DOCUMENT RESUME

ED 070 671 SE 015 488

AUTHOR	Kuczma, R. M.
TITLE	Individualized Instruction in Science, Introductory Physical Science, Learning Activity Packages.
INSTITUTION	Eastchester Public Schools, N. Y.
PUB DATE	[72]
NOTE	64p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Grading; Individualized Instruction; *Individualized Programs; *Instructional Materials; *Physical Sciences; Remedial Instruction; *Science Activities; Secondary Grades; *Secondary School Science
IDENTIFIERS	Eastchester New York Schools; Learning Activity Packages

ABSTRACT

Learning Activity Packages (LAP) mostly relating to the Introductory Physical Science Text are presented in this manual for use in sampling a new type of instruction. The total of 14 topics are incorporated into five units: (1) introduction to individualized learning; (2) observation versus interpretation; (3) quantity of matter; (4) introduction to atoms, compounds, and elements; and (5) models of matter. Brief descriptions are included of LAP, activity in chemistry laboratory, metric system, mass and volume, and a review of atoms and molecules. A set of directions for fulfilling specific objectives is given for each topic, making it possible for students to learn on their own as individuals. Among these, some are specially designed and others are identified in connection with the content of "Modern Chemistry; Terms, Tables, and Skills," by B. J. Woodruff, and "Modern Physical Science" by Brooks and others. In the course of learning, besides keeping a notebook and vocabulary sheets, the students are asked to take pretests, self-evaluation tests, and posttests. Students' grades are assigned on the basis of the amount of their work, posttest results, and work habits and attitudes. Also included are two remedial units dealing with calculation with decimals and standard scientific notation of numbers. (CC)

INDIVIDUALIZED INSTRUCTION IN SCIENCE

Learning Activity Packages

* * * * *
* * * *
* * *
* *
*

I.P.S.

Introductory Physical Science

PROPERTY OF
EASTCHESTER JUNIOR HIGH SCHOOL
Eastchester, N. Y.
SCIENCE DEPT.

Purchase Date..... No.....
Name of Student..... Yr.....
..... Yr.....
..... Yr.....
..... Yr.....
..... Yr.....

Eastchester Public Schools
Eastchester, New York

R.M. Kuczma

IPS

TABLE OF CONTENTS
LEARNING ACTIVITY PACKAGES

INDIVIDUALIZED INSTRUCTION
Introductory Remarks

. . . . . and so, friends, if you wish to be sure that you are getting the very best, buy Product X." You have probably heard comments like this time and time again. You have three choices - you do nothing, you buy the product, or you say - now, just a minute, how do I know this is so? In stopping to get the facts and then deciding, you are showing a sharpness that is needed in today's world.

Those of you who are planning to go out into the world's work or to bring up a family know that sharpness in all that is going on is a good trait to develop. However, since no two people are alike, your reaction will be different from that of any other person. How you go about getting your facts, if you do, may also be different. Why is this so?

Well, you are a very important person because you are an individual having talents and abilities different from any other individual in the world. However, because we are human beings, we all have common steps through which we go although how we go through these differs. You probably learned to walk, talk, read, and write in ways different from other individuals although you all matured into fine, young human beings.

This year you will be given a chance to find out how you, as a very special person, learns. Did you ever stop to think how you learn anything? Perhaps this year you will take the

opportunity to find this out for yourself. You will not only be learning about how science helps us to become sharper in observing and interpreting what we see but, more important, you may be able to learn more about yourself and how you work. You are going to sample a type of learning called "Individualized Instruction." What this is and how it will help you will be investigated this year. I hope you find this way of learning helpful. I look forward to knowing you and to helping you discover that special person call YOU.

Now that you have come this far, you are ready to take PRE-TEST I-1. This is not a test of the kind you may have experienced before - it is only a means of getting some information about what you know or think on a particular topic so that we may know where to start our working together. After all, I have no idea about how much you may already know. There is no "mark" with a pre-test. It has nothing to do with your grade so feel free to express yourself honestly.

When you have completed the pre-test, please hand it in and continue with UNIT I, Topic 1: INTRODUCTION TO INDIVIDUALIZED LEARNING. This will give you some idea of how we will work together this year.

If there is something you don't understand, please feel free to ask me.

IPS

INDIVIDUALIZED LEARNING

UNIT I: Introduction to Individualized Learning

TOPIC 1: Learning Activity Package (LAP)

OBJECTIVES:

1. To demonstrate your ability to read and understand written material by following instructions given in ACTIVITIES below.

2. To self-test your ability to depend on yourself by handing in, FIVE MINUTES BEFORE THE END OF THE PERIOD, any work you have done. You will not be reminded to do so.

3. To show that you can discuss the relationship between LAP and Individualized Learning by taking a self-evaluation test and entering into a group discussion on the matter.

ACTIVITIES:

1. Read A STUDENT GUIDE AS TO WHAT IS CONTAINED IN A LEARNING ACTIVITY PACKAGE.

2. Take out your pen or pencil, which you should have every day. If you forgot to bring one today, you may use the pencil provided. BE SURE TO RETURN IT FOR SOME ONE ELSE MAY NEED IT.

3. On WORKSHEET I-1-3, provided for you, list the contents of a LAP and briefly note what each one is supposed to do. This will serve as one example of what you will keep in your notebook.

4. Obtain an ANSWER SHEET and take the SELF-EVALUATION TEST. This is an example of how you can test yourself on material covered.

5. Obtain a VOCABULARY SHEET and list any words which are new to you. Check to see if you have spelled them correctly. Add the meaning next to the word.

6. Mark you own test by listening to the answers on the cassette or by using an answer guide which you may obtain. How to make the test is given in the answer guide.

7. When you feel that you have done all the activities above to the best of your ability, ask for the Post-Test on this Unit. This will serve as an example of whether or not you are ready to go on to the next Unit.

INDIVIDUALIZED LEARNING

ACTIVITIES: (continued)

8. Discuss the meaning of Individualized Instruction in a class discussion. This class discussion will serve to show how talking it over in a group helps to exchange opinions and clear up matters not understood. Of equal importance will be the realization that discussions are more interesting and worthwhile if you have some knowledge and experience to back up your opinions.

ADDITIONAL ACTIVITIES, as needed:

IPS

ACTIVITY I-1-1
A STUDENT GUIDE
AS TO WHAT IS CONTAINED IN A LEARNING ACTIVITY PACKAGE

First, let us answer the question, "What is a LAP?" A LAP or Learning Activity Package, is a set of directions for obtaining specified objectives. It doesn't teach you but rather guides you in obtaining the information you need. Different methods are suggested for your learning. How much you learn depends on you even though your teacher will always be on hand to help.

Just how the directions are carried out and the objectives achieved depend on you as an individual. This means that, instead of always working with the rest of the class as a group, some of the time you will be working on your own as an individual. You will cover the same material that you would have covered as a group but there are greater benefits to you as an individual such as:

1. YOU WILL BE WORKING AT YOUR OWN SPEED.

   If you feel, however, that you need extra time, you may finish at home the work not completed at class. This will be your "homework."

2. YOU WILL HAVE THE OPPORTUNITY TO TAILOR THE PROGRAM TO YOUR OWN REQUIREMENTS.

   Because of previous knowledge or experience, you will be free to concentrate more thoroughly on that material with which you are not familiar.

3. YOU WILL HAVE THE OPPORTUNITY TO SELECT THE METHOD YOU WISH TO FOLLOW IN LEARNING.

   Visual aids, such as, film loops or slides, may help you to understand the material in addition to choice of reading references and experiments.

4. YOU MAY WISH TO WORK BY YOURSELF.

   Even if equipment is limited, you will still be able to have your turn. Sometimes, however, after having completed your individual work, you might find it helpful to compare and discuss your results with others.

Some real advantages have been presented. They should be of benefit and make your work more enjoyable, but, as the saying goes, "You never get anything for nothing." Your contribution is to accept responsibility. No one will be checking constantly to make sure you are working. However, in one way or another, after you have completed the assignment, your knowledge must be tested so to assure success, you will find it necessary to depend on yourself. However, your teacher will be there to help and guide you.

Let us now take a look at some of the things that make up a LAP:

1. A written guide including:

   a. Unit - the major idea proposed to be learned
   b. Topic - the specific area to be explored
   c. Objectives - goals or guidelines, the achievement of which will help to show your mastery of the learning
   d. Activities - designed to enable you to fulfill the objectives.

      Each Activity has its own set of instructions.

      For purposes of identification, the activities are numbered with the Unit number followed by the Topic number and the particular activity number. For example, I-2-6 stands for Unit I, Topic 2, Activity 6.

2. Vocabulary sheet - to help you to remember new words learned and their correct spelling.

3. Self-Evaluation Test - to test yourself when you think you have mastered the Topic.

4. Answer Sheet for the Self-Evaluation Test. You will mark your own test and use it to recheck your learning.

5. Pre-Test - You will be given a pre-test for a Unit on a Topic to determine your weak and strong points.

6. Post-Test - This is a test designed to see if you have successfully completed sufficient activities and understand the work.

You will be expected to keep a notebook which will become your "textbook" and will be needed for review and testing. In addition to the Vocabulary Sheet and the notes you will take as you go through activities and reading, you will keep in this notebook ORIGINAL copies of your activities, the CARBON copies of which will be handed in and then returned with suggestions for rechecking where necessary. In this way, you will be responsible for correcting your own originals and inquiring about points you do not understand.

In order to check on your progress, you will need to obtain a STUDENT PROFILE sheet which you will keep in the front of your notebook. This STUDENT PROFILE will give you a quick summary of the activities you have completed, how well you are doing, and how long it is taking you to do them. You may want to improve your achievement, if they are not what you want them to be, or you may wish to think over better use of your time.

