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Chapter 9 Practice Worksheet:
Gases: Their Properties and Behavior

1) Describe the differences between atoms' behaviors in solids, liquids, and gases. Describe atomic motion and relative speed/energy in each. Draw a picture of a sample of each.

Solids: atoms vibrate within the solid structure but do not change positions relative to each other. Atomic speed is slowest in solids.

Liquids: atoms move randomly around each other, constant motion to take the shape of the container; move faster than solids but slower than gases.

Gases: atoms move very rapidly in straight-line motions until they collide with another atom or object; gaseous atoms move the fastest of the three phases.

2) Convert 755 torr to atm and mmHg.

755 torr = 0.993 atm = 755 mmHg

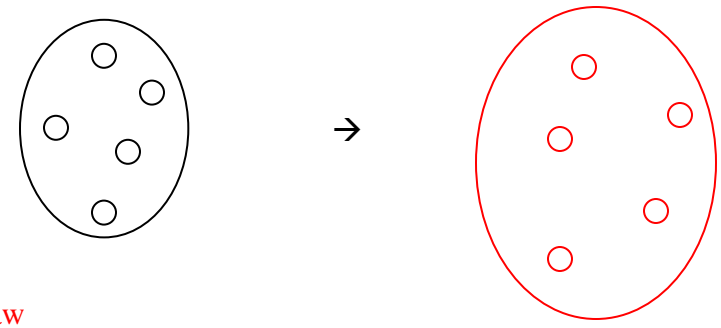
3) Define atmospheric pressure. How is it measured?

Atmospheric pressure is the pressure exerted by gases in the atmosphere on objects on the surface of the Earth. It is measured by how far mercury rises up an evacuated tube cause by pressure of gases pushing down on mercury outside the evacuated tube.

4) Write the formulas for a) Boyle's Law, b) Charles' Law, c) the Combined Gas Law, and d) the Ideal Gas Equation.

a) $P_1 V_1 = P_2 V_2$
b) $V_1 / T_1 = V_2 / T_2$
c) $P_1 V_1 / T_1 = P_2 V_2 / T_2$
d) $PV = nRT$

5) Consider the **closed** system (a balloon) below at a temperature of 200 K. Draw what will happen to the gas in the balloon if the balloon is heated to 400 K and pressure remains the same. Which gas law is being used in this example?



Charles' Law

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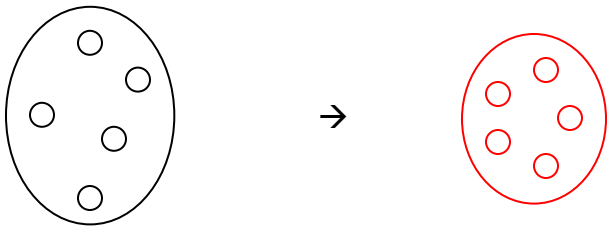
6) Consider the **closed** system below at atmospheric pressure (1.00 atm) and constant temperature. Draw what will happen to the gas in the balloon if the pressure on the balloon is increased to 2.00 atm and temperature remains the same. Which gas law is being used in this example?



Boyle's Law

7) A certain gas has a volume of 19.7 L at a pressure of 745 mm Hg. If the volume is increased to 22.5 L, what is the pressure of the system?

P = 0.858 atm

8) A sample of helium occupies 30.0 mL at a temperature of 25°C. If the temperature is increased to 75°C, what is the new volume of helium?

V = 35.0 mL

9) An inflated balloon has a volume of 6.0 L at sea level (1.0 atm) and is allowed to ascend in altitude until the pressure is 0.45 atm. During the ascent the temperature of the gas falls from 22°C to -21°C. Calculate the volume of the balloon at its final altitude.

V = 11 L

10) What is the pressure of 0.75 moles of an ideal gas at exactly 100°C that occupies 11.5 L of space?

P = 2.0 atm

11) What is the volume of 2.00 moles of gas at STP?

V = 44.8 L

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12) Calculate the density (in g/L) of octane (C_4H_{10}) vapor at 125.0°C and 720.0 torr.

d = 1.68 g/L

13) An organic chemist isolates a colorless liquid from a petroleum sample. She places the liquid in a flask and puts the flask in a boiling water bath, which vaporizes the liquid and fills the flask with gas. She closes the flask, reweighs it, and obtains the data below. Using this information, calculate the molar mass of the organic liquid.

Volume of flask: 213 mL Temperature: 100°C Pressure: 754 torr
Mass of flask + gas: 78.416 g Mass of empty flask: 77.834 g

Mass gas: 0.582 g
d = 2.732 g/L

MM = dRT / P = 84.3 g/mol

14) A sample of calcium carbonate, $CaCO_3$, is decomposed to give CaO and CO_2. The carbon dioxide is collected in a 0.500 L flask. After the reaction is complete, the gas has a pressure of 1.3 atm and a temperature of 31°C. How many grams of CO_2 were generated in the reaction?

Moles CO_2 (from ideal gas law)= 0.02604 mol

mass CO_2 = 1.1 g

15) 5.77 g of H_2CO_3 are heated in a test tube. A gas is produced in this decomposition reaction. What is the volume of the gas given off if the final temperature of the reaction is 25.0°C and the final pressure is 0.785 atm? (Hint: write a balanced equation for this reaction first.)

Moles CO_2 (from stoichiometry) = 0.09306 mol

V = nRT / P = 2.90 L

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16) The safety air bags in automobiles are inflated by nitrogen gas generated by the rapid decomposition of sodium azide, NaN_3 according to the equation: $2NaN_3\ (s) \rightarrow 2Na\ (s) + 3N_2\ (g)$. If an air bag has a volume of 36 L and is to be filled with nitrogen gas at a pressure of 1.15 atm at a temperature of 26.0°C, how many grams of NaN_3 must be decomposed?

Moles N_2 (from ideal gas law) = 1.686 mol

Use stoichiometry to find grams NaN_3: 73 g NaN_3

17) A container holds 4.0 mol of CO_2 and 3.0 mol of N_2. The container has a total pressure of 9.5 atm at 25°C. Calculate the partial pressure of N_2.

P_{N2} = 4.1 atm

18) A mixture of gases contains 0.75 mol N_2, 0.30 mol O_2, and 0.15 mol CO_2. If the total pressure of the mixture is 1.56 atm, what is the partial pressure of each component? (Hint: Find the mol fraction of each gas first.)

X_{N2} = 0.625 P_{N2} = 0.98 atm
X_{O2} = 0.25 P_{O2} = 0.39 atm
X_{CO2} = 0.125 P_{CO2} = 0.20 atm

19) List the 5 components of the Kinetic Molecular Theory of gases.

1. Gases are composed of tiny particles that move randomly.
2. The volume of gas particles is negligible compared to the total volume of the gas (low density, high compressibility).
3. Gas molecules move and act independently of one another and have no intermolecular attractions.
4. Pressures of gases come from the collisions of gas particles with the walls of containers.
5. The average kinetic energy of a sample of gas is proportional to the temperature (in K) of the sample.

20) Place the following gases in order of increasing molecular speed at 300 K: CO_2, H_2, F_2, N_2O_4, HF.

$N_2O_4 < CO_2 < F_2 < HF < H_2$