CHEMISTRY S5 MCB, PCB &PCM

HOME PACKAGE

1 Copper(II) nitrate decomposes on heating. The reaction is endothermic.

$2Cu(NO_3)_2(s) \longrightarrow 2CuO(s) + 4NO_2(g) + O_2(g)$

a Draw an enthalpy level diagram (reaction profile diagram) for this reaction.

b Draw an enthalpy cycle diagram to calculate the standard enthalpy change for this reaction, using enthalpy changes of formation.

c Calculate the enthalpy change for this reaction using the following enthalpy changes of formation.

$\Delta H_f^{\ominus}[Cu(NO_3)_2(s)] = -302.9\,kJ\,mol^{-1}$

$\Delta H_f^{\ominus}[CuO(s)] = -157.3\,kJ\,mol^{-1}$

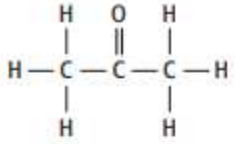
$\Delta H_f^{\ominus}[NO_2(g)] = +33.2\,kJ\,mol^{-1}$

d Copper(II) sulfate is soluble in water. A student dissolved 25.0 g of copper(II) sulfate in 100 cm^3 of water in a polystyrene beaker stirring all the time. The temperature of the water fell by 2.9 °C.

i Calculate the enthalpy change of solution of copper(II) sulfate. (specific heat capacity of water = 4.18 $J\,g^{-1}\,°C^{-1}$; relative molecular mass of copper(II) sulfate = 249.7 $g\,mol^{-1}$)

ii Suggest one source of error in this experiment and explain how the error affects the results.

2 Propanone is a liquid. It has the structure



The equation for the complete combustion of propanone is:

$CH_3COCH_3(l) + 4O_2(g) \longrightarrow 3CO_2(g) + 3H_2O(l)$

a Use the following bond energies (in $kJ\,mol^{-1}$) to calculate a value for the standard enthalpy change of this reaction:

E(C—C) = +347

E(C—H) = +413

E(O═O) = +496

E(C═O) = +805

E(O—H) = +465

b Suggest why it would be more accurate to use bond energies that are not average bond energies in this calculation.

c The standard enthalpy change of combustion of propanone is –1816.5 $kJ\,mol^{-1}$. Suggest why this value differs from the value obtained using bond energies.

d The standard enthalpy change of formation of propanone is –248 $kJ\,mol^{-1}$.

i Define the term **standard enthalpy change of formation**.

ii Write the equation that describes the standard enthalpy change of formation of propanone.

iii Explain why the enthalpy change of formation of propanone cannot be found by a single experiment.

3. Answer:

a Define **enthalpy change of solution**.

b Given the enthalpy changes ΔH_1 and ΔH_2 below, construct a Hess's cycle that will enable you to find the enthalpy change, ΔH_r, for the reaction:

$MgCl_2(s) + 6H_2O(l) \longrightarrow MgCl_2.6H_2O(s)$ $\quad \Delta H_r$

$MgCl_2(s) + aq \longrightarrow MgCl_2(aq)$ $\quad \Delta H_1$

$MgCl_2.6H_2O(s) + aq \longrightarrow MgCl_2(aq)$ $\quad \Delta H_2$

4. Then,

In an experiment, a spirit burner is used to heat 250 cm^3 of water by burning methanol (CH_3OH).
(A_r values: C = 12.0, H = 1.0, O = 16.0; specific heat capacity of water = 4.18 $J\,g^{-1}\,°C^{-1}$)

Results:

starting temperature of water = 20.0 °C

starting mass of burner + fuel = 248.8 g

final temperature of water = 43.0 °C

final mass of burner + fuel = 245.9 g

a How many joules of heat energy went into the water?

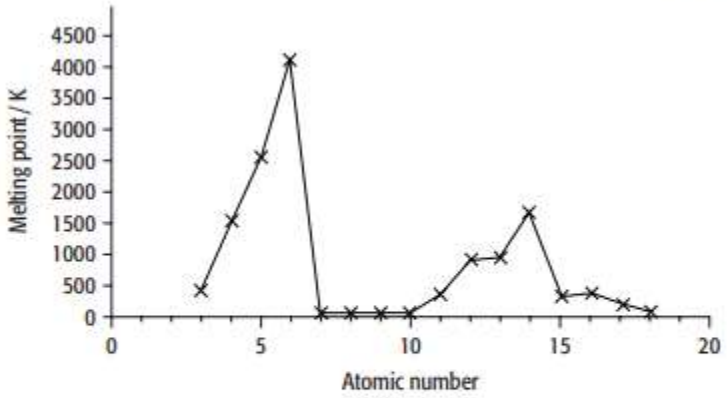
b How many moles of fuel were burnt?

c Calculate an experimental value for the enthalpy change of combustion of methanol from these results.

d Suggest three reasons why your answer is much smaller than the accepted standard enthalpy of combustion of methanol.

5. Next,

The variation of melting point with atomic number for Periods 2 and 3 is shown in the graph below.



a Explain what we mean when we say melting point is a periodic property.

b Explain the following.

i The melting point of silicon is much greater than that of phosphorus.

ii The melting point of aluminium is greater than that of sodium.

6. Lastly but not means the least,

A chemist was investigating the best way to produce 1,2-dichloroethane. He devised two methods, **I** and **II**, of doing this.

I He reacted ethane with chlorine in the presence of UV light by the following reaction:

$C_2H_6(g) + 2Cl_2(g) \longrightarrow C_2H_4Cl_2(l) + 2HCl(g)$

After doing this he found that 600 g of ethane gave 148.5 g of $C_2H_4Cl_2$.

a **i** How many moles of ethane are there in 600 g?

ii How many moles of 1,2-dichloroethane would have been formed if the yield had been 100%?

iii How many moles of 1,2-dichloroethane are there in 148.5 g?

iv Calculate the percentage yield of 1,2-dichloroethane.

II He reacted ethene with chlorine in the dark by the following reaction:

$C_2H_4(g) + Cl_2(g) \longrightarrow C_2H_4Cl_2(l)$

In this reaction 140 g of ethene gave 396 g of $C_2H_4Cl_2$.

b Calculate the percentage yield for this reaction. Show your working.

c There are isomers of the compound $C_2H_4Cl_2$. Draw the displayed formulae of the isomers and name them.

d Choose from redox, substitution, elimination, addition and hydrolysis to give the type of reaction for:

i reaction **I**

ii reaction **II**.

7. Finally,

The lattice energy of magnesium bromide, $MgBr_2$, can be calculated using the enthalpy changes shown in the table.

Type of enthalpy change	Value of enthalpy change / kJ mol^{-1}
1st ionisation energy of magnesium	+736
2nd ionisation energy of magnesium	+1450
1st electron affinity of bromine	–325
enthalpy change of formation of $MgBr_2$	–524
enthalpy change of atomisation of magnesium	+150
enthalpy change of atomisation of bromine	+112

a State the meaning of the terms:

i **lattice energy**

ii **2nd ionisation energy.**

b Draw and label a Born–Haber cycle to calculate the lattice energy of magnesium bromide.

c Calculate the lattice energy of magnesium bromide.

HAPPY HOLYDAYS TO YOU!!!!!