

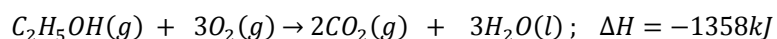
## **ORDINARY LEVEL CHEMISTRY PROBLEMS**

### **PART 11: THERMOCHEMISTRY**

1.
  - (a) When methane burns in oxygen, heat is evolved. Write equation for the combustion of methane in oxygen
  - (b) The heat of combustion of methane is  $-888\text{kJmol}^{-1}$ . Calculate the volume of methane gas at s.t.p that when burnt in excess oxygen would raise the temperature of 189g of water by  $12^{\circ}\text{C}$ . (specific heat capacity of water is  $4.2\text{J/g/K}$ )
  - (c) Calculate the volume of methane gas at s.t.p that will burn in excess oxygen to produce  $2540\text{kJ}$  of heat
  - (d) The enthalpy of combustion of carbon is  $-391\text{kJmol}^{-1}$ .
    - (i) Write equation for the reaction
    - (ii) 50kg of charcoal cost 6000Kg. calculate the cost of charcoal required to produce  $16292\text{kJ}$  of heat
2.
  - (a) Describe an experiment that can be carried out to determine the heat of combustion of ethanol
  - (b) Comment of the value obtained in the above experiment.
  - (c) When 0.46g of ethanol was burnt, the heat evolved raised the temperature of 120g of water from  $15^{\circ}\text{C}$  to  $42^{\circ}\text{C}$ . calculate the heat of combustion of ethanol
  - (d) Name the products of incomplete combustion of ethanol
3.
  - (a)  $50\text{cm}^3$  of 2M nitric acid and  $50\text{cm}^3$  of 2M potassium hydroxide solution both at  $20^{\circ}\text{C}$  were mixed in a plastic beaker. The maximum temperature recorded was  $37.2^{\circ}\text{C}$ .
    - (i) Give a reason why the plastic beaker was used in this experiment
    - (ii) Write an ionic equation for the reaction
    - (iii) Calculate the enthalpy of neutralisation.
  - (b) If ammonia solution was used in the experiment instead of sodium hydroxide. Comment on the value of the enthalpy of neutralization that would be obtained and give a reason for your answer
4.
  - (a) Define the term enthalpy of neutralization
  - (b)  $50\text{cm}^3$  of 0.2M hydrochloric acid and  $50\text{cm}^3$  of 0.2M sodium hydroxide solution. The temperature recorded rose from  $27.2^{\circ}\text{C}$  to  $40.5^{\circ}\text{C}$ . Calculate the enthalpy of neutralisation.
  - (c)  $50\text{cm}^3$  of 0.5M sulphuric acid and  $50\text{cm}^3$  of 1.0M potassium hydroxide solution in a plastic beaker. The temperature of the mixture rose by  $15^{\circ}\text{C}$ . Calculate the enthalpy of neutralisation.
5.
  - (a) Define the term enthalpy of combustion
  - (b) With the aid of a labelled diagram, describe an experiment you would carry out in the laboratory to determine the enthalpy of combustion of propanol
  - (c) In an experiment to determine the enthalpy of combustion of propanol, 0.54g of propanol was burnt and the heat evolved caused the temperature of  $150\text{cm}^3$  of water to rise by  $21.5^{\circ}\text{C}$ . Calculate the molar heat of combustion of propanol. (RFM of propanol is 60)

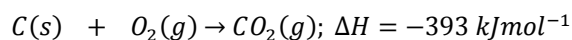
6. (a) Write equation for the complete combustion of ethene in air  
 (b) When 1.5g of ethene was burnt in excess oxygen, 78kJ of heat were produced. Calculate  
 (i) Mass of water formed  
 (ii) Volume of carbon dioxide produced  
 (iii) Molar heat of combustion of ethene

7. (a) What is meant by the term enthalpy of combustion  
 (b) Ethanol burns in oxygen according to the following equation



Calculate the mass of ethanol that is required to raise the temperature of 150cm<sup>3</sup> of water by 45°C.

