CHM 110 -Heat Practice Set ***SOLUTIONS***

Solve the problems.

1) If 1.54 L of butane (C_4H_{10}) at 25ºC and 1.00 atm is burned, how much heat is evolved?

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)\ ;\quad \Delta H = -5760\,\text{kJ}$$

- ___181_____________ kJ heat evolved.

Complete solution:
First, use PV = nRT to find the moles of butane reacted.

P = 1.00 atm
V = 1.54 L
n = ?
T = 25ºC = 298 K

$$n = \frac{(1\,\text{atm}) \times (1.54\,\text{L})}{\left(0.08206\,\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}\right) \times (298\,\text{K})} = 0.06297569\,\text{mol}\,C_4H_{10}$$

Next, use the thermochemical equation to find the heat (enthalpy change).

$$0.06297569\,\text{mol}\,C_4H_{10} \times \frac{-5760\,\text{kJ}}{2\,\text{mol}\,C_4H_{10}} = -181\,\text{kJ}$$

Note: Since the word "***evolved***" implies the process is exothermic (heat is leaving the system), we say that the "heat evolved" is 181 kJ. The enthalpy change for the process is -181 kJ.

2) If 2.57 g of Na_2O_2 is reacted with water, how much heat is evolved?

$$2Na_2O_2(s) + 2H_2O(l) \rightarrow 4NaOH(aq) + O_2(g)\ ; \quad \Delta H = -287\ \text{kJ}$$

- __4.73______________ kJ heat evolved.

Complete solution:
Find the number of moles of sodium peroxide using the formula weight of sodium peroxide, then find heat using stoichiometry.

$$2.57\,\text{g}\ Na_2O_2 \times \frac{1\ \text{mol}}{77.98\,\text{g}} \times \frac{-287\,\text{kJ}}{2\,\text{mol}\ Na_2O_2} = -4.73\ \text{kJ}$$

Note: As in problem #1, this one asks us about heat ***evolved***, so we report 4.73 kJ as our answer. The enthalpy change for the process is -4.73 kJ.

3) Calculate (from heats of formation) the enthalpy change for the following reaction:

$$2Cl_2(g) + 2H_2O(l) \rightarrow 4HCl(g) + O_2(g)\ ;\quad \Delta H = ?$$

- $\Delta H =$ __202.4____________ kJ

<u>Complete solution:</u>
Use Hess's Law to find the enthalpy change. Find standard enthalpies of formation in the back of your textbook or via the Internet. Be careful; make sure the phase labels on your enthalpies of formation match the ones in the chemical equation.

Reactants	***Products***
$Cl_2(g)$; ΔH_f = 0 kJ/mol	$HCl(g)$; ΔH_f = -92.3 kJ/mol
$H_2O(l)$; ΔH_f = -285.8 kJ/mol	$O_2(g)$; ΔH_f = 0 kJ/mol

Reactants: $2\times(0\,\mathrm{kJ})+2\times(-285.8\,\mathrm{kJ})=-571.6\,\mathrm{kJ}$
Products: $4\times(-92.3\,\mathrm{kJ})+1\times(0\,\mathrm{kJ})=-369.2\,\mathrm{kJ}$

Reaction = Products - Reactants = 202.4 kJ