ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

CHEMISTRY 9189/1

PAPER 1

NOVEMBER 2016 SESSION 2 hours

Additional materials:
- Answer paper
- Data Booklet
- Mathematical tables/ electronic calculator
- Graph paper

TIME: 2 hours

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **six** questions.

Answer **two** questions from Section A, **one** question from Section B, **two** questions from Sectio and **one** other question chosen from any section.

Write your answers on the separate answer paper provided.

If you use more than one sheet of paper, fasten the sheets together.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

You are reminded of the need for good English and clear presentation in your answers.

This question paper consists of 9 printed pages and 3 blank pages.

Section A

Answer at least two questions from this section.

1 **(a)** An organic compound, A, was found to contain 70.6% C, 23.5% O and 5.9 % H.

(i) Define the term *empirical formula*.

(ii) Calculate the empirical formula of A. [3]

(b) The mass spectrum of A is shown in **Fig. 1.1**.

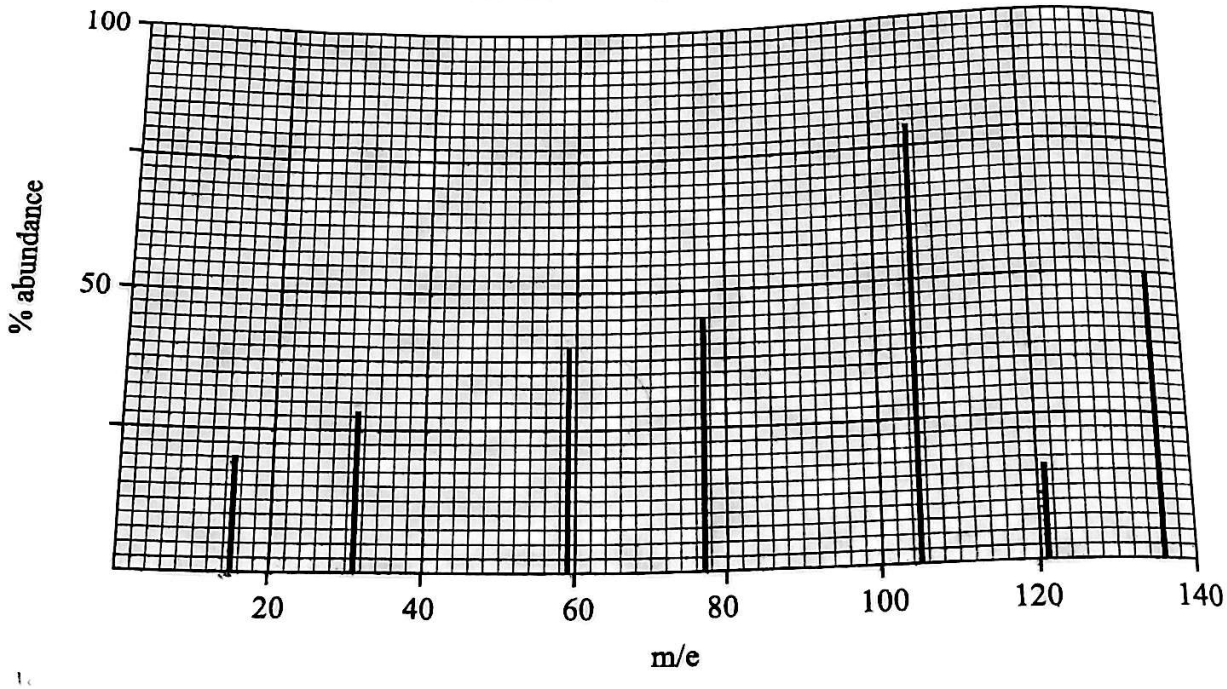


Fig. 1.1

(i) Deduce

1. the molecular formula of A.

2. the species giving rise to the peaks at m/e values of 31, 59 and 77.

(ii) Hence give the structural formula of A.

(iii) Calculate the relative molecular mass of a 1.00 g sample of A, given that its vapour occupied a volume of 218.20 cm^3 at 85°C and 1.01×10^5 Pa.

(iv) Compare the M_r value in **b(i)** and that in **b(iii)** and comment. [9]

[Total: 12]

Section B

*Answer at least **one** question from this section.*

4 **(a)** State and explain the difference in the atomic radii of chlorine and argon. [3]

(b) Write chemical equations for the reactions of the listed oxides of Period 3 elements with water.

(i) sodium oxide

(ii) phosphorus (III) oxide

(iii) sulphur dioxide [3]

(c) Suggest explanations for the following:

(i) $AlCl_3$ crystallises as the hexahydrate $AlCl_3.6H_2O$

(ii) $AlCl_3$ acts as a halogen carrier in the reaction between benzene and chlorine

(iii) adding sodium carbonate to $AlCl_3$ results in an effervescent reaction and production of a white precipitate [6]

[Total: 12]

[Tu

3 A 1.00 mole sample of ammonia was introduced into a 1.00 dm^3 vessel and allowed to dissociate at constant temperature. At equilibrium, it was 40% dissociated.

(a) **(i)** Write the equilibrium expression for the dissociation of ammonia.

(ii) Calculate the

1. equilibrium concentration of each component,
2. equilibrium constant, K_c.

[6]

(b) State and explain the effect on the equilibrium composition of

(i) increasing the volume of the container at constant temperature,

(ii) adding iron filings into the vessel.

[4]

(c) Sketch a graph to show how the concentration of ammonia changes with time.

[2]

[Total: 12]

2 (a) (i) Write equations to define the enthalpy changes of

1. formation of ethane,

2. atomisation of carbon.

