Name Key Per______

Gases and Gas Laws [redacted] Review Worksheet

The problems on this worksheet are Chem 10 level problems. They are provided to assist your review of the topics covered in Chp 13 of the McQuarrie textbook. Note that Chem 11 problems will be more involved and more rigorous than these! An answer key is provided at the end of this worksheet.

The Gas Laws

1. The average atmospheric pressure on Mount Everest is 0.311 atm. Convert this to mmHg and psi.

$\frac{.311\text{ atm} \mid 760\text{ mmHg}}{\mid 1\text{ atm}} = \boxed{236\text{ mmHg}}$ $\frac{.311\text{ atm} \mid 14.7\text{ psi}}{\mid 1\text{ atm}} = \boxed{4.57\text{ psi}}$

2. Consider a sample of gas in a cylinder with a moveable piston. Assuming that no gas is lost or gained (constant n), what would happen to:

a. the gas volume if the pressure is increased (at constant T)? V ↓

b. the gas volume if the temperature is increased (at constant P)? V ↑

c. the gas pressure if the temperature is decreased (at constant V)? P ↓

3. Oxygen gas is commercially sold in 49.0 L steel cylinders at a pressure of 150 atm. If it were all transferred to a 235 L tank at constant temperature, what would the pressure of this gas be in atm and in psi?

$(150\text{ atm})(49\text{ L}) = (235\text{ L})\,?$ $P = \boxed{31.3\text{ atm} = 460.\text{ psi}}$

4. A bicycle tire is inflated with air to a pressure of 125 psi at on a warm day with a temperature of [redacted] 29.4°C. At night, however, the temperature drops to [redacted] 12.8°C. Assuming a constant tire volume and no leakage of air out the tire, what is the new tire pressure (in psi) at this temperature?

$\frac{125\text{ psi}}{302.4\text{ K}} = \frac{P}{285.8\text{ K}}$ $P = \boxed{118\text{ psi}}$

5. Suppose you have a 25.0 mL sample of carbon dioxide gas in a syringe at 20.0 °C. Assuming constant pressure, what will the volume of this gas be (in mL) at a temperature of 37.0 °C?

$\frac{25\text{ mL}}{293\text{ K}} = \frac{V}{310\text{ K}}$ $V = \boxed{26.5\text{ mL}}$

6. A 558 mL sample of N_2 gas has a temperature of 22 °C and a pressure of 836 torr. The pressure and volume are then changed to 0.965 atm and 0.716 L, respectively. Assuming constant n, what is the new gas temperature (in °C)?

$\frac{(836\text{ torr})(558\text{ mL})}{295\text{ K}} = \frac{(733.4\text{ torr})(716\text{ mL})}{T}$ $T = 332\text{ K} - 273 = \boxed{59\text{°C}}$

X [redacted] A balloon filled with 15.0 grams of ammonia gas (NH_3) has a volume of 234 mL. If 0.332 moles of ammonia then leak out of the balloon, what is its new volume in mL (assuming no change in temperature or pressure)?

$\frac{V}{n}$ $\frac{15\text{ g } NH_3 \mid 1\text{ mol}}{\mid 17.04\text{ g}} = .880\text{ mol}$ $\frac{234\text{ mL}}{.880\text{ mol}} = \frac{?}{.332\text{ mol}}$ $V = \boxed{88.3\text{ mL}}$

Ideal Gas Law and STP

8. A balloon holds 30.0 kg of helium gas. What is the volume of this balloon (in L) if the gas pressure is 18.38 psi and the temperature is 22.0 °C?

$\frac{18.38\text{ psi} \mid 1\text{ atm}}{\mid 14.7\text{ psi}} = 1.25\text{ atm}$ $\frac{30\text{ kg} \mid 1000\text{ g} \mid 1\text{ mol}}{\mid 1\text{ kg} \mid 4\text{ g}} = 7500\text{ mol He}$ $V = \frac{nRT}{P} = \boxed{145{,}000\text{ L}}$

$\boxed{\text{cm}^3 = 1\text{ mL}}$ 9. What mass of methane gas (CH_4) would occupy a 6150 cm^3 cylinder at 300 K and 1140 torr?

$\frac{1140\text{ torr} \mid 1\text{ atm}}{\mid 760\text{ torr}} = 1.5\text{ atm}$ $n = \frac{PV}{RT} = .375\text{ mol}$ $\frac{.375\text{ mol} \mid 16.05\text{ g}}{\mid 1\text{ mol}} = 6.02\text{ g}$

10. A 12.0 mL sample of liquid methanol (CH_3OH, $d = 0.850$ g/mL) is placed in an evacuated, sealed 250. mL flask and then heated to a temperature of 60.0 °C to vaporize it completely. At this temperature, what is the pressure (in mm Hg) of the gaseous methanol in this flask?

