Name _____
Date _____

Chemistry 11

Unit 7 Review – Stoichiometry

1. Given the balanced equation:

$$2\ Si_4H_{10\ (s)} + 13\ O_{2\ (g)} \rightarrow 8\ SiO_{2\ (s)} + 10\ H_2O_{\ (g)}$$

a) What volume of oxygen (STP) is required to react with 204.0 g of Si_4H_{10}?

b) What mass of SiO_2 is formed when 345.0 g of H_20 are formed?

c) How many molecules of H_2O are formed when 17.92 L of O_2 are used at STP?

d) How many moles of Si_4H_{10} are needed to just react with 1.204×10^{26} molecules of oxygen?

2. Given the balanced equation:

$$Al_2C_6 + 6\,H_2O \rightarrow 2\,Al(OH)_3 + 3CH_{4\,(g)}$$

a) If 34.5 grams of Al_2C_6 is mixed with 72.0 grams of water, which reactant is in excess? Show by calculations.

b) If 34.5 grams of Al_2C_6 is mixed with 72.0 grams of water, what mass of $Al(OH)_3$ is formed?

c) If 34.5 grams of Al_2C_6 is mixed with 72.0 grams of water, what volume of CH_4 is formed at STP?

3. Given the equation: $4\,NH_3 + 5\,O_2 \rightarrow 4\,NO + 6\,H_2O$

When 51.0 grams of NH_3 is burned in an excess of oxygen, 52.65 g of water are produced.

a) Calculate the theoretical yield of H_2O.

b) Calculate the % yield of H_2O.

4. Given the equation: $N_2 + 3\,H_2 \rightarrow 2\,NH_3$ When 4.0 grams of hydrogen is combined with an excess of nitrogen, a 92% yield of NH_3 is obtained.

a) Calculate the theoretical yield of NH_3

b) Calculate the actual yield of NH_3

5. Given the balanced equation:

$$3\ HCl_{(aq)} + Fe(OH)_{3\ (aq)} \rightarrow 3\ H_2O_{(l)} + FeCl_{3\ (aq)}$$

a) It takes 19.56 mL of 0.50 M HCl to titrate a 25.0 mL sample of a solution of $Fe(OH)_3$. Calculate the $[Fe(OH)_3]$

b) What mass of $Fe(OH)_3$ is needed to completely react with 10.0 mL of 0.50M HCl solution?

c) What volume of 0.50M HCl is required to titrate a 21.36 gram sample of iron (III) hydroxide?

o. $Al + H_2CO_3 \rightarrow$

Reaction Type _____

p. $MgSO_4 + AgNO_3 \rightarrow$

Reaction Type _____

q. $MoSO_4 + 8H_2O \rightarrow$

Reaction Type _____

start here *

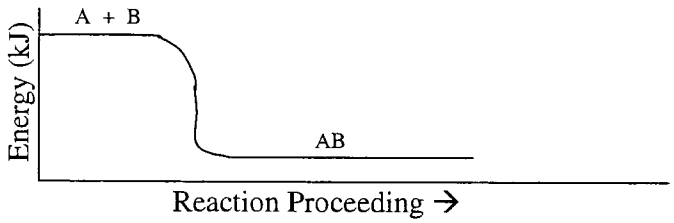
3. State whether each of the following are ***exothermic*** or ***endothermic***.

a. $HCl + 432\ kJ \rightarrow H + Cl$ Answer _____

b. $C_{12}H_{22}O_{11} + 12\ O_2 \rightarrow 12CO_2 + 11H_2O + 5638\ kJ$ Answer _____

c. $H_2O_{(l)} \rightarrow H_2O_{(g)}$ Answer _____

d.



Answer _____

e. $C + D \rightarrow CD \quad \Delta H = +65.7\ kJ$ Answer _____

f. $E + F \rightarrow G + H \quad \Delta H = -437\ kJ$ Answer _____

4. In an ***exothermic*** reaction, the surroundings get (*warmer/cooler*) _____.

5. Define ***enthalpy***

6. Given the equation: $C_{12}H_{22}O_{11} + 12O_2 \rightarrow 12CO_2 + 11H_2O + 5638\ kJ$

   a. How much heat is released during the formation of 9.6 moles of CO_2?

   Answer _____

   b. How much heat is released during the formation of 0.036 moles of H_2O?

   Answer _____

   c. If 1026 grams of $C_{12}H_{22}O_{11}$ are consumed, how much heat is released?

   Answer _____

   d. If 23.76 grams of CO_2 are produced, how much heat is released?

   Answer _____

7. Calculate the amount of heat (in Joules) required to warm 350.0 g of water from 30°C to 35°C. (Heat Capacity (C) for H_2O is 4180 J/kg · °C)

   Answer _____

8. 35.112 kJ of heat are added to a 500.0 gram sample of water initially at 7°C. Calculate the final temperature of the water sample. Be careful with units!