(ii) Calculate the enthalpy change for the reaction

$$2C_{(s)} + 6H_{(g)} \rightarrow C_2H_{6(g)},$$

(iii) Calculate the C – C bond energy.

Given that

$$\Delta H_f^{\theta}(C_2H_6) = -88 \text{ kJmol}^{-1}$$
$$\Delta H_{at}^{\theta}(C_{(s)}) = +720 \text{ kJmol}^{-1}$$

[7]

(b) A temperature rise of 50 °C is produced when 10 cm^3 of concentrated sulphuric acid is added to 900 cm^3 of distilled water.

(i) Write a chemical equation for the change that causes the temperature rise.

(ii) The concentration of concentrated sulphuric acid is 18.0 $moldm^{-3}$ and the specific heat capacity of the resultant mixture is 4.2 $Jg^{-1}\ K^{-1}$.

Calculate

1. the heat change for the process,

2. ΔH_r^{θ} for the process.

[5]
[Total: 12]

[Turn

5 **(a)** Fumes of HC*l*, HBr and HI are separately passed over a hot filament.

(i) State any **one** observation for each case.

(ii) Explain the differences in the observations. [4]

(b) **Table 5.1** shows some enthalpy changes for halogens in $kJmol^{-1}$.

Table 5.1

	$\Delta H_{atomisation}$	$\Delta H_{electron\ affinity}$	$\Delta H_{hydration}$
fluorine	+79	–328	–506
chlorine	+122	–349	–364
bromine	+112	–325	–355
iodine	+107	–295	–293

(i) Explain the variation, from chlorine to iodine, in

1. $\Delta H_{atomisation}$,
2. $\Delta H_{electron\ affinity}$,
3. $\Delta H_{hydration}$.

(ii) Explain why $\Delta H_{atomisation}$ of fluorine is lower than those of other halogens. [4]

(c) State the role of

(i) chlorine in the purification of drinking water,

(ii) 1,2-dibromoethane in leaded petrol. [4]

[Total: 12]

Section C

Answer at least two questions from this section.

6 **(a)** An organic compound **A** shown in **Fig. 6.1** can be converted to compounds **B**, **C** and **D** by adding the shown reagents.

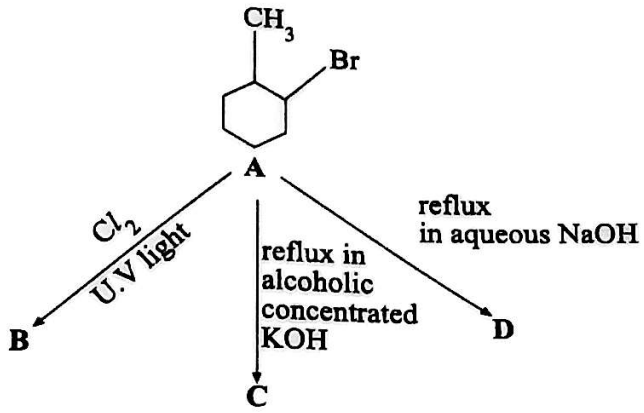


Fig. 6.1

(i) Name the organic compound **A**.

(ii) Give the possible structural formula of

1. **B**,
2. **C**,
3. **D**.

(iii) Name the type of reaction occurring in formation of

1. **B**,
2. **C**,
3. **D**.

[7]

(b) **(i)** Define the term *functional group*.

(ii) Explain why alkanes are chemically inert.

[3]

(c) Describe how alkenes are produced from alkanes. [2]

[Total: 12]

7 (a) (i) State the type of isomerism that arises due to the presence of a carbon to carbon double bond.

(ii) Explain, giving an example, how the carbon to carbon double bond causes this type of isomerism. [4]

(b) An organic compound **C** of molecular formula C_7H_{12} reacts with $Br_{2\,(aq)}$ in the ratio 1:1. **C** produces a single organic compound **D**, $C_7H_{12}O_3$, when mixed with concentrated $KMnO_4$. **D** gives a yellow precipitate when heated with aqueous alkaline iodine and an orange precipitate with 2.4-dinitrophenylhydrazine. **D** produces an effervesce with sodium carbonate.

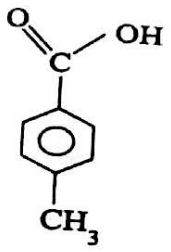
(i) Suggest suitable structural formulae for compounds **C** and **D**.

(ii) Write a chemical equation for the reaction of

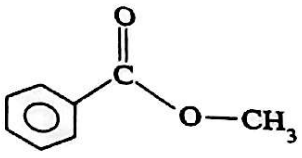
1. **C** with bromine,
2. **C** with concentrated $KMnO_4$,
3. **D** with aqueous alkaline iodine,
4. **D** with 2,4-dinitrophenylhydrazine,
5. **D** with sodium carbonate. [8]

[Total: 12]

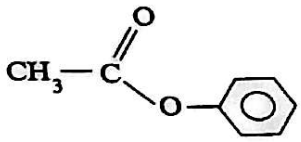
8 The structures of three isomers **E**, **F** and **G** are shown in **Fig. 8.1**.



E



F



G

Fig. 8.1

(a) Name

(i) **E**, **F** and **G**,

(ii) the type of isomerism shown in **Fig. 8.1**. [4]

(b) **(i)** State the reaction conditions for isomer **E** to react with

1. HNO_3,
2. $KMnO_4$.

(ii) Give the structural formula for the organic product formed when isomer **E** reacts with

1. HNO_3,
2. $KMnO_4$. [4]

(c) Name the type of reaction occurring in **b(ii)**. [2]

(d) Suggest a two step reaction to distinguish between **F** and **G**. [2]

[Total: 12]