Your grade will consist of the following:

1. Amount of work done (a MINIMUM as well as MAXIMUM number of activities will be posted.)

2. Post-Tests taken.

3. Work habits, including:
   a. Use of class time
   b. Care of equipment
   c. Neatness in writing reports
   d. Following directions

4. Attitude or Citizenship
   a. Dependability and honesty
   b. Self-discipline (talking quietly and only when necessary)
   c. Cooperation in clean-up and keeping immediate environment orderly

UNIT II: OBSERVATION vs INTERPRETATION

TOPIC 1: Observations in science

OBJECTIVES:

1. To enable the student to describe what he observes.

2. To obtain first hand experience of objects or events.

3. To prepare laboratory equipment needed for pursuit of observations.

4. To practice required safety rules and precautions in the handling of equipment and chemicals.

ACTIVITIES:

1. Obtain a candle, candle dish, and match. Light the candle. List as many observations as you can (at least 10) about the burning candle.

2. Obtain an alcohol burner and match. Light the burner. List as many observations as you can (at least 10)about the burning alcohol burner.

3. Obtain a film loop on the Bunsen burner. List as many observations as you can about the Bunsen burner as you view it on the film loop.

4. Obtain a Bunsen burner and a match. Consult your teacher as to proper precautions and safety rules in the lighting and use of the burner. List as many observations as you can about the lighted Bunsen burner.

5. Obtain a copy of INTRODUCTORY PHYSICAL SCIENCE (IPS Group). Make a drawing in your notebook of the equipment you will need for your first experiment. List the things that you will need to set up the equipment.

6. Obtain a length of glass tubing and show your ability to prepare equipment by cutting, fire polishing, making a 90° bend, and inserting the tubing into a rubber stopper.

7. Obtain the equipment needed for collection of gas and set it up as shown on page 4 of the Manual.

8. View film loops on SAFETY IN THE LABORATORY.

UNIT II:

ACTIVITIES: (continued)

9. Using the directions on pages 4-5 of the Manual, do the experiment on pages 4-5. Write out each question and the answer to it as given in the directions. These questions and answers are to be put into your notebook and are to be headed OBSERVATIONS ON THE DISTILLATION OF WOOD.

10. Obtain the SELF-EVALUATION TEST on your observations and follow the instructions given.

11. When you feel ready, take the POST-TEST for this Topic.

REMEMBER AT ALL TIMES: YOU ARE PARTICIPATING IN A LABORatory and not laboRATORY.

WARNING TO ALL STUDENTS IN CHEMISTRY LABORATORY

1. Do not smell, touch, or in any way handle any chemicals except under teacher supervision.

2. Do not plug in any electrical equipment except under teacher supervision.

3. Report any defects in gas fixtures, electrical outlets, and connections immediately.

4. In case of fire, NEVER USE WATER ON: sodium, potassium, calcium, calcium carbide, sulfuric.

5. Do not discard broken glassware, chemical residues, etc., into the wastepaper basket. Place in specified area or container.

6. Do not experiment with rocket fuels.

7. Never add water to concentrated sulphuric acid. Add acid to water in small quantities, stirring all the time.

8. Do not handle white phosphorus. This must be kept under water.

9. Never look into the mouth of a test tube while heating it. Point it away from yourself or any other person watching.

10. When heating liquids in test tubes, heat from upper portion then downward.

11. If bunsen burner burns at spud, shut off gas supply immediately. Do not touch the barrel.

12. In experiments of gas collection by water displacement, delivery tube must be removed from generating flask at end of experiment. If thistle tube is used for addition of acid, make sure that delivery tube is not clogged.

13. Do not handle glass tubing immediately after firing.

14. Use rubber gloves when handling appreciable quantities of acids or alkalis.

15. Never force glass tubing into stoppers.

16. In case of mercury spill, do not handle with your hands or let it get on gold belongings, such as rings.

WARNING TO ALL STUDENTS IN CHEMISTRY LABORATORY

17. In preparing oxygen: do not contaminate oxidizing agents
do not drop wood splints into hot mixture.

18. In preparing hydrogen: never ignite gas coming from generator until you are sure there is no air residue

19. In dehydration of sucrose by concentrated sulphuric acid, never touch the lump of carbon remaining.

20. In preparation of halogens (bromide, chlorine, iodine) do not inhale vapors.

* * * * * *

IPS

UNIT II: INTRODUCTION TO INDIVIDUALIZED LEARNING

TOPIC 2: Mathematics, the language of science

OBJECTIVES:

1. To enable the student to make meaningful observations in science through the use of mathematics.

2. To refresh and reinforce the student's use of decimals in problems involving addition, subtraction, multiplication, and division.

3. To enable the student to write numbers in standard scientific notation as an aid to handling very large and very small numbers in science.

4. To refresh and reinforce the student's skill in adding, subtracting, multiplying, and dividing astronomical and atomic figures using scientific notation.

ACTIVITIES:

1. The use of decimals

   a. Remedial Unit: CALCULATION WITH DECIMALS (Activities 1,2,3)
   b. Post Test
   c. Post retest, if required

2. Practice in Scientific Notation

   a. Remedial Unit: SCIENTIFIC NOTATION (Activities 1-10)
   b. Post Test: Decimals and Scientific Notation
   c. Post Retest, if required
   d. Read pp. 13-16 of TERMS, TABLES, AND SKILLS
   e. Study Table 3.1 on p.18 of TERMS, TABLES, AND SKILLS

UNIT III: QUANTITY OF MATTER

TOPIC 1: Introduction to Metric System

OBJECTIVES:

1. Using selected readings and visual aids, to help make the student aware of the development of the Metric System.

2. To focus attention on the relationship among the fundamental units of measurement by readings and self-tests from various sources.

ACTIVITIES:

1. Read INTRODUCTION TO METRIC SYSTEM: HISTORY AND MODERN DEVELOPMENT in Activity III-1-1.

2. Read Chapter 1 of TERMS, TABLES, AND SKILLS. Answer questions 5-18 in "Exercises" on page 11 and hand in.

3. Obtain the folder on COMPARISON BETWEEN ENGLISH AND METRIC SYSTEMS. (Activity III-1-3). Use the overhead projector to view the data given. Note observations in your notebook.

4. Read INTRODUCTION TO METRIC SYSTEM: LINEAR MEASUREMENTS (Activity III-1-4). Take notes on your observations.

5. Obtain a copy of MODERN PHYSICAL SCIENCE. Measure the area of this book in both systems. Time the difference between the English and the Metric systems.

6. Measure the top of your desk in both systems, timing the difference between the two.

7. Take Post Test III-1-7 on the Metric System.

INTRODUCTION TO METRIC SYSTEM:

HISTORY AND MODERN DEVELOPMENT OF MEASUREMENT

Mankind has always had a need to make measurements. How did we, in the United States, come to use the British or English system rather than the Metric? As the name itself implies, it was imposed on us when we were colonies of England. Because we have become accustomed to this system, it seems easy to us but a look into its beginnings and accuracy have made us aware, in this modern age, that it might be to our advantage to make a change to a system now being used universally. Even England itself has now gone on the Metric system.

Britain was (and still is) a form of monarchy. Tradition gave royalty undue powers and obedience. When man began to need to make more accurate measurements, the monarchy decided that 3 barley corns should equal an inch; that its royal foot should equal "one foot"; that the standard yeard would be the length from its royal nose to its outstretched arm; that a rod would equal the length required to hold the royal attendants; etc. Of course, since royalty's measurements were not all the same, the measurements from court to court would vary with the shoe size or arm length! This, then, was the precise mode of measurement which we inherited.

There was one saving grace, however. When we declared our Independence, our forefathers had the good sense to make our monetary system based on tens, like the Metric system.

In the meantime, other nations around the world realized the need for an international standard and in 1792, soon after the French Revolution, French scientists met and determined a standard

measurement for the meter, based on measuring one ten-millionth of the distance from the equator to the North Pole on the meridian that passes through Paris. A platinum bar measuring this distance was then used as the standard meter. In 1875, a meter stick, based on the bar adopted as the standard meter, was placed at the International Bureau of Weights and Measures at Sevres, France. This was still not a very precise instrument of measurement since expansion and contraction of metals did make changes in the length and no one could be absolutely sure about the accuracy of one ten-millionths of the distance from the equator to the North Pole on the meridian that passed through Paris is but it was cetainly more accurate than barley corns or a king's foot.

In 1960, a standard was used that could be duplicated in every laboratory around the world - the wave length of the orange light from Krypton isotope (an element of Krypton having same atomic number but different atomic mass). The wave length is given as 1,650,763.73 or 1.65×10^6 Å. The Å stands for "angstroms" and is a unit of measuring wave lengths and other dimensions too small for our normal purposes. One angstrom is equal to 1×10^{-8} cm. Since wave lengths are a characteristic property of what is called the "Electromagnetic Spectrum" (see the chart on page 143 in TERMS, TABLES, AND SKILLS), this would not be affected by heat or cold or other physical factors which could alter measurements of metals.

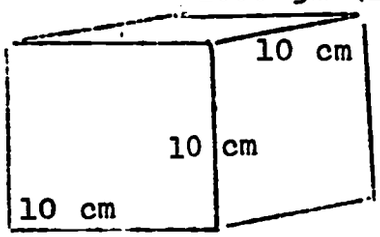
In 1964, the 12th General Conference on Weights and Measures

defined the liter as a volume exactly equal to the cubic decimeter or 1000 cm^3. In order to save time and space, instead of using cm^3 this was shortened to cc. (cubic centimeter). Since milliliter is the unit for volume of liquids but is still volume. Today cc and ml are used interchangeably inasmuch as cc also stands for volume. Laboratory apparatus is now usually marked "ml" although one may see "cc" on some.

