METRICS AND MEASUREMENT

Name _____

Scientists use the metric system of measurement, based on the number 10. It is important to be able to convert from one unit to another.

kilo	hecto	deca	**Basic Unit**	deci	centi	milli
(k)	(h)	(da)	gram (g)	(d)	(c)	(m)
1000	100	10	liter (L)	.1	.01	.001
10^3	10^2	10^1	meter (m)	10^{-1}	10^{-2}	10^{-3}

Using the above chart, we can determine how many places to move the decimal point and in what direction by counting the places from one unit to the other.

Example: Convert 5 mL to L.

Answer: To go from milli (m) to the basic unit, liters, count on the above chart three places to the left. Move the decimal point three places to the left and 5 mL becomes 0.005 L.

Convert the following.

1. 35 mL = _____ dL
2. 950 g = _____ kg
3. 275 mm = _____ cm
4. 1,000 L = _____ kL
5. 1,000 mL = _____ L
6. 4,500 mg = _____ g
7. 25 cm = _____ mm
8. 0.005 kg = _____ dag
9. 0.075 m = _____ cm
10. 15 g = _____ mg

UNIT CONVERSIONS AND FACTOR-LABEL METHOD

Name _____

Another method of going from one unit to another involves multiplying by a conversion factor. A conversion factor is a fraction that is equal to the number 1. For example, 60 seconds = 1 hour. Therefore, 60 sec/1 hr or 1 hr/60 sec = 1. When you multiply by the number 1, the value of the number is not changed, although the units may be different.

Example: How many milligrams in 20 kilograms?

Solution: Use the following relationships:

1000 mg = 1 g

1000 g = 1 kg

1. Start with the original number and unit.
2. Multiply by a unit factor with the unit to be discarded on the bottom and the desired unit on top.
3. Cancel units.
4. Perform numerical calculations.

$$20 \text{ kg} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1000 \text{ mg}}{1 \text{ g}} = 20{,}000{,}000 \text{ or } 2 \times 10^7 \text{ mg}$$

Perform the following conversions using unit factoring.

1. 500 mL = _____ L
2. 25 cg = _____ g
3. 400 mg = _____ kg
4. 30 cm = _____ mm
5. 3500 secs = _____ hr
6. 2 yrs = _____ secs (Assume 1 year = 365 days)
7. 15 m = _____ mm
8. 0.75 L = _____ mL
9. 6.4 kg = _____ g
10. 7200 m = _____ km
11. 4.2 L = _____ cm^3
12. 0.35 km = _____ m
13. 2.3 L = _____ mL
14. 4.5 yds = _____ in
15. 50 mm = _____ km
16. 150 mg = _____ g
17. 150 kg = _____ g
18. 23 mL = _____ L
19. 0.156 g = _____ mg
20. 1.25 L = _____ mL

USING CORRECT UNITS

Name _____

For each of the following commonly used measurements, indicate its symbol. Use the symbols to complete the following.

