Thermal Stoichiometry

Heat gained or released during a chemical reaction (heat of reaction) can be expressed in a chemical equation.

Heat released: exothermic

$C(s) + O_2(g) \rightarrow CO_2(g) + 393.5\ kJ$

Heat gained: endothermic

$CoCO_3 + 81.6\ kJ \rightarrow CoO + CO_2$

The amount of heat gained or lost depends on the amount of reactants used.

Ex. 1: $2Na_2O_2 + 2H_2O \rightarrow 4NaOH + O_2 + 215.76\ kJ$

How much heat is released by the reaction of 5.0 moles of Na_2O_2?

$$5.0\ \text{moles } Na_2O_2 \times \frac{215.76\ kJ}{2\ \text{mole } Na_2O_2} = 539.4\ kJ$$

Ex. 2: The decomposition of potassium chlorate is an endothermic reaction.

$2KClO_3(s) + 89.5kJ \rightarrow 2KCl(s) + 3O_2(g)$

How much heat is absorbed to decompose 1.50 grams of solid $KClO_3$?

$$1.50\text{g } KClO_3 \times \frac{1\ \text{mole } KClO_3}{122.5\ \text{g } KClO_3} \times \frac{89.5kJ}{2\ \text{mole } KClO_3} = .548kJ$$

Gas Stoichiometry

1 mole of any gas at STP takes up 22.4L volume.

S.T.P.= Standard Temperature (0°C or 273K) and Pressure (1 atm or 101.3kPa)

Ex.1: $CaCO_3(s) + 2HCl(aq) \rightarrow CO_2(g) + CaCl_2(aq) + H_2O$

What is the volume of 2.0 moles of CO_2 at STP?

$$2.0 \text{ mole } CO_2 \times \frac{22.4 \text{ L}}{1 \text{ mole } CO_2} = 44.8 \text{ L}$$

What volume of CO_2, at STP, will be formed from 1.0 mole HCl?

$$1.0 \text{ mole HCl} \times \frac{1 \text{ mole } CO_2}{2 \text{ mole HCl}} \times \frac{22.4 \text{ L}}{1 \text{ mole } CO_2} = 11.2 \text{ L}$$

Ex.2: What volume of CO_2, measured at STP, will be produced when 80.0g of $CaCO_3$ reacts?

$$80.0 \text{ g } CaCO_3 \times \frac{1 \text{ mole } CaCO_3}{100.1 \text{ g } CaCO_3} \times \frac{1 \text{ mole } CO_2}{1 \text{ mole } CaCO_3} \times \frac{22.4 \text{ L}}{1 \text{ mole } CO_2} = 17.9 \text{ L}$$

Ex. 3: How many molecules would be in 7.0L of O_2 gas at STP?

$$7.0 \text{ L } O_2 \times \frac{1 \text{ mole } O_2}{22.4 \text{ L}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mole } O_2} = 1.88 \times 10^{23} \text{ molecules}$$

Name _____ Date _____

Thermal Stoichiometry

Use the following balanced equation to answer the questions below.

$$2\ C_2H_6(g) + 7\ O_2(g) \rightarrow 4\ CO_2(g) + 6\ H_2O(l) + 3080kJ$$

1. If 3.00 moles of C_2H_6 react completely with oxygen, how many kilojoules of energy will form?

2. If 5.50 moles of CO_2 form, how many kilojoules of energy will form?

3. If 15.0g of C_2H_6 react totally with oxygen, how many joules of energy will be liberated?

4. If 15.0g of C_2H_6 is combined with 64.0g of oxygen present, how many kilojoules of energy will be formed?

5. Is this an exothermic or endothermic reaction?

Gas Stoichiometry

At STP (0°C or 273K, and 1 atm pressure) one mole of any gas occupies 22.4L.

This is another conversion factor: 1 mole gas = 22.4L (@ STP)

1. At STP, what is the volume of 2.5 mole O_2?

2. What is the volume of 2.5g of O_2 at STP?

3. What is the volume of 56.0g of nitrogen gas at STP?

4. In the reaction:

   $$C(s) + O_2(g) \rightarrow CO_2(g)$$

   How many grams of carbon are required to react completely with 44.8L of oxygen at STP?

5. In the reaction:

   $$Zn(s) + 2\,HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

   What volume of hydrogen can be produced at STP from 4.0 moles of HCl?

6. What is the volume of 3.01×10^{23} molecules of NO_2 gas at STP?