$\boxed{\text{Bonus type}}$

$\frac{12\text{ mL} \mid .85\text{ g} \mid 1\text{ mol}}{\mid 1\text{ mL} \mid 32.05\text{ g}} = .318\text{ mol}$ $P = \frac{nRT}{V} = \frac{(.318)(.0821)(333)}{.25} = 34.8\text{ atm} = \boxed{26{,}400\text{ mm Hg}}$

V = 49.5 L ↗ 74.1 atm

[redacted]. A steel cylinder contains 150 moles of argon gas at a temperature of 25.0 °C and a pressure of 5.63 x 10^4 mm Hg. Calculate the density of argon (in g/L) in this cylinder. Recall that $d = m/V$.

X

$$d = m/V \quad PV = nRT \quad n = \frac{m}{MM} \quad PV = \frac{mRT}{MM} \Rightarrow \frac{m}{V} = d = \frac{PMM}{RT} = \frac{(74.1atm)(39.95g/mol)}{.0821\,(298\,K)} = \boxed{121g/L}$$

[redacted]. A chemist finds that 15.3 grams of an unknown gas occupies 10.0 L at 18.0 °C and 986 torr. What is the molar mass of this gas? ↳ 1.30atm

X

$$PV = \frac{mRT}{MM} \Rightarrow MM = \frac{mRT}{PV} = \boxed{28.1g/mol}$$

13. What is the volume of 1 mole of any gas at STP? 22.4 L
What is the temperature and pressure of a gas at STP?

273 K   1atm

14. What is the mole quantity of chlorine in a 7.50 L sample of chlorine gas at STP? What is the density (in g/L) of this chlorine gas sample?

$$n = \frac{PV}{RT} = \frac{(1atm)(7.5L)}{(.0821)(273K)} = .335mol \text{ OR } \frac{7.5L}{} \left| \frac{1\,mol}{22.4L} \right. = \boxed{.335mol}$$

$$\frac{.335mol}{} \left| \frac{70.1g}{1mol} \right. = 23.5g$$

$$d = 23.5g/7.5L = \boxed{3.13g/L}$$

Gas Stoichiometry and Kinetic Molecular Theory

15. Consider the following reaction: $4\ \overset{5g}{KO_2}\ (s) + 2\ H_2O\ (l) \rightarrow 4\ KOH\ (s) + 3\ \overset{?L}{O_2}\ (g)$.
If 5.00 g of KO_2 reacts completely with excess water:

a. What volume of O_2 gas will be collected at STP? $\frac{5g\ KO_2}{} \left| \frac{1mol\,KO_2}{71.1g} \right| \frac{3mol\,O_2}{4mol\,KO_2} \left| \frac{22.4L}{1mol\,O_2} \right. = 1.18L$

b. If all the O_2 gas is collected in a 0.500 L metal cylinder at 37.0˚C, what pressure it exert (in atm)?

$$\frac{PV}{T} \quad \frac{(1atm)(1.18L)}{273K} = \frac{P(.5L)}{310K} \quad P = \boxed{2.68atm}$$

16. Calculate the volume of oxygen gas required for the complete combustion of 50.0 g of liquid benzene (C_6H_6) at 25 ˚C and 734 mm Hg. Hint: start by writing the balanced equation for this reaction. 734mmHg = .966atm

$$2\,C_6H_6 + 9O_2 \rightarrow 12CO_2 + 6H_2O \qquad \frac{50g\ C_6H_6}{} \left| \frac{1mol}{78.12g} \right| \frac{9mol\,O_2}{2mol\,C_6H_6} = 2.88mol\,O_2$$

$$V = \frac{nRT}{P} = \frac{(2.88)(.0821)(298)}{.966} = \boxed{72.9L\ O_2}$$

17. Consider the reaction: $CO\ (g) + 2\ H_2\ (g) \rightarrow CH_3OH\ (g)$
Suppose that 16.5 L of CO (g) is allowed to react with 25.2 L of H_2 (g) at constant temperature and pressure. What volume of CH_3OH gas would be produced?

$$16.5L\ CO \Rightarrow \boxed{16.5L\ CH_3OH}$$

18. Consider two flasks, A and B. Flask A contains 1 gram of F_2 gas and Flask B contains 1 gram of Cl_2 gas. Both flasks are at the same volume and temperature. Answer the following questions using kinetic molecular theory (no calculations are required).

Flask A a. Which flask contains the greater number of molecules? Why? F_2 because molar mass is lower
Flask B b. In which flask do the molecules move more slowly? Why? Cl_2 because molar mass is bigger
Flask A c. In which flask do the molecules collide with the flask walls more frequently? Why?

F_2 moves faster ∴ colliding more frequently