



ZIMBABWE SCHOOL EXAMINATIONS COUNCIL
General Certificate of Education Advanced Level

CHEMISTRY

9189/4

PAPER 4 Option Topics

NOVEMBER 2013 SESSION

1 hour 15 minutes

Additional materials:

Answer paper

Data booklet

Graph paper

Mathematical tables and/or electronic calculator

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

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

Answer a total of **four** questions. Do not answer more than **two** questions from any **one** Option.

You are advised not to attempt questions on Options for which you have not been prepared.

Write your answers on the separate answer paper provided.

Begin each answer on a fresh page.

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.

Where relevant, the symbols for aluminium, chlorine and iodine are printed as: *Al*; *Cl*; *I*; respectively.

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

This question paper consists of 10 printed pages and 2 blank pages.

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BIOCHEMISTRY

Not more than two questions to be answered from this Option.

- 1 (a) Widespread use of coal-heating-ovens in winter has led to deaths and this has been associated with haemoglobin.
- Suggest an explanation for the deaths. [2]
- (b) Describe and explain the role of haemoglobin and how the structure relates to its function. [4]
- (c) List the **four** types of structures of proteins. [2]
- (d) Distinguish between fibrous and globular proteins. [2]
- [Total:10]
- 2 (a) Starch and cellulose are carbohydrate polymers.
- (i) Draw structures of the monomers of
1. starch,
 2. cellulose.
- (ii) Name the bond formed between the monomers in their polymerisation reaction.
- (iii) Relate the structure of starch and cellulose to their functions. [6]
- (b) Describe and explain the differences in the solubilities of sucrose, starch and cellulose. [4]
- [Total:10]
- 3 (a) (i) Draw a diagram to show the basic structure of a nucleotide.
- (ii) Define ATP and describe its importance in biological systems. [4]
- (b) Identify the functions of the following in genetics:
- (i) mRNA
 - (ii) triplet code [2]
- (c) The sequence of bases in a section of mRNA was CCUAGUUAG.
- Give the base sequence of the corresponding DNA. [2]

- (d) Fig. 1 shows some of the bases in RNA.

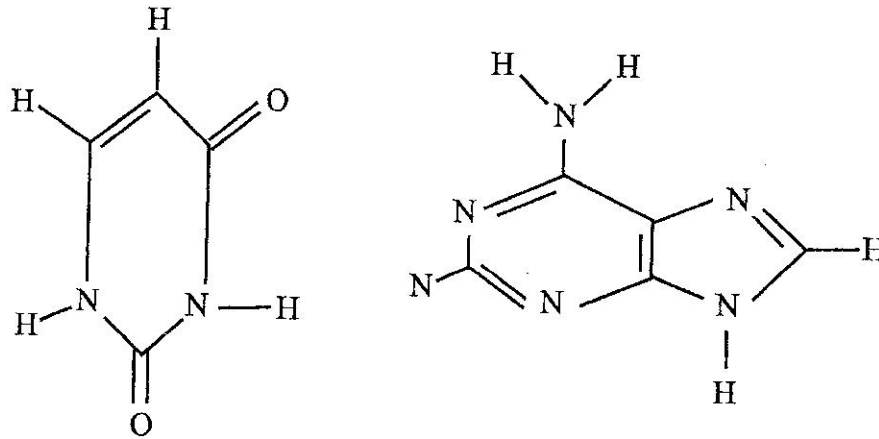


Fig. 1

- (i) Show by means of a diagram how pairing between these bases is possible.
- (ii) Name the bond involved.

[2]
[Total: 10]

ENVIRONMENTAL CHEMISTRY

Not more than two questions to be answered from this Option.

- 4 (a) When 2:1 clays dry, they shrink and crack.
Explain the formation of cracks in 2:1 clays. [3]
- (b) Explain the lack of stability of silicate clays in acidic solutions and the consequent release of aluminium ions. [2]
- (c) Using an equation, show how hydrated aluminium enhances acidity of soil. [2]
- (d) State **three** other factors that cause acidity in soils. [3]
- [Total: 10]

- 5 (a) Fig. 2 shows the variation of dissolved oxygen with distance downstream.

