WKS
Mass-Mass Calculations

NAME Answer Key
Period _____ **Date** _____

Perform the following stoichiometry calculations. Show your work, make sure all numbers have units, and watch Sig Figs! Remember:

Mass → Moles → Moles → Mass

1) Titanium is a transition metal used in many alloys because it is extremely strong and lightweight. Titanium(IV) chloride ($TiCl_4$) is extracted from titanium oxide using chlorine and coke (carbon):

$$TiO_2(s) + C(s) + 2\ Cl_2(g) \rightarrow TiCl_4(s) + CO_2(g)$$

If you begin with 1.25 mol TiO_2, what mass of Cl_2 gas is needed?

$$?\ g\ Cl_2 = 1.25\ \cancel{mol\ TiO_2} \times \frac{2\ \cancel{mol\ Cl_2}}{1\ \cancel{mol\ TiO_2}} \times \frac{70.90\ g\ Cl_2}{1\ \cancel{mol\ Cl_2}} = \boxed{177\ g\ Cl_2}$$

2) At high temperature, molten sodium chloride is decomposed into the elements sodium (a liquid at these temperatures) and chlorine (a gas) by means of electrical energy. How many grams of chlorine gas can be obtained from 2.50 mol NaCl? (You need to write and balance the chemical equation!)

$$2\ NaCl(l) \rightarrow 2\ Na(l) + Cl_2(g)$$

$$2.50\ \cancel{mol\ NaCl} \times \frac{1\ \cancel{mol\ Cl_2}}{2\ \cancel{mol\ NaCl}} \times \frac{70.90\ g\ Cl_2}{1\ \cancel{mol\ Cl_2}} = \boxed{88.6\ g\ Cl_2}$$

3) Aluminum oxidizes according the following unbalanced equation:

$$\underline{4}\ Al(s) + \underline{3}\ O_2(g) \rightarrow \underline{2}\ Al_2O_3(s)$$

a. Balance the equation

b. How many grams of Al_2O_3 would be formed by the reaction of 29.75 grams of Al with enough O_2?

$$?\ g\ Al_2O_3 = \underbrace{29.75\ \cancel{g\ Al} \times \frac{1\ \cancel{mol\ Al}}{26.98\ \cancel{g\ Al}}}_{=1.103\ mol\ Al} \times \underbrace{\frac{2\ \cancel{mol\ Al_2O_3}}{4\ \cancel{mol\ Al}}}_{=0.551\ mol\ Al_2O_3} \times \frac{101.96\ g\ Al_2O_3}{1\ \cancel{mol\ Al_2O_3}} = \boxed{56.18\ g\ Al_2O_3}$$

c. How many grams of O_2 would be required to form 65.32 grams of Al_2O_3?

$$?\ g\ O_2 = \underbrace{65.32\ \cancel{g\ Al_2O_3} \times \frac{1\ \cancel{mol\ Al_2O_3}}{101.96\ \cancel{g\ Al_2O_3}}}_{=0.6406\ mol\ Al_2O_3} \times \underbrace{\frac{3\ \cancel{mol\ O_2}}{2\ \cancel{mol\ Al_2O_3}}}_{=0.9610\ mol\ O_2} \times \frac{32.00\ g\ O_2}{1\ \cancel{mol\ O_2}} = \boxed{30.75\ g\ O_2}$$

4) Dinitrogen pentoxide is an acidic gas that reacts with water to forms aqueous nitric acid.
   a. Write and balance the chemical equation.

$$N_2O_5(g) + H_2O(l) \rightarrow 2\ HNO_3(aq)$$

   b. How many grams of dinitrogen pentoxide would be required to completely react with 13.44 grams of water?

$$?\ g\ N_2O_5 = \underbrace{\frac{13.44\ g\ H_2O}{}\ \frac{1\ mol\ H_2O}{18.02\ g\ H_2O}}_{=0.7458\ mol\ H_2O}\ \underbrace{\frac{1\ mol\ N_2O_5}{1\ mol\ H_2O}}_{=0.7458\ mol\ N_2O_5}\ \frac{108.02\ g\ N_2O_5}{1\ mol\ N_2O_5} = \boxed{80.56\ g\ N_2O_5}$$

   c. How many grams of dinitrogen pentoxide would be needed, given enough water, to produce 105.65 grams of nitric acid?

$$?\ g\ N_2O_5 = \underbrace{\frac{105.65\ g\ HNO_3}{}\ \frac{1\ mol\ HNO_3}{63.02\ g\ HNO_3}}_{=1.676\ mol\ HNO_3}\ \underbrace{\frac{1\ mol\ N_2O_5}{2\ mol\ HNO_3}}_{=0.8382\ mol\ N_2O_5}\ \frac{108.02\ g\ N_2O_5}{1\ mol\ N_2O_5} = \boxed{90.55\ g\ N_2O_5}$$

5) Solid iron(III) oxide reacts with gaseous carbon monoxide at high temperature and forms iron metal and carbon dioxide gas.
   a. Write and balance the chemical equation.

$$Fe_2O_3(s) + 3\ CO(g) \rightarrow 2\ Fe(s) + 3\ CO_2(g)$$

   b. How many grams of carbon dioxide would be formed in the reaction where 25.1 grams of iron are formed?

$$?\ g\ CO_2 = \underbrace{25.1\ g\ Fe \times \frac{1\ mol\ Fe}{55.85\ g\ Fe}}_{=0.449\ mol\ Fe} \times \underbrace{\frac{3\ mol\ CO_2}{2\ mol\ Fe}}_{=0.674\ mol\ CO_2} \times \frac{44.01\ g\ CO_2}{1\ mol\ CO_2} = \boxed{29.7\ g\ CO_2}$$

   c. How many grams of iron would be produced by the reaction of 182.0 grams of iron(III) oxide with sufficient carbon monoxide?

$$?\ g\ Fe = \underbrace{182.0\ g\ Fe_2O_3 \times \frac{1\ mol\ Fe_2O_3}{159.7\ g\ Fe_2O_3}}_{=1.140\ mol\ Fe_2O_3} \times \underbrace{\frac{2\ mol\ Fe}{1\ mol\ Fe_2O_3}}_{=2.280\ mol\ Fe} \times \frac{55.85\ g\ Fe}{1\ mol\ Fe} = \boxed{127.3\ g\ Fe}$$