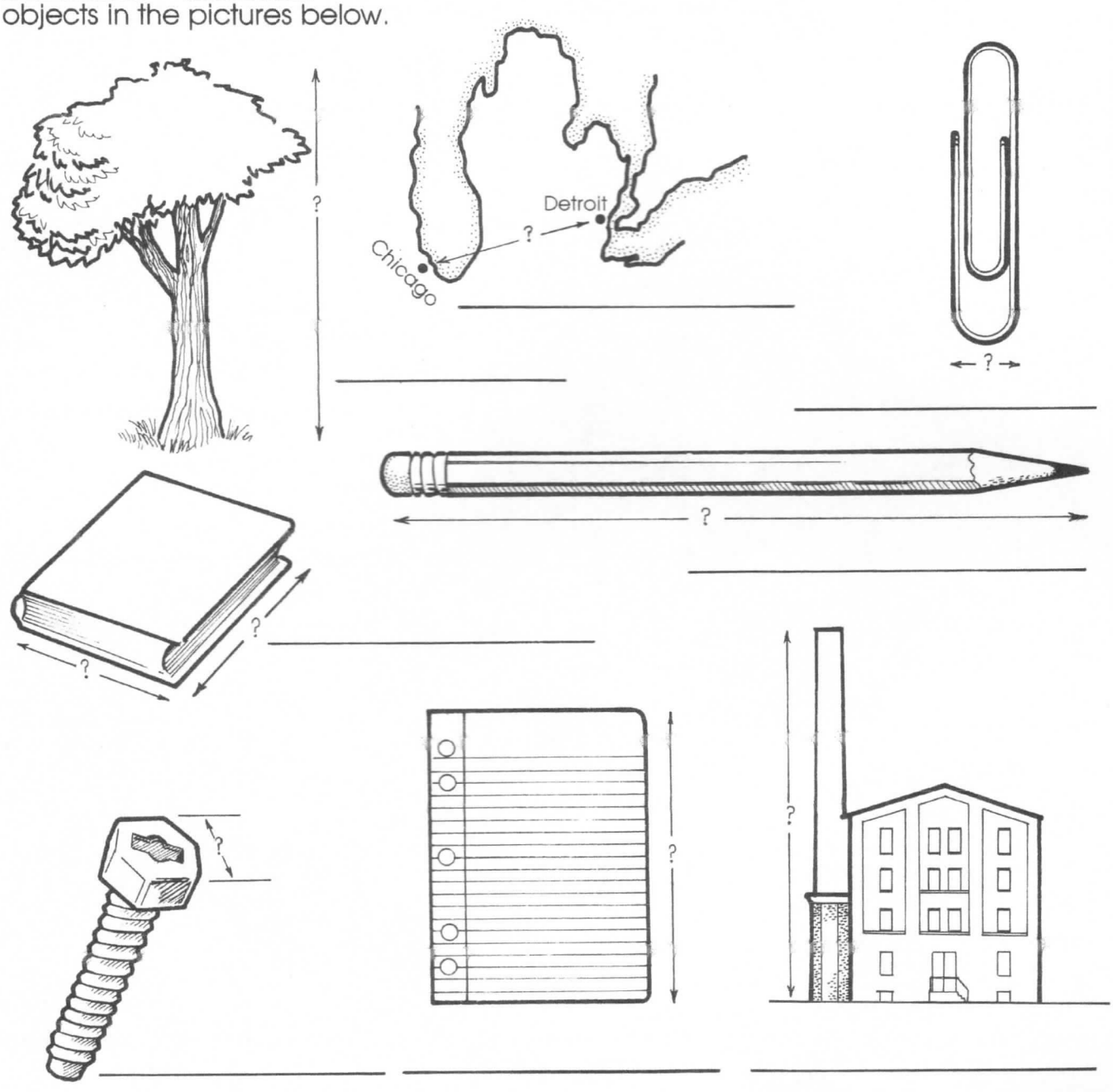
_____ milliliter	_____ milligram	_____ liter	_____ centimeter
_____ kilogram	_____ millimeter	_____ kilometer	_____ gram
_____ meter	_____ millisecond	_____ microgram	_____ nanometer

1. Colas may be purchased in two or three _____ bottles.
2. The mass of bowling ball is 7.25 _____ .
3. The length of the common housefly is about 1 _____ .
4. The mass of a paper clip is about 1 _____ .
5. One teaspoon of cough syrup has a volume of 5 _____ .
6. The speed limit on the highway is usually 106.6 _____ /h or 29 _____ /s.
7. The length of the small intestine in man is about 6.25 _____ .
8. Viruses such as AIDS, polio and flu range in length from 17 to 1000 _____ .
9. Adults require 1,000 _____ of calcium to meet the U.S. RDA.
10. In a vacuum, light can travel 300 km in 1 _____ .
11. The mass of a proton is 1.67×10^{-18} _____ .
12. Blue light has a wavelength of about 500 _____ .
13. One mole of oxygen gas at STP occupies 22.4 _____ .
14. Myoglobin, a protein that stores oxygen, has a mass of 2.98×10^{-14} _____ .
15. Buttery popcorn contained in a large 1 _____ bowl has a mass of about 50 _____ of fat and about 650 calories.
16. The dying comet fragments that continued to batter Jupiter travel at speeds of about 58,117 _____ / _____ or 130,000 miles per hour.
17. The human heart has a mass of about 1.05 _____ .
18. Stand with your arms raised out to your side. The distance from your nose to your outstretched middle finger is about 1 _____ .
19. The body mass of a flea is about 0.5 _____ and it can jump about 20 _____ high.
20. On a statistical basis, smoking a single cigarette lowers your life expectancy by 642,000 _____ or 10.7 minutes.

How Long Is It?

Name_____

The meter is the standard unit of measurement when measuring the length of an object or the distance between two objects. Use either kilometer, meter, centimeter or millimeter to label the unit that would be used to measure the objects in the pictures below.



_____ _____ _____

_____ _____ _____

_____ _____ _____

_____ _____ _____

WORD BANK

meter kilometer centimeter millimeter

The Long and Short of It

Name_____

Weight, length, area and volume are properties of matter that scientists can measure. Scientists use the units of grams, meters and liters to measure these properties.

Write the abbreviation for each of these units of measurement.

