KEY

CHEMISTRY UNIT 3 Review

1. Dissolving P_4O_{10} in water produces phosphoric acid (H_3PO_4). What mass of phosphoric acid is produced from 552 g of water? $P_4O_{10} + 6\,H_2O \rightarrow 4\,H_3PO_4$

$$5.52\text{g}\,H_2O\left(\frac{1\text{mol}\,H_2O}{18.02\text{g}\,H_2O}\right)\left(\frac{4\text{mol}\,H_3PO_4}{6\text{mol}\,H_2O}\right)\left(\frac{98.00\text{g}\,H_3PO_4}{1\text{mol}\,H_3PO_4}\right) = 20.0\text{g}\,H_3PO_4$$

2. 23.0 ~~liters~~ grams of hydrochloric acid (HCl) reacts with zinc to form hydrogen gas and zinc chloride ($ZnCl_2$). How many liters of hydrogen gas will be produced at STP?

$2HCl + Zn \rightarrow H_2 + ZnCl_2$

$$23.0\text{g}\,HCl\left(\frac{1\text{mol}\,HCl}{36.46\text{g}\,HCl}\right)\left(\frac{1\text{mol}\,H_2}{2\text{mol}\,HCl}\right)\left(\frac{22.4\text{L}\,H_2}{1\text{mol}\,H_2}\right) = 7.07\text{ L}\,H_2(g)$$

3. 10.0 grams of an aqueous zinc chloride reacts with a sodium sulfide solution in a double replacement reaction. Write and balance this equation and then calculate the molecules of sodium chloride produced. $ZnCl_{2(aq)} + Na_2S_{(aq)} \rightarrow ZnS + 2NaCl$

$$10.0\text{g}\,ZnCl_2\left(\frac{1\text{mol}\,ZnCl_2}{136.29\text{g}\,ZnCl_2}\right)\left(\frac{2\text{mol}\,NaCl}{1\text{mol}\,ZnCl_2}\right)\left(\frac{6.022\times10^{23}\text{ NaCl molecules}}{1\text{mol}\,NaCl}\right) = 8.84\times10^{22}\text{ NaCl molecules}$$

4. Complete and balance the following reactions

A.) Aluminum nitrate reacts with copper (I) sulfate in a double replacement reaction.

$$2\,Al(NO_3)_3 + 3\,Cu_2SO_4 \longrightarrow Al_2(SO_4)_3 + 6\,CuNO_3$$

B.) Zinc reacts with silver phosphate in a single replacement reaction.

$$3Zn + 2\,Ag_3PO_4 \longrightarrow Zn_3(PO_4)_2 + 6\,Ag$$

5. Find the empirical formula for a compound that contains 48.6% carbon, 43.2% oxygen, and 8.11% hydrogen.

$$48.6\text{g}\,C\left(\frac{1\text{mol}\,C}{12.01\text{g}}\right) = 4.05\text{mol}\,C \qquad 43.2\text{g}\,O\left(\frac{1\text{mol}\,O}{16.00\text{g}}\right) = 2.7\text{mol}\,O \qquad 8.1\text{g}\,H\left(\frac{1\text{mol}\,H}{1.01\text{g}}\right) = 8.03\text{mol}\,H$$

$$\frac{4.05}{2.7} \qquad \frac{2.7}{2.7} \qquad \frac{8.03}{2.7}$$

$$(C_{1.5}O_1H_{2.97})\times2 = \boxed{C_3O_2H_6}$$

6. The molecular mass of the compound in #5 is 222.0 g/mol. What is the molecular formula for the compound?

$C_3O_2H_6 \rightarrow$ m.m. = 74.09 g/mol

$$\frac{222.0\text{ g/mol}}{74.09\text{ g/mol}} = 3$$

$$(C_3O_2H_6)\times3 = \boxed{C_9O_6H_{18}}$$

$P_2O_5 = 141.94\ g/mol$

$4P + 5O_2 \rightarrow 2P_2O_5$

7. Phosphorus, when reacted with oxygen gas in a synthesis reaction yields diphosphorus pentoxide. If the reaction is begun with 205 grams of phosphorus and 12.6 L of oxygen gas, how much product can be made? How much of the excess reactant is remaining at the end of the reaction? (use either grams or liters depending on which reactant is in excess)

$$205g\ P\left(\frac{1mol\ P}{30.97g}\right)\left(\frac{2mol\ P_2O_5}{4mol\ P}\right)\left(\frac{141.94g}{1mol\ P_2O_5}\right) = 470.g\ P_2O_5$$

$$12.6L\ O_2\left(\frac{1mol\ O_2}{22.4L\ O_2}\right)\left(\frac{2mol\ P_2O_5}{5mol\ O_2}\right)\left(\frac{141.94g}{1mol\ P_2O_5}\right) = 31.9\ g\ P_2O_5$$

O_2 is L.R.

$$12.6L\ O_2\left(\frac{1mol\ O_2}{22.4L\ O_2}\right)\left(\frac{4mol\ P}{5mol\ O_2}\right)\left(\frac{30.97g}{1mol\ P}\right) = 13.9g\ P$$

$205g\ P - 13.9g\ P = 191g\ P$

$\Rightarrow 191g\ P$ left

8. Find the empirical formula for the compound that has: K = 24.6%, Mn = 34.8%, O = 40.6%

$$24.6g\ K\left(\frac{1mol\ K}{39.10g}\right) = \frac{0.629mol\ K}{0.629} \qquad 34.8g\ Mn\left(\frac{1mol\ Mn}{54.94g}\right) = \frac{0.633mol\ Mn}{0.629} \qquad 40.4g\ O\left(\frac{1mol\ O}{16.00g}\right) = \frac{2.53\ mol\ O}{0.629}$$

$K_1Mn_{1.01}O_{4.02} \Rightarrow KMnO_4$

9. A standard laboratory preparation of iodine is the following reaction:

$$2NaI + MnO_2 + 2H_2SO_4 \rightarrow Na_2SO_4 + MnSO_4 + 2H_2O + I_2$$

When 62.55 g of NaI are used with excess amounts of the other reactants, the actual yield of iodine (I_2) was 39.78 g. What is the percent yield?

$$62.55g\ NaI\left(\frac{1mol\ NaI}{149.89g}\right)\left(\frac{1mol\ I_2}{2mol\ NaI}\right)\left(\frac{253.8g\ I_2}{1mol\ I_2}\right) = 52.96g\ I_2$$

$$\frac{39.78g}{52.96g}(100) = 75.11\%\ yield$$

10. Coal gasification is a process that converts coal into methane gas. If this reaction has a percent yield of 85.0%, how much methane can be obtained from 1250 g of carbon?

$$2C + 2H_2O \rightarrow CH_4 + CO_2$$

$$1250gC\left(\frac{1mol\ C}{12.01g}\right)\left(\frac{1mol\ CH_4}{2mol\ C}\right)\left(\frac{16.05g\ CH_4}{1mol\ CH_4}\right) = 32.1g\ CH_4\ theoretical$$

$$32.1g\ (85.0\%) = \left(\frac{actual}{32.1g}\right)32.1g$$

actual yield = $27.3g\ CH_4$