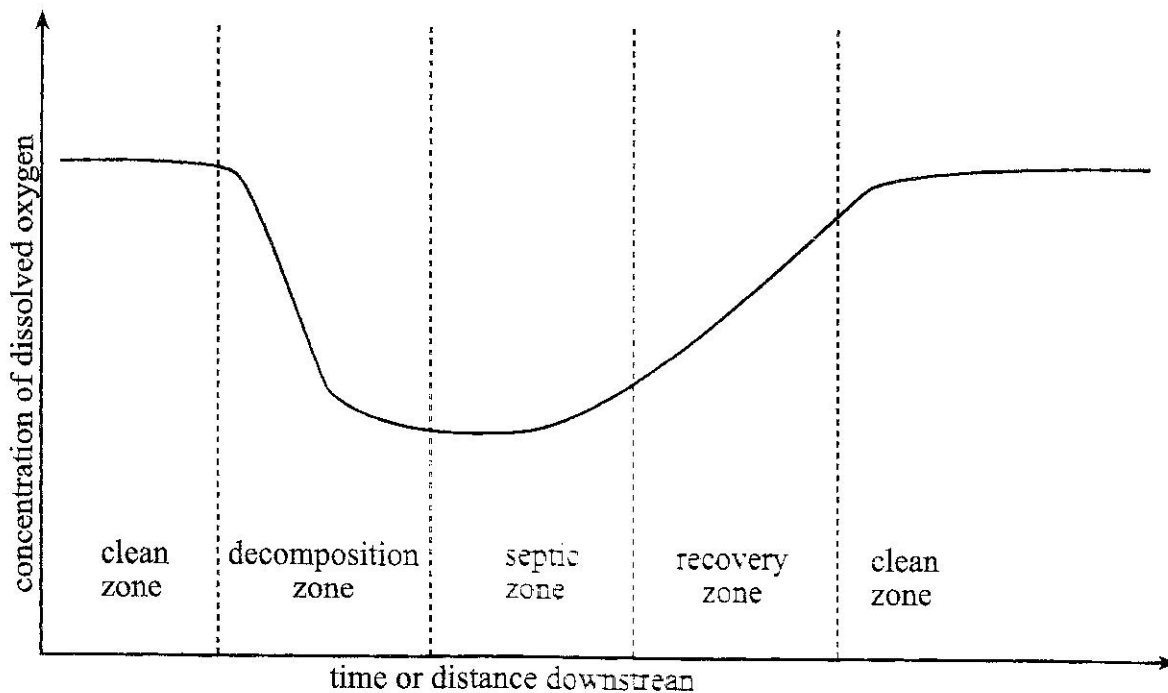


Fig. 2

Interpret and explain the diagram as fully as you can. [4]

- (b) (i) Give the meaning of B.O.D.
(ii) Outline how the B.O.D of a sample may be determined.
(iii) Name the crucial stages in preparation of portable water. [6]
- [Total:10]

- 6 (a) Outline the problems of dumping waste at seas and rivers. [4]
- (b) Comment on the environmental impact of
- (i) the disposal of chlorinated materials by incineration,
 - (ii) spilling of oil in the sea,
 - (iii) the disposal of organic material by landfilling.
- [6]
[Total:10]

PHASE EQUILIBRIA

Not more than two questions to be answered from this Option.

- 7 (a) Explain the use of electrophoresis in gene analysis and genetic fingerprinting. [4]
- (b) Sketch the phase diagram of water/ sodium chloride solution given that the minimum temperature is -17.8°C .
Include appropriate labels. [4]
- (c) Explain why electricians would prefer to use the eutectic mixture of tin and lead over pure metals for soldering. [2]
- [Total:10]

- 8 (a) (i) Define the term *fractional distillation*.
(ii) State any two factors that affect separation of substances during fractional distillation. [3]
- (b) During distillation of a liquid mixture of components **A** and **B**, the following values were obtained.

percentage of A	0	20	40	60	70	80	100
liquid mixture boiling point /$^{\circ}\text{C}$	130	106	89	75	70	74	106
vapour temperature / $^{\circ}\text{C}$	130	120	105	84	70	82	92

- (i) Construct the boiling point composition diagram for the mixture of **A** and **B**.
- (ii) A mixture of **A** and **B** containing 66% **A** was distilled.

Identify

1. its boiling point,
 2. percentage composition of vapour in equilibrium with the mixture,
 3. boiling point of the vapour produced.
- (iii) How many theoretical plates would be needed to obtain a distillate composition of 30% **B**. [7]
- [Total:10]

- 9 (a) In an experiment to investigate the phase changes of water, a length of wire was placed on top of a block of ice and weights hung as shown in Fig. 3. It was found that the ice under the wire melted and the wire slowly moved through the ice block. At the same time, the water above the wire refroze.