Unit of Measure	Abbreviation
gram	
kilogram	
milligram	
meter	
kilometer	
centimeter	
millimeter	
square centimeters	
cubic centimeters	
liter	
milliliter	

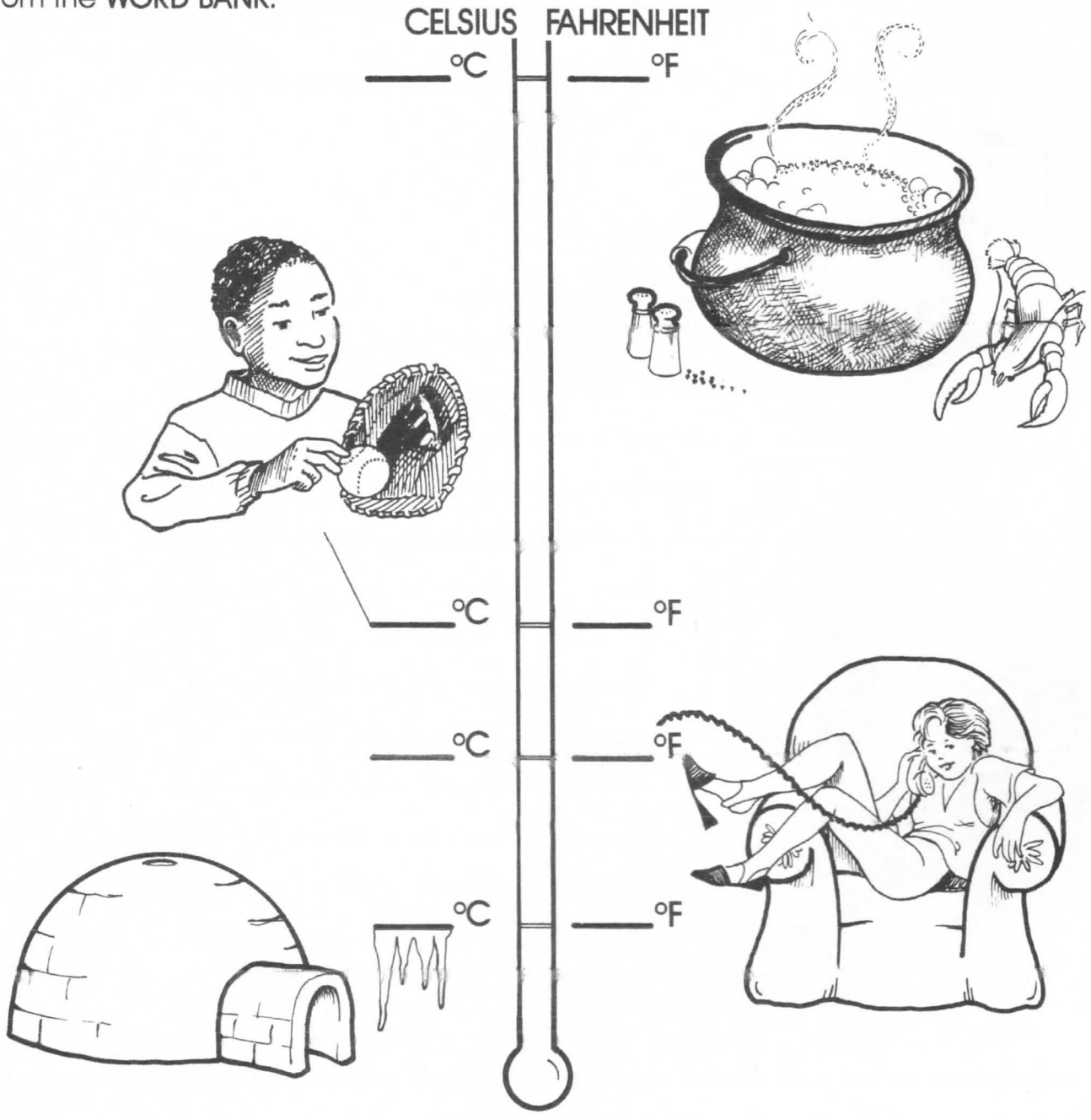
WORD BANK

g kg mg m km cm
mm cm^2 cm^3 l ml

Celsius vs. Fahrenheit

Name_____

The thermometer on this page compares the Celsius and Fahrenheit scales. Label the temperatures on the Celsius and Fahrenheit scales using the temperatures from the **WORD BANK.**