It was further decided that the mass of water at its greatest density filling the volume would equal 1000grams or gm. Please note that gram is abbreviated to "gm" in the modern use since "g" - the older use - may now be confused with our space use of gravity as small "g".

In summary, then:

1. The meter is based on a wave length of Krypton
2. The volume is based on one cubic decimter (which, in turn, is based on the meter) One decimeter = 10 centimeters.
3. The mass of water at its greatest density filling the volume is 1000 gm (1 kgm)



= 1000 cubic centimeters
1000 cc (cm^3) (linear)

1000 cc holds 1000 ml (volume)

1000 ml has mass of 1000 gm(mass)

THEREFORE: if 1000 cc is equivalent to 1000 ml which is 1000 gm

then 1 cc " 1 ml " 1 gm

If we add one other fundamental unit to the centimeter-gram, that is, TIME, we have the fundamental units of the CGS Metric system: centimeter-gram-second. These three - standing for length, mass, and time - a re considered the fundamental units of measurement. All other units are combinations of these three. It is interesting to note that time is also standardized on the vibrations of the Cesium atom and work is now in progress to further the accuracy of time by use of the vibrations of the Hydrogen atom.

For some scientific work it may be more convenient to use 1000 cm and 1000 gm instead of 1 cm and 1 gm. This becomes known as the MKS Metric system: meter-kilogram-second. (The English system, as you probably have guessed by now, is called the "Foot-Pound-Second" system or FPS).

A year after the Civil War, Congress had before it a bill to change our English system to the Metric. More than a hundred years have gone by with nothing done. This past summer, the bill was once more brought before Congress for consideration. If you were a member of Congress, how would you vote?

The Metric system is now being used in the design of rockets, for example, the "Maverick" is the first U.S. missile to be completely, designed on the Metric system. Model rocketry has now converted to the Metric. Of course, science classes use the Metric system because of the need for greater accuracy and desire to eliminate time wasted in doing mathematical problems in the English. It has been estimated from the experience of other countries that it takes approximately two generations to make a complete conversion to the Metric. How long do you think it will take us?

ACTIVITY III-1-4
INTRODUCTION TO METRIC SYSTEM
Linear Measurements

Our system of measurement in the United States (The English system) seems fairly easy to us. We know that, for example, 1 foot is equal to 12 inches or that 1 yard equals 3 feet because we have used these figures all our lives. However, what about considering how many inches there are in 6,721 yards? In order to get the answer, we have to multiply:

```
   6721
X     3  (1 yard = 3 feet)
  20163
X    12  (12 inches = 1 foot)
 241956  in.
```

Suppose, instead of doing all that multiplying, you could just move a decimal point? How many millimeters in 6721 meters? Since the Metric system is based on tens, and there are 1000 mm (millimeters) in one m (meter), to find out how many mm in 6721 m, all you need to do is move the decimal point three places (thousands):

6721 m = 6721 000 mm

understood decimal

Most of the world feels that moving decimal points is much easier and more accurate than multiplying various units as in the English system. Therefore, most of the world today uses a system of measurement called the Metric system. Instead of having to worry over fractions, inches, feet, yards, rods, furlongs, ounces, pounds, quarts, pecks, etc., all you would have to remember are milli, centi, and kilo:

milli	stands for	1/1000	of a certain quantity
centi	"	1/100	"
kilo	"	1000 times	"

You probably recall the prefixes for larger and smaller units used in the Metric system in the information on Scientific Notation. Can you remember what MEGA (as in megacycle) represented?

In order to make it even easier for you to remember the prefixes, it may help to think of the meter as one dollar:

If 1 dollar represents 1 meter

then, just as

100 cents = 1 dollar	100 centimeters = 1 meter
1 cent = 1/100 of a dollar	1 centimeter = 1/100 of a meter
10 mills = 1 cent	10 millimeters = 1 centimeter

As you can see, our currency is easy to use because it is based on tens, just like the Metric system.

Obtain a ruler that has both systems on it. Note on the Metric side that each centimeter is divided into ten millimeters. Two centimeters + 5 millimeters would be written as 2.5 cm since the 5 millimeters (mm) are tenths of a centimeter (cm). Into how many parts is the inch divided? How many inches does 2.5 cm represent?

You will need the ruler for the rest of the activities so keep it as you go on to Activity 2.

IPS 9th

UNIT III: QUANTITY OF MATTER

TOPIC 2: Mass

OBJECTIVES:

1. To reinforce the student's use of decimals as pre-requisite to mass measurements in Metric System, needed for experiments.

2. To review the use of powers of ten for use in scientific notation, needed for experiments.

3. To enable the student to measure with a balance, using bead equivalents of grams.

4. To review the use of the graph for purposes of clarifying observations and data compiled.

5. To observe and use the fundamental unit of amount of matter or mass.

ACTIVITIES:

1. Read INTRODUCTION TO METRIC SYSTEM: MASS.

2. Obtain Experiment III-2-2, an equal arm balance, and bead.

3. Read instructions on pages 11-14 (2,4to 2.6 in IPS). Write out proper format in five steps following the instructions.

4. Prepare the balance.

5. Make observations as given in instructions. Write out Experiment II-2-2 in final form, keeping the original in your notebook and handing in the carbon copy.

6. Obtain a copy of TERMS, TABLES, AND SKILLS. Read Chapter 10. Look through Chapters 11 and 12 for examples of graph types.

7. Read Experiment III-2-7 (2.7 in IPS) regarding of graphing of data.. Complete the graph and hand in.

8. Take the Post-Test III-2-8 on mass.

INTRODUCTION TO METRIC SYSTEM

Mass

One of the most important concepts of matter in the modern age is that of mass. It is especially important since we have started space exploration.

Mass in science refers to the quantity of matter - how much there is of a substance. This is quite different from how much it weighs. A given quantity of matter will remain the same if nothing is done to remove any part of it but its weight will change depending on how the force of gravity acts upon it. The greater the pull of gravity, the greater the weight; the weaker the pull of gravity, the smaller the weight. Mass, then, is the amount of matter in a substance while weight is the degree to which gravity is pulling on the given amount. An astronaut, weighing on Earth about 160 pounds, will in deep outer space weigh zero while, on the moon, about one-sixth his Earth weight. However, whether in space or on the moon, the amount of matter of which he is made remains the same although his weight varies with the gravitational environment. Mass is constant, while weight changes.

Working with a factor that would constantly change would be complicated and inaccurate to say the least. For that reason, science uses the concept of mass. How can we overcome the force of gravity on Earth (or anywhere) in making mass measurements? Isn't gravity constantly pulling on the amount of matter we are measuring? To overcome this problem, science makes use of the equal arm balance which measures the unknown quantity of matter against a known quantity set up as a standard. Balancing one against the other

cancels the effect of gravity.

The standard used is the gram. Undoubtedly some other intelligence on some other planet has its own standard but, should we ever meet, comparisons could be made and a conversion system made. It, therefore, really makes no difference what standard is used - stones, beads, grain or whatever, AS LONG AS EVERYONE ELSE USES THE SAME UNIT.

UNIT III: QUANTITY OF MATTER

TOPIC 3: Relationship of Mass and Volume

OBJECTIVES:

1. To reinforce the concept and skill of mass measurements by experiment, using various media.

2. To have the students experience the use of quantitative mass measurements in the formulation of a law-Conservation of Mass.

3. To clarify the difference between mass and volume by use of the experimental method.

ACTIVITIES: (All experiments are to be handed in -written report)

1. EXPERIMENT 2.8 in IPS text: THE MASS OF DISSOLVED SALT.

2. EXPERIMENT 2.9 in IPS test: THE MASS OF ICE AND WATER.

3. EXPERIMENT 2.10 in IPS test: THE MASS OF MIXED SOLUTIONS.

4. EXPERIMENT 2.11 in IPS test: THE MASS OF COPPER AND SULFUR.

5. EXPERIMENT 2.12 in IPS text: THE MASS OF GAS.

6. Read and record in your notebook the most important points in CONSERVATION OF MASS AND LAWS OF NATURE to be found in 2.13 and 2.14 of IPS text.

7. Obtain Activity I II-3-7: MEASUREMENT OF REGULAR OBJECTS. While doing the activity, keep a record of your work in your notebook.

8. Obtain and read Activity III-3-8 and do EXPERIMENT 2.2 in IPS text: MEASUREMENT OF IRREGULAR OBJECTS.

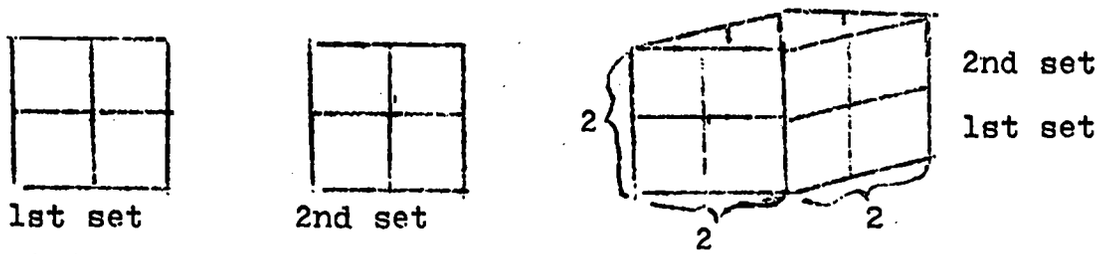
9. Take Post-Test III-3-9.

