WKS
Comprehensive Stoichiometry

NAME Answer Key
Period _______ **Date** _________________

1) When gaseous disilane (disilicon hexahydride) reacts with oxygen gas, solid silicon dioxide and water vapor are produced.

a) Write and balance the equation with the lowest whole number coefficients. What kind of reaction is it?

$$2\ Si_2H_6\ (g) + 7\ O_2\ (g) \rightarrow 4\ SiO_2\ (s) + 6\ H_2O\ (g)$$

Combustion

b) How many moles of oxygen would be used to completely react with 12.5 moles of disilane?

$$?\ \text{mol } O_2 = 12.5\ \text{mol } Si_2H_6 \times \frac{7\ \text{mol } O_2}{2\ \text{mol } Si_2H_6} = \boxed{43.8\ \text{mol } O_2}$$

c) How many grams of disilane would be needed to react with sufficient oxygen to produce 50.0 g of silicon dioxide?

$$?\ \text{g } Si_2H_6 = \underbrace{50.0\ \text{g } SiO_2 \times \frac{1\ \text{mol } SiO_2}{60.09\ \text{g } SiO_2}}_{0.832\ \text{mol } SiO_2} \times \underbrace{\frac{2\ \text{mol } Si_2H_6}{4\ \text{mol } SiO_2}}_{0.416\ \text{mol } Si_2H_6} \times \frac{62.22\ \text{g } Si_2H_6}{1\ \text{mol } Si_2H_6} = \boxed{25.9\ \text{g } Si_2H_6}$$

d) When 75.0 g disilane reacts with 100. g oxygen, which reactant is limiting?

$$75.0\ \text{g } Si_2H_6 \times \frac{1\ \text{mol } Si_2H_6}{62.22\ \text{g } Si_2H_6} = 1.21\ \text{mol } Si_2H_6;\ 100.\ \text{g } O_2 \times \frac{1\ \text{mol } O_2}{32.00\ \text{mol } O_2} = 3.13\ \text{mol } O_2$$

$$\text{mol eq. } Si_2H_6 = \frac{1.21\ \text{mol } Si_2H_6}{2\ \text{mol } Si_2H_6} = 0.605;\ \text{mol eq. } O_2 = \frac{3.13\ \text{mol } O_2}{7\ \text{mol } O_2} = 0.447$$

$$0.605 > 0.447,\ \text{so } \boxed{O_2 \text{ is limiting.}}$$

e) How many grams of the excess reactant are used after the reaction is complete?

$$?\ \text{g } Si_2H_6 \text{ used} = \underbrace{3.13\ \text{mol } O_2 \times \frac{2\ \text{mol } Si_2H_6}{7\ \text{mol } O_2}}_{0.893\ \text{mol } Si_2H_6} \times \frac{62.23\ \text{g } Si_2H_6}{1\ \text{mol } Si_2H_6} = \boxed{55.6\ \text{g } Si_2H_6 \text{ used}}$$

f) How many grams of the excess reactant remain after the reaction is complete?

$$?\ \text{g } Si_2H_6 \text{ remaining} = 75.0\ \text{g } Si_2H_6 \text{ present} - 55.6\ \text{g } Si_2H_6 \text{ used} = \boxed{19.4\ \text{g } Si_2H_6 \text{ remaining}}$$

g) What is the theoretical yield of silicon dioxide from these reactants?

$$?\ \text{g } SiO_2 = \underbrace{3.13\ \text{mol } O_2 \times \frac{4\ \text{mol } SiO_2}{7\ \text{mol } O_2}}_{1.79\ \text{mol } SiO_2} \times \frac{60.09\ \text{g } SiO_2}{1\ \text{mol } SiO_2} = \boxed{107\ \text{g } SiO_2}$$

h) After the reaction, you find that you have collected 97.8 g silicon dioxide. What is the percent yield?

$$\%\ \text{Yield} = \frac{97.8\ \text{g } SiO_2}{107\ \text{g } SiO_2} \times 100\% = \boxed{91.4\%}$$

2) When solid tin(II) oxide reacts with nitrogen trifluoride gas, solid tin(II) fluoride and gaseous dinitrogen trioxide are produced.

