Stoichiometry, Enthalpy, and Heat

1. How much heat will be released when 6.44 g of sulfur reacts with excess O_2 according to the following equation?

$$2\ S + 3O_2 \rightarrow 2SO_3 \quad \Delta H = -791.4\ kJ$$

$6.44\ g\ S \times \frac{1\ mol\ S}{32\ g\ S} \times \frac{-791.4\ kJ}{2\ mol\ S} = \boxed{-79.6\ kJ}$

2. How much heat will be released when 4.72 g of carbon reacts with excess O_2 according to the following equation?

$$C + O_2 \rightarrow CO_2 \quad \Delta H = -393.5\ kJ$$

$4.72\ g\ C \times \frac{1\ mol\ C}{12\ g\ C} \times \frac{-393.5\ kJ}{1\ mol\ C} = \boxed{-154.7\ kJ}$

3. How much heat will be absorbed when 38.2 g of bromine reacts with excess H_2 according to the following equation?

$$H_2 + Br_2 \rightarrow 2HBr \quad \Delta H = +72.80\ kJ$$

$38.2\ g\ Br_2 \times \frac{1\ mol\ Br_2}{159.8\ g\ Br_2} \times \frac{+72.80\ kJ}{1\ mol\ Br_2} = \boxed{+17.4\ kJ}$

4. How much heat will be released when 1.48 g of chlorine reacts with excess phosphorus according to the following equation.

$$2P + 5Cl_2 \rightarrow 2PCl_5 \quad \Delta H = -886\ kJ$$

$1.48\ g\ Cl_2 \times \frac{1\ mol\ Cl_2}{70.9\ g\ Cl_2} \times \frac{-886\ kJ}{5\ mol\ Cl_2} = \boxed{-3.70\ kJ}$

5. What mass of propane, C_3H_8 must be burned in order to produce 76,000 kJ of energy?

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O \quad \Delta H = -2200\ kJ$$

$-76{,}000\ kJ \times \frac{1\ mol\ C_3H_8}{-2200\ kJ} \times \frac{44\ g\ C_3H_8}{1\ mol\ C_3H_8} = \boxed{1520\ g\ C_3H_8}$

$q = -76{,}000$ kJ (heat released or produced, exothermic)

6. How much heat will be absorbed when 13.7 g of nitrogen reacts with excess O_2 according to the following equation?

$$N_2 + O_2 \rightarrow 2NO \quad \Delta H = +180\ kJ$$

$13.7\ g\ N_2 \times \frac{1\ mol\ N_2}{28\ g\ N_2} \times \frac{+180\ kJ}{1\ mol\ N_2} = \boxed{+88.1\ kJ}$

7. What mass of iron must react to produce 3600 kJ of energy? $q = -3600$ kJ

$$3Fe + 2O_2 \rightarrow Fe_3O_4 \quad \Delta H = -1120\ kJ$$

$-3600\ kJ \times \frac{3\ mol\ Fe}{-1120\ kJ} \times \frac{55.847\ g\ Fe}{1\ mol\ Fe} = \boxed{539\ g\ Fe}$

8. How much heat will be released when 12.0 g of H_2 reacts with 76.0 g of O_2 according to the following equation? (when one reactant runs out the reaction stops)

$$2H_2 + O_2 \rightarrow 2H_2O \quad \Delta H = -571.6\ kJ$$

Two reactants given = limiting reagent problem

$12.0\ g\ H_2 \times \frac{1\ mol\ O_2}{2\ g\ H_2} \times \frac{32\ g\ O_2}{1\ mol\ O_2} = 192\ g\ O_2$ required to react w/ 12.0 g H_2. Only 76.0 g O_2 available. O_2 is limiting

$76.0\ g\ O_2 \times \frac{1\ mol\ O_2}{32\ g\ O_2} \times \frac{-571.6\ kJ}{1\ mol\ O_2} = \boxed{-1358\ kJ}$