ACTIVITY III-3-7

MEASUREMENT OF REGULAR OBJECTS

Measurement of regular objects, to find out how much space they occupy (volume), requires three sides: length, width, and height. Multiplying length, by width, by height gives the volume.

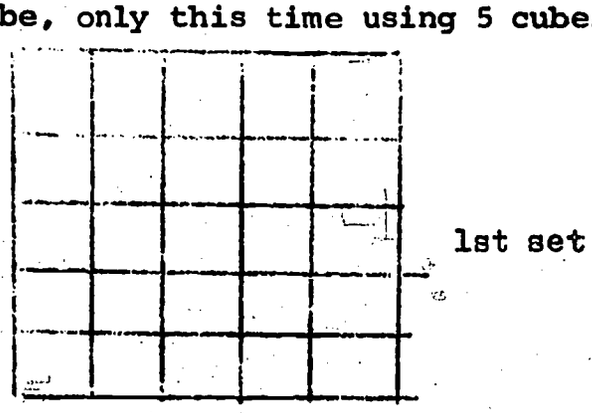
In order to prove if this is possible, obtain a set of cubes. If you want to find the volume of a cube that is made of two cubes to one side, how would you do this if you did not know that length, times width, times height equals volume? You might put together enough cubes to make this double-cube size. If two cubes make one side of the new structure you want to make, how many cubes will you need to complete it? Try making such a cube. It probably looks like this:



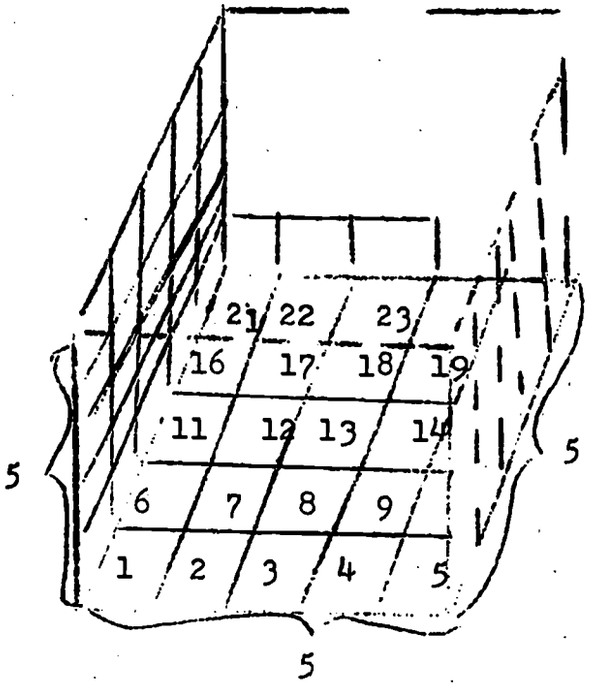
You probably found that 8 cubes would be needed. If you used the formula (length X width X height) you would find:

$$2 \times 2 \times 2 = 8$$

Now imagine a cube with 5 cubes making one side. How many cubes would be needed to make this cube? Make a drawing, like the one of the 2-sided cube, only this time using 5 cubes to each side.



If you could look into the cube, you would probably see that you would need 25 cubes to make the first set or layer. To make a cube with one side equal to five cubes, you would then need five sets, each with 25 cubes. If there are five sets or layers each with a total of 25 cubes, then you would need:

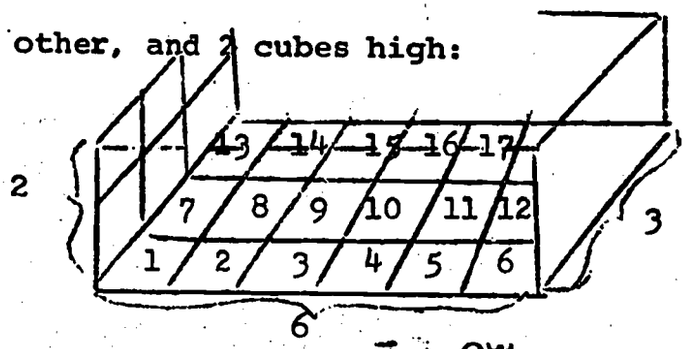


25	cubes for 1st layer
25	2nd
25	3rd
25	4th
25	5th
125	TOTAL CUBES NEEDED

Instead of going through this, you might use the formula and find that:

$$5 \times 5 \times 5 = 125$$

Now, if you think this is true only for cubes, with three equal sides, let us try the same idea with a rectangle, with three unequal sides. Imagine a rectangle made of 6 cubes on one side, 3 on the other, and 2 cubes high:



You will need two layers of 18 cubes each, making a total of:

layer 1: 18
2: 18
36 TOTAL CUBES NEEDED

Now, using the formula again: 6 X 3 X 2 = 36

In all three cases, you had a choice: actually counting all the cubes or blocks to find the volume or multiplying length times width times height. The answer was the same. Suppose you have a figure that is 100 blocks long, 50 blocks wide, and 25 blocks high. Wouldn't you get the same result by multiplying the measured sides instead of counting blocks? This would be quite a task. Since L X W X H = Volume, then 100 X 50 X 25 would give the same answer as building and counting. What volume did you get? Suppose, instead of saying blocks or cubes, we say 100 cm long, 50 cm wide, and 25 cm high. How would you write your answer? How would you write this in scientific notation?

MEASUREMENT OF IRREGULAR OBJECTS

Of course, not everything in life comes in neat, regular sides that can be measured with a ruler or counted in blocks. Obtain a sample mineral or rock. Looking at it, you probably realize that it would take a very long time to find the length, width, and height of many different sides.

Science has a very easy method. It is based on a discovery which an ancient Greek made long, long ago. The story goes that he had to determine for his king whether or not a crown the king had been given was made of gold or had been mixed with silver. In order to make his decision, he would not be permitted to damage the crown in any way or to take it apart. Archimedes, the ancient philosopher, thought about this problem but could get no answer.

As was the custom of the Greeks, he went to the Baths to relax and think in the warm waters. As he stepped into the bath, he noticed that the water rose up. Why did it rise up? Because he had gotten in. The space that he took up pushed away the same space of water. If he could measure the amount of water, he would have the volume of the crown. How would this help to know if the crown were pure gold? Different amounts of things would displace different amounts of water. Since gold was different from silver, the amount of gold would decide how much water would be displaced but the amount displaced (volume) would be the same when compared to different amounts of gold while the volume of silver, for example, would be the same proportionally for different amounts of silver but the final result would be different from gold. This relationship between how much there is (mass) compared to how much

space it occupies (volume) we call density, which we will investigate later. For the present, we shall use the idea of getting the volume of irregular objects by water displacement.

Using a graduated cylinder, fill it with any amount of water and read the meniscus (the lowest part of the curve of water). Now gently slide in the rock or mineral. This will prevent splashing which might result in the loss of some water. Now read the meniscus again. The difference in amount is the amount of space taken up by the mineral, or its volume.

You are now ready to do EXPERIMENT 2.2 in your IPS text.

UNIT IV: INTRODUCTION TO THE ATOM

TOPIC 1: The Nature of Matter

OBJECTIVES:

1. To introduce the student to the relationship between mass and volume as properties of matter with discussion of the atom as the point of reference.

2. To introduce the Periodic Chart as a tool for prediction of behavior of matter.

ACTIVITIES:

1. Read pages 19-33 of MODERN PHYSICAL SCIENCE (Brooks, Tracy, Tropp, Friedl). Draw into your notebook diagrams of atoms as given in the text.

2. Obtain a copy of TERMS, TABLES, AND SKILLS (B.J. Woodruff) and look through pages 122-125. Draw into your notebook the PERIODIC TABLE OF THE ELEMENTS.

3. Read Activity IV-1-3 on INTRODUCTION TO THE ATOM.

4. Take Post-Test IV-1-4 on INTRODUCTION TO THE ATOM.

ACTIVITY IV-1-3

INTRODUCTION TO THE ATOM

What has the atom to do with what we have been studying?

What do you recall about the Conservation of Matter? As your experiments showed you, the chemicals that you used in your experiments did not seem to lose mass even though they changed in appearance or even "disappeared." What was this mass?

We had said that mass was how much there was of something. Something and everything, we found, was matter. Matter was anything that had mass and volume. Of what was matter made? We said that all matter was made up of atoms. The wood that was distilled at the beginning of the year turned out to be made of solids, liquids, and gases. What were these made of: atoms and molecules, - which brings us to this introduction to the atom.

In your reading and drawing of what we think atoms look like, you probably found that all atoms are made up of protons, neutrons, and electrons, except for Hydrogen which has only a proton. It is number one of all the atoms. We say it has an atomic number of 1. All the other atoms about which we know are arranged according to atomic number in a chart - the PERIODIC TABLE. The Table tells us quite a bit about each atom. What it tells us, we shall discuss later, after we review something about the atoms and molecules (combinations of atoms) that were involved in the experiments that you did.

The first chemical we used was salt. In chemical language it is NaCl. The Na stands for sodium and it is atomic number 11 on the Chart. Find it in the Periodic Chart or Table that you copied into your notebook. Since it is number 11, this means that it has

11 protons and 11 neutrons - 11 positive charges neutralized by 11 negative. Protons are positively charged and electrons, negatively. Find the second chemical of which salt is made: chlorine. It is number 17. This tells us that chlorine has 17 protons and, of course, 17 electrons. When we make a drawing of these two atoms, we notice a particular arrangement of the electrons. (Go back into the drawings you made in your notebook and find those of Na and Cl.)

