Section A

Answer any two questions from this section.

1 **(a)** The kinetics of the reaction shown were investigated.

$NO_{2(g)} + CO_{(g)} \rightarrow NO_{(g)} + CO_{2(g)}$

The results of the investigation are shown in **Table 1.1**.

Table 1.1

time/sec	0	20	50	75	150	300	400
$[NO_2]/\times 10^{-1}$ moldm^{-3}	5.0	4.4	3.8	3.4	2.5	1.25	0.8

(i) Plot a graph of the results.

(ii) Deduce the

1. half-life for the reaction,

2. order of the reaction with respect to $[NO_2]$.

(iii) Calculate the rate constant, *k*.

[7]

(b) (i) Describe how the standard electrode potential of $Sn^{4+}_{(aq)}/Sn^{2+}_{(aq)}$ half cell can be measured.

(ii) The $Sn^{4+}_{(aq)}/Sn^{2+}_{(aq)}$ half cell was connected to a standard half cell of $I_{2(aq)}/I^-_{(aq)}$ as shown in Fig. 1.

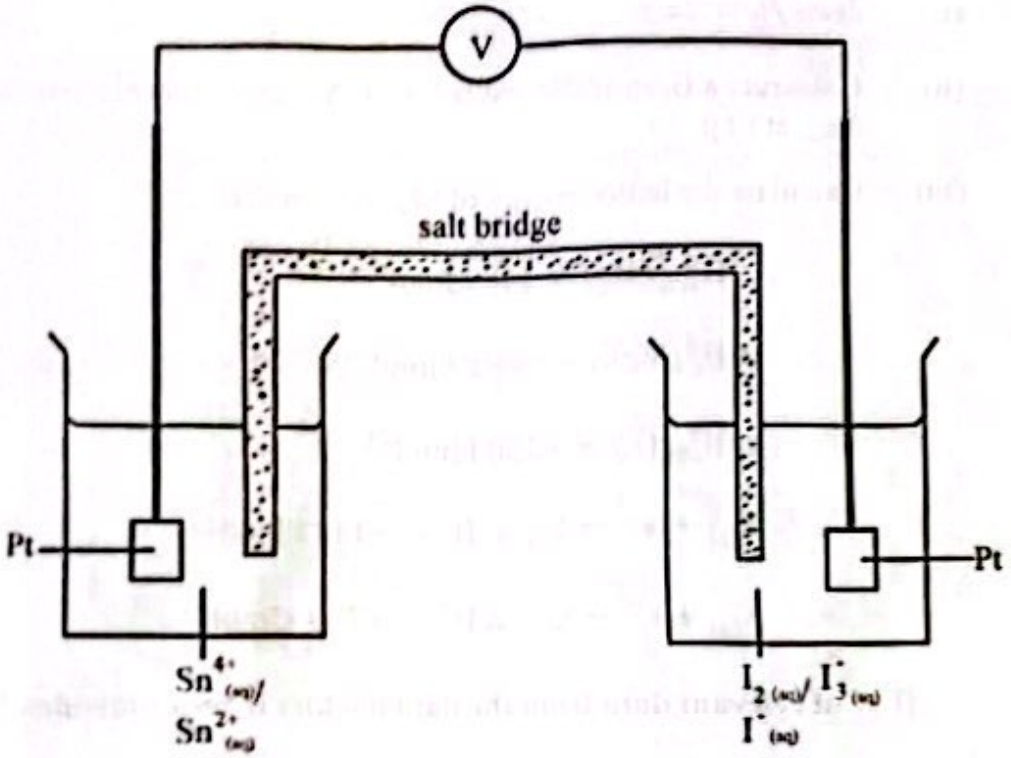


Fig. 1

1. Write a balanced ionic equation for the overall cell reaction.

2. Calculate the standard cell potential for the cell.

[8]
[Total: 15]

(a) (i) Define the term *lattice Energy*.

(ii) Write an equation to represent the lattice energy of a magnesium compound $MgX_{(s)}$.

[2]

(b) (i) State *Hess' Law*.

(ii) Construct a Born-Haber cycle for $MgX_{(s)}$ given that element X exists as $X_{2(g)}$ at r.t.p.

(iii) Calculate the lattice energy of MgX given that:

$$\Delta H^{\theta}_{atm}(Mg) = 148\ kJmol^{-1}$$

$$\Delta H^{\theta}_{f}(MgX) = -602\ kJmol^{-1}$$

$$\Delta H^{\theta}_{atm}(X) = +250\ kJmol^{-1}$$

$$X_{(g)} + e^{-} \rightarrow X^{-}_{(g)}\ \Delta H^{c} = -141\ kJmol^{-1}$$

$$X^{-}_{(g)} + e^{-} \rightarrow X^{2-}_{(g)}\ \Delta H^{\theta} = +798\ kJmol^{-1}$$

[Use of relevant data from the data booklet is recommended.]