- (c) The molar heat of combustion of carbon is -393kJmol<sup>-1</sup>. Calculate the  
 (i) Amount of heat evolved when 4.8g of carbon is completely burnt in oxygen (C=12)  
 (ii) Volume of oxygen at s.t.p that would be required to produce 49.3kJ of heat. (1 mole of gas occupies 22.4dm<sup>3</sup> at s.t.p)
8. (a) Excess iron powder was added to zinc sulphate solution  
 (i) State what was observed  
 (ii) Write equation for the reaction  
 (iii) Explain your observation  
 (b) Explain what is observed when iron powder was replaced with copper turnings in the experiment  
 (c) When excess iron powder was added to 25cm<sup>3</sup> of 1.5M zinc sulphate solution, the temperature of the solution rose by 45°C. calculate the molar heat of displacement
9. (a) State what is meant by the term enthalpy of combustion  
 (b). Carbon burns in oxygen according to the following equation



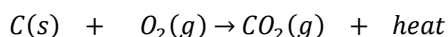
Calculate the

- (i). Amount of heat evolved when 3.6 g carbon is burnt completely in oxygen (C = 12)  
 (ii). Volume of oxygen at s.t.p that would be required to produce 78.6 kJ of heat. (1 mole of gas occupies 22.4 dm<sup>3</sup> s.t.p)
10. (a) 50cm<sup>3</sup> of 1.0M copper(II) chloride is poured into a plastic beaker. 4.0g of excess zinc powder was added. The mixture was stirred and its temperature rose from 28°C to 79°C.  
 (i) Write equation for the reaction that took place  
 (ii) Name the type of reaction that took place  
 (iii) Is the reaction endothermic or exothermic? Give a reason for your answer  
 (iv) Calculate the heat of displacement of copper by zinc.

14. (a). (i). Write the equation for the complete combustion of ethanol  
 (ii). Outline an experiment that can be carried out in the laboratory to determine the enthalpy of combustion of ethanol. (diagram is not required)
- (b). When 0.15g of a compound W, molecular mass 60 g was burnt, it caused the temperature of 150 cm<sup>3</sup> of water to rise by 8°C. calculate the enthalpy of combustion of W. (density of water = 1.0 gcm<sup>3</sup>, specific heat capacity of water = 4.2Jg<sup>-1</sup>K<sup>-1</sup>)
- (c). The enthalpies of combustion,  $\Delta H_c$ , of some hydrocarbons are shown in the table below.

| Hydrocarbon  | $CH_4$ | $C_2H_6$ | $C_3H_8$ | $C_4H_{10}$ | $C_6H_{14}$ |
|--------------|--------|----------|----------|-------------|-------------|
| $\Delta H_c$ | 890    | 1560     | 2220     | 2880        | 4160        |

- (i). Plot a graph of enthalpy of combustion against number of carbon atoms in the hydrocarbon
- (ii). State from the graph you have plotted in (c) (i), the enthalpy of combustion of  $C_5H_{12}$ .
- (iii). Determine the slope of graph you have drawn.
- (iv). Using your slope and intercept, calculate the enthalpy of combustion of the hydrocarbon,  $C_7H_{16}$
15. (a). State the difference between **endothermic** and **exothermic** reaction
- (b). Carbon burns in air according to the following equation



When 4.00 g of carbon was burnt in air, the heat produced raised the temperature of 550 g of water by 56.8°C. calculate the molar heat of combustion of carbon. ( $C = 12$ , *specific heat capacity of water* = 4.2 Jg<sup>-1</sup>K<sup>-1</sup>)

- (c). From the above equation in (b), suggest one use of carbon
16. When excess iron filings were added to 200 cm<sup>3</sup> of 0.5M copper(II) sulphate solution in plastic cup, the temperature of the solution rose by 17.9°C.
- (a). Write an ionic equation for the reaction that took place.
- (b). Suggest a reason why a plastic cup was used instead of a metallic cup
- (c). Calculate the enthalpy change for the reaction between iron filings and copper(II) sulphate solution ( $O = 16$ ;  $S = 32$ ;  $Fe = 56$ ;  $Cu = 64$ . *Density of water* = 1 gcm<sup>-3</sup> and the *specific heat capacity of water* = 4.2 JK<sup>-1</sup>).
- (d). State any assumptions you have made in the calculation in (c) (i)