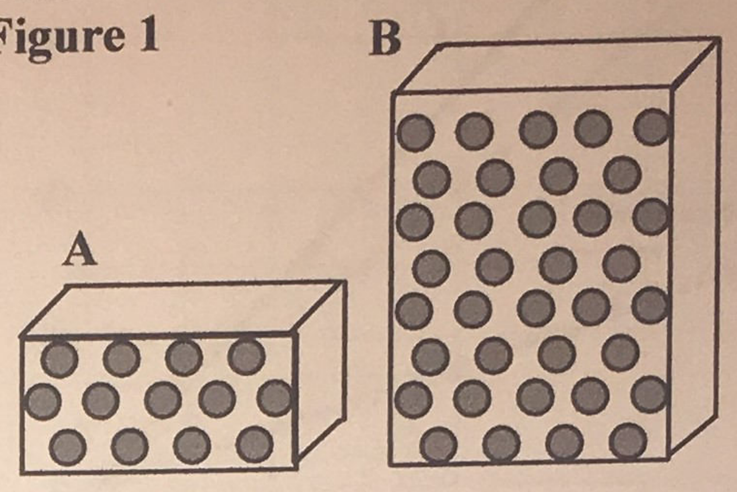
Name Answer Key Date _____ Pd ___

Chemistry – Unit 2 Matter & Energy

Mass, Volume, and Density

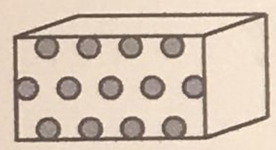
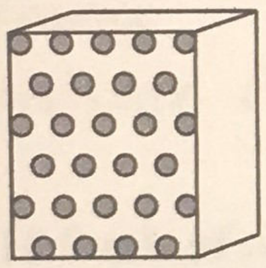
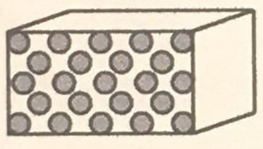
1. Study the matter shown in Figure 1. Each dot represents a particle of matter. [*Assume the particles are uniformly distributed throughout each object, and particles of the same size have the same mass.*]
   a. In the table below, show how the masses, volumes, and densities of A and B compare by adding the symbol <, >, **or** = to the statement in the second column.
   b. Explain your reasoning for each answer in the last column.

Figure 1



Property	Relationship	Reasoning
Mass	A < B	B has more particles (Mass = particles)
Volume	A < B	B has more height (Volume = L×W×H)
Density	A = B	Mass and volume increased at same rate

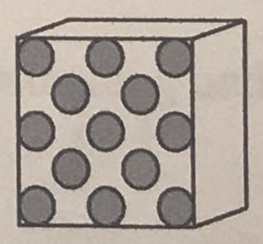
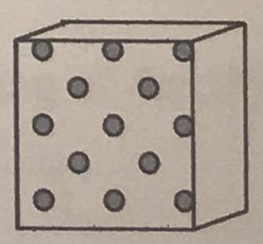
Figure 2

A	B	C
		

2. Study the matter in Figure 2. [*Assume the particles are uniformly distributed throughout each object, and particles of the same size have the same mass.*]
   a. In the table below show how the masses, volumes, and densities compare by adding the symbol **<, >, or =** to the statement in the second column.
   b. Explain your reasoning for each answer in the last column.

Property	Relationship	Reasoning
Mass (dots)	A < B A < C	B has more particles C has more particles
Volume (l x w x h)	A < B A = C	B has more height L, W, h remain the same
Density (m/v)	A = B A < C	mass and volume increase at same rate mass of C increased but volume stayed same so density increased

3. Is object E or object F more dense? [*Assume the particles are uniformly distributed throughout each object, and particles with a larger size have a larger mass.*] Explain your reasoning.

E	F
	

E > F Even though both cubes have same number of particles, E has larger particles. Larger particles have more mass.

igure 4 below, a graph shows the relationship between mass and volume for two substances, A and B. se the graph to answer questions about these two substances.

