WKS – Extra
Stoichiometry Review

NAME Answer Key
Period ______ **Date** ______________

1) Disilane (Si_2H_6) is a highly flammable gas (D = 2.70 g/L @ 25°C) that reacts with oxygen gas to form solid silicon dioxide (SiO_2) and water vapor:

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

a. Balance the equation with the lowest whole number coefficients.

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

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

c. How many liters of disilane, at 25°C, would be needed to react with sufficient oxygen to produce 50.0 g of silicon dioxide?

$$?\text{ g } Si_2H_6 = \underbrace{50.0\ \cancel{\text{g } SiO_2} \times \frac{1\ \cancel{\text{mol } SiO_2}}{60.09\ \cancel{\text{g } SiO_2}}}_{0.8321\text{ mol } SiO_2} \times \underbrace{\frac{2\ \cancel{\text{mol } Si_2H_6}}{4\ \cancel{\text{mol } SiO_2}}}_{0.4160\text{ mol } Si_2H_6} \times \underbrace{\frac{62.22\text{ g } Si_2H_6}{1\ \cancel{\text{mol } Si_2H_6}}}_{25.89} \times \frac{1\text{ L}}{2.70\text{ g}} = \boxed{9.59\text{ L } Si_2H_6}$$

d. When 27.1 L disilane @ STP (NOT 25°C) reacts with 70.1 L O_2, also at STP, which reactant is limiting?

$$27.1\ \cancel{\text{L } Si_2H_6} \times \frac{1\text{ mol } Si_2H_6}{22.4\ \cancel{\text{L } Si_2H_6}} = 1.21\text{ mol } Si_2H_6;\ 70.1\ \cancel{\text{L } O_2} \times \frac{1\text{ mol } O_2}{22.4\ \cancel{\text{L } O_2}} = 3.13\text{ mol } O_2$$

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

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

e. How many L of the excess reactant remain after the reaction is complete?

$$?\text{ L } Si_2H_6\text{ used} = \underbrace{3.13\ \cancel{\text{mol } O_2} \times \frac{2\ \cancel{\text{mol } Si_2H_6}}{7\ \cancel{\text{mol } O_2}}}_{0.8941\text{ mol } Si_2H_6} \times \frac{22.4\text{ L } Si_2H_6}{1\ \cancel{\text{mol } Si_2H_6}} = 20.0\text{ L } Si_2H_6\text{ used}$$

$$?\text{ L } Si_2H_6\text{ remaining} = 27.1\text{ L } Si_2H_6\text{ present} - 20.0\text{ L } Si_2H_6\text{ used} = \boxed{7.1\text{ L } Si_2H_6\text{ remaining}}$$

f. What is the theoretical yield of *solid* silicon dioxide from these reactants?

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

g. 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.

$$\underline{\ 3\ }\ SnO\ (s) + \underline{\ 2\ }\ NF_3\ (g) \rightarrow \underline{\ 3\ }\ SnF_2\ (s) + \underline{\quad}\ N_2O_3\ (g)$$

a. Balance the equation with the lowest whole number coefficients.

b. How many moles of tin(II) oxide would be needed to form 29.4 L of N_2O_3 at STP?

$$?\ \text{mol SnO} = \underbrace{29.4\ \cancel{\text{L } N_2O_3} \times \frac{1\ \text{mol } N_2O_3}{22.4\ \text{L } N_2O_3}}_{1.313\ \text{mol } N_2O_3} \times \frac{3\ \text{mol SnO}}{1\ \text{mol } N_2O_3} = \boxed{3.94\ \text{mol SnO}}$$

c. How many grams of tin(II) oxide would be needed to completely react with 44.1 L of nitrogen trifluoride (D = 2.90 g/L @ 25°C)?

$$?\ \text{g SnO} = \underbrace{44.1\ \text{L } NF_3 \times \frac{2.90\ \text{g } NF_3}{1\ \text{L } NF_3}}_{127.9\ \text{g } NF_3} \times \underbrace{\frac{1\ \cancel{\text{mol } NF_3}}{71.01\ \cancel{\text{g } NF_3}}}_{1.801\ \text{mol } NF_3} \times \underbrace{\frac{3\ \cancel{\text{mol SnO}}}{2\ \cancel{\text{mol } NF_3}}}_{2.702\ \text{mol SnO}} \times \frac{134.7\ \text{g SnO}}{1\ \cancel{\text{mol SnO}}} = \boxed{364\ \text{g SnO}}$$

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

$$158.9\ \cancel{\text{g SnO}} \times \frac{1\ \text{mol SnO}}{134.7\ \cancel{\text{g SnO}}} = 1.180\ \text{mol SnO};\ 62.5\ \cancel{\text{g } NF_3} \times \frac{1\ \text{mol } NF_3}{71.01\ \cancel{\text{g } NF_3}} = 0.880\ \text{mol } NF_3$$

$$\text{equiv. SnO} = \frac{1.180\ \text{mol SnO}}{3\ \text{mol SnO}} = 0.3933;\ \text{equiv. } NF_3 = \frac{0.880\ \text{mol } NF_3}{2\ \text{mol } NF_3} = 0.440$$

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

e. How many grams of the excess reactant remain after the reaction is complete?

$$?\ \text{g } NF_3\ \text{used} = \underbrace{1.180\ \cancel{\text{mol SnO}} \times \frac{2\ \cancel{\text{mol } NF_3}}{3\ \cancel{\text{mol SnO}}}}_{0.7867\ \text{mol } NF_3} \times \frac{71.01\ \text{g } NF_3}{1\ \cancel{\text{mol } NF_3}} = 55.86\ \text{g } NF_3\ \text{used}$$

$$?\ \text{g } NF_3\ \text{remaining} = 62.5\ \text{g } NF_3\ \text{present} - 55.86\ \text{g } NF_3\ \text{used} = \boxed{6.6\ \text{g } NF_3\ \text{remaining}}$$

f. What is the theoretical yield of dinitrogen trioxide from these reactants?

$$?\ \text{g } N_2O_3 = \underbrace{1.180\ \cancel{\text{mol SnO}} \times \frac{1\ \cancel{\text{mol } N_2O_3}}{3\ \cancel{\text{mol SnO}}}}_{0.3933\ \text{mol } N_2O_3} \times \frac{76.02\ \text{g } N_2O_3}{1\ \cancel{\text{mol } N_2O_3}} = \boxed{29.90\ \text{g } N_2O_3}$$

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

$$\%\ \text{Yield} = \frac{24.8\ \text{g } N_2O_3}{29.90\ \text{g } N_2O_3} \times 100\% = \boxed{82.9\%}$$