

## Unit 8 Study Guide: Solids, Liquids, Gases

### Chm.1.2.3 Compare inter- and intra- particle forces.

- Explain why intermolecular forces are weaker than ionic, covalent or metallic bonds
- Explain why hydrogen bonds are stronger than dipole-dipole forces which are stronger than dispersion forces
- Apply the relationship between bond energy and length of single, double, and triple bonds (conceptual, no numbers).
- Describe intermolecular forces for molecular compounds. (*Questions 19,20*)
  - H-bond as attraction between molecules when H is bonded to O, N, or F. Dipole-dipole attractions between polar molecules.
  - London dispersion forces (electrons of one molecule attracted to nucleus of another molecule) – i.e. liquefied inert gases.
  - Relative strengths (H>dipole>London/van der Waals).

### Chm.2.1.1 Explain the energetic nature of phase changes.

- Explain physical equilibrium: liquid water-water vapor. Vapor pressure depends on temperature and concentration of particles in solution. (conceptual only – no calculations)
- Explain how the energy (kinetic and potential) of the particles of a substance changes when heated, cooled, or changing phase. (*Question 17*)
- Identify pressure as well as temperature as a determining factor for phase of matter.
- Contrast heat and temperature, including temperature as a measure of average kinetic energy, and appropriately use the units Joule, Celsius, and Kelvin.

### Chm.2.1.2 Explain heating and cooling curves (heat of fusion, heat of vaporization, heat, melting pt. and boiling pt).

- Define and use the terms and/or symbols for: specific heat capacity, heat of fusion, heat of vaporization.
- Interpret the following:
  - heating and cooling curves (noting both significance of plateaus and the physical states of each segment (*Questions 17, 18*))
  - Phase diagrams for H<sub>2</sub>O and CO<sub>2</sub>.
- Complete calculations of:  $q = mC_p\Delta T$ ,  $q = mH_f$  and  $q = mH_v$  using heating/cooling curve data.
- Explain phase change calculations in terms of heat absorbed or released (endothermic vs. exothermic processes).

### Chm.2.1.3 Interpret the data presented in phase diagrams.

- Draw phase diagrams of water and carbon dioxide (shows how sublimation occurs). Identify regions, phases and phase changes using a phase diagram. (*Question 18*)
- Use phase diagrams to determine information such as (1) phase at a given temperature and pressure, (2) boiling point or melting point at a given pressure, (3) triple point of a material. (*Question 18*)

### Chm.2.1.5 Explain the relationships between P, T, V, and quantity of gas (moles) both qualitative and quantitative.

#### *(Question 11)*

- Identify characteristics of ideal gases. (*Question 1*)
- Apply general gas solubility characteristics.
- Apply the following formulas and concepts of kinetic molecular theory.
  1. 1 mole of any gas at STP=22.4 L (*Questions 12, 13*)
  2. Ideal gas equation ( $PV=nRT$ ), Combined gas law ( $P_1V_1/T_1 = P_2V_2/T_2$ ) and applications holding one variable constant: for  $PV=k$ , (*Questions 8, 9, 14*)  
 $P_1V_1 = P_2V_2$ ; for  $V/T=k$ ,  $V_1/T_1 = V_2/T_2$ ; for  $P/T=k$ ,  $P_1/T_1 = P_2/T_2$ . *Note: Students should be able to derive and use these gas laws, but are not necessarily expected to memorize their names.* (*Questions 2, 3, 5, 6, 7, 10*)
  3. Avogadro's law ( $n/V=k$ ),  $n_1/V_1 = n_2/V_2$
  4. Dalton's law ( $P_t=P_1+P_2+P_3 \dots$ ) (*Question 4*)
  5. Vapor pressure of water as a function of temperature (conceptually). (*Questions 15, 16*)

### Practice Problems:

1) What are four (4) characteristics of gases according to Kinetic Molecular Theory (KMT)?

a)

c)

b)

d)

2) **Identify as pressure, volume, temperature, or moles.**

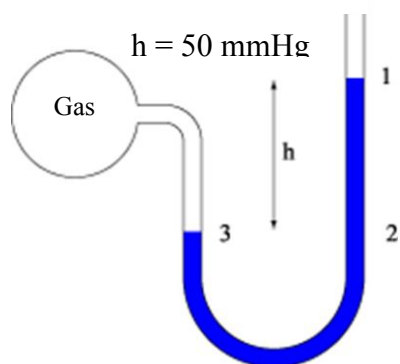
- a) The speed of the particles
- b) The size of the container
- c) The number of collisions between the particles and the walls of the container
- d) The number of particles in the container

