Unit 1: Physical and Chemical Properties of Matter

Practice Free Response 2

Directions: The suggested time is about 15 minutes for answering the constructed response section of the chemistry test. The parts within a question may not have equal weight. For calculations, show all your work in the spaces provided after each part. Pay particular attention to the proper use of units. Be sure your final answer is rounded to the correct number of significant figures. Make sure your work is legible. Illegible work will receive a grade of zero.

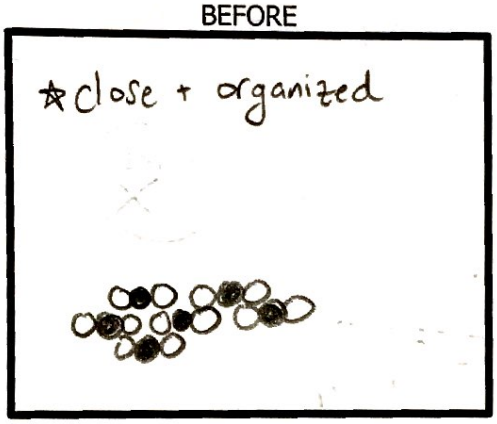
Question 1 [10 POINTS]

A student is investigating the chemical and physical properties and changes of carbon dioxide, CO_2.

A. A student places a piece of solid carbon dioxide into a container and allows it ~~to~~ sublime. In the boxes below, illustrate the carbon dioxide before and after sublimation. Use six molecules of carbon dioxide in each box. **[2 POINTS]**

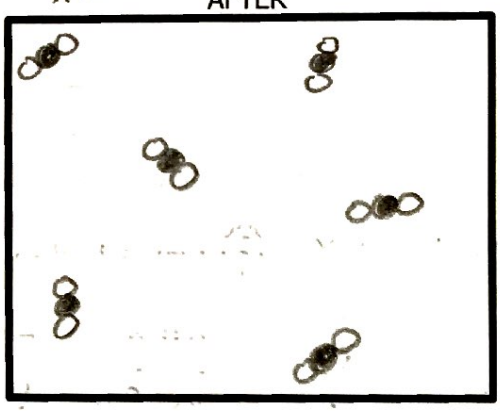
Represent carbon dioxide molecules as

BEFORE



*far apart, disorganized

AFTER



B. Energy is required to sublimate carbon dioxide. Consider the statement "As carbon dioxide sublimes, energy goes into breaking C–O bonds." Is the statement true or false? Justify your answer. **[1 POINT]** False - Sublimination is a physical change, thus no chemical bonds are broken.

C. The student made a list of intensive physical properties that she observed about solid carbon dioxide. Clearly place a line through the item(s) that do not belong on the list. **[1 POINT]**

Intensive Properties of CO_2 Sample:
-White color
~~-Mass is 5.20 g~~
-Odorless
-Brittle
-Sublimes at -78.5°C

CONTINUED ON REVERSE SIDE ☞

A student performed a laboratory experiment to determine the density of carbon dioxide gas at room temperature. The steps below outline her procedure. Assume the balloon is perfectly spherical, that carbon dioxide is the only gas inside the balloon, and that no carbon dioxide escapes once the balloon has been filled.

Step 1: Determine mass of empty balloon.
Step 2: Fill the balloon with carbon dioxide gas.
Step 3: Use a string to determine the circumference of the balloon.
Step 4: From the circumference determined in Step 3, calculate the volume of gas in the balloon.
Step 5: Determine mass of balloon filled with carbon dioxide gas.

The data table below summarizes the information collected by the student throughout the lab.

Data Table 1

Mass of empty balloon	2.70 g
Volume of balloon filled with carbon dioxide gas	1.00 L
Mass of balloon filled with carbon dioxide gas	4.54 g

D. Calculate the following:

i. What is the mass of the carbon dioxide collected? **[1 POINT]**

$4.54 - 2.70 = \boxed{1.84\ g\ CO_2}$

ii. What is the density of the carbon dioxide gas? Answer in units of g/~~cm³~~ mL. **[2 POINTS]**

1pt [$1.00L \times \frac{1000mL}{1L} = 1.00 \times 10^3 mL$

1pt [$D = \frac{m}{V} = \frac{1.84g}{1.00E3 mL} = \boxed{1.84 \times 10^{-3} g/mL}$

E. When determining the circumference of the balloon, the student compresses the balloon so that the measured circumference and therefore calculated volume of the balloon is smaller than its actual value. Would the calculated density of the carbon dioxide increase, decrease, or remain the same? ~~Mathematically justify your answer.~~ **[2 POINTS]** Justify.

Decreasing measured volume will increase calculated density, b/c D and V have an indirect relationship (↓V, ↑D).

F. The density of air is 1.2×10^{-3} g/cm³. Would a bubble of carbon dioxide float or sink in air? Explain. (Assume the bubble has no effect on the density of the carbon dioxide). **[1 POINT]**

Sink, b/c the density of CO_2 is greater than the density of air ($1.84E-3\ g/mL > 1.2E-3\ g/mL$)