a) Write and balance the equation with the lowest whole number coefficients. What kind of reaction is it?

$$3\ \text{SnO (s)} + 2\ \text{NF}_3\ \text{(g)} \rightarrow 3\ \text{SnF}_2\ \text{(s)} + \text{N}_2\text{O}_3\ \text{(g)}$$

Double Replacement (unusual kind)

b) How many moles of tin(II) oxide would be needed to form 29.4 moles of tin(II) fluoride?

$$?\ \text{mol NF}_3 = 29.4\ \cancel{\text{mol SnF}_2} \times \frac{3\ \text{mol SnO}}{3\ \cancel{\text{mol SnF}_3}} = \boxed{29.4\ \text{mol SnO}}$$

c) How many grams of tin(II) oxide would be needed to completely react with 128 g of nitrogen trifluoride?

$$?\ \text{g SnO} = \underbrace{128\ \cancel{\text{g NF}_3} \times \frac{1\ \cancel{\text{mol NF}_3}}{71.01\ \cancel{\text{g NF}_3}}}_{1.80\ \text{mol NF}_3} \times \underbrace{\frac{3\ \cancel{\text{mol SnO}}}{2\ \cancel{\text{mol NF}_3}}}_{2.70\ \text{mol SnO}} \times \frac{134.7\ \text{g SnO}}{1\ \cancel{\text{mol SnO}}} = \boxed{364\ \text{g SnO}}$$

d) When 158.9 g tin(II) oxide reacts with 62.5 g nitrogen trifluoride, which reactant is limiting?

$$158.9\ \cancel{\text{g SnO}} \times \frac{1\ \text{mol SnO}}{134.7\ \cancel{\text{g SnO}}} = 1.180\ \text{mol SnO};\ 62.5\ \cancel{\text{g NF}_3} \times \frac{1\ \text{mol NF}_3}{71.01\ \cancel{\text{g NF}_3}} = 0.880\ \text{mol NF}_3$$

$$\text{mol eq. SnO} = \frac{1.180\ \text{mol SnO}}{3\ \text{mol SnO}} = 0.3933;\ \text{mol eq. NF}_3 = \frac{0.880\ \text{mol NF}_3}{2\ \text{mol NF}_3} = 0.440$$

$$0.3933 < 0.440\ \text{so}\ \boxed{\text{SnO is limiting}}$$

e) How many grams of the excess reactant are used after the reaction is complete?

$$?\ \text{g NF}_3\ \text{used} = \underbrace{1.180\ \cancel{\text{mol SnO}} \times \frac{2\ \cancel{\text{mol NF}_3}}{3\ \cancel{\text{mol SnO}}}}_{0.7867\ \text{mol NF}_3} \times \frac{71.01\ \text{g NF}_3}{1\ \cancel{\text{mol NF}_3}} = \boxed{55.86\ \text{g NF}_3\ \text{used}}$$

f) How many grams of the excess reactant remain after the reaction is complete?

$$?\ \text{g NF}_3\ \text{remaining} = 62.5\ \text{g NF}_3\ \text{present} - 55.86\ \text{g NF}_3\ \text{used} = \boxed{6.6\ \text{g NF}_3\ \text{remaining}}$$

g) What is the theoretical yield of dinitrogen trioxide from these reactants?

$$?\ \text{g N}_2\text{O}_3 = \underbrace{1.180\ \cancel{\text{mol SnO}} \times \frac{1\ \cancel{\text{mol N}_2\text{O}_3}}{3\ \cancel{\text{mol SnO}}}}_{0.3933\ \text{mol N}_2\text{O}_3} \times \frac{76.02\ \text{g N}_2\text{O}_3}{1\ \cancel{\text{mol N}_2\text{O}_3}} = \boxed{29.90\ \text{g N}_2\text{O}_3}$$

h) After the reaction, you isolate 24.8 g dinitrogen trioxide. What is the percent yield?

$$\%\ \text{Yield} = \frac{24.8\ \text{g N}_2\text{O}_3}{29.90\ \text{g N}_2\text{O}_3} \times 100\% = \boxed{82.9\%}$$