(iv) Explain why the second electron affinity of X is endothermic.

[8]

(c) Sulphur trioxide decomposes to form sulphur dioxide and oxygen according to the equation:

$$2SO_{3(g)} \rightleftharpoons 2SO_{2(g)} + O_{2(g)}$$

(i) Draw sketch graphs, on the same axes, to show how the concentrations of sulphur trioxide and sulphur dioxide change with time.

(ii) Explain the shape of each graph.

[5]
[Total: 15]

3 (a) Define the term

(i) *electronegativity*,

(ii) *bond polarity*.

[2]

(b) (i) Describe, using a 'dot-and-cross' diagram, the bonding in carbon disulphide CS_2.

(ii) Suggest the shape of the CS_2 molecule and give its bond angle.

(iii) Comment on the polarity of CS_2.

[6]

(c) **Table 3.1** shows ΔH_f^θ values of three different compounds.

Table 3.1

compound	ΔH_f^θ/kJmol$^-$
$SO_{2(g)}$	−298
$CO_{2(g)}$	−395
$CS_{2(g)}$	+119

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

(ii) Write an equation to show the enthalpy change of formation of CS_2 under standard conditions.

(iii) Carbon disulphide reacts with oxygen according to the equation.

$$CS_{2(g)} + 3O_{2(g)} \rightarrow CO_{2(g)} + 2SO_{2(g)}$$

Calculate the standard enthalpy change of combustion of CS_2.

(iv) Suggest **two** safety precautions to take into account when using carbon disulphide.

[Total:

[Tu

Answer any one question from this section.

4 (a) Describe and explain

(i) the trend in the boiling points of halogens,

(ii) the trend in the acidicity of hydrogen halides,

(iii) what happens when bromine gas is bubbled through

1. aqueous potassium iodide,

2. aqueous potassium chloride.

[10]

(b) Compare and comment on the

(i) solubility of potassium chloride and iodine in water,

(ii) electrical conductivity of potassium chloride and iodine.

[5]

[Total: 15]

5 (a) The equation shows how iron is extracted from its ores.

$$2Fe_2O_{3(s)} + 3C_{(s)} \xrightarrow{\text{heat}} 4Fe_{(l)} + 3CO_{2(g)}$$

(i) Name, with reasons, this method of extraction.

(ii) Explain why aluminium can not be extracted from its oxide by a similar method.

(iii) State any three advantages of obtaining iron by recycling rather than the method shown in (i).

[6]

(b) Iron is converted to more useful iron alloys by alloying.

(i) Define the term *alloy*.

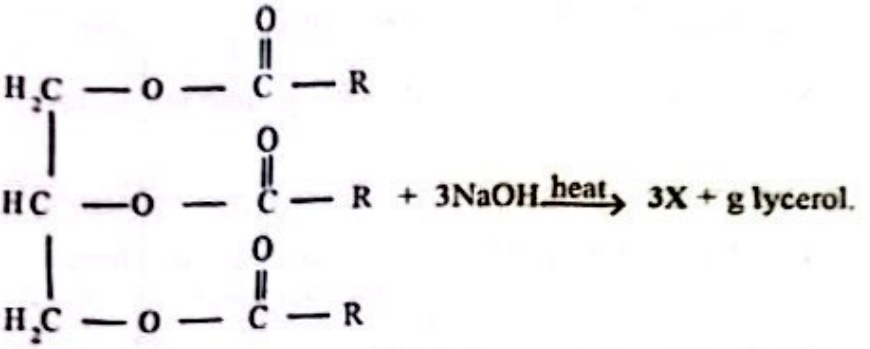
(ii) Explain how alloying makes iron more suitable for its uses.

[3]

Section C

Answer any two questions from this section

6 (a) The equation shows how esters react with sodium hydroxide.



(i) Deduce the structural formula of product **X**.

(ii) Explain why glycerol

1. has a high boiling point,
2. is highly soluble in water.

[4]

(b) **Fig. 6.1** shows the structural formulae of three organic acids, **L**, **M** and **N**.

