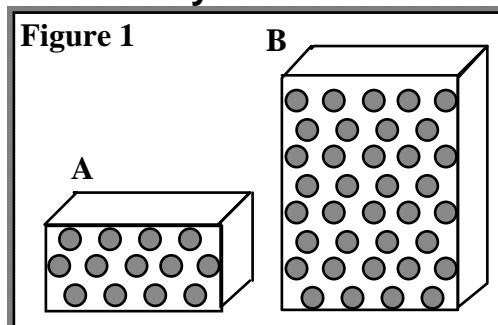


### Mass, Volume, and Density

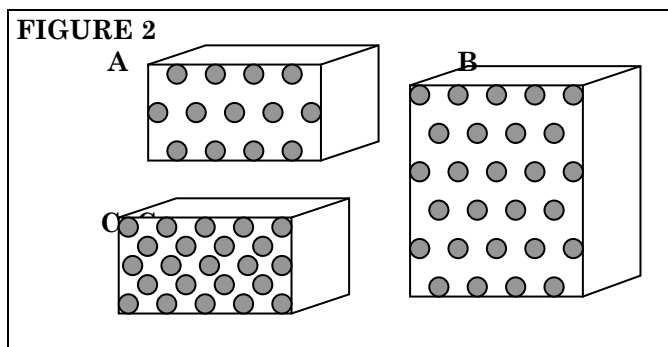
1. Study the matter shown in Figure 1. Each dot represents a particle of matter. [Assume the particles are uniformly distributed throughout each object, and particles of the same size have the same mass.]



- 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.
- Explain your reasoning for each answer in the last column.

Property	Relationship	Reasoning
Mass	A ____ B	
Volume	A ____ B	
Density	A ____ B	

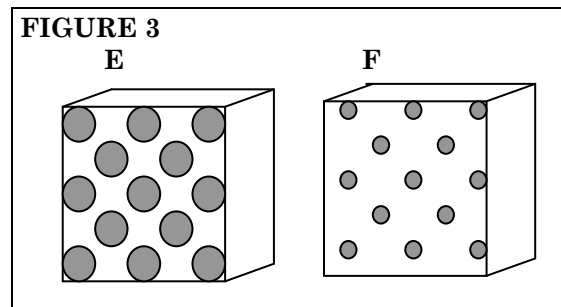
2. Study the matter in Figure 2. [Assume the particles are uniformly distributed throughout each object, and particles of the same size have the same mass.]



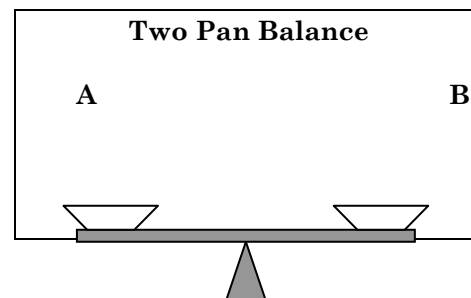
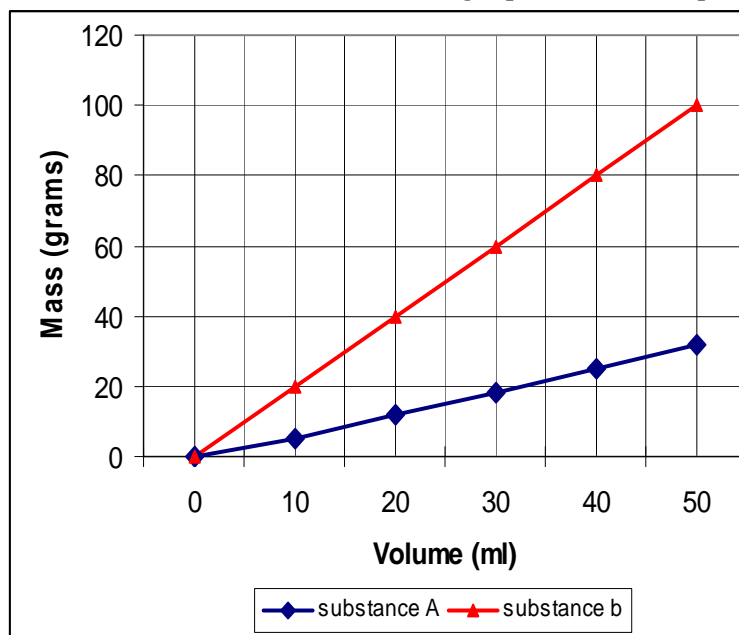
- In the table below show how the masses, volumes, and densities compare by adding the symbol  $<$ ,  $>$ , or  $=$  to the statement in the second column.
- Explain your reasoning for each

Property	Relationship	Reasoning
Mass	A ____ B	
	A ____ C	
Volume	A ____ B	
	A ____ C	
Density	A ____ B	
	A ____ C	

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.