3) **Match the law with the equation:**

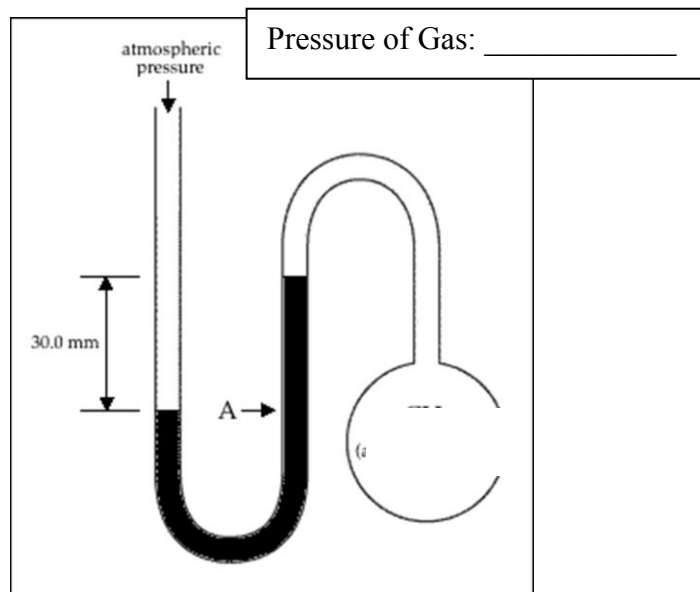
_____ Boyle's Law	a) $PV = nRT$	d) $P_1V_1 = P_2V_2$
_____ Charles's Law	b) $\frac{P_1}{T_1} = \frac{P_2}{T_2}$	e) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
_____ Gay-Lussac's Law	c) $\frac{V_1}{T_1} = \frac{V_2}{T_2}$	f) $\frac{V_1}{n_1} = \frac{V_2}{n_2}$
_____ Avogadro's Law		
_____ Combined Gas Law		
_____ Ideal Gas Law		

4) **Reading a Manometer:**

Determine the pressure of the gas if the atmospheric pressure is 750 mmHg for both.



Pressure of Gas: \_\_\_\_\_



5) **Convert these pressures. SHOW YOUR WORK.**

- a) 600 Torr = \_\_\_\_\_ atm
- b) 40 kPa = \_\_\_\_\_ mmHg
- c) 2.5 atm = \_\_\_\_\_ kPa
- d) 755 mmHg = \_\_\_\_\_ Torr ☺

**Gas Law Problems:**

- 6) If the volume of a gas is expanded from 45.0 mL to 105 mL, what is the new temperature if the temperature starts at 15°C and the pressure is held constant?

Equation: \_\_\_\_\_ Solution: \_\_\_\_\_

- 7) If the pressure on a gas is increased from 750 mmHg to 900 mmHg, what is the new volume if it was initially 250 mL and the temperature is held constant?

Equation: \_\_\_\_\_ Solution: \_\_\_\_\_

- 8) What number of moles of carbon dioxide gas occupies 55.5 L at 95 kPa and 20°C?

Equation: \_\_\_\_\_ Solution: \_\_\_\_\_

- 9) If the pressure on a sample of gas decreases from 1.25 atm to 0.75 atm and the volume expands from 2.44 L to 2.90 L, what is the final temperature if the initial temperature of the gas is -40°C?

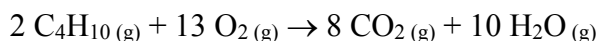
Equation: \_\_\_\_\_ Solution: \_\_\_\_\_

- 10) If the temperature on a sample of gas increases from 0°C to 37°C, what is the new pressure if the initial pressure was 1.00 atm?

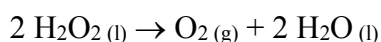
Equation: \_\_\_\_\_ Solution: \_\_\_\_\_

**Gas Stoichiometry & Gas Laws:**

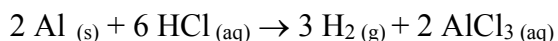
- 11) What are the values for standard temperature and pressure?
- 12) (***Easiest***) Given the reaction shown here, how many liters of CO<sub>2</sub> will be produced from the combustion of 0.750 L of C<sub>4</sub>H<sub>10</sub> if this reaction occurs at constant temperature and pressure.



