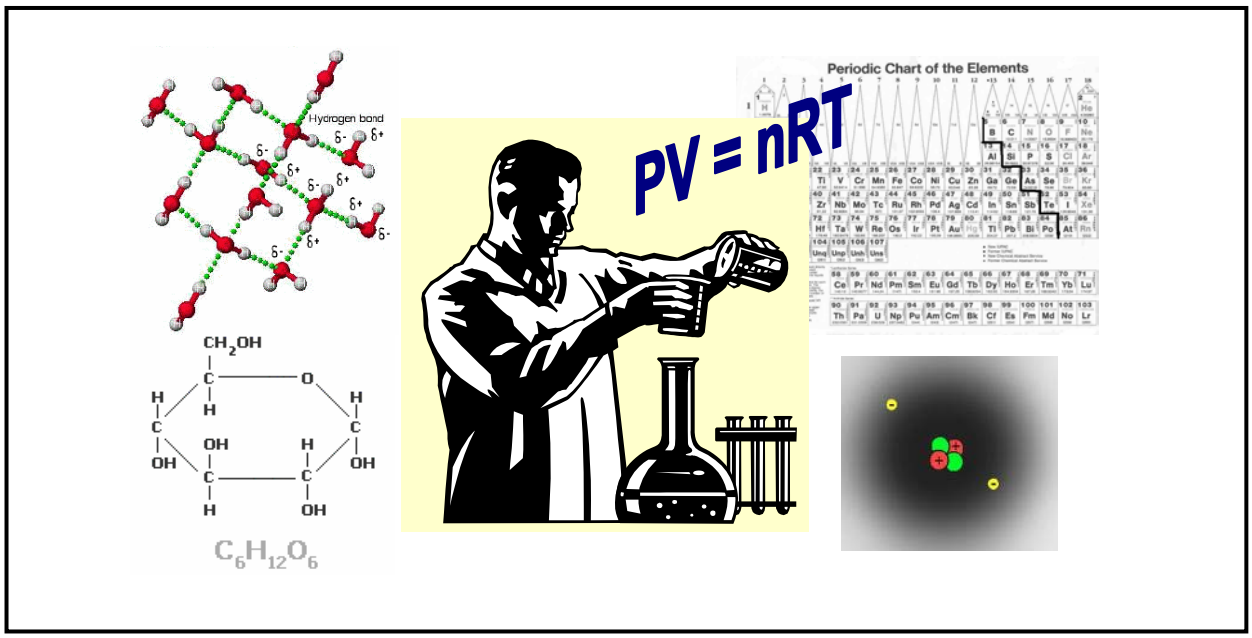
Project EASE

(Effective Alternative Secondary Education)

CHEMISTRY



MODULE 1

Chemistry and You

BUREAU OF SECONDARY EDUCATION
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Module 1
Chemistry and You

What this module is about

The study of chemistry is interesting for many reasons. It explains events in nature, it touches nearly every aspect of human life, and it plays a vital role in the daily activities we do at home or elsewhere. Chemistry has been called the central science because it is essential to the study of other sciences. Like all other sciences, the study of chemistry is fun.

This module can help you look at the world in ways you have never imagined. It tackles the importance of chemistry in our daily lives. It also looks at the desirable qualities and attitudes of some Filipino and foreign scientists that lead them to develop new technologies. Lastly, it discusses scientific measurements and their applications.

This module contains the following lessons:

- **Lesson 1 – Chemistry: Its Beginning and Importance to Human Life**
- **Lesson 2 – Desirable Qualities and Attitudes of Scientists in the Field of Chemistry**
- **Lesson 3 – Scientific Measurements**

Read this module and you will see why chemistry can and should play an important role in your life.

So, start and enjoy.

What you are expected to learn

After going through this module, you are expected to:

1. discuss how chemistry started;
2. explain its importance to human lives;
3. apply desirable qualities and scientific attitudes in solving problems encountered everyday; and
4. discuss the importance of scientific measurement.

How to learn from this module

Here's a simple guide for you in going about the module:

1. Read and follow the instructions carefully.
2. Answer the pretest in order to determine how much you know about the lessons in this module.
3. Check your answers with the given answer key at the end of this module.
4. Read each lesson and do all the activities that are provided for you.
5. Perform all the activities diligently to help and guide you in understanding the topic.
6. Take the self-tests after each lesson to determine how well you understood the topic.
7. Answer the posttest to measure how much you have gained from the lessons.

Good luck!

What to do before (Pretest)

Multiple Choice: Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. The science that tackles the study of matter, its structure and the changes in composition that matter undergoes is
   a. Astrology
   b. Chemistry
   c. Ecology
   d. Physics

2. When a chemist performs an experiment, the quantity that is being tested is the
   a. control
   b. law
   c. theory
   d. variable

3. Juan is comparing how many kilos of rice can be contained in a sack. What process is he doing?
   a. counting
   b. interpolation
   c. measurement
   d. testing

4. After making an observation and proposing a hypothesis, the next step that a scientist should do is to
   a. form a conclusion
   b. do another experiment
   c. analyze the data gathered
   d. state the conclusion

5. A famous chemist has these words: "*One may take it for granted that in every reaction there is an equal quantity of matter before and after*." He was able to establish the science of Modern Chemistry. Who was this famous chemist?
   a. John Dalton
   b. Alexander Fleming
   c. Robert Boyle
   d. Antoine Lavoisier

6. Jack and Rose gather information using their five senses. What are they doing?
   a. stating their conclusion
   b. gathering data through observation
   c. formulating hypothesis based on the gathered data
   d. measuring the exact quantity compared to the other quantities

7. The statement "Mercury is denser than water" is a _____.
   a. law
   b. fact
   c. theory
   d. problem

8. During an experiment, one tries to form his/her theory as quickly as possible. This process is called _____.
   a. data-gathering
   b. generalizing
   c. hypothesizing
   d. observing

9. Which of the following statements is **CORRECT**?
   a. A scientist's good characteristics include open-mindedness, honest, perseverance and curiosity.
   b. Only the most brilliant people like scientists can make discoveries
   c. Scientists must follow a strict plan in order to make a successful result
   d. All of the above

10. In what manner is chemistry of immediate use to an agriculturist?
   a. in soil preparation
   b. in the sowing technique
   c. in the use of soil fertilizer
   d. in selecting what seed to plant