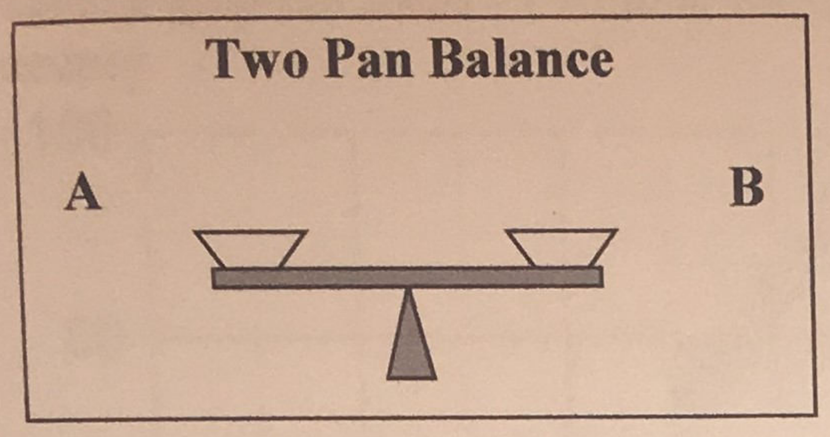
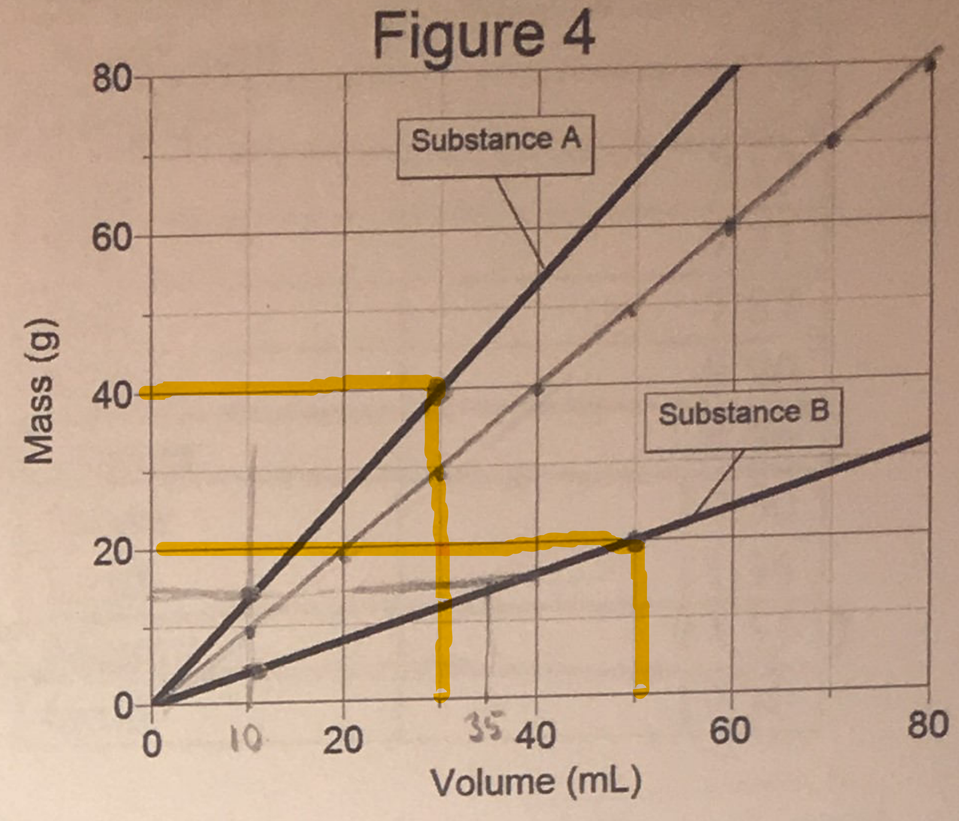


Figure 4



You have built a simple two-pan balance shown above to compare the masses of substances **A** and **B**.

a. What would happen to the balance if you put **equal masses** of **A** and **B** in the two pans? Explain your reasoning. If mass is equal, the balance will be level on both sides.

b. What would happen to the balance if you put **equal volumes** of **A** and **B** in the two pans? Explain your reasoning. When volume is equal, A always has more mass. So the balance will tilt down on the A side.
Ex. @ 40ml A = 52g B = 14g

c. Find the slope of the line for both A and B using correct units. State the physical meaning of the slope for each substance

Substance A = $\frac{40g}{30ml}$ = 1.33 g/ml Substance B = $\frac{20g}{50ml}$ = 0.4 g/ml

d. If you put **10.0 mL of A** in one balance pan, how much **mass of B** would you need in the other pan to make it balance? Explain your reasoning.

$\frac{10.0ml\ A}{1\ ml} \left| \frac{1.33g}{} \right| = 13.3g$

So to keep the pan balanced, 13.3g of B must be placed on scale.

e. If you put **35.0 mL of B** in one balance pan, what **volume of A** would you need in the other pan to make it balance? Explain your reasoning.

$\frac{35.0ml}{1ml} \left| \frac{0.4g}{} \right| = 14g\ B$ ↖ must be same mass ↗ $\frac{14g\ A}{1.33g} \left| \frac{1ml}{} \right| = 10.5ml\ A$

f. Water has a density of 1.00 g/mL. Sketch the line representing water on the graph in Figure 4.

g. Determine whether substance A and B will sink or float when placed in a bucket of water.

