G12 Chemistry: Class 8 Homework

1. P_4O_{10}, is an acidic oxide. It reacts with water to produce H_3PO_4 in an exothermic reaction. **[3 marks]**

$$P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(aq) \qquad \Delta H°_{rxn} = -257.2kJ/mol$$

   a) Rewrite the thermochemical equation, including the enthalpy change as a heat term in the equation.

   b) How much energy is released when 5.00mol of P_4O_{10} reacts with excess water?

   c) How much energy is released when 235g of $H_3PO_4(aq)$ is formed?

2. Nitric acid is neutralized with potassium hydroxide in the following reaction:

$$HNO_3(aq) + KOH(aq) \rightarrow KNO_3(aq) + H_2O(l) \qquad \Delta H = -53.4kJ/mol$$

   55.0ml of 1.30mol/L solutions of both reactants at 21.4°C are mixed in a calorimeter. What is the final temperature of the mixture? Assume that the density of both solutions is 1.00g/mL. Also assume that the specific heat capacity of both solutions is the same as the specific heat capacity of water. No heat is lost to the calorimeter itself. **[5 marks]**

3. A student uses a coffee-cup calorimeter to determine the enthalpy of reaction for hydrobromic acid and potassium hydroxide. The student mixes 100.0mL of 0.50mol/L HBr(aq) at 21.0°C with 100.0 mL of 0.50mol/L KOH(aq) also at 21.0°C. The highest temperature that is reached is 24.4°C. Write the thermochemical equation for the reaction. **[6 marks]**

4. A 1.75 g sample of acetic acid CH_3COOH was burned in oxygen in a calorimeter. The calorimeter contained 925 g of water and had a heat capacity of 2.53 kJ/°C. The temperature of the calorimeter and its contents increased from 22.2°C to 26.5°C. What is the molar heat of combustion of acetic acid? **[6 marks]**

5. Ethene, C_2H_4 reacts with water to from ethanol $CH_3CH_2OH(l)$.

$$C_2H_4(g) + H_2O(l) \rightarrow CH_3CH_2OH(l)$$

Determine the enthalpy change of this reaction, given the following thermochemical equations. **[3 marks]**

(1) $CH_3CH_2OH\ (l) + 3O_2(g) \rightarrow 3H_2O(l) + 2CO_2(g)$ $\Delta H° = -1367$ kJ
(2) $C_2H_4(g) + 3O_2(g) \rightarrow 2H_2O(l) + 2CO_2(g)$ $\Delta H° = -1411$ kJ

6. A typical automobile engine uses a lead-acid battery. During discharge, the following chemical reaction takes place.

$$Pb(s) + PbO_2(s) + 2H_2SO_4(l) \rightarrow 2PbSO_4(s) + 2H_2O(l)$$

Determine the enthalpy change of this reaction, given the following equations. **[3 marks]**

(1) $Pb(s) + PbO_2(s) + 2SO_3(g) \rightarrow 2PbSO_4(s)$ $\Delta H° = -775$ kJ
(2) $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(l)$ $\Delta H° = -133$ kJ

7. Calculate the enthalpy change of the following reactions between nitrogen gas and oxygen gas, given thermochemical equations (1), (2) and (3). **[4 marks]**

$$2N_2(g) + 5O_2(g) \rightarrow 2N_2O_5(g)$$

(1) $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ $\Delta H° = -572$kJ
(2) $N_2O_5(g) + H_2O(l) \rightarrow 2HNO_3(l)$ $\Delta H° = -77$kJ
(3) $\frac{1}{2}N_2(g) + 3/2O_2(g) + \frac{1}{2}H_2(g) \rightarrow HNO_3(l)$ $\Delta H° = -174$kJ

8. Use the following equation to answer the questions below:

$$CH_3OH(l) + 1.5O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

   a) Calculate the enthalpy change of the complete combustion of one mole of methanol, using enthalpies of formation. **[2 marks]**
   b) How much energy is released when 125g of methanol undergoes complete combustion? **[2 marks]**

9. Small amounts of oxygen gas can be produced in a laboratory by heating potassium chlorate, $KClO_3$. **[2 marks]**

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

   Calculate the enthalpy change of this reaction, using the enthalpies of formation.

10. Iron(III) oxide reacts with carbon monoxide to produce elemental iron and carbon dioxide. Determine the enthalpy change of this reaction, using known enthalpies of formation. **[2 marks]**

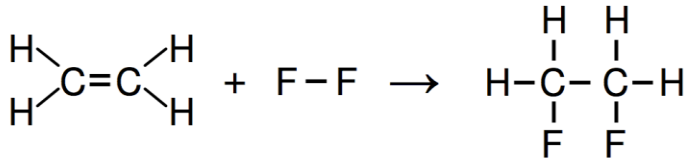
$$Fe_2O_3(s) + 3CO(g) \rightarrow 3CO_2(g) + 2Fe(s)$$

11. Using the following average bond energy table, estimate the enthalpy change $\Delta H°_{rxn}$ of the following reactions using the bond energies above. **[6 marks]**

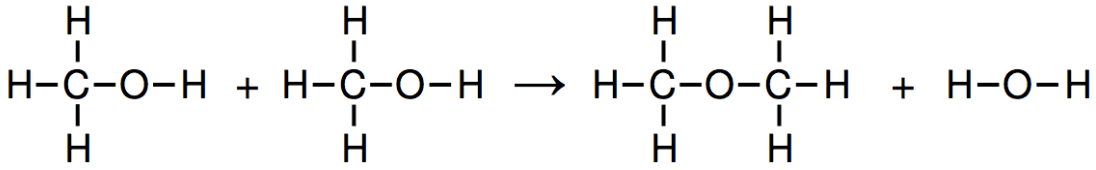
Average Bond Energies (kJ/mol)

H–H	436 kJ/mol	C–H	413 kJ/mol	C=C	614 kJ/mol
H–Cl	431 kJ/mol	C–C	348 kJ/mol	C≡C	839 kJ/mol
H–F	567 kJ/mol	C–N	293 kJ/mol	C=O	799 kJ/mol
N–H	391 kJ/mol	C–O	358 kJ/mol	O=O	495 kJ/mol
N–O	201 kJ/mol	C–F	485 kJ/mol	C≡O	1072 kJ/mol
O–H	463 kJ/mol	C–Cl	328 kJ/mol	C=N	615 kJ/mol
O–O	146 kJ/mol	C–S	259 kJ/mol	N=N	418 kJ/mol
F–F	155 kJ/mol	Cl–Cl	242 kJ/mol	N≡N	941 kJ/mol
				C≡N	891 kJ/mol

a)



b)



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