You may wonder why the electrons are arranged as they are. From observation and experiment, scientists have determined that only two electrons may exist on the first energy level (the first circle you see enclosing the nucleus of the atom), eight on the second level, and 8 on the third up to atoms having three levels. As the atoms become bigger, 8 in the last level is still the desired maximum number. Another observation (indirect) made by scientists is that atoms try for a completed outer level or shell.

In the case of Na and Cl, if Na could give up its extra electron and if Cl could gain one electron, each would have a completed shell, sodium in the level beneath and chlorine in the last shell. If they should come into contact with each other, this could happen. Indeed, it does - and when this occurs a new compound is formed: sodium chloride, the salt that we know. We say that Na gave up an electron and that chlorine (Cl) gained one. Na is a donor while Cl is a receiver. The chemistry shorthand for

Na+Cl----------NaCl**

sodium + chlorine ----------sodium chloride (salt)

If you look at the Periodic Table and find Na again, you will notice that is one member of a group that is labeled IA at the top. This IA means that the elements in this column have one electron to donate (one electron on the last shell). We say that they have a +1 VALENCE. The valence tells us about the combining ability of an atom. How may electrons do you think the elements in IIA have to donate? Two, is correct. The elements in this column are said to have a +2 valence because they can donate 2 electrons (and still have a complete shell underneath). Column IIIA tells us that the elements in that column have 3 electrons to donate or a valence of +3. When we get to IVA, it seems just as easy for the atoms in that column to donate 4 electrons as to receive 4 electrons to have a complete shell. Either way, they could complete the magic number of 8. In this instance, we say that the elements in IVA have a valence of ± 4.

When we get to VA, the situation changes. Since the atoms have 5 electrons in their outer shell, it is easier for them to borrow or receive 3 electrons to make up the 8 needed than it is to "go looking" for an atom that wants 5 electrons to take on. In this case we say that those in Column VA are missing 3 electrons, or they have a valence of -3. Those in Column VIA

**This equation is not balanced. It should be written as:

$\underline{2}$ Na + $Cl_{\underline{2}}$ ---------- $\underline{2}$ NaCl WHY?

have 6 electrons and are missing 2 to make the desired 8 electrons. The valence is, therefore, -2. In the case of VIIA, the atoms have a total of 7 electrons, that is, they are missing 1 electron to make the completed shell of 8. Therefore, the valence is -1. In the last column, the gases, the atoms each have a completed shell of 8 electrons (excluding Helium which can have only 2 electrons since its atomic number is 2 - but 2 electrons in the first shell is the maximum allowed.). The valence of these gases is, therefore, is zero since they have completed shells and need no additional electrons.

Add the valence number of its proper column in the Periodic Chart. Why is the valence important? It helps to tell us what elements can combine with others. In order to have a combination take place, the plus and minus valences must cancel each other out. For example, why can sodium and chlorine combine? Since the valence of sodium is +1 and the valence of chlorine is -1, the sum of these two is zero, therefore, the combination will stay together.

Why must water be H_2O and not HO as was once believed before scientists knew about the idea of valence? If you find Hydrogen in the Periodic Chart, you will find that it has a valence of +1. The valence of oxygen is -2. Therefore, two minus valences are needed to balance the -2 of oxygen, making the formula 2 hydrogens to every oxygen, or H_2O. Water is stable - it says together.

34- However, what do you think of H_2O_2? Will this combination

stay together easily? If you add up the valences, you will find that they do not equal zero for the two hydrogens equal -2 while the two oxygens equal -4. This chemical is PEROXIDE and is purposely not stable. As you probably know, peroxide is used to care for wounds and cuts. For this purpose, it is advisable to have water for cleansing and some substance that kills germs. When peroxide is exposed to the air, when you remove it from the bottle by pouring it on a cut, for example, the unstable compound separates into oxygen and water - just what is needed to do the job of taking care of the injury.

You are probably wondering about the columns in the Periodic Chart marked as "B" which are located in the center of the Chart. Why are these designated "B" and separated from the "A" columns? Their valence numbers vary from reaction to reaction and are not as easy to pinpoint as the A group. Anything that can vary and is not precisely one thing or another may be thought of as in transition, therefore, these B elements are appropriately called the TRANSITION ELEMENTS. Add this information to your chart by putting a bracket over the B group.

On the right-hand side of the chart you will notice a step-like line starting at Boron and going down to Astatine. This step-down line divides the elements into metals on the left and non-metals on the right. Add this information to your chart. An important fact from this information is that metals are electron DONORS or those that have a + valence while non-metals are electron RECEIVERS

or those that have a - valence. With this brief discussion of atoms and the Periodic Chart, you probably guessed why it was possible for the atoms in your experiments to form new combinations. In each case, the valences must have equalled zero.

In your notebook, write down the work sentence of what you think happened in each of your experiments and then rewrite it in the shorthand of chemistry. This is what you should have:

Lead Nitrate + Sodium Iodide ---------Sodium Nitrate + Lead Iodide

$Pb(NO_3)_2 + 2\ NaI$ ---------- $2\ Na(NO_3) + PbI_2$

When the lead nitrate and sodium iodide came into contact with each other, they separated into their original plus and minus valences and then recombined to form two new compounds. In each case, whether starting out or ending, each compound would have its valence equal zero, if you took the time to check this.

Copper + Sulfur ---------- Copper Sulfide

$Cu + S$ ---------- CuS

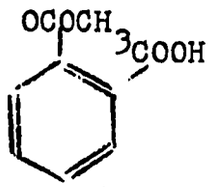
In this case, Cu has a valence of +2 and S has a valence of -2. Why do you think that the compound CuS stayed together?

Summarizing, then, matter is made up of atoms and molecules. Molecules are combinations of atoms so, in the end, matter is made up of atoms. Atoms are known as elements and appear in the Periodic Chart according to their atomic number which tells us how many protons (and electrons) they have. The particular place in the Chart tells us a great deal about the atom, such as, its combining ability (or valence) and whether or not it is a metal or

non-metal. There are many other things the Chart tells us about the atom but that would take a whole year to learn. If you are interested, you might be tempted to take Chemistry in the high school.

What more could you learn there? For example, one of the chemicals you used was: ALKA-SELTZER. You probably would find out that this common substance is made up of:

ASPIRIN (acetylsalicylic acid)



SODIUM BICARBONATE

$Na\ H\ CO_3$

CITRIC ACID

$HOOCCH_2C(OH)(COOH)CH_2COOH$

MONO CALCIUM PHOSPHATE

$Ca\ H\ (PO_4)$

Do you remember what gas was produced when this chemical (alka-seltzer) was added to water?

UNIT IV: INTRODUCTION TO THE ATOM

TOPIC 2: Characteristic Properties of Matter

OBJECTIVES:

1. To experience characteristic properties of matter through experiment.

2. To reinforce mathematical and laboratory skills learned in previous Units.

ACTIVITIES: (All experiments are to be handed in as written reports)

1. Read pages 27-28 in your IPS text, including 3.1. Record in your notebook points of interest and questions for discussion.

2. EXPERIMENT 3.2 in IPS text: THE DENSITY OF SOLIDS.

3. EXPERIMENT 3.3 in IPS text: THE DENSITY OF LIQUIDS.

4. EXPERIMENT 3.4 in IPS text: THE DENSITY OF GAS

5. EXPERIMENT 3.11 in IPS text: GREEZING AND MELTING

6. EXPERIMENT 3.12 in IPS text: MICRO-MELTING POINT

7. EXPERIMENT 3.13 in IPS text: BOILING POINT

8. EXPERIMENT 4.1 in IPS text: SOLUBILITY

9. EXPERIMENT 4.2 in IPS text: EFFECT OF TEMPERATURE ON SOLUBILITY

10. Take Post-Test IV-2-10 on CHARACTERISTIC PROPERTIES OF MATTER

- - - - - - - - - -

EXTRA:

11. EXPERIMENT 5.1 in IPS text: FRACTIONAL DISTILLATION

12. Read 5.2 in IPS text: SEPARATION OF SUBSTANCES - PETROLEUM. Make drawing of cross section of earth's crust in your notebook.

UNIT V: COMPOUNDS AND ELEMENTS

TOPIC 1: Law of Constant Proportions

OBJECTIVES:

1. To enable the student to distinguish by experimental evidence the difference between elements and compounds.

2. To experience one basic difference between elements and compounds in the synthesis of compounds with resulting compilation of data for the establishment of the Law of Constant Proportions.

ACTIVITIES:

1. EXPERIMENT 6.2 in IPS text: DECOMPOSITION OF WATER

2. EXPERIMENT 6.3 " : SYNTHESIS OF WATER

3. EXPERIMENT 6.4 " : SYNTHESIS OF ZINC CHLORIDE

4. EXPERIMENT 6.6 " : REACTION WITH COPPER

5. EXPERIMENT 6.7 " : REDUCTION OF COPPER OXIDE

6. Activity 6.5 " : LAW OF CONSTANT PROPORTIONS

7. Answer question on pages 120-124 in the IPS text. Hand in the results.

8. Take Post-Test V-1-8.

IPS 9th

UNIT V: COMPOUNDS AND ELEMENTS

TOPIC 2: Identification of Elements

OBJECTIVES:

1. To carry over the experience gained by students in identification of substances to identification of elements of which substances are made.

2. To develop techniques for identification of elements: flame tests and spectral analysis.

ACTIVITIES:

1. Read Activity 6.8 in your IPS text: ELEMENTS. Note Table 6.2 on page 113 and compare Lavoisier's List of the Elements with your Periodic Chart.