11. A doctor performed several laboratory tests like X-ray, complete blood count, urinalysis and stool test on a patient. Which of the following steps in the scientific method did the doctor do?
   a. making a generalization
   b. formulating a hypothesis
   c. testing the hypothesis
   d. identifying a problem

12. Basically, chemistry deals with the study of the following **EXCEPT**:
   a. changes that matter undergoes
   b. composition of matter
   c. properties of matter
   d. forces

13. How many significant figures are there in the measurement 9.0052 kg?
   a. 5
   b. 6
   c. 7
   d. 8

14. An appropriate metric unit to measure the distance from Manila to Jolo would be:
    a. meter
    b. centimeter
    c. kilometer
    d. nanometer

15. The scientific method of solving a problem follows the sequence:
    a. hypothesize, conclude, experiment
    b. hypothesize, experiment , conclude
    c. conclude, hypothesize, experiment
    d. experiment, hypothesize, conclude

16. The ratio of mass to volume is called
    a. area
    b. volume
    c. density
    d. temperature

17. The number of digits by which a series of number is known with a degree of reliability is called:
    a. accuracy
    b. parallax
    c. precision
    d. significant figures

18. Discoveries are sometimes made through accident. This is called
    a. invention
    b. innovation
    c. serendipity
    d. discovery by luck

19. The system of measurement used by scientists around the world is
    a. British System
    b. English System
    c. Metric system
    d. All of these

20. Derived quantities are called such because they were based on the:
    a. SI units
    b. secondary units
    c. fundamental units
    d. formula

21. What is the equivalent of -40°C in Fahrenheit scale?
    a. 32°F
    b. 40°F
    c. -32°F
    d. -40°F

22. The product of (2×10^3) and (3×10^3) is
    a. 6×10^1
    b. 6×10^3
    c. 6×10^4
    d. 6×10^6

23. Which of the following statements is **TRUE** about a scientific method?
    a. When results of an experiment do not fit the hypothesis, a scientist may ethically discard the results and repeat the experiment.
    b. The scientific method is a continuous process by which people learn about the physical universe.
    c. Scientists report the experimental results, but not the experimental design.
    d. People structure their lives on the principles of scientific method.

24. Which equivalent factor does **NOT** describe a LITER?
    a. 1 Liter = 1000 cubic centimeters
    b. 1 gallon = 3.79 liters
    c. 1 Liter = 10^3 mL
    d. 1 Liter = 1 m^3

25. The branch of science that deals with the study of matter, its structure and the changes in its composition is
    a. life science
    b. chemistry
    c. earth science
    d. physics

Key to answers on page 27.

Lesson 1. Chemistry: Its Beginning and Importance to Human Life

Chemistry is a branch of science that helps us understand all forms of matter. Like all other sciences, chemistry began in the prehistoric era and flourished in the modern time. Using the concepts, principles and skills in chemistry, this module will open our world to the wonders of the things that surround and affect us.

What you will do

Activity 1.1

Read this lesson and begin to understand how chemistry started and became the central science.

The Origins of Chemistry: Where It All Began

The earliest attempts to explain natural phenomena led to fanciful inventions – to myths and fantasies – but not to understanding.

Around 600 B.C., a group of Greek philosophers became dissatisfied with these myths. Stimulated by social and cultural changes as well as curiosity, they began to ask questions about the world around them. They were able to discover basic truths of nature by thinking things through experiments. The years between 600 B.C. and 400 B.C. are called the “Golden Age of Philosophy”.

Some of the Greek philosophers believed they could find a single substance from which everything else was made. Thales believed that it was water and Anaximenes thought it was air. Empedocles’ idea was that the universe is made of four elements namely earth, air, fire and water.

The period from 440 B.C and 420 B.C. was known as the ***age of atomism*** when Leucippus and Democritus believed that matter was made of smallest particle which they called ***atom***, a particle that could not be seen. Two thousand years later scientists proved that this idea was true.

Chemistry Today

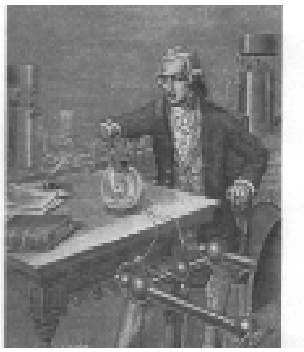
The Greek philosophers continued to search for truth and while they were studying philosophy and mathematics, the Egyptians were practicing the art of chemistry. They were mining and purifying the metals gold, silver and copper. They were making embalming fluids and dyes. They called this art ***khemia***. This Egyptian word became the Arabic word ***alkhemia*** and then the English word ***alchemy.*** Alchemists tried to find the *"philosopher's stone"*, a supposed cure for all diseases, and the *"elixir of life"* which would prolong life indefinitely. They failed in both attempts but along the way, they were able to discover acetic acid, nitric acid, ethyl alcohol and other substances used by chemists today.

Robert Boyle, The Forerunner of Modern Chemistry

The modern age of Chemistry dawned in 1661 when Robert Boyle, an English chemist, published his book ***The Sceptical Chymist.*** His idea opposed the alchemists' belief. Instead he proposed that scientists must start from basic principles and that theories about the world have to be proven by a series of experiment. He formulated the law relating volume and pressure.

If Robert Boyle laid down the basic definition of an element, a French chemist Antoine Laurent Lavoisier laid down the basic definition for testing whether a substance fitted its definition.

Antoine Lavosier, The Father of Modern Chemistry



Innovative and scientific approaches paved the way for the rapid development of chemistry. In 1770, Antoine Lavoisier gained wide recognition when he refuted the then prevalent belief that water is converted into earth by repeated distillation. By carefully weighing both the earthy residue and the distilling apparatus, he demonstrated that the solid matter came from the glass vessels and not from the water. Speculating on the nature of the traditional four elements—earth, water, air, and fire, he began to investigate the role of air in combustion.

On November 1, 1772, he stated that when burned sulfur and phosphorus increased in weight because they absorbed "air". On the other hand, the metallic lead formed when

litharge was heated with charcoal weighed less than the original litharge because it had lost "air." He gave phlogisticated air the name oxygen, or "acid producer" He explained **phlogiston theory** as the result of the combination of the burning substance with oxygen. This theory was later revised and now known as the **theory of combustion.** On June 25, 1783, he also explained that water was the product formed by the combination of hydrogen and oxygen. An English chemist named Henry Cavendish opposed this idea and later was able to produce quantities of hydrogen, called "inflammable air," by decomposing water into its constituent gases.

