Chemistry 20 - Unit 4 - Gas Stoichiometry EX

Name: _____

1.00000 atm = 760.000 mmHg = 101.325 kPa
$R = 8.314$ (L*kPa)/(K*mol)
$pV = nRT$ $T_K = T_{°C} + 273.15$

1) 11.688 grams of aqueous sodium chloride can be electrolysed with sufficient voltage, prompting the formation of sodium metal and chlorine gas.

   a) Write a balanced chemical equation detailing this reaction.

   b) Calculate how many moles of sodium chloride decompose in this reaction.

   c) If this reaction takes place at SAPT, what volume of chlorine gas is produced?

2) When 34.8 grams of methane ($CH_{4(g)}$) combusts, it produces $CO_{2(g)}$ and $H_2O_{(g)}$.

   a) Write a balanced chemical equation detailing this reaction.

   b) Calculate how many moles of methane combust.

   c) If this reaction takes place at STP, what volume of carbon dioxide is produced?

3) Benzene ($C_6H_{6(l)}$) is a highly flammable substance that was once a component of gasoline.
   a) Write a balanced chemical equation detailing the complete combustion of benzene.

   b) Calculate how many moles of benzene combust if 7.812 grams of it react.

   c) If this reaction takes place in a reaction chamber with a volume of 400 mL at a temperature of 600.0 °C, what pressure is exerted by the carbon dioxide gas?

4) Gaseous ammonium nitrate is a violently explosive compound that can decompose to nitrogen gas, oxygen gas, and water vapour.
   a) Write a balanced chemical equation detailing this reaction.

   b) If 1.50 x 10^4 mL of ammonium nitrate decomposes at an external pressure of 745.00 mmHg and a temperature of 125.00 °C, how many moles of ammonium nitrate are consumed in the reaction?

   c) What mass of oxygen gas is produced by the decomposition of ammonium nitrate?

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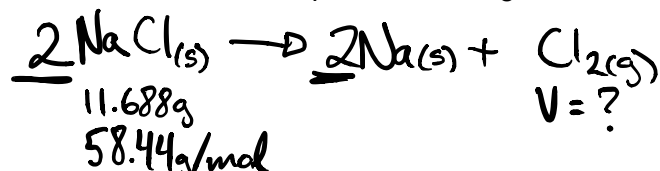
1.00000 atm = 760.000 mmHg = 101.325 kPa
R = 8.314 (L*kPa)/(K*mol)
pV = nRT $T_K = T_{°C} + 273.15$

1) 11.688 grams of aqueous sodium chloride can be electrolysed with sufficient voltage, prompting the formation of sodium metal and chlorine gas.

a) Write a balanced chemical equation detailing this reaction.

$$\underline{2}NaCl_{(s)} \xrightarrow{D} \underline{2}Na_{(s)} + Cl_{2(g)}$$
$$11.688g \qquad\qquad\qquad V = ?$$
$$58.44g/mol$$

b) Calculate how many moles of sodium chloride decompose in this reaction.

$$^nNaCl_{(s)} = 11.688g \times \frac{1 mol}{58.44g} = \boxed{0.2000 \, mol}$$
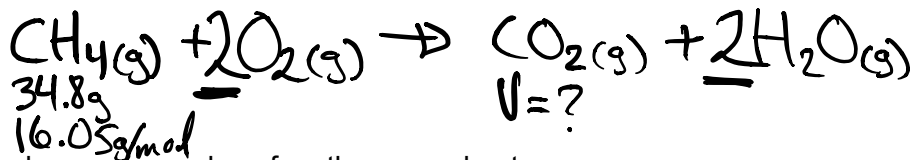
c) If this reaction takes place at SAPT, what volume of chlorine gas is produced?

$$^nCl_2 = 0.2000 mol \times \frac{1}{2} = 0.1000 mol$$

$$V = \frac{nRT}{P} = \frac{(0.1000)(8.3145)(298.15)}{100.00 \, kPa} = \boxed{2.479 \, L}$$

2) When 34.8 grams of methane ($CH_{4(g)}$) combusts, it produces $CO_{2(g)}$ and $H_2O_{(g)}$.

a) Write a balanced chemical equation detailing this reaction.