2. Using Table 6.3 on page 115 of your IPS text: KNOWN ELEMENTS add two more columns "Atomic Number" and "Valence" and hand in the completed list. It should include: Element, Symbol, Atomic Number and Valence.

3. EXPERIMENT 6.10 in your IPS text: FLAME TESTS OF SOME ELEMENTS Make a drawing of the spectrum in each case. See page 119 for suggestions.

4. EXPERIMENT 6.11-6.12 in your IPS text: SPECTRA OF SOME ELEMENTS. Make a drawing of the spectrum of each element or elements observed.

5. Obtain a copy of MODERN CHEMISTRY and observe Plates II and III found between pages 230 and 231. Note how these compare with your own findings.

6. Take Post-Test V-2-6.

UNIT VI: "MODELS" OF MATTER

TOPIC 1: Black Box

OBJECTIVES:

1. To have the students experience the "indirect method" used in science to determine the nature of objects or substances which cannot be observed directly.

2. To actualize with visible models the behavior the students have observed in their previous experiments.

ACTIVITIES:

1. Read page 142 in your IPS text: Construct a 'black box.'

2. EXPERIMENT 8.2: A BLACK BOX. Make a drawing of what you have constructed before exchanging with your neighbor for his or her identification. Repeat the construction and exchange until your neighbor has come close to the original construction.

3. Read Activity 8.3 in your IPS text: THE ATOMIC MODEL OF MATTER. Make notes of your findings.

4. Read pages 41-46 in MODERN CHEMISTRY (paragraphs 1-10). Take notes on the reading.

5. Take Post-Test VI-1-5.

UNIT VI: "MODELS" OF MATTER

TOPIC 2: Constant and Multiple Proportions

OBJECTIVES:

1. To have students visualize through construction of models the behavior of elements in the formation of compounds.

2. To help the students to "see" with models how constant composition and the Law of Multiple Proportions is deduced.

ACTIVITIES:

1. EXPERIMENT 8.4 in IPS text: FASTENERS AND RINGS: CONSTANT COMPOSITION.

2. EXPERIMENT 8.5: SOME OTHER COMPOUNDS OF Fs and R.

3. Read Activity 8.6 in IPS text: PREDICTION FROM THE ATOMIC MODEL OF MATTER

4. EXPERIMENT 8.7 in IPS text: TWO COMPOUNDS OF COPPER

5. Read Activity 8.8: THE LAW OF MULTIPLE PROPORTIONS. Take notes for future discussion.

6. Read Activity 8.9: MOLECULES. Add the figures shown into your notebook.

7. Hand in answers to the questions 1,3,5, and 9 on pages 157-158 of your IPS text.

8. Take Post-Test VI-2-8.

UNIT VI: "MODELS" OF MATTER

TOPIC 3: Sizes and Masses of Atoms and Molecules

OBJECTIVES:

1. To reinforce the student's ability to handle powers of ten and other mathematical skills learned throughout the course.

2. To experience practical application of the "indirect method" to measurement of "atoms" and "molecules."

ACTIVITIES:

1. Read Activity 9.1 in your IPS text: THE THICKNESS OF A THIN LAYER.

2. Obtain a copy of the SCIENCE WORKSHEET and answer the questions. Hand in the completed worksheet.

3. EXPERIMENT 9.2 in your IPS text: THICKNESS OF A THIN SHEET OF METAL.

4. EXPERIMENT 9.3 in your IPS text: THE SIZE AND MASS OF AN OLEIC ACID MOLECULE.

5. Answer question 2,4,8,13, and 17 on pages 176-178 in your IPS text. Hand in your results.

6. Take Post-Test VI-3-5.

UNIT VI: "MODELS" OF MATTER

TOPIC 4: Molecular Motion

OBJECTIVES:

1. To observe, by use of a model, the motion of atoms through which behavior reactions previously noted can take place.

2. To reinforce the predictive value of graphs in a study of Boyle's Law.

ACTIVITIES:

1. Read Activities 10.1 and 10.2 in your IPS text: MOLECULAR MOTION AND DIFFUSION. Note points for discussion.

2. EXPERIMENT 10.3 in IPS text: DENSITY AND PRESSURE OF A GAS.

3. EXPERIMENT 10.4 in IPS text: BOYLE'S LAW. Graph should be handed in with the results of the experiment.

4. EXPERIMENT 10.5 in your IPS text: TEMPERATURE AND MOLECULAR SPEED.

5. Take Post-Test VI-4-5.

UNIT VI: "MODELS" OF MATTER

TOPIC 5: Arrangement of Atoms

OBJECTIVES:

1. To visualize how the motion of atoms differs in different states of matter.

2. To grow and observe crystals as an example of atomic arrangement in solids.

ACTIVITIES:

1. EXPERIMENT 10.6 in IPS text: MOLECULAR MOTION IN LIQUIDS AND SOLIDS.

2. EXPERIMENT 10.7 in IPS text: GROWING SMALL CRYSTALS

3. EXPERIMENT 3.10 in IPS text: ELASTICITY OF GASES

4. Hand in answers to questions 1,2,8,14, and 30 on pages 200-202 in your IPS text.

5. Take Post-Test VI-5-5.

APPENDIX A
UNIT: REMEDIAL

TOPIC: Calculation with decimals

OBJECTIVES:

1. To enable the student to make meaningful observations in science through the use of mathematics.

2. To refresh and reinforce the student's use of decimals in problems involving addition, subtraction, multiplication, and division.

ACTIVITIES:

1. Addition and subtraction

When adding with decimal numbers it is important first to make sure the decimal points all line up in a column. Then you simply add as usual. The decimal point in the answer is in the same column as the numbers above. For example, add the following numbers: 5.2, 6.14, 91.368, and 17.4. Be sure to line up the numbers properly. Your column should look like the following:

```
   5 . 2
   6 . 1 4
 9 1 . 3 6 8
 1 7 . 4
-----------
1 2 0 . 1 0 8
```

When subtracting, you do exactly the same thing - putting numbers and decimals in proper columns - but this time substract rather than add.

If you think you now understand, complete the following problems in your notebook. Check the answers by looking at the Answer Sheet at the end of the Unit.

ADD THE FOLLOWING NUMBERS:

A. 4.3, 6.273, 173.504

B. 0.007, 5.01, 6.049, 2.3

C. 3.9, 5.04943, 2.67

D. 16.42, 897.463, 8.0004

TOPIC: Calculation with decimals

ACTIVITIES:

1. SUBTRACT THE FOLLOWING NUMBERS:

   E. 14.73 - 9.6

   F. 742.04 - 16.73

   G. 7.46932 - 2.24

   H. 3.407 - 2.3

   I. 74.2 - 67.354

2. Multiplication

   Multiply the numbers as usual just as if the decimal points were not there.

   Count the number of places there are to the right of the decimal in each number.

   Add the number of decimal places.

   In the answer, begin at the number on the right and count back to the left the number of decimal places found in #3.

   For example, in multiplying 2.7 X 3.2:

```
    2.7  (1 decimal place)
X   3.2  (1 decimal place)
     54
    81
   8.64  (2 decimal places needed)

   8 6 4 = 8.64
    2-1
```

MULTIPLY THE FOLLOWING NUMBERS in your notebook if you think you now understand. Check the answers by looking at the Answer Sheet at the end of the Unit.

TOPIC: Calculation with decimals

A. 5.5 X 2.3

B. 3.82 X 1.3

C. 5.004 X .001

D. 23.42 X .25

E. 7.03 X 6.7

F. 47.1 X 3.22

G. .33 X .44

3. Division

For dividing with decimals, follow the steps below:

Determine which is the divisor and which the dividend --

```
          Quotient
Divisor/  Dividend
```

Count the number of places there are to the right of the decimal in the divisor

3.24/ 9.73 (2 places)

Move the decimal point in the divisor to the right that (2) number of places

3.24/ 9.72 = 324/ 9.72

Find the decimal point in the dividend and move the decimal to the right the same number of places as you did the divisor

324/ 9.72 = 324/ 972

Move the decimal up into the quotient section directly above the new position in the dividend:

324/ 972.

Now divide, making sure the quotient numbers are placed in their proper places

```
        3.0
324/  972.0
      972
        0 0
```

UNIT: REMEDIAL

TOPIC: Calculation with decimals

Work out the following in your notebook. Check answers by looking at the Answer Sheet at the end of the Unit.

DIVIDE THE FOLLOWING. Please note that ÷ means divided by.

A. 62.7 ÷ 3.4

B. 6.248 ÷ .2

C. 3.624 ÷ 3

D. 396.4 ÷ 2.4

E. .5226 ÷ .13

F. .549 ÷ .9

ANSWER SHEET

UNIT: REMEDIAL
TOPIC: Calculation with Decimals

1. A. 184.077
   B
   B. 13.366
   C. 11.61943
   D. 921.8834
   E. 5.13
   F. 725.31
   G. 5.22932
   H. 1.107
   I. 6.846

2. A. 12.65
   B. 4.966
   C. .005004
   D. 5.8550
   E. 47.101
   F. 151.662
   G. .1452

3. A. 18.4
   B. 31.24
   C. 1.208
   D. 165.2
   E. 4.02
   F. .61

APPENDIX B

UNIT: REMEDIAL

TOPIC: Scientific Notation

OBJECTIVES:

1. To enable the student to write numbers in standard scientific notation as an aid to handling very large and very small numbers in science.

2. To refresh and reinforce the student's skill in adding, subtracting, multiplying, and dividing astronomical and atomic figures using scientific notation.