Because of Lavoisier's findings, chemists tasted the first sound understanding of the nature of chemical reactions. His experiments paved the way for the flourishing of modern chemistry. Thus, he became known as the ***Father of modern chemistry.***

Time Line in Chemistry

Date	Person	Event
600 B.C.	Thales	Idea that water is the main form of matter
546 B.C	Anaximenes	Idea that air is the main form of matter
450 B.C.	Empedocles	Idea that the four elements – earth, air, fire and water combine in different proportions
420 B.C.	Leucippus and Democritus	Idea of the atom or the Age of Atomism
1661	Robert Boyle	The Sceptical Chymist
1766	H. Cavendish	Discovery of hydrogen
1775	A. Lavoisier	Discovery of the composition of air
1800	John Dalton	Proposed the Atomic Theory
1820	John Jacob Berzelius	Devised the modern symbols of elements
1869	Dmitri Mendeleev	Periodic Law and designed the Modern Periodic Table of Elements
1886	Eugene Goldstein	Naming of cathode rays and discovery of proton
1897	J.J. Thomson	Proposed the structure of the atom; discovery of electron
1911	E. Rutherford	Proposed the nuclear atom; discovery of a nucleus
1913	Niels Bohr	Proposed the energy levels in atoms;

Soon after, chemists like Joseph Priestly, John Dalton, Niels Bohr, Ernest Rutherford, the Curies and other scientists made new advancements in chemistry. These advancements led to many distinct branches of chemistry.

Branches of Chemistry

During the 1700s and early 1800s, most chemists believed that there were two main branches of chemistry: organic and inorganic. These two branches still exist today, however, the rules governing their classification have changed.

1. ***Organic Chemistry*** is the study of the compounds of carbon. This branch of chemistry is important to the petrochemical, pharmaceutical and textile industries. All living organisms have traces of carbon.

2. ***Inorganic Chemistry*** is the study of chemical elements and their compounds except carbon.

3. Other branches:

    a. ***Physical Chemistry*** deals with the relations between the physical properties of substances and their chemical formations along with their changes.

    b. ***Biochemistry*** is a science that fused biology and chemistry. It is concerned with the composition and chemical reactions that occur in the formation of living species.

    c. ***Analytical Chemistry*** deals mostly with the composition of substances. It seeks to improve means of measuring chemical composition of natural and artificial materials. In medicine, this is the basis for clinical laboratory tests for disease diagnosis. The nutritional value of the food we eat is determined through chemical analysis. Analytical chemists analyze many household products.

Importance of Chemistry

Chemistry plays a very important role in different areas of life. Some people view chemistry as a very technical subject that deals with formulas and mind-boggling computations. This may be true, but if you will try to look at things around you, you will begin to appreciate its importance. The products of chemistry and technology are highly useful. For example, when you go to a beauty saloon and ask the hair stylist to straighten or curl your hair, she/he needs to use a correct solution, or else it will not come out right. Chemistry also plays a very important role in medicine, engineering, agriculture, photography and other related fields.

What you will do

Self-Test 1.1

Match COLUMN A with COLUMN B.

COLUMN A	COLUMN B
Pioneers of Chemistry	
1. started the age of atomism	a. Empedocles
2. proposed the phlogiston theory	b. Leuccipus
3. discovered hydrogen	c. Anaximenes
4. father of modern chemistry	d. Henri cavendish
5. forerunner of modern chemistry	e. John Dalton
6. believers of "false" chemistry	f. Robert Boyle
7. proposed the atomic theory	g. Antoine Lavoisier
8. wrote the Sceptical Chymist	h. Alchemist
Branches of Chemistry	
9. study of carbon and its compounds	i. Organic Chemistry
10. study of different chemical elements, its properties and structure	j. Inorganic Chemistry
11. study of the properties of substances and their chemical formations	k. Physical Chemistry
12. study of the chemical properties of substances particularly living organisms	l. Biochemistry
13. a branch of chemistry that is used as basis for laboratory tests for disease diagnosis	m. Analytical Chemistry
Chemistry Timeline	
14. "false" chemistry	n. Between 600 B.C. and 400 B.C.
15. Golden Age of philosophy	o. alchemy

Key to answers on page 27.

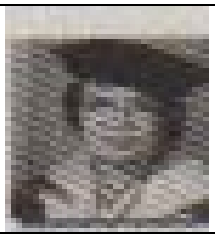
Lesson 2. Desirable Qualities and Attitudes of Scientists

The many wonders of chemistry have made it the central science. What distinguishes science from the other fields of study is the way in which it seeks answers to questions and the approach of scientists in solving problems.

What are some of the characteristics and attitudes that chemists generally have in common? Like us, chemists ask how and why things happen. However, unlike most of us,

they are not satisfied with asking “why”. They always have possible solutions to a problem. They will not stop unless a problem is solved.

Some Famous Filipino Chemists

 **DR. JULIAN A. BANZON**	A biophysical chemist who did the pioneering works on coconut as a source of chemicals and fuels. He devised the process of extracting residual coconut oil by chemical means rather than by physical means
 **DR. ALFREDO C. SANTOS**	He gained recognition for his researches on natural products. He did a lot of work on alkaloids from indigenous medicinal plants.
 **DR. LOURDES J. CRUZ**	She has made significant contributions to the biochemistry of toxic peptides from venom of fish-hunting Conus marine snails. Her studies led to the biochemical characterization of active peptides from Conus venom and the development of conotoxins as biochemical probes
 **DR. LUZ OLIVEROS-BELARDO**	A pharmaceutical chemist who worked on the chemistry of natural products and essential oils from most Philippines plants. Her works resulted in the production of new flavors and herbal medications.
 **DR. BIENVENIDO O. JULIANO**	An organic chemist who is concerned with the properties of starch and protein and other grain constituents in relation to grain quality of rice.
 **CLARA Y. LIM-SYLIANCO**	An organic chemist with an expertise on mutagens, anti-mutagens and bio-organic reactions. She has written numerous scientific articles, books, monographs and related materials. Some of her books published are used as textbooks in college chemistry.

 **DR. SOLITA CAMARA-BESA**	A medical doctor by profession, she worked on sodium and potassium content of Philippine foods and established standards useful in the preparation of diets. Her analysis of cholesterol gave the Filipino the idea of the importance of diet especially on fats and cholesterol.