WORD BANK

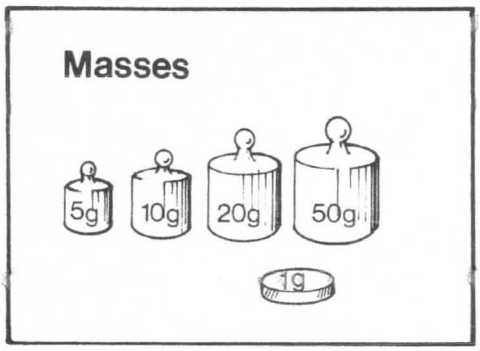
0	20	32	37
98.6	100	212	70

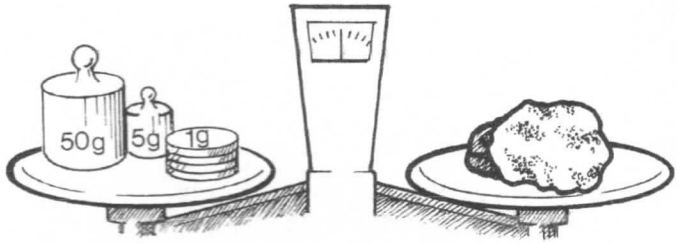
Reading a Double Pan Balance

Name _____

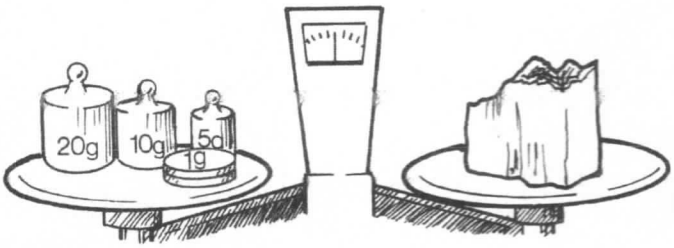
To determine the weight of an object using a double pan balance, find the sum of masses needed to balance the two pans. Do this by making the pointer on the balance line up with the indicated line.

Find the mass of each of the objects pictured below.



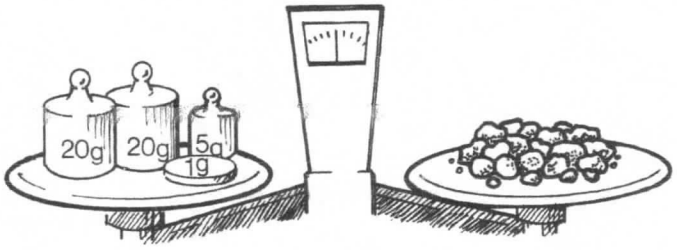


1. _____ g



2. _____ g

3. _____ g



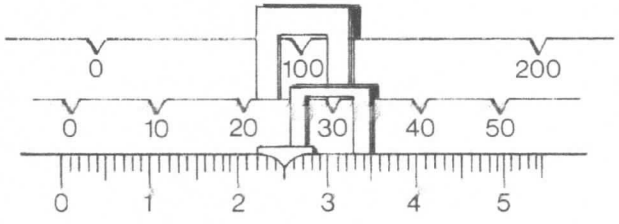
4. _____ g

Reading a Triple Beam Balance

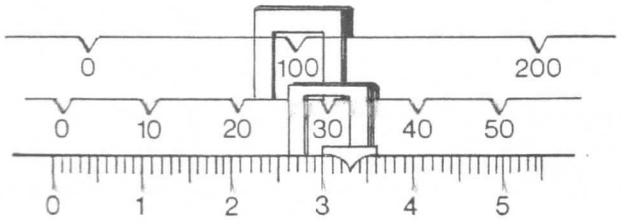
Name _____

To determine the mass or weight of an object using a triple beam balance, find the sum of the masses shown on all the riders.

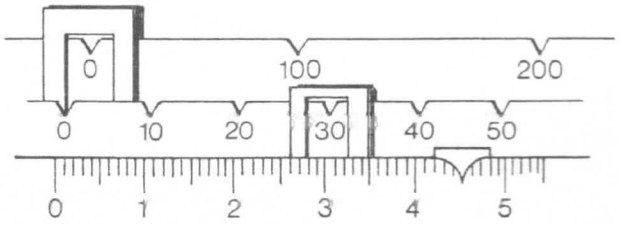
Find the mass indicated on each of the triple beam balances pictured below.