ACTIVITIES:

1. In order to write numbers in scientific notation, it is important to learn how to express powers of ten. Every number may be expressed as the product of two numbers:

   (figures given in the problem) X (power of ten)

   Copy the following set into your notebook. Count the places determining the power of ten:

1,000,000,000,000	.....1×10^{12}	.....TERA
1,000,000,000	.....1×10^{9}	.....GIGA
1,000,000	.....1×10^{6}	.....MEGA
1,000	.....1×10^{3}	.....KILO
100	.....1×10^{2}	.....MECTO
10	.....1×10^{1}	.....DEKA
1	.....1×10^{0}	.....
0.1	.....1×10^{-1}	.....DECI
0.01	.....1×10^{-2}	.....CENTI
0.001	.....1×10^{-3}	.....MILLI
0.000.001	.....1×10^{-6}	.....MICRO
0.000.000.001	..... 1×10^{-9}	.....NANO
0.000,000,000,001	..... 1×10^{-12}	.....PICO

TOPIC: Scientific Notation

2. Another way of expressing scientific notation is as follows:

10^{-5}	10^{-4}	10^{-3}	10^{-1}	10^{0}	10^{1}	10^{3}	10^{4}	10^{5}
.00001	.0001	.001	.1	1	10	1000	10000	100000
$\frac{1}{10X10X10X10X10}$		$\frac{1}{10X10X10}$				$\frac{}{(10X10X10)}$		$\frac{}{(10X10X10X10X10)}$

In your notebook, copy the powers of ten heading but including the missing power.

Substituting "5" for the "1" under the power of 10^{0}, enter the proper figures. Check your answer with the Answer Sheet.

3. Scientific notation may be looked at as a "shorthand" or time saver where large numbers are concerned. For example,

7,000,000
may be written: 7×10^{6}

This is a product of two factors - 7 is one factor and the other 10^{0} which is a power of 10. In counting the number of places to determine the power of ten, you probably realized that "7" was the significant number and that the zeros served to place the decimal point, understood after the last zero.

Generally speaking, all digits that make up a number, except zeros that designate ten, hundreds, thousands, etc., are significant figures. For example, in:

375,000

"375" are significant since they identify that particular number. In scientific notation, it would be written as:

3.75×10^{5}

Some other examples are:

83.000 = 8.3×10^{4}

845,000,000,000 = 8.45×10^{11}

0.0716 = 7.16×10^{-2}

0.000,000,342 = 3.42×10^{-7}

TOPIC: Scientific Notation

In each case, you put a decimal after the first significant figure and then count the number of places TO THE RIGHT if the number is more than 1 and TO THE LEFT if the number is less than 1.

TURN TO PAGE 16 in TERMS, TABLES AND SKILLS (Bobby J. Woodruff). Work out examples 1-15 in your notebook. Check your answers on page 150. Redo those problems which you found incorrect.

4. Problems in science using scientific notation

A. Light year

A "light year" is the distance traveled by light in one earth year.

Light travels at a speed of 186,000 mi/sec (English)
30,000,000,000 cm/sec (Metric)

In your notebook, calculate a light year in cm. Use the following pattern to aid you in your calculations:

30,000,000,000 cm/sec
X 60 sec (60 sec = 1 min)

..... cm/min
X 60 min (60 min = 1 hr)

..... cm/hr
X 24 hr (24 hr = 1 day)

.....
X 365 days (365 days = 1 yr)

Answer: ..... cm/year (light year)

Repeat the above problem but this time use scientific notation. Check your answers with Answer Sheet at the back of the Unit.

B. What is the mass of a PROTON? (How much matter exists in a proton?)

0,000 000 000 000 000 000 000 001 67 gm

Write this figure into your notebook and then rewrite it in

TOPIC: Scientific Notation

C. What is the mass of an ELECTRON? (How much matter exists in an electron?)

0,000 000 000 000 000 000 000 000 000 91 gm

Write this figure into your notebook, properly labeled, and then rewrite it in scientific notation. Check your answer with the Answer Sheet in back of the Unit.

IF YOU FOUND THAT YOUR ARE STILL HAVING TROUBLE WITH SCIENTIFIC NOTATION, TRY THE FOLLOWING ACTIVITIES. IF YOU WERE ABLE TO DO ALL THE PROBLEMS GIVEN SO FAR WITHOUT DIFFICULTY, YOU MAY SKIP THIS SECTION AND GO ON TO ACTIVITY 8.

* *

5. In scientific notation we want to change the way the number appears and not its value. We must adjust the answer so that it really has the same value as before.

To change the appearance and not the value, we move the decimal point and then adjust the final result by multiplying by 10, 100,1000 or 1/10, 1/100, 1/1000 depending on which way we move the decimal and how many places.

In scientific notation we move the decimal point until it is placed after the greatest place value number. For example:

7984 is the same as 798.4 X 10 (decimal moved 1 place)

or

79.84×10^2 (79.84 X 10 X 10)
decimal moved 2 places

or

7.984×10^3 (7.984 X 10 X 10 X 10)
decimal moved 3 places

Since "7" has the greatest place value, 7.984×10^3 would be the correct form in scientific notation.

DO THE FOLLOWING IN YOUR NOTEBOOK:

Change 768 to scientific form by

a. putting the decimal after the greatest place value number:

TOPIC: Scientific Notation

b. adjusting this change by multiplying 7.68 X 10 X 10

c. writing the correct form as 7.68×10^2

Change 78,959.5 to scientific form by:

a. putting the decimal after the greatest place value number:
7.8 9 5 9.5 (decimal moved 4 places)

b. adjusting this change by multiplying 7.89595 X 10 X 10 X 10 X 10 X 10

c. correct form: 7.89595×10^4

6. Complete the following chart in your notebook and check the answers in the Answer Sheet in the back of the Unit:

NUMBER	EXPANDED SCIENTIFIC FORM	SCIENTIFIC FORM
384	3.84 X 10 X 10	3.84×10^2
55.4		
76.37		
237		
486.2		
963.22		
1374		
7542.6		
6384.57		
11,463		
16,824.5		
84,923.76		
246,892		
861,394.2		
1,830.402		
2,560,000		
40,004.000		
98,000,000		
476,000,000		
3,967,000,000		

After having completed this chart, you may be better able to understand why scientists feel that SCIENTIFIC NOTATION is a "shorthand" for writing large numbers.

UNIT: REMEDIAL

TOPIC: Scientific Notation

7. So far the numbers considered have been larger than "one". It is just as easy to work with numbers that are less than one. For example, to change

.69

to the expanded scientific form, move the decimal after the first significant figure:

6.9 (one place)

and multiply by 1/10 this time, instead of by 10, since the number .69 is less than one:

6.9 X 1/10

In the same way, the number:

.00076 becomes 7.6 (four places)

7.6 X 1/10 X 1/10 X 1/10 X 1/10

In scientific notation:

$6.9 \times 1/10 = 6.9 \times 10^{-1}$

$7.6 \times 1/10 \times 1/10 \times 1/10 \times 1/10 = 7.6 \times 10^{-4}$

COMPLETE THE FOLLOWING CHART in your notebook and check the answers in the Answer Sheet in the back of the Unit:

NUMBER	EXPANDED SCIENTIFIC FORM	SCIENTIFIC NOTATION
.65	6.5 X 1/10	6.5×10^{-1}
.7		
.06		
.082		
.080		
.002		
.0006		
.0034		
.01234		
.00005		
.0105		
.0000008		

TOPIC: Scientific Notation

8. Scientific Notation helps the scientist to handle large numbers more easily. You may have noticed that, in some of the examples used, the number of decimal places was also quite large. In order to further simplify the handling of large numbers, unlimited significant figures may be rounded off.

If the extra digits are less than 5, the preceding figure is not changed:

13.462 13.46

If the digit to be dropped is greater than 5, the last figure kept is increased by 1:

13.468 13.47

If the digit to be dropped is exactly 5, round off so that the retained figure is an even number:

13.465 13.46

13.475 13.48

In our work, we shall use no more than TWO decimal places which may be further rounded off to one place.

TO REFRESH YOUR MEMORY OF SIGNIFICANT FIGURES IN SCIENTIFIC NOTATION AND THE ROUNDING OFF OF THE FIGURES, do the excercises on page 19 of TERMS, TABLES, AND SKILLS. Check your answers at the back of the book. Rewrite in scientific notation.

Round off each of the answers. Check your final answer at the end of the Unit.

9. SCIENTIFIC NOTATION IN ADDITION AND SUBTRACTION

In order to add or subtract numbers using scientific notation, it is important and necessary to have the exponents of 10 the same. (You may recall that when you add or subtract the items have to be similar - when you are adding "apples" you can't put in a few oranges.)

For example, in order to add the following:

2.6×10^3

TOPIC: Scientific Notation

the exponents of ten must first be made the same. It does not matter which power you choose but the final answer must be in the correct scientific notation form.

$2.6 \times 10^3 = 2.6 \times 10^3$ or $.26 \times 10^4$

$6.2 \times 10^4 = 62.0 \times 10^3$ $\quad 6.2 \times 10^4$

$5.2 \times 10^1 = \underline{.052 \times 10^3}$ $\quad \underline{.0052 \times 10^4}$

64.652×10^3 $\quad 6.4652 \times 10^4$

6.4652×10^4

Round off, we get 6.5×10^4

PROBLEM: In your notebook, work out the addition of the following:

a.

$$\begin{array}{r} 1.72 \times 10^2 \\ + \quad 0.15 \times 10^3 \\ \underline{627.1 \times 10^4} \end{array}$$

Be sure to write out the answer in final scientific notation form and to round off the figures. Check your answer in the Answer Sheet at the back of the Unit.