Do the activity below to get a feel of how it is to be a chemist.

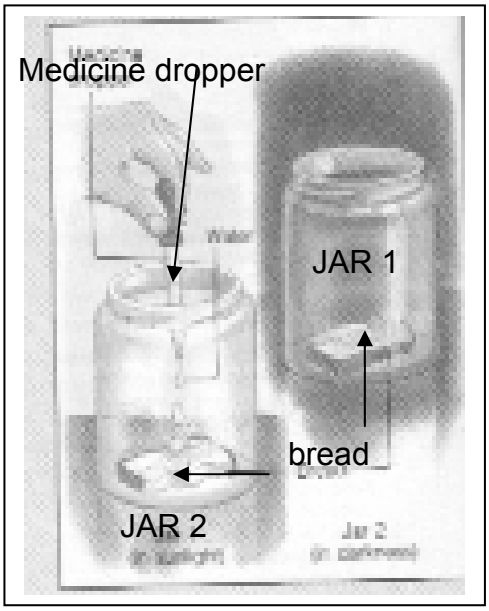
What you will do

Activity 2.1

A. Perform this experiment designed for you:

Materials: 2 jars with lid
1 medicine dropper
2 slices of bread

Set-up:



Procedure:

1. Put half a slice of bread into each jar.
2. Moisten each half slice with ten drops of water.
3. Cover the jars tightly. Keep one jar in sunlight and the other in a dark room or closet.
4. Repeat procedures 1 and 3 in the other jar.
5. Observe the jars daily for 1 week.
6. Compare the results.
7. Write your observations on the table.

Observations:

Day	Jar 1	Jar 2	Jar 3	Jar 4
Sunday				
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				

Analysis of Observations:

_____
_____
_____
_____
_____
_____
_____

1. What could be the problem in the experiment?

_____
_____

2. How will you answer the problem?

_____
_____

3. What are the implications of the experiment in your everyday living?

_____
_____
_____
_____

Key to answers on page 28.

B. How do scientists solve a particular problem in his/her experiment?

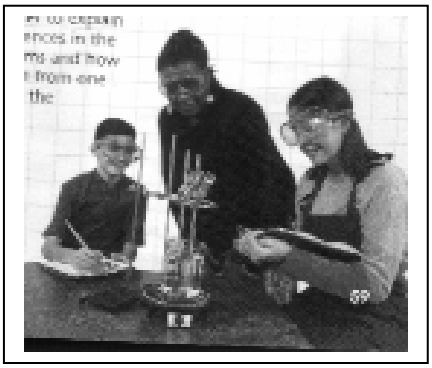
The problem in the experiment was solved step by step. The step-by-step approach is what we call **SCIENTIFIC METHOD**. It is a systematic way of problem solving used by scientists.

The basic steps in the scientific method are:

1. **STATING THE PROBLEM** – identifying or knowing what you want to investigate or study

2. **GATHERING INFORMATION ON THE PROBLEM –** jotting down important data or information gathered through observations

3. **FORMING HYPOTHESIS** – ***hypothesis is an educated guess***. Forming this would help you find out what the answer to your problem *might be*.



4. **PERFORMING EXPERIMENTS TO TEST HYPOTHESIS** – design and carry out an experiment to test your hypothesis. Observe everything you can. The smallest detail can sometimes be the most significant.

5. **RECORDING AND ANALYZING DATA** – interpret and evaluate the information gathered. Do calculations if needed to come up with your conclusion

6. **STATING A CONCLUSION** – this answers the problem stated. If the problem is still unsolved, try a new approach or perform another experiment. Repeat the steps from the beginning until a solution may become clear.

Scientists run an experiment setup and a control setup to make sure the results of the experiment were caused by the variable and not by some hidden factors.

Try this activity and identify the different science processes.

What you will do

Activity 2.2

1. Examine the picture below. What can you say about Picture A and Picture B?

PICTURE A

PICTURE B

_____ _____

_____ _____

What made you say so?

_____

_____

2. The pictures on the next page show a boy who is using a colored shampoo. Which of the following pictures implies observation, inference, hypothesis and prediction?

A **B** **C** **D**

The boy says:

Picture A: "My shampoo is purple." _____
Picture B: "Purple? Someone must have added color to my shampoo." _____
Picture C: "The color of the shampoo doesn't change hair color." _____
Picture D: " Water will wash away all purple color in my hair." _____

Key to answers on page 28.

Discoveries in science sometimes occur by luck or by accident. This is called **SERENDIPITY.**

What you will do

Self-Test 2.1

Analyze the following situations and answer the questions that follow.

Rachel was doing an experiment. She placed a piece of orange peel in each of the two jars. She added 3 milliliters of water to jar 1 and placed it in the refrigerator. She added no water to jar 2 and placed it on a windowsill in the kitchen. By the end of the week, she noticed more mold growth in jar 2. She concluded that light, warm temperature, and no moisture were ideal conditions for mold growth.

1. What was Rachel's problem?

_____
_____

2. What were her observations?

_____
_____
_____

3. How did she check her observations?

_____
_____

4. What was her conclusion?

_____
_____

5. Can you say that Rachel's conclusion was correct? Why or why not?

_____
_____

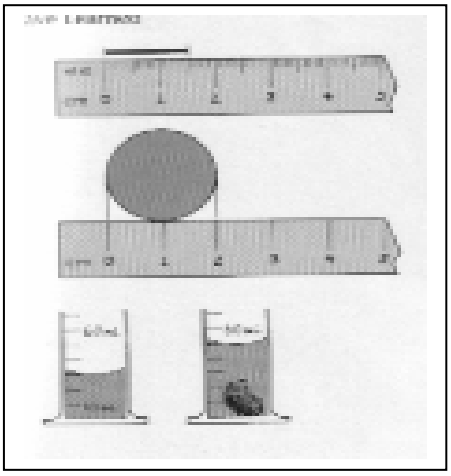
Key to answers on page 28.

Lesson 3. Scientific Measurement

Chemistry is an experimental and a quantitative science. The development of its principles is based on carefully designed experiments carried out under controlled conditions.

At the heart of any quantitative experiment in our surroundings and in laboratories is the performance of operations called *measurements.* Measurements are made nearly everyday, not only in the laboratory but in every establishment and even at home.

This lesson will take you to the world of scientific measurements. Read this lesson and learn to appreciate its importance.