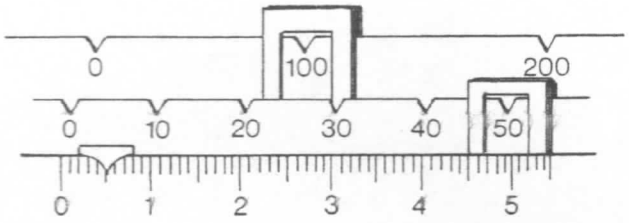
1. _____



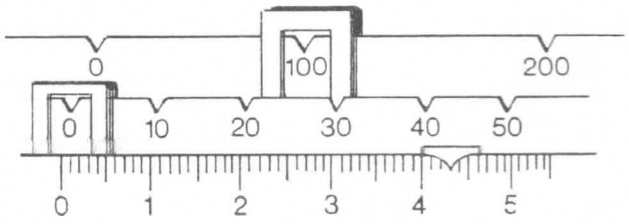
4. _____



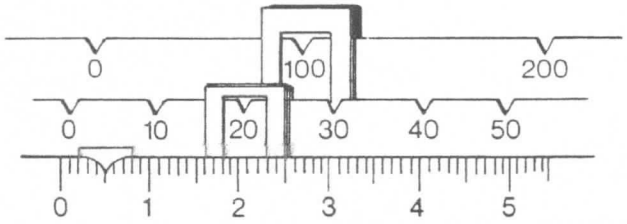
2. _____



5. _____



3. _____



6. _____

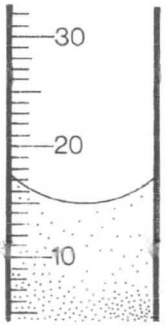
Reading a Graduated Cylinder

Name _____

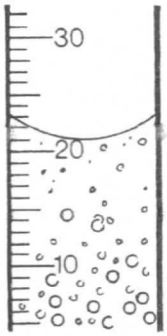
Small quantities of a liquid can be measured using a graduated cylinder. You may notice how the liquid curves up the side of the cylinder. To get an accurate reading, read the measurement at the bottom of the curve, or *meniscus.*

Read the following volumes.

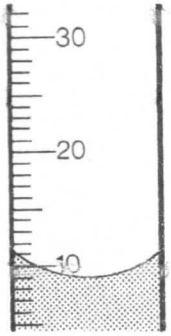
1. _____ ml



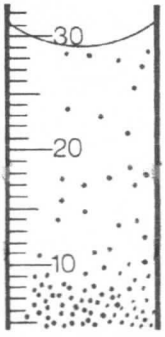
2. _____ ml



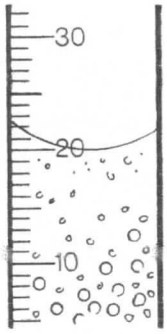
3. _____ ml



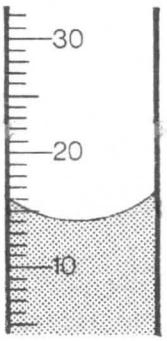
4. _____ ml



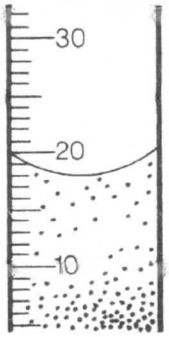
5. _____ ml



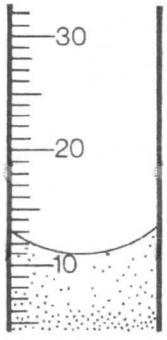
6. _____ ml



7. _____ ml



8. _____ ml



PHYSICAL VS. CHEMICAL PROPERTIES

Name _____

A physical property is observed with the senses and can be determined without destroying the object. For example, color, shape, mass, length, density, specific heat and odor are all examples of physical properties.

A chemical property indicates how a substance reacts with something else. When a chemical property is observed, the original substance is changed into a different substance. For example, the ability of iron to rust is a chemical property. The iron has reacted with oxygen and the original iron metal is gone. It is now iron oxide, a new substance. All chemical changes include physical changes.

Classify the following properties as either chemical or physical by putting a check in the appropriate column.

	Physical Property	Chemical Property
1. red color		
2. density		
3. flammability		
4. solubility		
5. reacts with acid to form hydrogen		
6. supports combustion		
7. bitter taste		
8. melting point		
9. reacts with water to form a gas		
10. reacts with a base to form water		
11. hardness		
12. boiling point		
13. can neutralize a base		
14. luster		
15. odor		

CHEMICAL vs. PHYSICAL CHANGE

Name _____

In a physical change, the original substance still exists, it has only changed in form. Energy changes usually do not accompany physical changes, except in phase changes and when substances dissolve.

In a chemical change, a new substance is produced. Energy changes always accompany chemical changes. Physical changes usually accompany chemical changes.

Classify the following as being either a chemical or a physical change.

1. Sodium chloride dissolves in water. _____
2. Hydrochloric acid reacts with sodium hydroxide to produce a salt, water and heat. _____
3. A pellet of sodium is sliced in half. _____
4. Water is heated and changed to steam. _____
5. Food is digested. _____
6. Starch molecules are formed from smaller glucose molecules. _____
7. Ice melts. _____
8. Plant leaves lose water through evaporation. _____
9. A red blood cell placed in distilled water will swell and burst. _____
10. The energy in food molecules is transferred into molecules of ATP. _____
11. The roots of a plant absorb water. _____
12. Iron rusts. _____
13. Oxygen is incorporated into hemoglobin to bring it to the cells. _____
14. A person gets cooler by perspiring. _____
15. Proteins are made from amino acids. _____
16. A match burns. _____
17. A toothpick is broken in half. _____

PHYSICAL VS. CHEMICAL CHANGES

Name _____

In a physical change, the original substance still exists, it has only changed in form. In a chemical change, a new substance is produced. Energy changes always accompany chemical changes.