Do the same as above for the following:

b.

$$\begin{array}{r} 2.6 \times 10^{-4} \\ + \quad \underline{3.4 \times 10^{-2}} \end{array}$$

Check your answer as above.

PROBLEM: In your notebook, work out the subtraction of the following:

c.

$$\begin{array}{r} 3.93 \times 10^7 \\ - \quad \underline{7.81 \times 10^6} \end{array}$$

d.

$$\begin{array}{r} 2.9 \times 10^{-4} \\ - \quad \underline{6.4 \times 10^{-5}} \end{array}$$

UNIT: REMEDIAL

TOPIC: Scientific Notation

10. SCIENTIFIC NOTATION IN MULTIPLICATION AND DIVISION

In order to multiply or divide numbers using scientific notation:

Multiply or divide the significant figures just as you would in any other problem with decimals

BUT

<u>Add</u> the exponents when <u>multiplying</u>

<u>Subtract</u> the exponents when <u>dividing</u>

For example:

$$\begin{array}{r} 3.2 \times 10^{3} \\ \times \quad \underline{1.5 \times 10^{2}} \\ 160 \\ \underline{32} \\ 4.80 \times 10^{3+2} \end{array} = 4.8 \times 10^{5}$$

Another example would be:

$$\begin{array}{r} 3.2 \times 10^{-3} \\ \times \quad \underline{1.5 \times 10^{2}} \\ 160 \\ \underline{32} \\ 4.80 \times 10^{-3+2} \end{array} = 4.8 \times 10^{-1}$$

IN YOUR NOTEBOOK, work out the following multiplication problems:

a. $(3.2 \times 10^{-3}) \times (1.5 \times 10^{-2})$

b. $(2.0 \times 10^{8}) \times (8.0 \times 10^{2})$

c. (8,200) X (510) BE SURE TO REWRITE IN SCIENTIFIC NOTATION

d. (910) X (0.00030)

e. $(7.2 \times 10^{4})\ (6.3 \times 10^{7})$

f. $(6.3 \times 10^{5})\ (1.2 \times 10^{4})$

g. $(2.2 \times 10^{4})\ (4.44 \times 10^{1})$

h. $(8.74 \times 10^{2})\ (4.1 \times 10^{2})$

UNIT: REMEDIAL

TOPIC: Scientific Notation

j. $(2.5 \times 10^{7})\ (1.5 \times 10^{-2})$

k. $(3.4 \times 10^{2})\ (5.2 \times 10^{-3})$

l. $(2.4 \times 10^{-2})\ (2.4 \times 10^{-6})$

m. $(1 \times 10^{5})\ (2 \times 10^{7})$

n. $(3 \times 10^{-11})\ (3 \times 12^{-12})$

Check your answers in the Answer Sheet at the end of the Unit.

- - - - - - - - - - - -

IN YOUR NOTEBOOK, work out the following division problems:

Remember that although the significant numbers are divided as usual, the EXPONENTS are SUBTRACTED as for example:

$$\frac{6.6 \times 10^{4}}{2.2 \times 10^{2}} = 3 \times 10^{(4)-(2)} = 3 \times 10^{2}$$

$$\frac{8 \times 10^{2}}{4 \times 10^{4}} = 2 \times 10^{(2)-(-4)} = 2 \times 10^{-2}$$

$$\frac{6 \times 10^{-4}}{3 \times 10^{5}} = 2 \times 10\ (-4) - (+5) = 2 \times 10^{-9}$$

$$\frac{6 \times 10^{5}}{3 \times 10^{-2}} = 2 \times 10^{(+5)-(-2)} = 2 \times 10^{7}$$

o. $\frac{8.4 \times 10^{7}}{2.1 \times 10^{-4}}$

p. $\frac{8.4 \times 10^{-7}}{2.1 \times 10^{-4}}$

q. $\frac{2.73 \times 10^{4}}{9.1 \times 10^{-2}}$

r. $2.6 \times 10^{4} \div 1.3 \times 10^{2}$

s. $3.8 \times 10^{5} \div 2 \times 10^{-2}$

t. $1.8 \times 10^{7} \div 9 \times 10^{6}$

u. $8 \times 10^{3} \div 4 \times 10^{1}$

v. $8 \times 10^{-2} \div 8 \times 10^{3}$

w. $6 \times 10^{4} \div 2 \times 10^{-7}$

x. $5 \times 10^{6} \div 1 \times 10^{5}$

y. $6.52 \times 10^{5} \div 4 \times 10^{2}$

z. $1.344 \times 10^{8} \div 6 \times 10^{1}$

APPENDIX B

ANSWER SHEET

UNIT: Remedial

TOPIC: Scientific Notation

2.

10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	10^{0}	10^{1}	10^{2}
.00005	.0005	.005	.05	.5	5	50	500

10^{3}	10^{4}	10^{5}
5000	50000	5000000

3. (See pg. 150 in TERMS, TABLES, AND SKILLS)

4. A. 946,080,000,000,000,000 cm/yr

9.4608×10^{17}

B. 1.67×10^{-24} gm

C. 9.1×10^{-28}

6.

EXPANDED	SCIENTIFIC NOTATION
5.54 X 10	5.54×10^{1}
7.637 X 10	7.637×10^{1}
2.37 X 10 X 10	2.37×10^{2}
4.862 X 10 X 10	4.862×10^{2}
9.6322 X 10 X 10	9.6322×10^{2}
1.374 X 10 X 10 X 10	1.374×10^{3}
7.5426 X 10 X 10 X 10	7.5426×10^{3}
6.38457 X 10 X 10 X 10	6.38457×10^{3}
1.1463 X 10 X 10 X 10 X10	1.1463×10^{4}
1.68245 X 10 X 10 X10 X 10	1.68245×10^{4}
8.492376 X 10 X 10 X 10 X 10	8.492376×10^{4}
2.46892 X 10 X 10 X 10 X 10 X 10	2.46892×10^{5}
8.613942 X 10 X 10 X10 X10 X 10	8.613942×10^{5}
[illegible]	[illegible]

APPENDIX B

ANSWER SHEET

UNIT: Remedial

TOPIC: Scientific Notation

EXPANDED	SCIENTIFIC NOTATION
2.56 X 10 X 10 X 10 X 10 X 10 X 10	2.56×10^{6}
4.0004 X 10 X 10 X 10 X 10 X 10 X 10 X 10	4.004×10^{7}
9.8 X 10 X 10 X 10 X 10 X 10 X 10 X 10	9.8×10^{7}
4.76 X 10 X 10 X 10 X 10 X 10 X 10 X 10 X 10	4.76×10^{8}
3.967X10 X 10 X 10 X 10 X 10 X 10 X 10 X 10 X 10	3.967×10^{9}

7.

EXPANDED	SCIENTIFIC NOTATION
7 X 1/10	7×10^{-1}
6 X 1/10 X 1/10	6×10^{-2}
8.2 X 1/10 X 1/10	8.2×10^{-2}
8.0 X 1/10 X 1/10	8.0×10^{-2}
2 X 1/10 X 1/10 X 1/10	2×10^{-3}
6 X 1/10 X 1/10 X 1/10 X 1/10	6×10^{-4}
3.4 X 1/10 X 1/10 X 1/10	3.4×10^{-3}
1.23 X 1/10 X 1/10	1.23×10^{-2}
5 X 1/10 X 1/10 X 1/10 X 1/10 X 1/10	5×10^{-5}
8 X 1/10 X 1/10 X 1/10 X 1/10 X 1/10 X 1/10X1/10	8×10^{-7}
6.7432 X 1/10	6.7432×10^{-1}
5.74 X 1/10 X 1/10 X 1/10	5.74×10^{-3}
1 X1/10X1/10X1/10X1/10X1/10X1/10X1/10	1×10^{-8}
7.3 X 1/10 X 1/10	7.3×10^{-2}

APPENDIX B

ANSWER SHEET

UNIT: Remedial

TOPIC: Scientific Notation

8.	(1)	2.9625×10^{4}	3×10^{4}
	(2)	2.006×10^{-2}	2.01×10^{-2}
	(3)	3.017×10^{0}	3.02×10^{0}
	(4)	1.0082×10^{1}	1.01×10^{1}
	(5)	1.1×10^{-4}	1.1×10^{-4}
	(6)	9×10^{-6}	9×10^{-6}
	(7)	3.000009×10^{0}	3×10^{0}
	(8)	2.690×10^{3}	2.7×10^{3}
	(9)	6.50×10^{0}	6.5×10^{0}
	(10)	9×10^{2}	9×10^{2}
	(11)	6.0013×10^{4}	6×10^{4}
	(12)	2.1040×10^{1}	2.1×10^{1}
	(13)	7.01×10^{6}	7.01×10^{6}
	(14)	2.00×10^{3}	2×10^{3}
	(15)	9.060×10^{5}	9.1×10^{5}

9.	a.	6.3×10^{6}	c.	4.7×10^{7}
	b.	3.43×10^{-2}	d.	2.3×10^{-4}

10.	a.	4.8×10^{-5}	j.	3.8×10^{5}	r.	2×10^{2}
	b.	1.6×10^{11}	k.	1.8×10^{0}	s.	1.9×10^{7}
	c.	4.2×10^{6}	l.	5.8×10^{-8}	t.	2×10^{0}
	d.	2.7×10^{-1}	m.	2×10^{12}	u.	2×10^{2}
	e.	4.5×10^{12}	n.	9×10^{-23}	v.	1×10^{-5}
	f.	7.6×10^{9}	o.	4×10^{11}	w.	3×10^{11}
	g.	9.8×10^{5}	p.	4×10^{-3}	x.	5×10^{1}