   Answer _____

Key

o. Al + H_2CO_3 →

Reaction Type _____

p. $MgSO_4$ + $AgNO_3$ →

Reaction Type _____

q. $MoSO_4$ + $8H_2O$ →

Reaction Type _____

Start here *

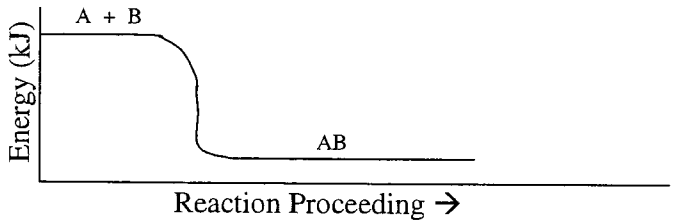
3. State whether each of the following are ***exothermic*** or ***endothermic***.

a. HCl + 432 kJ → H + Cl Answer endo

b. $C_{12}H_{22}O_{11}$ + 12 O_2 → 12CO_2 + 11H_2O + 5638 kJ Answer exo

c. $H_2O_{(l)}$ → $H_2O_{(g)}$ Answer endo

d.



Answer exo

e. C + D → CD ΔH= +65.7 kJ Answer endo

f. E + F → G + H ΔH= - 437 kJ Answer exo

4. In an ***exothermic*** reaction, the surroundings get (*warmer/cooler*) warmer.

5. Define ***enthalpy***

stored chemical energy in a substance

6. Given the equation: $C_{12}H_{22}O_{11} + 12O_2 \rightarrow 12CO_2 + 11H_2O + 5638\ kJ$

a. How much heat is released during the formation of 9.6 moles of CO_2?

$9.6\ mol\ CO_2 \times \frac{5638\ kJ}{12\ mol\ CO_2}$

Answer 4510. KJ

b. How much heat is released during the formation of 0.036 moles of H_2O?

$0.036\ mol\ H_2O \times \frac{5638\ kJ}{11\ mol\ H_2O}$

Answer 18.45 => 19 KJ

c. If 1026 grams of $C_{12}H_{22}O_{11}$ are consumed, how much heat is released?

$1026g\ C_{12}H_{22}O_{11} \times \frac{1\ mol}{342.0g} = 3\ mol\ C_{12}H_{22}O_{11} \times \frac{5638\ kJ}{}$

Answer 16910 KJ

d. If 23.76 grams of CO_2 are produced, how much heat is released?

Answer 254 KJ

Calculate the amount of heat (in Joules) required to warm 350.0 g of water from 30°C to 35°C. (Heat Capacity (C) for H_2O is 4180 J/kg · °C)

Answer _____

35.112 kJ of heat are added to a 500.0 gram sample of water initially at 7°C. Calculate the final temperature of the water sample. Be careful with units!

Answer _____

Name Key
Date

Chemistry 11

Unit 7 Review – Stoichiometry

1. Given the balanced equation:

$$2\ Si_4H_{10\ (s)} + 13\ O_{2\ (g)} \rightarrow 8\ SiO_{2\ (s)} + 10\ H_2O_{(g)}$$

a) What volume of oxygen (STP) is required to react with 204.0 g of Si_4H_{10}?

$$204.0\text{g } Si_4H_{10} \times \frac{1\text{mol } Si_4H_{10}}{122.4\text{g } Si_4H_{10}} \times \frac{13\text{mol } O_2}{2\text{mol } Si_4H_{10}} \times \frac{22.4\text{L } O_2}{1\text{mol } O_2} = \boxed{243\text{L } O_2}$$

b) What mass of SiO_2 is formed when 345.0 g of H_20 are formed?

$$345.0\text{g } H_2O \times \frac{1\text{mol } H_2O}{18.0\text{g } H_2O} \times \frac{8\text{mol } SiO_2}{10\text{mol } H_2O} \times \frac{60.1\text{g } SiO_2}{1\text{mol } SiO_2} = \boxed{922\text{g } SiO_2}$$

c) How many molecules of H_2O are formed when 17.92 L of O_2 are used at STP?

$$17.92\text{L } O_2 \times \frac{1\text{mol } O_2}{22.4\text{L } O_2} \times \frac{10\text{mol } H_2O}{13\text{mol } O_2} \times \frac{6.02\times10^{23}\text{molecules } H_2O}{1\text{mol } H_2O} = \boxed{3.71\times10^{23}\text{ molec. } H_2O}$$

d) How many moles of Si_4H_{10} are needed to just react with 1.204×10^{26} molecules of oxygen?

$$1.204\times10^{26}\text{molec } O_2 \times \frac{1\text{mol } O_2}{6.02\times10^{23}\text{molec } O_2} \times \frac{2\text{mol } Si_4H_{10}}{13\text{mol } O_2} = \boxed{30.8\text{ mol } Si_4H_{10}}$$

2. Given the balanced equation:

$$Al_2C_6 + 6\,H_2O \rightarrow 2\,Al(OH)_3 + 3CH_{4\,(g)}$$

a) If 34.5 grams of Al_2C_6 is mixed with 72.0 grams of water, which reactant is in excess? Show by calculations.

