Chemistry Name FITCH

Unit 6: Gases Study Guide

1. State the postulates of the **Kinetic Molecular Theory**.

GASES ARE NOT DENSE = PARTICLES FAR APART
MOLECULES ARE MOVING RAPIDLY AND RANDOMLY
GASES HAVE MASS

2. Under what conditions does a gas NOT behave ideally? What part or parts of KMT do not hold true under these conditions? EXTREME LOW TEMPS + EXTREME HIGH PRESSURES.
- VIOLATES GASES MOVING RAPIDLY - VIOLATES LOW DENSITY

3. What factor determines average kinetic energy of a gas? TEMPERATURE

4. Know the relationships between T, V, P, and n of a gas; and be able to apply these gas laws:
   - Charles' Law
   - Boyle's Law
   - Gay-Lussac's Law
   - Combined Gas Law
   - Avogadro's Law
   - Ideal Gas Law
   - Dalton's Law

5. Know the following constants and unit conversions:

   1 atm (exactly) = 760 mmHg = _____ torr = 101.3 kPa

   Values for standard temperature and pressure are 0°C and 1 ATM.

   At STP, the molar volume of any gas is 22.4 L.

   The value for the ideal gas constant R is *(include units)* .0821 $\frac{L \cdot ATM}{mol \cdot K}$ when pressure is expressed in atm.

6. Be able to solve gas stoichiometry problems involving the ideal gas law. OK

Review Exercises

Solve each problem** ON A SEPARATE SHEET OF PAPER **using the appropriate gas law.

1. A sample of air has a volume of 140.0 mL at 67°C. At what kelvin temperature will its volume be 50.0 mL if pressure is held constant? (121 K) $\frac{V_1}{T_1} = \frac{V_2}{T_2}$
2. A gas has a volume of 450.0 mL. If temperature is constant, what volume will the gas occupy if the pressure is reduced to one-fourth of its original value? (1800. mL) $P_1V_1 = P_2V_2$

3. If I have 4.00 moles of a gas at a pressure of 5.60 atm and a volume of 12.0 liters, what is the temperature in kelvins? (205 K or -68°C) $PV=nRT$

4. To what Celsius temperature must a sample of nitrogen initially at 27°C and 63.3 kPa be taken so that its pressure increases to 1.125 atm at constant volume? (267°C) $\frac{P_1}{T_1}=\frac{P_2}{T_2}$

5. An unknown quantity of gas in a 31.0-L container has a pressure of 1.20 atm at 87.0°C. How many moles of gas are in the container? (1.26 moles) $PV=nRT$

6. 3.00 moles of gas are in a 60.0-L container at 400.0 K. What is the pressure inside the container? (1.64 atm) $PV=nRT$

7. A 30.0-liter sample of gas initially at 150.°C is cooled at constant pressure to -25.0°C. What is the new volume of the gas? (17.6 L) $\frac{V_1}{T_1}=\frac{V_2}{T_2}$

8. If I have 7.7 moles of gas at 0.090 atm and 56°C, what volume does the gas occupy? (2300 L)

10. A 25.0-L sample of gas is initially at 35.0°C and 700. torr. When conditions are changed to 30.0°C and 800. torr, what is the new volume of the gas? (21.5 L) $PV=nRT$ $\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}$

11. Which gas would diffuse faster throughout our classroom when at the same temperature: Methane (CH_4) or oxygen (O_2)? Why?

METHANE - IT'S LESS MASSIVE SO HAS TO BE MOVING FASTER.

Gas stoichiometry

12. Acetylene gas, C_2H_2, undergoes combustion to produce CO_2 and water vapor. If 75.0 L of CO_2 are produced, how many liters of C_2H_2 are required? (37.5 L)

13. How many liters of fluorine gas could be collected at 850. mmHg and 45.0°C if you decompose 20.0 grams of silver fluoride according to the following equation?

$$2AgF\ (s) \rightarrow 2Ag\ (s) + F_2\ (g)$$

(1.84 L)

15. Solid iron (III) hydroxide decomposes to produce solid iron (III) oxide and water vapor.

    a) Write the balanced equation for this reaction.

    _____

    b) If this reaction produces 0.75 L of water vapor at STP...

    i. How many grams of iron (III) hydroxide have reacted? (2.4 g)

    ii. How many grams of iron (III) oxide have been produced? (1.8 g)

16. What is the mass in grams of 2.80 L CO_2 at STP? (5.50 g)

17. A 3.25-g sample of solid calcium carbide, CaC_2, reacts with water to produce acetylene gas, C_2H_2, and aqueous calcium hydroxide.

    a) Write the balanced equation for the reaction.

    _____

    b) If the acetylene is collected over water at 17°C when the barometric pressure is 0.974 atm, how many milliliters of acetylene are produced? Hint: You will need to consult your water vapor pressure table. (1260 mL)

SEE FOLLOWING PAGES

REVIEW EXERCISES (U6 STUDY GUIDE)

1. $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad \frac{140\text{ mL}}{340\text{ K}} = \frac{50\text{ mL}}{T_2}$

$\frac{340\text{ K}}{140\text{ mL}}$ $T_2 \frac{(140\text{ mL})}{(340\text{ K})} = (50\text{ mL}) \frac{340\text{ K}}{140\text{ mL}}$ $\quad T_2 = 121.43\text{ K}$

$273 + 67 = 340$

2. $P_1V_1 = P_2V_2$ $\quad \frac{P_1(450\text{ mL})}{.25P_1} = \frac{(.25P_1)(V_2)}{.25P_1}$ $\quad 1800\text{ mL} = V_2$