METRIC – The Universal Language of Scientific Measurement

- Measurement is the process of comparing a known quantity like a measuring device to an unknown quantity or the things or objects to be measured. It is the process of determining how many times a certain quantity is contained in a standard measuring device.

- The scientific system of measurement is called the ***metric system***. The metric system is often referred to as the ***International System of Units, or SI***.

- Scientists throughout the world use the metric system of measurement. The two subdivisions of the metric system are the mks (meter-kilogram-second) and cgs (centimeter-gram-second). It is based on units of ten. SI consists of three classes of units that form coherent set base units, derived units and supplementary units.

  There are seven basic or fundamental units considered in the SI.

  Fundamental Quantities are quantities that can be measured directly using measuring devices.

- **Basic Types of Physical Quantities**

  1. **Mass (m)** is a basic property of matter. It is the measure of the amount of matter it contains. The standard unit of mass is the kilogram, kg. One **kilogram (kg)** is the mass of 1 **liter (L)** of water at 4°C and a pressure of 1 atmosphere **(atm)**. The mass of an object remains the same even if the position of the object is changed with reference to the earth's center. It is measured using the triple beam balance or the equal arm balance.
  2. **Length (l)** is a distance between two distinct points. It is measured by using a metric ruler. **Width (w)** is also a length, and **height (h)**, is the vertical distance. The basic unit is the **meter (m)**.
  3. **Time (t)** is the regular interval between two successive points. The standard unit of time is the second. The second was originally defined in terms of the motion of the earth, but it was revised and instead compared to vibrations of cesium atoms.
  4. **Temperature (T)** is the measure of the hotness or coldness of an object. It is technically defined as the measure of the average kinetic energy of a body. **Kelvin (K)** is used as the basic unit.
  5. **Electric current (I)** is the measure of the flow of electrons or charges. An ammeter is used to measure current expressed as **Ampere (A).**
  6. **Luminous intensity (E)** is the amount of illumination received by an object. The unit of measure used to describe this is **candela (cd).**
  7. **Amount of substance (n)** is the number of moles. The basic unit is the **mole** or **mol**.

The different units of measurements are used in our day-to-day activities. When you go the gas station to fill up your gas tank, the unit of measurement used is liter. In the sari-sari store or supermarket, the units used for mass are grams and kilograms. For volume, milliliters or liters are used. On road markers, the distances are measured in kilometers.

The most common measurements you will be using in the laboratory are those of length, mass, volume and temperature.

The Common Metric Units

Length	Mass
1 meter, m = 100 centimeters, cm 1 meter, m = 1000 millimeters, mm 1 meter, m = 1000 000 micrometers, μm 1000 meters, m = 1 kilometer, km	1 kilogram, kg = 1 000 grams, g 1 gram, g = 1000 milligrams, mg 1000 kilograms, kg = 1 metric ton
Volume	**Temperature**
1 Liter, L = 1000 milliliters, mL 1 Liter, L = 1000 cubic centimeter, cc	**°C** = 5/9(°F – 32) or **°C** = (°F – 32)/ 1.8 **°F** = 9/5(°C) +32 or **°F** = 1.8(°C) +32 Kelvin, **K** = °C + 273

The Table of Prefixes

Prefix	Symbol	Powers of Ten	Example
Deci	d	0.1 $=10^{-1}$	decimeter, dm
Centi	c	0.01 $=10^{-2}$	centimeter, cm
Milli	m	0.001 $=10^{-3}$	milligram, mg
Micro	μ	0.000001 $=10^{-6}$	microgram, μg
Nano	n	0.000000001 $=10^{-9}$	nanometer, nm
Deka	da	10^{1} = 10	dekagram, dag
Hecto	h	10^{2} = 100	hectometer, hm
Kilo	k	10^{3} = 1 000	kilogram, kg
Mega	M	10^{6} = 1 000 000	Megagram, Mg
Giga	G	10^{9} = 1 000 000 000	Gigameter, Gm

Metric – English Equivalents

Metric	English
1 Liter, L	1.06 quartz, qt.
250 milliliter, mL	1 cup, c
1 kilogram, kg	2.2 pounds, lb.
28.3 grams, g	1 ounce, oz.
3.79 Liters, L	1 gallon, gal.

What you will do

Activity 3.1 Conversion

Study the examples.

1. Convert 75 millimeters (mm) to its corresponding length in
   a. meters b. centimeters c. kilometers

   Solution:

   a. $75\,\cancel{\text{mm}} \times \dfrac{1\,\text{m}}{1000\,\cancel{\text{mm}}} = \dfrac{75\,\text{m}}{1000} = 0.075\,\text{m}$

   b. $0.075\,\cancel{\text{m}} \times \dfrac{100\,\text{cm}}{1\,\cancel{\text{m}}} = 0.075 \times 100\,\text{cm} = 7.5\,\text{cm}$

   c. $7.5\,\cancel{\text{cm}} \times \dfrac{1\,\cancel{\text{m}}}{100\,\cancel{\text{cm}}} \times \dfrac{1\,\text{km}}{1000\,\cancel{\text{m}}} = \dfrac{7.5\,\text{km}}{100\,000} = 0.000075\,\text{m}$

2. Change 430 milligrams to grams
   From the Table of Prefixes , milli = 10^{-3}
   Change the powers of ten to a prefix. 430 x 10^{-3} grams
   By the use of scientific notation, it would be 4.30 x 10^{2} x 10^{-3}
   The final answer is **4.30 x 10^{-1}**

3. 5 gallons of mineral is equivalent to how many liters?