$34.5\text{g } Al_2C_6 \times \frac{1\text{ mol } Al_2C_6}{126.0\text{g } Al_2C_6} \times \frac{2\text{ mol } Al(OH)_3}{1\text{ mol } Al_2C_6} \times \frac{78.0\text{g } Al(OH)_3}{1\text{ mol } Al(OH)_3} = 42.7\text{g } Al(OH)_3$

$72.0\text{g } H_2O \times \frac{1\text{ mol } H_2O}{18.0\text{g } H_2O} \times \frac{2\text{ mol } Al(OH)_3}{6\text{ mol } H_2O} \times \frac{78.0\text{ g } Al(OH)_3}{1\text{ mol } Al(OH)_3} = 104\text{g } Al(OH)_3$ ∴ H_2O is excess

b) If 34.5 grams of Al_2C_6 is mixed with 72.0 grams of water, what mass of $Al(OH)_3$ is formed?

42.7 g see above

c) If 34.5 grams of Al_2C_6 is mixed with 72.0 grams of water, what volume of CH_4 is formed at STP?

$34.5\text{g } Al_2C_6 \times \frac{1\text{mol } Al_2C_6}{126.0\text{g } Al_2C_6} \times \frac{3\text{mol } CH_4}{1\text{mol } Al_2C_6} \times \frac{22.4\text{ L } CH_4}{1\text{mol } CH_4} = 18.4\text{ L } CH_4$

3. Given the equation: $4\,NH_3 + 5\,O_2 \rightarrow 4\,NO + 6\,H_2O$

When 51.0 grams of NH_3 is burned in an excess of oxygen, 52.65 g of water are produced. ← Actual Yield.

a) Calculate the theoretical yield of H_2O.

$51.0\text{g } NH_3 \times \frac{1\text{mol } NH_3}{17.0\text{g } NH_3} \times \frac{6\text{ mol } H_2O}{4\text{ mol } NH_3} \times \frac{18.0\text{g } H_2O}{1\text{mol } H_2O} = \boxed{81.0\text{g } H_2O}$

b) Calculate the % yield of H_2O.

$\%\text{ yield} = \frac{AY}{TY} \times 100\% = \frac{52.65}{81.0} \times 100\% = \boxed{65\%}$

4. Given the equation: $N_2 + 3\,H_2 \rightarrow 2\,NH_3$ When 4.0 grams of hydrogen is combined with an excess of nitrogen, a 92% yield of NH_3 is obtained.

a) Calculate the theoretical yield of NH_3

$4.0\text{g } H_2 \times \frac{1\text{mol } H_2}{2.0\text{g } H_2} \times \frac{2\text{mol } NH_3}{3\text{mol } H_2} \times \frac{17.0\text{g } NH_3}{1\text{ mol } NH_3} = 23\text{g } NH_3$

b) Calculate the actual yield of NH_3

$AY = \frac{\%Y}{100} \times TY = \frac{92}{100} \times 23 = \boxed{21\text{g}}$

5. Given the balanced equation:

$$3\ HCl_{(aq)} + Fe(OH)_{3\ (aq)} \rightarrow 3\ H_2O_{(l)} + FeCl_{3\ (aq)}$$

a) It takes 19.56 mL of 0.50 M HCl to titrate a 25.0 mL sample of a solution of $Fe(OH)_3$. Calculate the $[Fe(OH)_3]$

$$\text{moles HCl} = 0.50\text{M} \times 0.01956\text{L} = 0.00978\text{mol HCl}$$

$$\text{moles } Fe(OH)_3 = 0.00978\text{mol HCl} \times \frac{1\text{mol } Fe(OH)_3}{3\text{mol HCl}} = 0.00326\ \text{mol } Fe(OH)_3$$

$$[Fe(OH)_3] = \frac{0.00326\text{ mol}}{0.0250\text{L}} = \boxed{0.130\text{ M}}$$

b) What mass of $Fe(OH)_3$ is needed to completely react with 10.0 mL of 0.50M HCl solution?

$$\text{moles HCl} = 0.50\text{M} \times 0.0100\text{L} = 0.00500\text{ mol HCl}$$

$$0.00500\text{ mol HCl} \times \frac{1\text{mol } Fe(OH)_3}{3\text{mol HCl}} \times \frac{106.8\text{g } Fe(OH)_3}{1\text{ mol } Fe(OH)_3}$$

$$= \boxed{0.178\text{ g } Fe(OH)_3}$$

c) What volume of 0.50M HCl is required to titrate a 21.36 gram sample of iron (III) hydroxide?

$$21.36\text{g } Fe(OH)_3 \times \frac{1\text{mol } Fe(OH)_3}{106.8\text{g } Fe(OH)_3} \times \frac{3\text{mol HCl}}{1\text{mol } Fe(OH)_3}$$

$$= 0.600\text{ mol HCl}$$

$$L = \frac{\text{mol}}{M} = \frac{0.600\text{ mol}}{0.50\text{ M}} = \boxed{1.20\text{ L}}$$