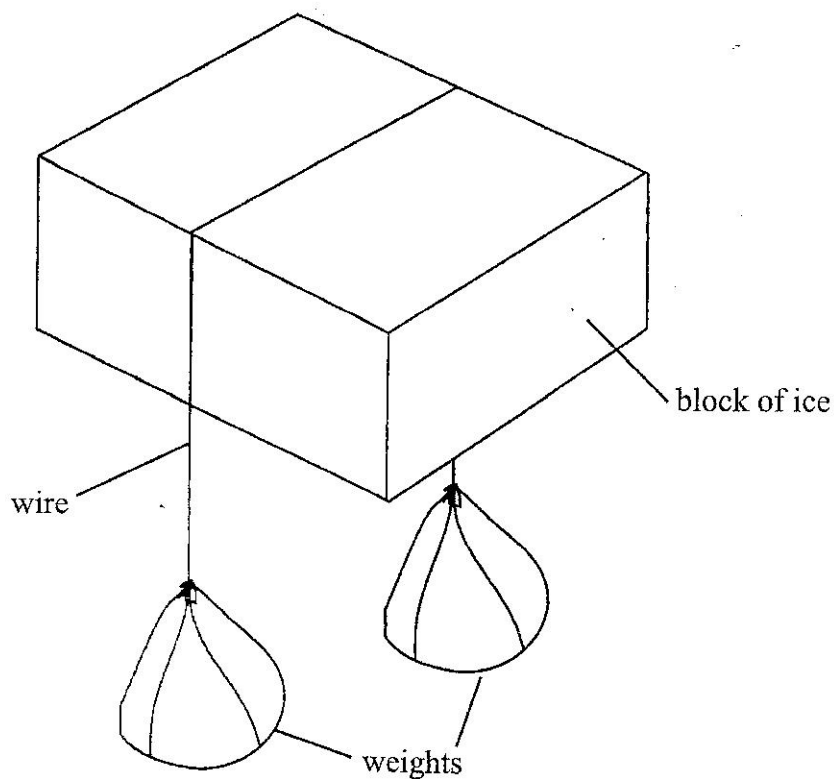


Fig. 3

Explain the phase changes that were observed.

[4]

- (b) With the aid of a diagram, describe the effect of a non volatile solute on
- (i) vapour pressure,
 - (ii) boiling point and
 - (iii) freezing point.

[6]

[Total: 10]

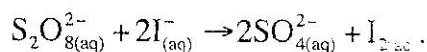
TRANSITION METALS

Not more than two questions to be answered from this Option.

- 10 (a) One of the following species is not capable of acting as a ligand.

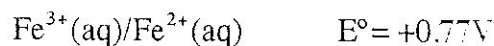
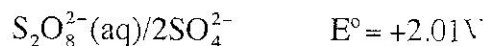


- (i) Give the molecule or ion that cannot act as a ligand.
- (ii) Explain why the molecule you named in (a) (i) cannot act as a ligand. [2]
- (b) There are two complexes of the formula $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$, a green one and violet one.
- (i) State the oxidation state and the coordination number of cobalt in these complexes.
- (ii) Predict the geometry of these complexes.
- (iii) With the aid of diagrams explain the difference in colour of these complexes. [6]
- (c) Peroxodisulphate (VI) ions, $\text{S}_2\text{O}_8^{2-}$ oxidise iodide ions, I^- , to iodine, according to the equation.



The reaction is catalysed by Fe^{3+} ions.

Using the data given below, explain why Fe^{3+} ions can catalyse this reaction.



[2]

[Total:10]

- 11 (a) Fig. 4 shows results obtained in an investigation of the complex formation between iron (III), Fe^{3+} , and salicylic acid, HSal , in aqueous solution.