   $5\,\text{gallons} \times \dfrac{3.79\,\text{Liters}}{\text{gallon}} = \mathbf{18.95\ liters}$

4. 2 x **10^{9}** bytes is equal to 2 **Giga**bytes or 20 **Gb**

5. The normal body temperature is 37°C. What is its equivalent in **°F** and **K**?

   Formula:

   $°C = \dfrac{5}{9}(°F - 32)$ or $°C = \dfrac{(°F - 32)}{1.8}$

   $°F = \dfrac{9}{5}(°C + 32)$ or $°F = 1.8\,(°C) + 32$

   $\text{Kelvin}, K = °C + 273$

   Solution:

   $\mathbf{°F} = \dfrac{9}{5}(37°C) + 32 = 1.8\,(37°C + 32) = 66.6 + 32 = \mathbf{98.6\,°F}$

   $\mathbf{K} = °C + 273 = \mathbf{376}$

or 98°F is equal to ____°C

$$°\mathbf{C} = \frac{5}{9}(°F - 32) \text{ or } °\mathbf{C} = \frac{(°F - 32)}{1.8}$$

$$°\mathbf{C} = \frac{5}{9}(98 - 32) \text{ or } °\mathbf{C} = \frac{(98 - 32)}{1.8}$$

$$= \frac{66}{1.8}$$

$$= \mathbf{36.67}\ °\mathbf{C}$$

6. The density of water in the ***cgs*** is 1 g/cm^3. What is its density in ***mks***?

$$\frac{1\text{g}}{\text{cm}^3} \times \frac{(100\text{cm})^3}{1\text{m}^3} \times \frac{1\text{kg}}{1000\text{ g}} = \frac{1\text{g}}{\text{cm}^3} \times \frac{(10^2\text{cm})^3}{1\text{m}^3} \times \frac{1\text{kg}}{10^3\text{ g}}$$

$$= \frac{1\cancel{\text{g}}}{\cancel{\text{cm}^3}} \times \frac{10^6\cancel{\text{cm}^3}}{1\text{m}^3} \times \frac{1\text{kg}}{10^3\cancel{\text{g}}}$$

$$= \frac{10^6\text{kg}}{10^3\text{ m}^3}$$

$$= \frac{\mathbf{10^3\ kg}}{\mathbf{m^3}} \text{ or } \mathbf{1000}\ \frac{\mathbf{kg}}{\mathbf{m^3}}$$

SCIENTIFIC NOTATION is a compact, simple and easy way of writing down very small and very large numbers using powers of ten. The ***exponent*** tells the number of times the decimal point is moved from its original place to the right or from the original place to the left. The exponent is **NEGATIVE** if the decimal point is moved from ***left to right*** and **POSITIVE** if it is moved from ***right to left***.

Example:

1. 4 000 000 = 4.0×10^6
2. 532 000 000 = 5.32×10^8
3. 0.000000045 = 4.5×10^{-8}
4. 0.0032 = 3.2×10^{-3}

1. `To add and subtract numbers expressed in powers of ten, simply copy the common exponent and proceed as in addition or subtraction. (*If the exponents are not the same, make them the same first before adding or subtracting)*

Add: $(1.3 \times 10^2) + (2.4 \times 10^2) = \mathbf{3.7 \times 10^2}$

$(4.0 \times 10^3) - (2.3 \times 10^2) = \mathbf{1.7 \times 10^2}$

$(5.2 \times 10^5) + (1.3 \times 10^4) =$

(*First make the exponent the same, then add the numbers and copy the common exponent.*)

$(5.2 \times 10^5) + (0.13 \times 10^5) =$ **5.33×10^5**

2. To multiply numbers expressed in powers of ten, add the exponents. If the exponents are of different signs, meaning, one is positive and the other one is negative, add them algebraically by subtracting the smaller number from the larger number and copying the sign of the larger number.

$$(2.5 \times 10^5) \bullet (4.3 \times 10^3) = 10.75 \times 10^8$$
$$= 1.075 \times 10^{8+1}$$
$$= \mathbf{1.075 \times 10^9}$$

Final answer should be expressed in standard form. M.N x 10^n, where ***M*** is the only digit before the decimal point, ***N*** is/are the number(s) after the decimal point, and ***n*** is the exponent.

$$(2.5 \times 10^5) \bullet (4.3 \times 10^{-3}) = 10.75 \times 10^2 = \mathbf{1.075 \times 10^3}$$
$$(2.5 \times 10^{-5}) \bullet (4.3 \times 10^3) = 10.75 \times 10^{-2} = \mathbf{1.075 \times 10^{-1}}$$

3. To divide numbers expressed in powers of ten, subtract the exponents. If the exponents are of different signs, meaning, one is positive and the other one is negative, change the sign of the number to be subtracted and then proceed as in addition.

$$\frac{4.3 \times 10^5}{2.5 \times 10^3} = 1.72 \times 10^{5-3} = \mathbf{1.72 \times 10^2}$$
$$\frac{4.3 \times 10^{-5}}{2.5 \times 10^3} = 1.72 \times 10^{-5-3} = \mathbf{1.72 \times 10^{-8}}$$
$$\frac{4.3 \times 10^5}{2.5 \times 10^{-3}} = 1.72 \times 10^{-5-3} = \mathbf{1.72 \times 10^{-8}}$$

Parallax - is the apparent shift in position of an object as it is viewed or observed at different angles.

Accuracy and Precision

Accuracy is a degree of agreement between a measured value and the true value.
Precision is the degree of the instrument's exactness.

Significant figures – the number of digits or figures that best represents the value of a measurement.

Rules in Determining the Number of Significant Figures:

- All non-zero digits are significant. (1, 2, 3, 4, 5, 6, 7, 8, 9)
- All zeros in between two non-zero digits are significant. 2804 has four (4) significant figures.
- All zeros to the right of a decimal point but to the left of a non-zero digit are NOT significant. For example, 0.0003068 has four (4) significant figures
- All zeros to the right of non-zero digit without an expressed decimal point following it are NOT significant. For example, 406,000 has three (3) significant figures, but 406,000. has six (6) significant figures because of the indicated decimal point.

Graph - is a tool or mechanism to show the relationship between two variables. The two kinds of variables are the **dependent variables** plotted on the **Y-axis** or the **ordinate** and the **independent variables** plotted on the **X-axis** or the **abscissa.**

What you will do

Self-Test 3.1

Direction: Do the indicated operation.

1. A block of iron is 5.0 cm long, 3.0 cm high and 4.0 cm wide weighs 474 g. What is the density of the iron?

2. The density of alcohol is 0.8 g/cm^3. Calculate the volume of 1.6 kg of alcohol.

3. Convert the following units:
   a. 1.2 L to gallons to quartz
   b. 4.17 kg to grams to decigrams
   c. 40°C to °F

4. Indicate the number of significant figures:
   a. 2 546 000 000
   b. 0.00000000150
   c. 0.00003007

5. a. $(3.6 \times 10^4) / (4 \times 10^{-6})$
   b. $(2.3 \times 10^{-5}) \bullet (3.0 \times 10^8)$

Key to answers on page 28.

Let's Summarize

1. **Pure science** involves gathering information or the discovery of a pattern. When that information is applied to some use, it becomes technology. **Chemistry** is a central science that deals with the composition of matter, its structure and the changes in composition that this matter undergoes.

