Unit 6 - Gases

SECTION 1

SHORT ANSWER: *Answer the following questions in the space provided.*

1. B **Pressure = force ÷ surface area**
   For a constant force, when the surface area is tripled the pressure is
   (a) doubled.
   (b) a third as much.
   (c) tripled.
   (d) unchanged.

2. Explain how to calculate the partial pressure of a dry gas that is collected over water when the total pressure is atmospheric pressure.
   $P_{TOTAL} = P_1 + P_2 + \dots P_n$ THE PRESSURE OF GASES COLLECTED OVER WATER = ATMOSPHERIC PRESSURE. A SINGLE GAS COLLECTED LIKE THIS WILL HAVE WATER VAPOR IN IT TOO. WE MUST SUBTRACT THE PRESSURE OF THE WATER VAPOR TO GET THE PRESSURE OF THE GAS WITHOUT THE WATER VAPOR PRESSURE

3. Convert a pressure of 0.200 atm to the following units:
   a. mm Hg 152 mmHg b. kPa 20.26 kPa

4. When an explosive like TNT is detonated, a mixture of gases at high temperature is created. Suppose that gas X has a pressure of 50 atm, gas Y has a pressure of 20 atm, and gas Z has a pressure of 10 atm.
   a. What is the total pressure in this system? 80 ATM
   b. What is the total pressure in this system in kPa? 8104 kPa

5. The height of the mercury in a barometer is directly proportional to the pressure on the mercury's surface. At sea level, pressure averages 1.0 atm and the level of mercury in the barometer is 760 mm (30. inches). In a hurricane, the barometric reading may fall to as low as 28 in.
   1 ATM = 30. IN $(28\text{in}) \times \frac{1\text{ ATM}}{30\text{in}}$
   a. Convert a pressure reading of 28 in. to atmospheres. .933 ATM
   b. What is the barometer reading, in mm Hg, at a pressure of 0.50 atm? 380 mmHg $(.5\text{ ATM}) \times \frac{760\text{ mmHg}}{1\text{ ATM}}$

SECTION 2

SHORT ANSWER: *Answer the following questions on the lines.*

1. State whether the pressure of a fixed mass of gas will increase, decrease, or stay the same in the following circumstances:
   a. INCREASE temperature increases, volume stays the same
   b. DECREASE volume increases, temperature stays the same
   c. DECREASE temperature decreases, volume stays the same
   d. INCREASE volume decreases, temperature stays the same

2. Two sealed flasks, A and B, contain two different gases of equal volume at the same temperature and pressure. Assume that flask A is warmed as flask B is cooled. Will the pressure in the two flasks remain equal? If not, which flask will have the higher pressure? Explain.

THE PRESSURE IN FLASK A WILL BE HIGHER. WHEN IT'S TEMP INCREASES, IT'S KE INCREASES. $KE = \frac{1}{2}mv^2$. IT'S m (MASS) STAYS THE SAME SO IT'S VELOCITY (v) MUST BE GREATER. GREATER VELOCITY PUTS MORE FORCE ON A SURFACE. FORCE ON A SURFACE = PRESSURE, SO PRESSURE INCREASES.

PROBLEMS: *Write your answers on the lines. Show your work in the spaces provided.*

3. A bicycle tire is inflated to 55 psi at 15°C. Assume that the volume of the tire does not change appreciably once it is inflated.

   a. INCREASE If the tire and the air inside it are heated to 30°C by road friction, does the pressure in the tire increase or decrease? (Assume the volume of air in the tire remains constant.)

   b. YES Because the temperature has doubled, does the pressure double to 110 psi?

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ $\frac{55\text{ psi}}{288\text{ K}} = \frac{110\text{ psi}}{T_2}$ $\frac{T_2(55\text{ psi})}{55} = \frac{(110\text{ psi})(288\text{ K})}{55}$ $T_2 = 576\text{ K} = (2)(288)$

   c. 110 psi What will the pressure be when the temperature has doubled? Express your answer in pounds per square inch.

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ $\frac{55\text{ psi}}{288\text{ K}} = \frac{P_2}{576\text{ K}}$ $\frac{(576\text{ K})(55\text{ psi})}{288\text{ K}} = 110\text{ psi}$

4. 4.5 L A 24-L sample of a gas at fixed mass and constant temperature exerts a pressure of 3.0 atm. What pressure will the gas exert if the volume is changed to 16 L?

$P_1V_1 = P_2V_2$ $\frac{(24\text{ L})(3.0\text{ atm})}{16\text{ L}} = \frac{(16\text{ L})(P_2)}{16\text{ L}}$ $\Rightarrow 4.5\text{ L} = P_2$

5. .025 L = 25 ml A common laboratory system to study Boyle's law uses a gas trapped in a syringe. The pressure in the system is changed by adding or removing identical weights on the plunger. The original gas volume is 50.0 mL when two weights are present. Predict the new gas volume when four more weights are added.

$P_1V_1 = P_2V_2$ $\frac{(.050\text{ L})(2P_1)}{2P_1} = \frac{(V_2)(2P_1)}{2P_1}$ $.025\text{ L} = V_2$

6. 1029.70 ml A sample of argon gas occupies a volume of 950 mL at 25.0°C. What volume will the gas occupy at 50.0°C if the pressure remains constant?

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{(323\text{ K})(950\text{ ml})}{298\text{ K}} = \frac{V_2}{323\text{ K}} \cdot (323\text{ K})$ $V_2 = 1029.70\text{ ml}$

7. 190480 Pa A 500.0-mL gas sample at STP is compressed to a volume of 300.0 mL, and the temperature is increased to 35.0°C. What is the new pressure of the gas in **pascals**?