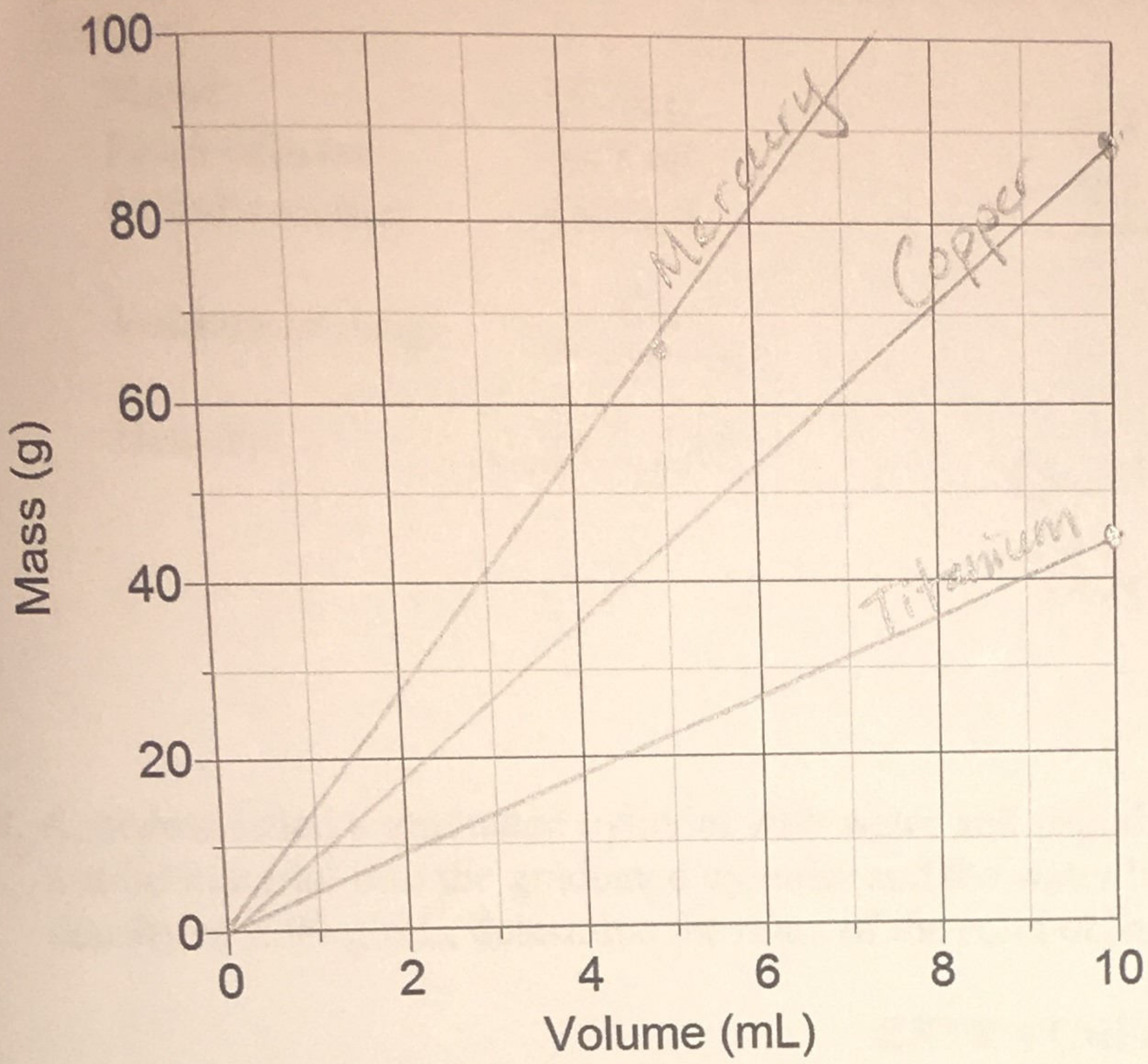
A: (sink) float **B:** sink (float) (circle correct response)

Defend your answer using the mass vs. volume graph, and your outstanding understanding of density.

According to the graph, substance A's density is greater than water so it will sink. Substance B is less than water so it will sink.

to the table of densities to answer the following questions.

Sketch a graph of mass vs volume for titanium, copper and mercury.



