**Energetics – Homework 1**

In all the following questions, assume that the densities and specific heat capacities of the solutions are the same as pure water

i.e. ρ = 1.0 gcm-3 and c = 4.18 Jg-1K-1

1. Zinc will displace copper from copper (II) sulphate solution according to the following equation:

CuSO4(aq) + Zn(s) 🡪 Cu(s) + ZnSO4(aq)

If an excess of zinc powder is added to 50 cm3 of 1.0 moldm-3 copper(II) sulphate, the temperature increases by 6.3 oC. Calculate the enthalpy change for the reaction. 2

2. Magnesium will also displace copper from copper (II) sulphate solution. If an excess of magnesium is added to 100 cm3 of 1.0 moldm-3 copper(II) sulphate, the temperature increases by 46.3 oC.

a) Calculate the molar enthalpy change for the reaction

b) Calculate the minimum quantity of magnesium required to ensure it is in excess.

c) Calculate the temperature change if only 0.8 g of magnesium is added. 6

3. When 5.73 g of sodium chloride (NaCl) dissolves in 100 cm3 of water, the temperature of the water fell from 22.4 oC to 19.8 oC. Calculate the enthalpy change of the reaction. 2

4. When 2.3 g of magnesium chloride dissolves in 200 cm3 of water, the temperature rose by 3.4 oC. Calculate the enthalpy change for the reaction. 2

5. If 50 cm3 of 0.1 moldm-3 HCl and 50 cm3 of 0.1 moldm-3 NaOH are mixed, the temperature of the solution rises by 0.68 oC. Calculate the enthalpy change of the reaction in kJmol-1.

6. If 50 cm3 of 1.0 moldm-3 NaOH is added to 25 cm3 of 2.0 moldm-3 CH3COOH, the temperature rose by 8.3 oC. Calculate the molar enthalpy change for the reaction. 2

7. Given the following data:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Substance | H2O(l) | CO2(g) | Ethane C2H6(g) | Ethene C2H4(g) |
| Hf/kJmol-1 | -285.5 | -393 | -83.6 | +52.0 |

1. Write equations for the complete combustion of
2. ethane
3. ethene
4. hydrogen

b) Calculate the enthalpy of combustion in each case using the above data.

8. Given the following data: Hf(CH4) = -74.8 kJmol-1, Hf(CH3Cl) = -134.5 kJmol-1, Hf(HCl) = -92.3 kJmol-1;

Calculate ΔH for the reaction CH4(g) + Cl2(g) 🡪 CH3Cl(g) + HCl(g)

9. Given the data:

4NH3(g) + 3O2(g) 🡪 2N2(g) + 6H2O(l), H = -1530kJmol-1

H2(g) + 1/2O2(g) 🡪 H2O(l), H = -288 kJmol-1

Calculate the enthalpy of formation of ammonia.

10. Given the data:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Substance | B2H6(g) | B2O3(s) | C6H6(g) | CO2(g) | H2O(g) |
| Hf/kJmol-1 | +31.4 | -1270 | +83.9 | -393 | -242 |

Calculate the enthalpy of combustion of gaseous diborane and gaseous benzene given that they burn according to the following equations:

B2H6(g) + 3O2(g) 🡪 B2O3(s) + 3H2O(g), C6H6(g) + 7.5O2(g) 🡪 6CO2(g) + 3H2O(g)

11. When ethanol burns in oxygen under standard conditions, carbon dioxide, water and 1368 kJmol-1 of energy are produced. Calculate the enthalpy of formation of ethanol, given that the enthalpies of formation of carbon dioxide and water are -393.7 and -285.9 kJmol-1 respectively.

12. Calculate the enthalpy of formation of butane (C4H10) from the following data:

Enthalpy of combustion of graphite = -393.6 kJmol-1

Enthalpy of combustion of hydrogen = -285.9 kJmol-1

Enthalpy of combustion of butane = -2877.1 kJmol-1

13. Given the following data:

|  |  |  |  |
| --- | --- | --- | --- |
| Substance | CH3CH2CH2CH3 | CH3CH2CH=CH2 | H2 |
| Hc/kJmol-1 | -2877 | -2717 | -286 |

Calculate H for the following reaction: CH3CH2CH=CH2 + H2 🡪 CH3CH2CH2CH3

14. Given the following data:

|  |  |
| --- | --- |
| CH4(g) + 2O2(g) 🡪 CO2(g) + 2H2O(l) | H = -890 kJmol-1 |
| CO(g) + 1/2O2(g) 🡪 CO2(g) | H = -284 kJmol-1 |
| C(s) + O2(g) 🡪 CO2(g) | H = -393 kJmol-1 |
| H2(g) + 1/2O2(g) 🡪 H2O(l) | H = -286 kJmol-1 |

Calculate:

1. The enthalpy of formation of methane
2. The enthalpy of formation of carbon monoxide
3. The enthalpy change when methane is burned in limited oxygen to form carbon monoxide and water.

**.............. Out of 16 (Grade )**