3. $PV = nRT$ $\quad \frac{(5.6\text{ atm})(12\text{ L})}{(4\text{ mol})(.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})} = \frac{(4\text{ mol})(.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol K}})(T)}{(4\text{ mol})(.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol K}})}$

$204.63\text{ K} = T$

4. $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ $\quad \frac{.6248\text{ atm}}{300\text{ K}} = \frac{1.125\text{ atm}}{T_2}$

$\frac{(300\text{ K})}{(.6248\text{ atm})}$ $T_2 \frac{(.6248\text{ atm})}{300\text{ K}} = \frac{(1.125\text{ atm})(300\text{ K})}{(.6248\text{ atm})}$

$T_2 = 540.11\text{ K}$

$540.11\text{ K} - 273\text{ K} = 267.11^\circ\text{C}$

$\frac{(63.34\text{ kPa})(1\text{ atm})}{(101.3\text{ kPa})} = .6248\ldots\text{ atm}$

5. $PV = nRT$ $\quad \frac{(1.2\text{ atm})(31.0\text{ L})}{(.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol K}})(360\text{ K})} = \frac{n(.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol K}})(360\text{ K})}{(.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol K}})(360\text{ K})}$

$1.26\text{ mol} = n$

$273 + 87 = 360$

KEY (CH 5G)

6. $PV = nRT$ $\quad P = \frac{nRT}{V}$

$$P(60L) = (3\,mol)(.0821\,\tfrac{L\cdot atm}{mol\cdot K})(400K)$$

$$\frac{60L}{60L}$$

$$\boxed{P = 1.64\ atm}$$

7. $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad T_2V_1 = V_2T_1$ $\quad \frac{T_2V_1}{T_1} = V_2$

$$\frac{248K(30L)}{423K} = \frac{V_2}{248K}\cdot 248K$$

$$\boxed{17.59L = V_2}$$

$\frac{273}{56}$

329

8. $PV = nRT$

$$\frac{(.09\,atm)(V)}{.09\,atm} = \frac{(7.7\,mol)(.0821\,\tfrac{L\cdot atm}{mol\cdot K})(324K)}{.09\,atm}$$

$$\boxed{V = 2310.93L}$$

9. $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\quad \frac{T_2P_1V_1}{P_2T_1} = V_2$

$$\frac{(303K)(700\,torr)(25L)}{(800\,torr)(308K)} = \boxed{V_2 = 21.52L}$$

12. $C_2H_2 + 2O_2 \rightarrow 2CO_2 + H_2O$ @ STP?

$$(75L\,CO_2)\frac{(1\,C_2H_2)}{(2\,CO_2)} = 37.5L\,C_2H_2$$

13. $2AgF_{(s)} \rightarrow 2Ag_{(s)} + F_{2(g)}$

$$(20g\,AgF)\frac{(1\,mol)}{126.87g} = .1576\,mol\,AgF$$

$$(.1576\,mol\,AgF)\frac{(1\,mol\,F_2)}{(2\,mol\,AgF)} = .0788\,mol\,F_2$$

$\frac{107.87}{19.00}$

126.87

$$\frac{(850\,mmHg)(1\,atm)}{760\,mmHg} = 1.1184\,atm$$

$$\frac{(1.1184\,atm)(V)}{1.1184\,atm} = \frac{(.0788\,mol)(.0821\,\tfrac{L\cdot atm}{mol\cdot K})(318K)}{1.1184\,atm}$$

$$\boxed{V = 1.84L\ F_2}$$

REV Ex (U6 5G)

15. a) $2Fe(OH)_3 \rightarrow Fe_2O_3 + 3H_2O$

b) i. $(.75\,L)\left(\frac{1\ mol}{22.4\,L}\right) = .03348\ldots\ mol\ H_2O$

$(.03348\ldots\ mol\ H_2O)\left(\frac{2\ mol\ Fe(OH)_3}{3\ mol\ H_2O}\right) = .02232\ldots\ mol\ Fe(OH)_3$

$(.02232\ mol\ Fe(OH)_3)\left(\frac{106.88\ g}{mol}\right) = \boxed{2.39\ g\ Fe(OH)_3}$

$1(55.85) + 3(16.00) + 3(1.01) = 106.88$

ii. $(.03348\ mol\ H_2O)\left(\frac{1\ mol\ Fe_2O_3}{3\ mol\ H_2O}\right) = .01116\ mol\ Fe_2O_3$

$(.01116\ mol\ Fe_2O_3)\left(\frac{159.7\ g}{mol}\right) = \boxed{1.78\ g\ Fe_2O_3}$

$2(55.85) + 3(16) = 159.7\ g$

16. $(2.8\,L\ CO_2)\left(\frac{1\ mol}{22.4\,L}\right) = .125\ mol\ CO_2$

$(.125\ mol\ CO_2)\left(\frac{44.01\ g}{mol}\right) = \boxed{5.50\ g\ CO_2}$

17. a. $CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$

b. $(3.25\ g\ CaC_2)\left(\frac{1\ mol}{64.10\ g}\right) = .05077\ mol\ CaC_2$

$40.08 + 24.02 = 64.10\ g$

$(.05077\ mol\ CaC_2)\left(\frac{1\ mol\ C_2H_2}{1\ mol\ CaC_2}\right) = .05077\ mol\ C_2H_2$

$P = .974\ atm = 740.24\ mmHg - 14.5\ mmHg = 725.74\ mmHg$

$= .9549\ atm$

$V = \frac{nRT}{P}$ $\quad V = \frac{(.05077\ mol)(.0821\ L\cdot atm/mol\cdot K)(290\ K)}{.9549\ atm} = 1.2658\ L$

$= \boxed{1265.8\ mL}$