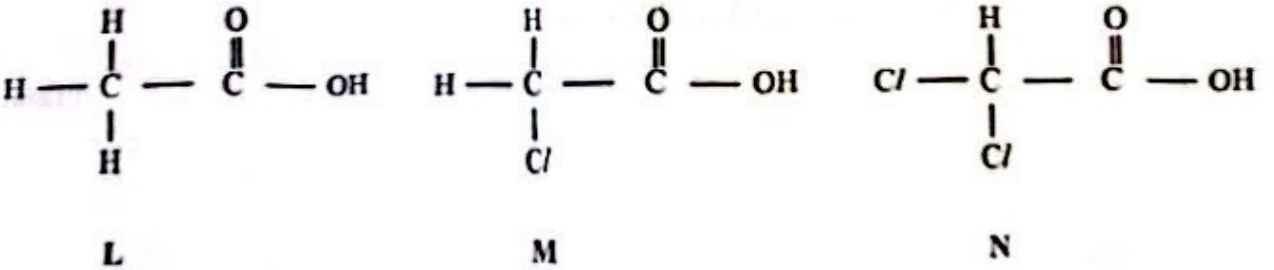


Fig. 6.1

Identify, with reasons, the strongest organic acid. [4]

(ii) Draw the structural formula of the organic products formed when the compound shown in Fig. 7.2 reacts with

1. $HBr_{(aq)}$,
2. bromine water,
3. ethanoyl chloride.

(iii) Name the type of reaction undergone in each of the reactions in (ii).

[8]

(c) Nonane and 2,4-dimethylheptane are isomers with the molecular formula C_9H_{20}.

(i) Draw displayed structural formula of

1. nonane,
2. 2,4-dimethylheptane.

(ii) State the type of isomerism shown by these alkanes.

(iii) Describe and explain how a mixture of these two alkanes can be separated.

[5]

[Total:15]

8 (a) Fig. 8.1 shows the structural formula of an organic compound.

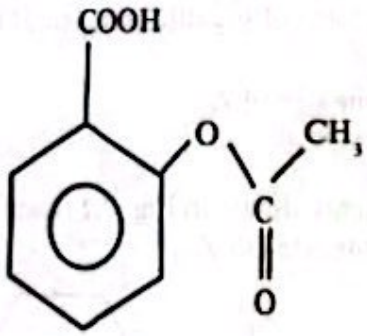


Fig. 8.1

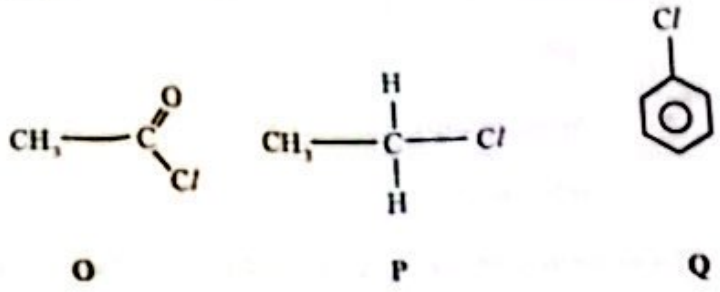
(i) Name the functional groups in the organic compound.

(ii) Describe and explain how the compound reacts with

1. sodium carbonate,
2. hot dilute hydrochloric acid,
3. sodium metal.

[9]

(c) Fig. 6.2 shows the structural formulae of three chlorine containing organic compounds, O, P and Q.



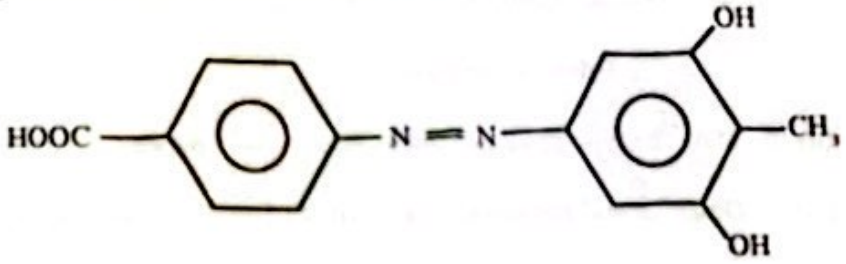
O P Q

Fig. 6.2

Describe and explain the relative ease of hydrolysis of O, P and Q. [7]

[Total:15]

7 (a) Fig. 7.1 shows the structural formula of an organic compound Z.



Z

Fig. 7.1

(i) Name the group of organic compounds to which Z belongs.

(ii) State any one use of Z. [2]

(b) An organic compound shown in Fig. 7.2 reacts to form an intermediate S, which can be converted to Z.

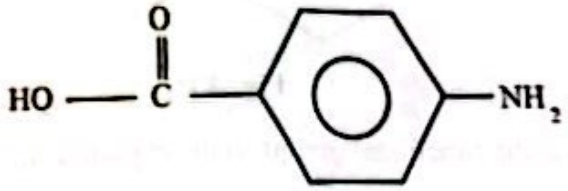


Fig. 7.2

(i) Deduce the structural formula of the

1. intermediate S,
2. compound that reacts with S to form Z.

[Turn o