$$CH_{4(g)} + \underline{2}O_{2(g)} \xrightarrow{D} CO_{2(g)} + \underline{2}H_2O_{(g)}$$
$$34.8g \qquad\qquad\qquad\qquad V = ?$$
$$16.05g/mol$$

b) Calculate how many moles of methane combust.

$$^nCH_4 = 34.8g \times \frac{1 mol}{16.05g} = \boxed{2.17 \, mol}$$
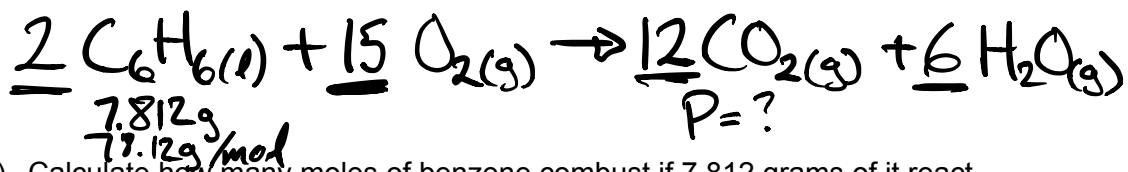
c) If this reaction takes place at STP, what volume of carbon dioxide is produced?

$$^nCO_2 = 2.17 mol \times \frac{1}{1} = 2.17 mol$$

$$V_{CO_2} = \frac{nRT}{P} = \frac{(2.17)(8.3145)(273.15)}{101.325 \, kPa} = \boxed{48.6 \, L}$$

3) Benzene ($C_6H_{6(l)}$) is a highly flammable substance that was once a component of gasoline.

a) Write a balanced chemical equation detailing the complete combustion of benzene.

$$\underline{2}\ C_6H_{6(l)} + \underline{15}\ O_{2(g)} \rightarrow \underline{12}\ CO_{2(g)} + \underline{6}\ H_2O_{(g)}$$

7.812g

77.12g/mol

$P = ?$

b) Calculate how many moles of benzene combust if 7.812 grams of it react.

$$n_{C_6H_6} = 7.812g \times \frac{1 mol}{78.12g} = \boxed{0.1000 mol}$$

c) If this reaction takes place in a reaction chamber with a volume of 400 mL at a temperature of 600.0 °C, what pressure is exerted by the carbon dioxide gas?

$$n_{CO_2} = 0.1000 mol \times \frac{12}{2} = 0.6000 mol$$

$$P_{CO_2} = \frac{nRT}{V} = \frac{(0.6000)(8.3145)(873.2)}{0.400} = \boxed{1.089 \times 10^5 kPa}$$

4) Gaseous ammonium nitrate is a violently explosive compound that can decompose to nitrogen gas, oxygen gas, and water vapour.

a) Write a balanced chemical equation detailing this reaction.

$$\underline{2}\ NH_4NO_{3(g)} \rightarrow \underline{2}\ N_{2(g)} + O_{2(g)} + \underline{4}\ H_2O_{(g)}$$

1.50x10⁴mL

$m = ?$
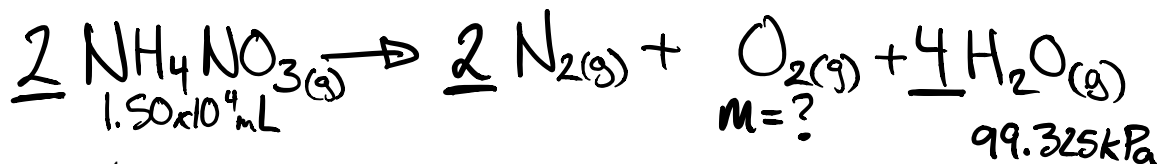
99.325kPa

b) If 1.50 x 10⁴ mL of ammonium nitrate decomposes at an external pressure of ~~745.00~~ mmHg and a temperature of 125.00 °C, how many moles of ammonium nitrate are consumed in the reaction?

$$n_{NH_4NO_3} = \frac{PV}{RT} = \frac{(99.325 kPa)(15.0 L)}{(8.3145)(398.15 K)} = \boxed{0.450 mol}$$

c) What mass of oxygen gas is produced by the decomposition of ammonium nitrate?

$$n_{O_2} = 0.450 mol \times \frac{1}{2} = 0.225 mol$$

$$m_{O_2} = 0.225 mol \times \frac{32.00g}{mol} = \boxed{7.20 g}$$