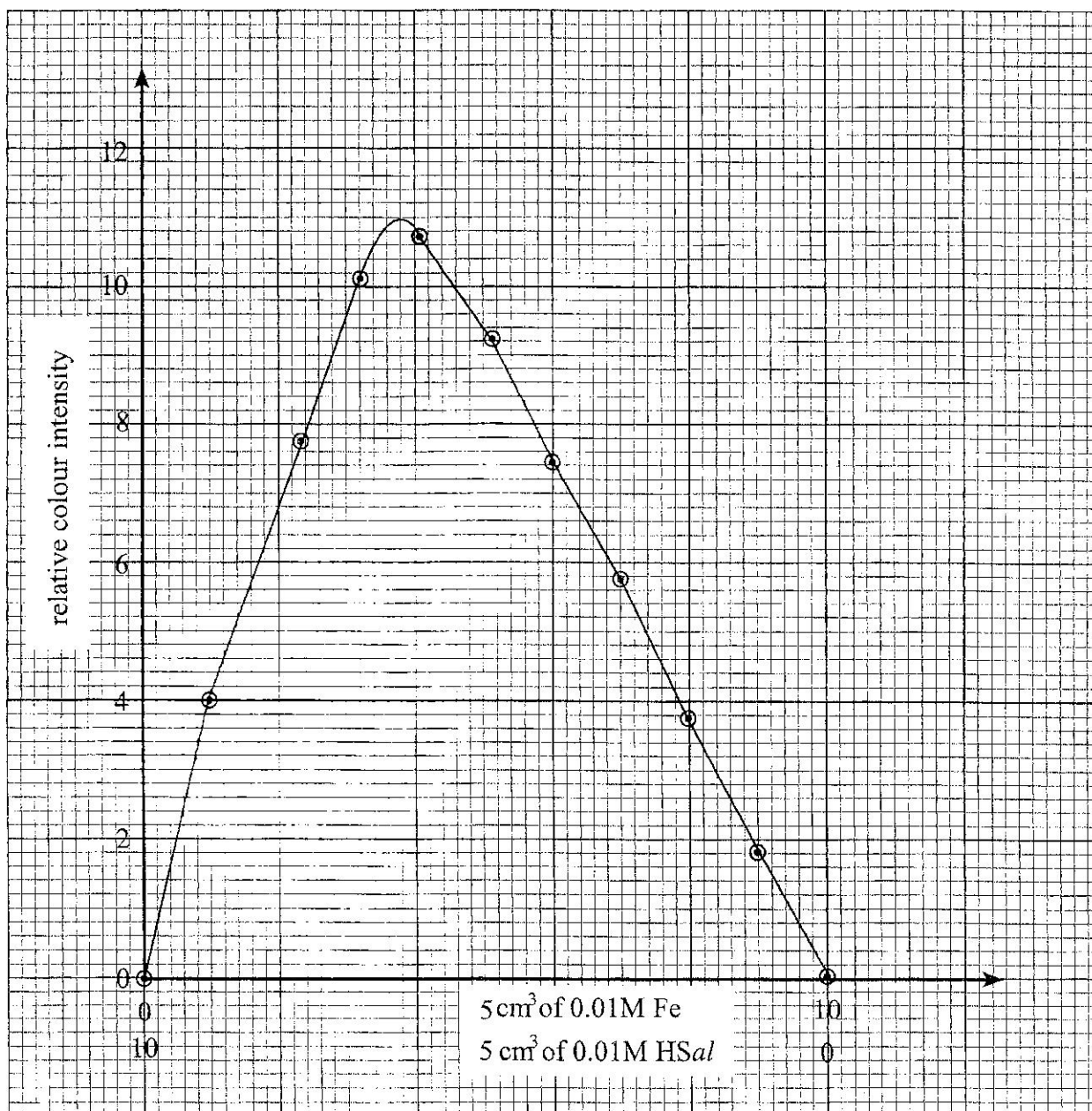


Fig. 4

The composition of the iron (III) salicylic acid complex may be represented by $[\text{Fe}_x(\text{Sal})_y]$.

- From the graph, deduce the most likely values of x and y .
- Calculate the overall charge of the iron (III) salicylate complex given that the charge on the salicylate ion, Sal^- is -1 .
- Write down an equation representing the formation of the complex from its constituent ions.

(iv) Write down an expression for the stability constant of the iron (III) salicylate complex. [6]

(b) Iron (III) salicylate complex ion has a deep violet colour.

Explain why this ion is coloured. [4]

[Total:10]

12 (a) Complexes with polydentate and bidentate ligands have larger stability constants than those of monodentate ligands.

(i) Define the terms

1. *bidentate*

2. *polydentate*

(ii) Using $[M(H_2O)_6]^{n+}$ as an example, explain the term *stability constant*. [6]

(b) Table 1 shows stability constants of some copper complexes.

Table 1

ion with water as a ligand	complex	Log (stability constant)
Cu^{2+}	$[Cu(NH_3)_4]^{2+}$	13.1
Cu^{2+}	$[CuCl_4]^{2-}$	5.6

With reference to **Table 1** suggest what would happen if small amounts of concentrated ammonia are added to $[CuCl_4]^{2-}$ solution until present in excess.

Use equations where possible.

[4]

[Total:10]