Chemistry

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Name _____
Period _____
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Gas Law Stoichiometry Worksheet

SHOW ALL WORK!!!

Directions: Use significant figures and units in the problems below.

$PV = nRT$

1. Given the following unbalanced chemical equation for the combination reaction of sodium metal and chlorine gas:

$$\underline{2}\ Na_{(s)} + \underline{\ \ }\ Cl_{2(g)} \longrightarrow \underline{2}\ NaCl_{(s)}$$

   a. What volume of chlorine gas, measured at STP, is necessary for the complete reaction of 4.81 g of sodium metal.

2.34 ℓ Cl_2

$$4.81\ g\ Na \left| \frac{1\ mol}{23.0\ g\ Na} \right| \frac{1\ mol\ Cl_2}{2\ mol\ Na} \left| \frac{22.4\ \ell\ Cl_2}{1\ mol} \right| = 2.34\ \ell\ Cl_2$$

2. $\underline{\ \ }\ C_3H_{8(g)} + \underline{5}\ O_{2(g)} \longrightarrow \underline{3}\ CO_{2(g)} + \underline{4}\ H_2O_{(g)}$

   a. Balance the above reaction.
   b. What volume of oxygen gas at 25°C and 1.04 atm is needed for the complete combustion of 5.53 g of propane?

14.6 L

n = X
V = O_2(X)
$T_1 = 25 + 273 = 298K$
$P_1 = 1.05$ atm.

$$V = \frac{(0.628\ mol)(0.0821\ L \cdot atm/mol \cdot K)(298K)}{1.05\ atm}$$

$$5.53\ g\ C_3H_8 \left| \frac{1\ mol\ C_3H_8}{44\ g} \right| \frac{5\ mol\ O_2}{1\ mol\ C_3H_8} = 0.628\ moles$$

$V = 14.6\ L$

3. Potassium permanganate, $KMnO_4$, is produced commercially by oxidizing aqueous potassium manganate, K_2MnO_4.

$$\underline{2}\ K_2MnO_{4\,(g)} + \underline{\ \ }\ Cl_{2(g)} \longrightarrow \underline{2}\ KMnO_{4\,(g)} + \underline{2}\ KCl_{(g}$$

   a. Balance the above reaction.
   b. What volume of Cl_2(g), measured at STP, is needed to produce 10.0 g of $KMnO_4$?

0.709 L

$V = \frac{nRT}{P}$

$$10.0\ g\ KmnO_4 \left| \frac{1\ mole}{158\ g} \right| \frac{1\ mole\ Cl_2}{2\ mol} \left| \frac{22.4\ \ell}{1\ mol\ Cl_2} \right| = 0.709\ L\ Cl_2$$

4. If water is added to magnesium nitride, ammonia gas is produced when the mixture is heated.

$$\underline{\ \ }\ Mg_3N_{2(g)} + \underline{3}\ H_2O_{(g)} \longrightarrow \underline{3}\ MgO_{(g)} + \underline{2}\ NH_{3(g)}$$

(10.3 g over Mg_3N_2; 10.3 g over H_2O; x mol → ℓ over NH_3)

   a. Balance the above reaction.
   b. If 10.3 g of magnesium nitride is treated with 10.3 g of water, what volume of ammonia gas would be collected at 24°C and 752 mmHg?

$PV = nRT$

9.39 L

$$10.3\ g\ Mg_3N_2 \left| \frac{1\ mole}{100.9\ g} \right| \frac{2\ NH_3}{1\ mol} = 0.204\ mol \quad \text{Lim Reagent}$$

$$10.3\ g\ H_2O \left| \frac{1\ mol}{18\ g} \right| \frac{2\ mol\ NH_3}{3\ mol} = 0.381\ mol$$

$24 + 273 = 297K$

$752/760 = 0.989$ atm

$$V = \frac{(0.204\ mol)(0.0821\ L \cdot atm/mol \cdot K)(297K)}{0.989\ atm}$$

$V = 9.39\ L$

$V = \frac{nRT}{P}$

$98.4\ kPa \left| \frac{1\ atm}{101.3\ kPa} \right| = \boxed{0.971\ atm}$ $\quad 101.3\ kPa = 1\ atm$

$50.0 + 273 = 323\ K$

$1\ L = 1\ dm^3$

4. How many grams of $AlCl_3$ must decompose in order to produce 3.10 dm^3 of Cl_2 at 50.0°C and 98.4 kPa? (HINT: You must correct to STP.)

$PV = nRT$

$$2AlCl_{3(s)} \rightarrow 2Al_{(s)} + 3Cl_{2(g)}$$

$$n = \frac{PV}{RT} \quad \frac{(0.971\ atm * 3.10\ L)}{(0.0821\ L \cdot atm / K \cdot mol) * 323\ K)} = 0.114\ moles\ Cl_2$$

Al(1)27 $\quad$ 27
Cl(3)35.5 $\quad$ 106.5
$\quad\quad\quad\quad$ 133.5 g

$$0.114\ mol\ Cl_2 \left| \frac{2\ mol\ AlCl_3}{3\ mol\ Cl_2} \right| \left| \frac{133.5\ g}{1\ mol\ AlCl_3} \right| = \boxed{10.1\ g}$$

ANSWER: **10.1 g**

5. What volume of nitrogen can be produced by the decomposition of 50.0 g of NH_4NO_2 at 25°C and 1.20 atm? (HINT: You must correct to STP.)

$PV = nRT$

$$NH_4NO_{2(s)} \rightarrow N_{2(g)} + 2H_2O_{(g)}$$

$$50.0\ g\ NH_4NO_2 \left| \frac{1\ mole\ NH_4NO_2}{64.0\ g} \right| \left| \frac{1\ mole\ N_2}{1\ mole} \right| = 0.781\ moles\ N_2$$

$$V = \frac{nRT}{P} = \frac{(0.781\ mol * 0.0821\ L \cdot atm / K \cdot mol * 298\ K)}{1.2\ atm}$$

$$V = 15.9\ L$$

ANSWER: **15.9 L**