2. **Branches of Chemistry**

    a. ***Organic Chemistry*** is the study of the compounds of carbon. This branch of chemistry is important to the petrochemical, pharmaceutical and textile industries. All living organisms have traces of carbon.
    b. ***Inorganic Chemistry*** is the study of chemical elements and their compounds except carbon.
    c. Other branches:
        - ***Physical Chemistry*** deals with the relations between the physical properties of substances and their chemical formations along with their changes.
        - ***Biochemistry*** is a science that is concerned with the composition and changes in the formation of living species.
        - ***Analytical Chemistry*** deals mostly with the composition of substances. It seeks to improve means of measuring chemical composition of natural and artificial materials. In medicine, this is the basis for clinical laboratory tests for disease diagnosis. The nutritional value of the food we eat is determined through chemical analysis. Analytical chemists analyze many household products.

3. **Origin of Chemistry**

    a. **Age of Alchemy** – the chemistry of mining and purifying the metals gold, silver and copper. This art is called ***khemia***. This Egyptian word became the Arabic word ***alkhemia*** and then the English word ***alchemy***.
    b. **Age of atomism** when Leucippus and Democritus believed that matter was made of smallest particle which they called ***atom***, a particle that could not be seen.
    c. **Modern Chemistry** – the stage when Antoine Lavoisier proposed the **phlogiston theory** as the result of the combination of the burning substance with oxygen. This theory was later revised and now known as the **theory of combustion**.

4. A problem is a situation that seems to be missing some information.

5. Solving problems involves looking for patterns, making predictions, and testing the predictions. An approach to problem solving used by chemists is called the **scientific method**.

6. **Scientific Method** is a systematic approach consisting of the following basic steps:

a. **Stating the Problem** – identifying or knowing what you want to investigate or study
b. **Gathering Information on the Problem –** jotting down important data or information gathered through observations
c. **Forming Hypothesis** – ***hypothesis is an educated guess***. Forming this would help you find out what the answer to your problem *might be*.
d. **Performing Experiments to Test Hypothesis –** designing and carrying out an experiment to test your hypothesis. Observe everything you can. The smallest detail can sometimes be the most significant. An experiment is an organized procedure for testing a hypothesis.
e. **Recording and Analyzing Data –** interpreting and evaluating the information gathered. Do calculations if needed to come up with your conclusion
f. **Stating a Conclusion –** this answers the problem stated. If the problem is still unsolved, try a new approach or perform another experiment. Repeat the steps from the beginning until a solution may become clear.

7. A **hypothesis** is testable prediction.

8. A **theory**, based on many observations, is the most logical explanation of why things work.

9. A **scientific fact** is a summary of many experimental results that describes a pattern in nature.

10. A standard of measurement is an exact quantity that people agree to use as a basis of comparison.

11. When a standard measurement is established, all measurements are compared to the same exact quantity – the standard.

SI BASE UNITS / FUNDAMENTAL QUANTITIES		
Quantity Measured	**Unit**	**Symbol**
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	Ampere	A
Temperature	Kelvin	K
Amount of substance	Mole	mol
Luminous Intensity	candela	cd

12. In **International Systems of units**, **SI**, prefixes are used to make the base units larger or smaller by powers of ten.

Prefix	Symbol	Powers of Ten	Example
Deci	d	0.1 $=10^{-1}$	decimeter, dm
Centi	c	0.01 $=10^{-2}$	centimeter, cm
Milli	m	0.001 $=10^{-3}$	milligram, mg
Micro	μ	0.000001 $=10^{-6}$	microgram, μg
Nano	n	0.000000001 $=10^{-9}$	nanometer, nm
Deka	da	10^{1} = 10	dekagram, dag
Hecto	h	10^{2} = 100	hectometer, hm
Kilo	k	10^{3} = 1000	kilogram, kg
Mega	M	10^{6} = 1000 000	Megagram, Mg
Giga	G	10^{9} = 1000 000 000	Gigameter, Gm

13. **Scientific Notation** is a compact, simple and easy way of writing down very small and very large numbers using powers of ten.

14. **Significant figures** – the number of digits or figures that best represents the value of a measurement.

    Rules in determining the Number of Significant Figures:

    a. All non-zero digits are significant. (1, 2, 3, 4 , 5, 6, 7, 8, 9)
    b. All zeros in between two non-zero digits are significant. 2804 has four (4) significant figures.
    c. All zeros to the right of a decimal point but to the left of a non-zero digit are NOT significant. For example, 0.0003068 has four (4) significant figures.
    d. All zeros to the right of non-zero digit without an expressed decimal point following it are NOT significant. For example, 406 000 has three (3) significant figures, but 406 000 has six (6) significant figures because of the indicated decimal point.

15. **Graph** - is a tool or mechanism to show the relationship between two variables. The two kinds of variables are the **dependent variables** plotted on the **Y-axis** or the **ordinate** and the **independent variables** plotted on the **X-axis** or the **abscissa.**

Posttest

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which refers to a step-by-step approach of a scientist in solving a problem?
    a. conclusion
    b. experiment
    c. hypothesis
    d. scientific method

2. The boiling point of water is 100°C. What is its equivalent in Fahrenheit scale?
   a. 312
   b. 212
   c. 100
   d. 32

3. The sides of a rectangle are 8 cm and 4 cm. Its area is
   a. 16 cm^2
   b. 32 cm^2
   c. 64 cm^2
   d. 128 cm^2

4. The basic unit of mass in the metric system is the
   a. kilogram
   b. kilometer
   c. gram
   d. meter

5. A meaningful measurement must have
   a. a number only
   b. a unit only
   c. a number and a unit
   d. a prefix and a unit

6. Gram/milliliter s a unit used to express
   a. area
   b. mass
   c. density
   d. temperature

7. The product of (4×10^3) and (9×10^3) is
   a. 6×10^1
   b. 1.6×10^4
   c. 2.6×10^5
   d. 3.6×10^7

8. Which of the following equations shows an inverse relationship?
   a. A = kB
   b. k = AB
   c. k = A/B
   d. B = kA

9. In nature, if one variable decreases as another variable increase, the relationship between the two variables is said to be
   a. vectors
   b. inverse
   c. direct
   d. inverse square

10. A skill developed by performing laboratory investigations and observations is
   a. using and manipulating equipment
   b. making observations
   c. working cooperatively
   d. All of these

11. The amount of space an object takes up is its
   a. mass
   b. pressure
   c. weight
   d. volume

12. The quotient of 66.0×10^5 and 3×10^8 is
   a. 22×10^{11}
   b. 22×10^{-5}
   c. 2.2×10^5
   d. 2.2×10^{-2}

13. Which of the following steps is **NOT** a part of scientific method?
    a. Recognize a problem.
    b. Perform experiments to test predictions.
    c. Make a guess about the answer and form your conclusion.
    d. Repeat the experiments until the answers match the predictions.