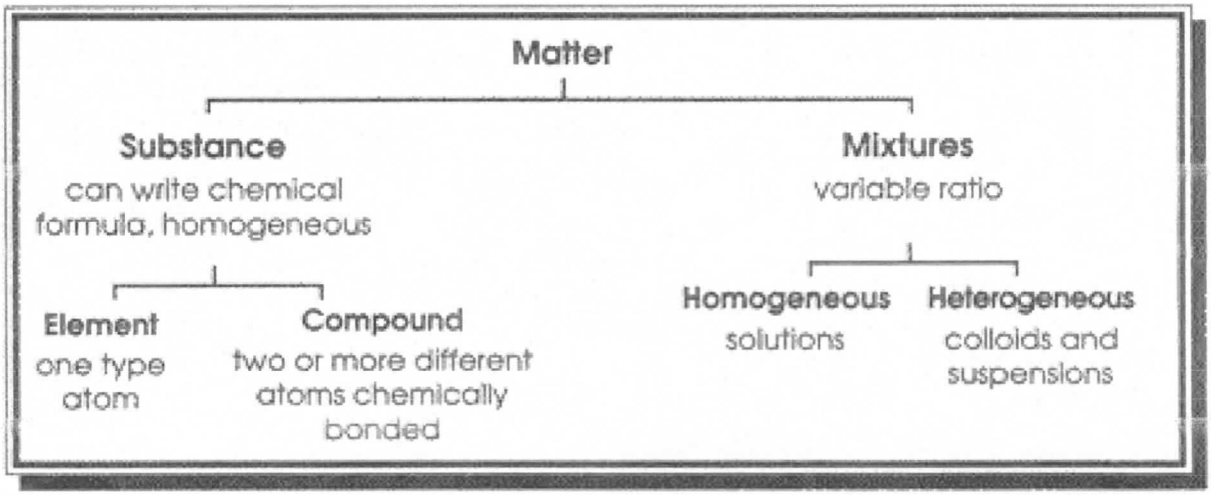
Classify the following as being a physical or chemical change.

1. Sodium hydroxide dissolves in water. _____
2. Hydrochloric acid reacts with potassium hydroxide to produce a salt, water and heat. _____
3. A pellet of sodium is sliced in two. _____
4. Water is heated and changed to steam. _____
5. Potassium chlorate decomposes to potassium chloride and oxygen gas. _____
6. Iron rusts. _____
7. When placed in H_2O, a sodium pellet catches on fire as hydrogen gas is liberated and sodium hydroxide forms. _____
8. Evaporation _____
9. Ice melting _____
10. Milk sours. _____
11. Sugar dissolves in water. _____
12. Wood rotting _____
13. Pancakes cooking on a griddle _____
14. Grass growing in a lawn _____
15. A tire is inflated with air. _____
16. Food is digested in the stomach. _____
17. Water is absorbed by a paper towel. _____

MATTER—SUBSTANCES VS. MIXTURES

Name _____

All matter can be classified as either a substance (element or compound) or a mixture (heterogeneous or homogeneous).



Classify each of the following as to whether it is a substance or a mixture. If it is a substance, write Element or Compound in the substance column. If it is a mixture, write Heterogeneous or Homogeneous in the mixture column.

Type of Matter	Substance	Mixture
1. chlorine		
2. water		
3. soil		
4. sugar water		
5. oxygen		
6. carbon dioxide		
7. rocky road ice cream		
8. alcohol		
9. pure air		
10. iron		

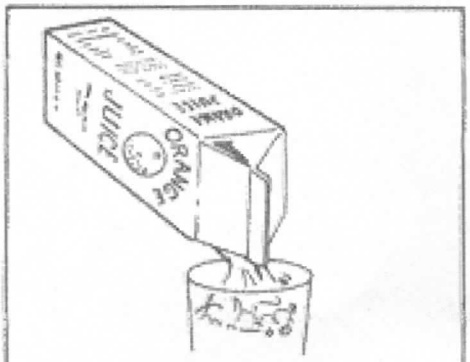
ELEMENTS, COMPOUNDS AND MIXTURES

Name _____

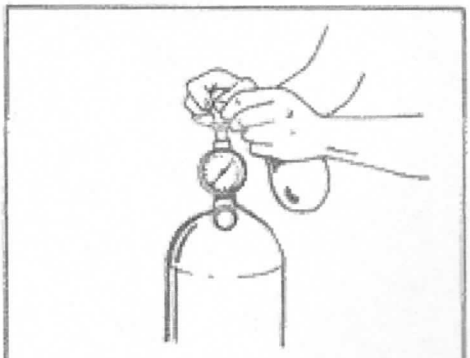
An element consists of only one kind of atom. A compound consists of two or more different elements chemically combined in a fixed ratio. The components of a mixture can be in any proportion and are not chemically bound.