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



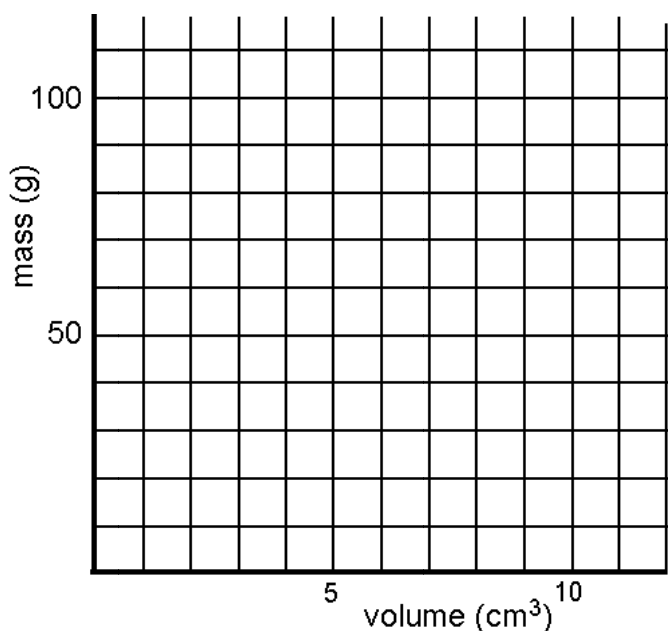
- a) You have built a simple two-pan balance shown above to compare the masses of substances **A** and **B**. What would happen to the balance if you put **equal masses** of **A** and **B** in the two pans? **Equal volumes** of **A** and **B** in the two pans? Explain your reasoning.
- b) Find the slope of the line for both A and B using correct units. State the physical meaning of the slope for each substance.
- c) If you put **10.0 mL of B** in one balance pan, how much **mass of A** would you need in the other pan to make it balance? Explain your reasoning.

- d) If you put **35.0 mL of A** in one balance pan, what **volume of B** would you need in the other pan to make it balance? Explain your reasoning.
- e) Water has a density of 1.00 g/mL. Sketch the line representing water on the graph in Figure 4.
- f) 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 m-V graph, and your outstanding understanding of density.

Refer to the table of densities at the right to answer the following questions.



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

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

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 **cm<sup>3</sup>**? in **mL**? (Show your thinking)

V = \_\_\_\_\_ cm<sup>3</sup>

V = \_\_\_\_\_ mL

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

lead cube \_\_\_\_\_

nickel cube \_\_\_\_\_

zinc cube \_\_\_\_\_

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

**DATA:**

**Mass:** 15.28 g  
**Final volume:** 43.7 mL  
**Initial volume:** 42.2 mL  
**Volume of ring:** \_\_\_\_\_  
**Density:** \_\_\_\_\_

8. A student filled a graduated cylinder with water and read the meniscus 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.

## EXTRA CREDIT

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

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?
- b) Which of these 3 metal wires would be the shortest?
- c) Explain your reasoning for answers a) and b).
- 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)
- e) What is the diameter of the titanium wire? (Hint: diameter is related to volume; assume it is a cylinder – Geometry! Oh, yeah!)

**Answers: #4 to end (quantitative problems, primarily)**

4a) Balance would tip to the right:  $m_A > m_B$  for the same volume

b)  $D_A = 60\text{g}/45\text{mL} = \mathbf{1.3\text{g/mL}}$ ;  $D_B = 32\text{g}/60\text{mL} = \mathbf{0.53\text{g/mL}}$   
Each mL of substance has a mass of (1.3 or 0.53) grams.

c)  $m_A = m_B$  when it is balanced.  $m_A = 1.3 \text{ g/mL} * 10.0 \text{ mL} = 13 \text{ g}$  A  $\Rightarrow$   **$m_B = 13 \text{ g}$**

d)  $35 \text{ mL B} * 0.53\text{g/mL} = 18.6 \text{ g B} = 18.6 \text{ g A}$   
 $18.6\text{g A} * 1\text{mL}/1.3 \text{ g} = \mathbf{14.3 \text{ mL A}}$

e) (sketch line on graph w/slope of 1.0g/1mL)

f) **A will sink**, ( $d_A > d_{\text{water}}$ ); **B will float**, ( $d_B < d_{\text{water}}$ )

5. Copper; Mercury; Titanium

6 a) volume =  $2.0 \text{ cm} * 2.0 \text{ cm} * 2.0 \text{ cm} = 2.0^3 \text{ cm}^3 = \mathbf{8.0 \text{ cm}^3} = \mathbf{8.0 \text{ mL}}$

b) <b>Volume</b>	*	<b>Density</b>	=	<b>mass</b>
8.0 mL	*	11.35 g/mL	=	90.8 g Pb
	*	8.90 g/mL	=	70.2 g Ni
	*	7.13 g/mL	=	57.0 g Zn

7) Density of ring =  $\frac{15.28\text{g}}{43.7\text{mL} - 42.2\text{mL}} = 10.2 \text{ g/mL}$ ; Looks like Pb/Cu mix!! Throw it at him!!

**Extra Credit:**

a, c) Longest: Titanium (needs more volume (=length) than the others for 10g mass because its density is smallest)

b, c) Shortest: Copper (needs less volume (=length) than the others for 10 g mass because its density is the greatest)

$$\text{d) } length = 10.0\text{g} * \frac{1.0\text{cm}}{0.15\text{g}} = 66.7\text{cm}$$

$$volume = 10.0\text{g} * \frac{1\text{mL}}{4.54\text{g}} = 2.20\text{mL}$$

$$v = \pi r^2 l$$
$$r = \sqrt{\frac{v}{\pi * l}} = \sqrt{\frac{2.20\text{cm}}{\pi * 66.67\text{cm}}} = 0.1025\text{cm}$$

$$d = 2r = 2 * 0.1025\text{cm} = 0.205\text{cm}$$