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\frac{(308\text{ K})}{300\text{ ml}} \frac{(101.3\text{ kPa})(500\text{ ml})}{273\text{ K}} = \frac{P_2(300\text{ ml})}{308\text{ K}} \cdot \frac{308\text{ K}}{300\text{ ml}}$

$190.48\text{ kPa} = P_2 \Rightarrow 190480\text{ Pa}$

$P_1V_1 = P_2V_2$

8. 1266.67 mL A sample of gas occupies 1000. mL at standard pressure. What volume will the gas occupy at a pressure of 600. mm Hg if the temperature remains constant?

$\frac{(760\ mmHg)(1000\ mL)}{600\ mmHg} = \frac{(600\ mmHg)(V_2)}{600\ mmHg}$

$1266.67\ mL = V_2$

SECTION 3

SHORT ANSWER: *Answer the following questions in the space provided.*

1. B The molar mass of a gas at STP is the density of that gas in g/L

   Molar mass $= \frac{g}{mol}$ $\left(\frac{g}{L}\right)\frac{22.4\ L}{mol}$

   a. multiplied by the mass of 1 mol.
   b. multiplied by 22.4 L.
   c. divided by the mass of 1 mol.
   d. divided by 22.4 L.

2. B For the expression $PV = nRT$, which of the following will cause the volume to increase?
   a. increasing P
   b. increasing T
   c. decreasing T
   d. decreasing n

3. Two sealed flasks, A and B, contain two different gases of equal volume at the same temperature and pressure.

   TRUE a. The two flasks must contain an equal number of molecules. True or False?

   FALSE b. The two samples must have equal masses. True or False? - DIFFERENT GASES HAVE DIFFERENT MASSES.

PROBLEMS: *Write the answer on the line to the left of each question.*

4. Use the data in the table below to answer the following questions. Assume all gases are at STP.

Formula	Molar mass (g/mol)
N_2	28.02
CO	28.01
C_2H_2	26.04
He	4.00
Ar	39.95

   a. ALL THE SAME Which gas contains the most molecules in a 5.0 L sample?

   b. He Which gas is the least dense?

   c. N_2 & CO Which two gases have virtually the same density?

   d. 1.25 g/L What is the density of N_2 (in g/L) measured at STP?

$\frac{(28.02\ g)}{mol}\frac{(1\ mol)}{22.4\ L}$

5. .25 mol How many moles of gas are present in 5.6 L of any ideal gas at STP?

$(5.6\,L)\ \frac{1\ mol}{22.4\,L} = .25\ mol$

6. Consider the following reaction: $CH_4\ (g) + 2O_2\ (g) \rightarrow CO_2\ (g) + 2H_2O\ (g)$

a. .25 mol How many moles of methane, CH_4 are present in 5.6 L of the gas at STP?

WORK

b. 4.01 g What is the mass of the 5.6 L sample of CH_4?

$(.25\ mol)\frac{(16.05\ g)}{(1\ mol)} = 4.0125\ g = 4.01\ g\ CH_4$

12.01
4.04
16.05

7. A large cylinder of He gas such as that used to inflate balloons has a volume of 25.0 L at 22°C and 5.6 atm.

a. 5.78 mol How many moles of He are in such a cylinder? $PV = nRT \Rightarrow$

$\frac{(5.6\ ATM)(25\ L)}{(.0821\ L\cdot ATM/mol\cdot K)(295\ K)} = n \quad \frac{(.0821\ L\cdot ATM/mol\cdot K)(295\ K)}{(.0821\ L\cdot ATM/mol\cdot K)(295\ K)} = 5.78\ mol\ He$

b. 23.12 g What is the mass of the He calculated in Question a? $(5.78\ mol)\frac{(4.00\ g)}{mol}$

$= 23.12\ g$

6. When C_3H_4 combusts at STP, 5.6 L of C_3H_4 are consumed according to the following equation:

$C_3H_4\ (g) + 4O_2\ (g) \rightarrow 3CO_2\ (g) + 2H_2O\ (l)$

a. .25 mol How many moles of C_3H_4 react?

$(5.6\ L)\frac{(1\ mol)}{22.4\ L} = .25\ mol$

b. _____ How many moles of O_2, CO_2, and H_2O are either consumed or produced?

$(.25\ mol\ C_3H_4)\frac{(4\ mol\ O_2)}{(1\ mol\ C_3H_4)} = 1\ mol\ O_2\ CONSUMED$

$(.25\ mol\ C_3H_4)\frac{(3\ mol\ CO_2)}{(1\ mol\ C_3H_4)} = .75\ mol\ CO_2\ PRODUCED$

$(.25\ mol\ C_3H_4)\frac{(2\ mol\ H_2O)}{(1\ mol\ C_3H_4)} = .5\ mol\ H_2O\ PRODUCED$

c. 10.02 g How many grams of C_3H_4 are consumed?

$(.25\ mol)\frac{(40.07\ g)}{(mol)} = 10.0175\ g\ C_3H_4$

3·12.01
+4·1.01
40.07

d. 16.8 L How many liters of CO_2 are produced?

STP $\Rightarrow (.75\ mol)\frac{(22.4\ L)}{mol} = 16.8\ L$

e. 9.01 g How many grams of H_2O are produced?

$(.50\ mol\ H_2O)\frac{(18.02\ g)}{mol} = 9.01\ g$

12.01
32.00
44.01

16.00
2.02
18.02