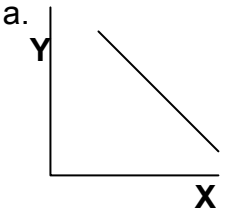
14. Which best describes a scientific fact?
    a. something you believe is true because a friend told you about it
    b. an educated guess that has yet to be proven by experiment
    c. a synthesis of collection of data that includes well-tested guesses
    d. a prediction that has been tested over and over again and always found to be true

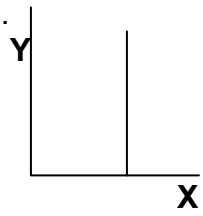
15. Which best defines a hypothesis?
    a. the long side of a right triangle
    b. an educated guess that has yet to be proven by experiment
    c. a synthesis of collection of data that includes well-tested guesses
    d. a guess that has been tested over and over again and always found to be true

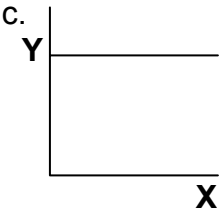
16. Which statement is **TRUE** about a theory?
    a. It is a science story about atoms and molecules.
    b. It is an educated guess that has yet to be proven.
    c. It is a synthesis of large collection of information with well-tested guesses.
    d. It is an agreement among competent observers of the same phenomena.

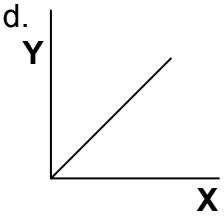
17. A metal block measuring 25 cm x 10 cm x 0.05 cm has a mass of 13.50 kg. What is its density in g/cm^3?
    a. 0. 108
    b. 1.08
    c. 10.8
    d. 108

18. The pressure of a given gas increases as its temperature increases. When plotted what will be the shape of the line graph?

a. 

b. 

c. 

d. 

19. The number .00045700 has _____ significant figures.
    a. 8
    b. 7
    c. 6
    d. 5

20. Antoine Lavoisier was known as the
    a. Forerunner of Chemistry
    b. Father of Modern Chemistry
    c. Advocate of "False" Chemistry
    d. Proponent of the Age of Atomism

21. Rizza is 5 feet and 2 inches tall. What is her height in meters?
    a. 1
    b. 1.5
    c. 1.57
    d. 1.59

22. The _____ describe(s) the steps followed in conducting an experiment.
    a. conclusion
    b. data
    c. problem
    d. procedure

23. The SI prefix that means 1/1000 is
    a. centi-
    b. kilo-
    c. milli-
    d. nano-

24. The symbol μg is read as
    a. kilogram
    b. microgram
    c. milligram
    d. nanogram

25. Which of the following is **NOT** a derived unit?
    a. meter
    b. cubic centimeter
    c. square meter
    d. grams per milliliter

Key to answers on page 29.

Key to Answers

Pretest

1. c	6. b	11. d	16. c	21. d
2. b	7. b	12. d	17. d	22. d
3. c	8. c	13. a	18. c	23. b
4. c	9. a	14. c	19. c	24. d
5. d	10. c	15. b	20. c	25. b

Lesson 1

Self-Test 1.1

1. b	6. h	11. k
2. g	7. e	12. l
3. d	8. f	13. m
4. g	9. i	14. o
5. f	10. j	15. n

Lesson 2

Activity 2.1

Possible Answers

1. Problem: What are the common factors affecting reactions?
2. Follow the steps in scientific method.
3. There are factors that affect the reactions like light and moisture

Activity 2.2

1. Picture A – shows that she feels hot
   Picture B – shows that she feels cold
   } (Look at the barometer reading in both pictures)
2. Picture A – observation
   Picture B – inference or formation of hypothesis
   Picture C – prediction
   Picture D – experimentation or testing the hypothesis

Self-Test 2.1

1. What are the conditions ideal for mold growth?
2. That there were more mold growth in jar 2.
3. She compared her results with jar 1.
4. She concluded that light, warm temperature and no moisture were ideal conditions for mold growth.
5. Yes, because it was stated in her observations

Lesson 3

Self-Test 3.1

1. Given: m = 474 g
   l = 5.0 cm w = 4.0 cm h = 3.0 cm
   Compute for the Volume, V = l x w x h = 60 cm^3
   Find: Density of the wood

   Formula:

   $$D = \frac{m}{V}$$

   $$D = \frac{474\ g}{60\ cm^3} = 7.9\frac{g}{cm^3}$$

2. Given: $D = 0.8\ g/cm^3$ $m = 1.6\ kg = 1600\ g$
   Find: Volume

   Formula:

   $$D = \frac{m}{V} \text{ or } V = \frac{m}{D}$$

   $$V = \frac{1600\ g}{0.8\ \frac{g}{cm^3}}$$

   $$V = 2000\ cm^3$$

3. a. 1.2 L to gallons $\quad 1.2\,L \times \frac{1\,gal}{3.79\,L} = \mathbf{0.3166\ gal}$

   1.2 L to quartz $\quad 1.2\,L \times \frac{1.06\,qt}{1L} = \mathbf{1.272\ qt}$

   b. $4.17\,kg = 4.17 \times 10^3\,g = 4170\,g \times \frac{10^{-1}\,dg}{1g} = 417$ decigrams or **417 dg**

   c. 40°C to °F

   $$°F = \frac{9}{5}(°C) + 32 = \frac{9}{5}(40°C) + 32 = 72 + 32 = \mathbf{104°F}$$

4. a. 4
   b. 3
   c. 4

5. a. 7.5×10^{-9}
   b. 6.9×10^3

Posttest

1. d	6. c	11. d	16. d	21. c
2. b	7. d	12. d	17. d	22. d
3. b	8. b	13. c	18. d	23. c
4. a	9. b	14. d	19. d	24. b
5. c	10. d	15. b	20. b	25. a

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