Classify each of the following as an element, compound or mixture by writing E, C or M in the space provided.

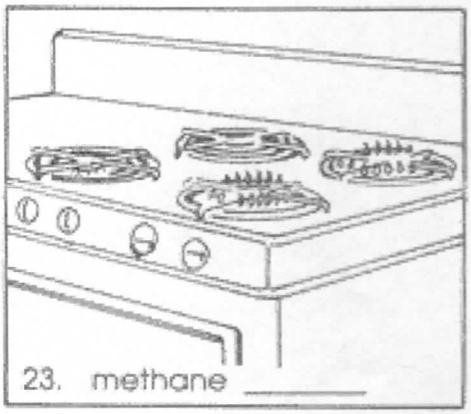
1. sodium _____
2. water _____
3. soil _____
4. coffee _____
5. oxygen _____
6. alcohol _____
7. carbon dioxide _____
8. cake batter _____
9. air _____
10. soap _____
11. iron _____
12. salt water _____
13. ice cream _____
14. nitrogen _____
15. eggs _____
16. blood _____
17. table salt _____
18. nail polish _____
19. milk _____
20. cola _____



21. orange juice _____



22. hellum _____



23. methane _____

HOMOGENEOUS VS. HETEROGENEOUS MATTER

Name _____

Classify the following substances and mixtures as either homogeneous or heterogeneous. Place a √ in the correct column.

	HOMOGENEOUS	HETEROGENEOUS
1. flat soda pop		
2. cherry vanilla ice cream		
3. salad dressing		
4. sugar		
5. soil		
6. aluminum foil		
7. black coffee		
8. sugar water		
9. city air		
10. paint		
11. alcohol		
12. iron		
13. beach sand		
14. pure air		
15. spaghetti sauce		

SEPARATION OF MIXTURES

Name _____

Taking advantage of various physical and chemical properties, how would you separate the following mixtures into their components?

1. Sand and water _____

2. Sugar and water _____

3. Oil and water _____

4. Sand and gravel _____

5. A mixture of heptane (boiling point 98°C) and heptanol (boiling point 176°C)

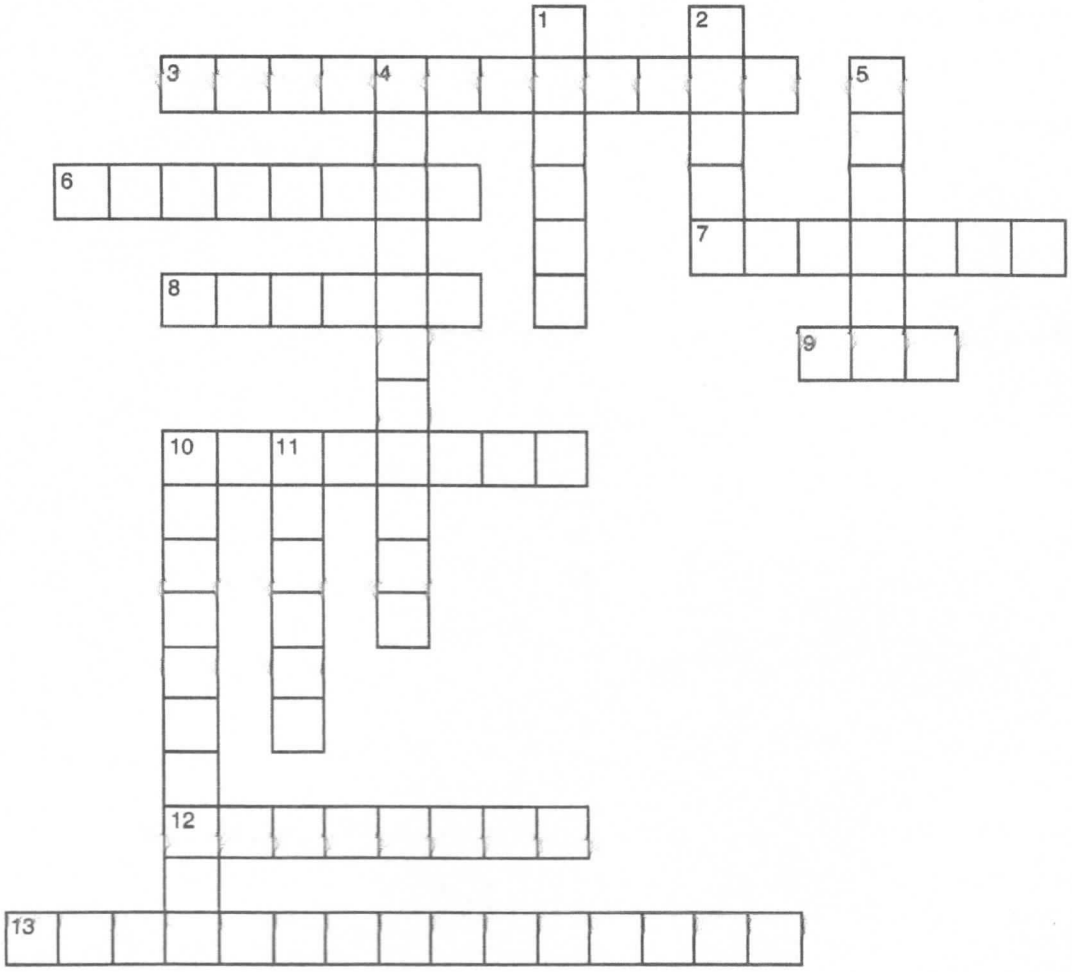
6. A mixture of iodine solid and sodium chloride (Hint: Iodine is not soluble in water.)

