper clips by the total number of paper clips and multiply by 100. Record this result also. The following is an example of how to determine a percentage:

12/15 = .8 X 100 = 80% (which may be represented as 80.00%, depending on significant figures.)

	Quantity	Total Number	Percent
Standard metal paper clips			
Standard plasic paper clips			
Large metal paper clips			

Now, you will need to multiply the mass of each size and type of paper clip times the percentage of the total it is. Then, the results are added together. For example, let's say you have a test average of 75, a homework average of 80, and a lab average of 70. Then we will assume that your test counts 60% of your final average, the homework is 10% and your lab average is 30% of the final average.

You would multiply 60% times the test average and get an answer. You would multiply 10% times the homework average and get an answer. You would multiply 30% times the lab average and get a result. Add the results together, and you would have your final average. In exactly the same way, the average atomic masses of elements are found.

To multiply percents, you must make them a decimal number first. To do that, simply move the decimal two places to the left, like this:

98.46 % as a decimal number =.9846

If you run out of places to move the decimal, as in the following example, add zeroes (0) to the <u>front</u> of the number until you are able to move the decimal two places and then put your decimal in position:

8.23 % as a decimal number = .0823
.79% as a decimal number = .0079

Now, multiply the percent of each paper clip type times the mass of that type of paper clip and record the results:

	Mass	Percent	Result
Standard metal paper clips			
Standard plasic paper clips			
Large metal paper clips			

To find the "average atomic mass" of your paper clips, add the results from above together:

	Result
Standard metal paper clips	
Standard plasic paper clips	
Large metal paper clips	
Total	

What you have in the total box above is the "average atomic mass" of your paper clips. You have followed the same type of procedure scientists use. They determine the amount of each isotope that is in nature, the mass of each isotope, and multiply the percent abundance of that isotope times its mass, then add all the results together.

Questions:

1. Define average atomic mass.

2. Explain why the masses of elements as given on the Periodic Table of Elements are decimal numbers.

3. Define isotope.

4. What particle in the atom has a positive charge?

5. Where is the particle in the atom which has no charge? What is it?

6. If two elements have an atomic number of 23, but have different masses (47 and 48) are they the same element? Explain your answer.

7. How do you change a percent into a decimal?

8. Change the following to percents:

   a. 0 .343 b. 0.0786 c. 0.0068 d. 0.12

9. What are nucleons?

10. For what reason were the percentages of each type of paper clip multiplied times the mass of that type of paper clip?

PACE Chemistry: An Applied Approach

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