Substance	Density (g/mL)
Aluminum	2.70
Titanium	4.54
Zinc	7.13
Tin	7.31
Iron	7.87
Nickel	8.90
Copper	8.96
Silver	10.50
Lead	11.35
Mercury	13.55
Gold	19.30

$\frac{D}{1} = \frac{M}{V}$

Titanium

$\frac{4.54}{1} = \frac{\text{mass}}{10\text{ ml}}$

Copper

$\frac{8.96}{1} = \frac{\text{mass}}{10\text{ ml}}$

Mercury

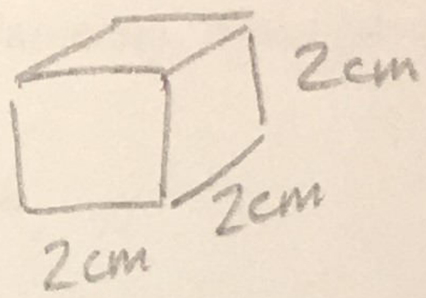
$\frac{13.55}{1} \times \frac{\text{mass}}{5\text{ ml}}$

6. You made some cubes out of each metal in the table that each measures 2.00 cm on every side. (all except mercury – why can't you make a cube of mercury?)
   a. What is the volume of each cube in **cm³**? in **mL**? (Show your thinking)

V = 8 cm³ V = 8 mL

$V = l \times w \times h$ $1\text{ cm}^3 = 1\text{ ml}$

Hg is a liquid at room temp



   b. Find the mass of these metal cubes: (Show your work below)

lead cube 90.8g

nickel cube 71.2g

zinc cube 57.0g

Lead $\frac{11.35\text{ g/cm}^3}{1} = \frac{\text{mass}}{8\text{ cm}^3}$

Nickel $\frac{8.90\text{ g/cm}^3}{1} = \frac{\text{mass}}{8\text{ cm}^3}$

Zinc $\frac{7.13\text{ g/cm}^3}{1} = \frac{\text{mass}}{8\text{ cm}^3}$

's cheapskate boyfriend gave her a ring he claims is 24 carat gold. Alicia is skeptical. After istry class the next day she measures the mass of the ring, finds the volume of the ring by water acement, and then calculates the density of the ring. Should she treasure the ring as his first truly erous gift to her, or throw it at him the next time he walks by? **Defend your answer.**

ATA:

Mass:	**15.28 g**
Final volume:	**43.7 mL**
Initial volume:	**42.2 mL**

43.7 ml. − 42.2 ml = 1.5 ml

$\frac{15.28\text{g}}{1.5\text{ ml}} = 10.2\text{ g/ml}$

Volume of ring: 1.5 ml

Density: 10.2 g/ml

Gold's density is 19.3 g/ml.
This ring is not real gold.

8. A student filled a graduated cylinder with water and read the miniscus at 25.8 mL. The student then dropped a solid material into the graduated cylinder and the water level rose to 35.9 mL. If the solid material had a density of 2.99 g/mL, determine the mass of the solid object.

35.9 − 25.6 = 10.1 ml

$\frac{2.99\text{g/ml}}{1} = \frac{\text{mass}}{10.1\text{ ml}}$

mass = 30.2 g

EXTRA CREDIT

Refer to the table of densities on page 3 of this worksheet to answer these questions:

7.87 g/ml 8.96 g/ml 4.54 g/ml

You have some iron wire, copper wire, and titanium wire (all the same gauge, or diameter). Your lab group measured out a length of wire that is exactly 10.00g for each type of metal wire.

a. Which of these 3 metal wires would be the longest?

$\frac{4.54\text{g/ml}}{1} = \frac{10.0\text{g}}{\text{volume}}$ $V = 2.20\text{ cm}^3$ titanium

b. Which of these 3 metal wires would be the shortest?

$\frac{8.96\text{g/ml}}{1} = \frac{10.0\text{g}}{\text{volume}}$ $V = 1.12\text{ cm}^3$ copper

c. Explain your reasoning for answers a. and b.

$\div\ D = \frac{M}{V}$ $\frac{D}{1} \quad \frac{M}{V}$ so $V = \frac{M}{D}$ As density gets larger, the volume gets smaller.

d. If every 1.0 cm length of the titanium wire has a mass of 0.15 g, how long would the 10.00g wire be? (Hint: write a conversion ratio for the two quantities you are working with)

$10.00\text{g} \left| \frac{1\text{ cm}}{0.15\text{g}} \right. = 66.67\text{ cm}$

e. What is the diameter of the titanium wire? (Hint: diameter is related to volume; assume it is a cylinder – Geometry! Oh, yeah!)

$V = \pi r^2 h$

$r = \sqrt{\frac{V}{\pi h}}$

$r = \sqrt{\frac{(2.20)}{(3.14)(66.67)}} = 0.1025\text{ cm}$

diameter = 2r = 0.205 cm