7. A mixture of lead and aluminum pellets _____

8. A mixture of salt and iron filings _____

STATES OF MATTER CROSSWORD

Name _____



ACROSS

3. Change of a gas to a liquid
6. This type of property can be observed without destroying the substance.
7. Mass of a substance divided by unit volume
8. Physical change of a solid to a liquid at the melting point
9. State of matter having no definite volume or shape
10. Homogeneous mixture
12. This type of change produces a new substance.
13. Change of a liquid to a solid

DOWN

1. Anything that has mass and takes up space
2. State in which atoms or molecules are very close together and are regularly arranged
4. Change of a liquid to a gas
5. This state of matter consists of electrically charged particles.
10. Elements and compounds
11. State of matter having a definite volume but no definite shape.

BOYLE'S LAW

Name _____

Boyle's Law states that the volume of a gas varies inversely with its pressure if temperature is held constant. (If one goes up, the other goes down.) We use the formula:

$$P_1 \times V_1 = P_2 \times V_2$$

Solve the following problems (assuming constant temperature).

1. A sample of oxygen gas occupies a volume of 250. mL at 740. torr pressure. What volume will it occupy at 800. torr pressure?

_____

2. A sample of carbon dioxide occupies a volume of 3.50 liters at 125 kPa pressure. What pressure would the gas exert if the volume was decreased to 2.00 liters?

_____

3. A 2.0 liter container of nitrogen had a pressure of 3.2 atm. What volume would be necessary to decrease the pressure to 1.0 atm?

_____

4. Ammonia gas occupies a volume of 450. mL at a pressure of 720. mm Hg. What volume will it occupy at standard pressure?

_____

5. A 175 mL sample of neon had its pressure changed from 75 kPa to 150 kPa. What is its new volume?

_____

6. A sample of hydrogen at 1.5 atm had its pressure decreased to 0.50 atm producing a new volume of 750 mL. What was its original volume?

_____

7. Chlorine gas occupies a volume of 1.2 liters at 720 torr pressure. What volume will it occupy at 1 atm pressure?

_____

8. Fluorine gas exerts a pressure of 900. torr. When the pressure is changed to 1.50 atm its volume is 250. mL. What was the original volume?

_____

CHARLES' LAW

Name _____

Charles' Law states that the volume of a gas varies directly with the Kelvin temperature, assuming that pressure is constant. We use the following formulas:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad \text{or} \quad V_1 \times T_2 = V_2 \times T_1$$

$$K = °C + 273$$

Solve the following problems assuming a constant pressure.

1. A sample of nitrogen occupies a volume of 250 mL at 25° C. What volume will it occupy at 95° C?

_____

2. Oxygen gas is at a temperature of 40° C when it occupies a volume of 2.3 liters. To what temperature should it be raised to occupy a volume of 6.5 liters?

_____

3. Hydrogen gas was cooled from 150° C to 50° C. Its new volume is 75 mL. What was its original volume?

_____

4. Chlorine gas occupies a volume of 25 mL at 300 K. What volume will it occupy at 600 K?

_____

5. A sample of neon gas at 50° C and a volume of 2.5 liters is cooled to 25° C. What is the new volume?

_____

6. Fluorine gas at 300 K occupies a volume of 500 mL. To what temperature should it be lowered to bring the volume to 300 mL?

_____

7. Helium occupies a volume of 3.8 liters at -45° C. What volume will it occupy at 45° C?

_____

8. A sample of argon gas is cooled and its volume went from 380 mL to 250 mL. If its final temperature was -55° C, what was its original temperature?

_____