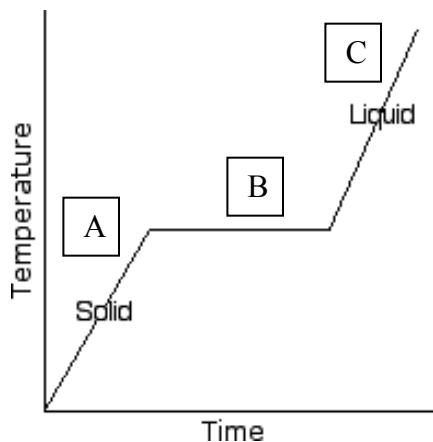
- 13) (***Medium***) If 25 grams of hydrogen peroxide decompose at STP according to the following reaction, how many liters of oxygen are produced?



- 14) (***Hardest***) Given the reaction of 0.25 g of Al with HCl, how many liters of H<sub>2</sub> gas will be produced if the temperature is 40°C and the pressure is 1.15 atm? *Hint: Is this at STP?*

**Lab Type Questions:**

- 15) You collect a gas over water at 20°C and the vapor pressure of the water is 21.1 mmHg. What is the pressure on the gas you collected if the atmospheric pressure outside the gas collection chamber is 755 mmHg. Express your answer in atmospheres.
- 16) You react a strip of magnesium with HCl in a gas collection tube over water. The temperature of the water and gas are 22°C. The vapor pressure of water at that temperature is 19.8 mmHg and the atmospheric pressure is 730 mmHg. The volume of gas you collect is 92.5 mL. What mass of magnesium must you use in the reaction?  
*Hint: very similar to #15, but you have to remove water vapor first!*



17) To the left is shown a heating curve for a substance. Describe what is happening in the three parts of the graph as heat is added. Be sure to include: temperature, kinetic energy, and potential energy.

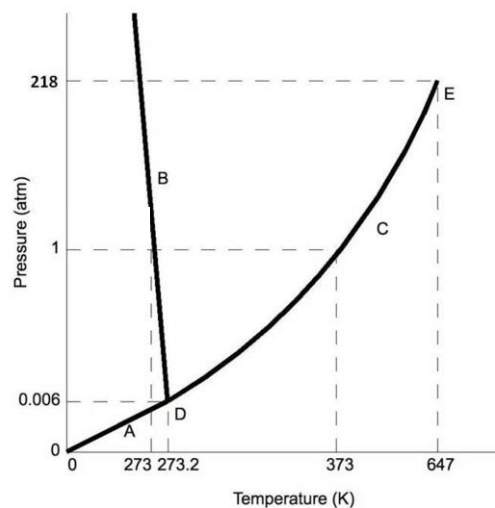
A:

B:

C:

18) Answer the following questions using the phase diagram shown here.

- Could this be a phase diagram for water?
- What is the approximate value for the critical temperature?
- Label the three phases on the diagram.
- Along which line does freezing occur?
- What is the temperature and pressure at the triple point?
- Sketch a heating curve for this substance going from 0 K to 647 K at 1 atm.



**Intermolecular (Interparticle) Forces (IMF):**

19) Identify type of substance as ionic, polar covalent, non-polar covalent, network covalent, or metallic. Identify the interparticle force (IMF) that holds the substance together: hydrogen bond, ion-dipole, London dispersion force, metallic, ionic, or dipole-dipole.

Substance	Type of Substance	Interparticle Force
a) SiO <sub>2</sub> (quartz)		
b) NBr <sub>3</sub>		
c) Fe		
d) ZnCl <sub>2</sub>		
e) SO <sub>2</sub>		
f) Br <sub>2</sub>		
g) HBr		

20) Of the substances in the table above:

- Which should have the highest melting point?
- Which should have the lowest boiling point?
- Which should be the most ductile?
- Which has a bond that involves sharing electrons unequally?
- Which is made of cations that are bonded together by a sea of electrons?
- Which is bonded together by a transfer of electrons?
- Which would be considered an electrolyte?