**Our country, our future**

**525/1**

# S6 CHEMISTRY

**Exam 23**

***PAPER 1***

## DURATION: 2 HOUR 45 MINUTES

***Instructions:***

- This paper consists of two sections **A** and **B**
- Section A is compulsory.
- Attempt **only six** questions in section B
- Answers must be written in the spaces provided **only**

| **For Examiner's Use Only** | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| | | | | | | | | | | | | | | | | |

**SECTION A**

**Answer all questions from this section.**

1. (a) (i) The decay law is given the expression

$$-\frac{dN}{dt} = \lambda \mathrm{N}$$

State what the symbols represent. (01½)

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(ii) Using the above expression derive the expression for the relation between half life and the decay constant. (02 )

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(b) (i) Nickel($^{63}$Ni) decays to copper ($^{63}$Cu)

Name the particle emitted and write the equation for the reaction:

Name of particle; (01)

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Equation

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(ii) Calculate the time taken for $\frac{15}{16}$ of nickel to be change to copper.

[The half life for nickel is 120 years ] (02)

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2. (a) State conditions for the reaction between aluminium oxide and sulphuric acid and write the equation for the reaction.
Conditions;

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Equation

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(b) The resultant solution in (a) was mixed with aqueous sodium carbonate solution. State what would be observed and write equation for the reaction that takes place
Observation; (02 ½ )

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Equation;

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3. The following experimental results were obtained for the reaction
$A + 2B \longrightarrow$ products

| Exp | Initial concentrations (mol $\lfloor^{-1}$) | | Initial rate (mol $\lfloor^{-1} S^{-1}$) |
|---|---|---|---|
| | A | B | |
| 1 | $3.0 \times 10^{-2}$ | $3.0 \times 10^{-2}$ | $2.7 \times 10^{-5}$ |
| 2 | $3.0 \times 10^{-2}$ | $6.0 \times 10^{-2}$ | $5.4 \times 10^{-5}$ |
| 3 | $6.0 \times 10^{-2}$ | $3.0 \times 10^{-2}$ | $10.8 \times 10^{-5}$ |

(a) (i) Deduce the order of reactions with respect to

A;

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B;

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(ii) Write the expression for the rate equation (0½ )

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(b) The rate of reaction under certain conditions for temperature and pressure is x. Express the rate in terms of x when the following changes are made. (0 ½ each )

(i) The concentration B is halved while the concentration of A remains unchanged

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(ii) The rate constant is doubled, by increasing temperature, but keeping the concentrations of A and B unchanged.

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(iii) If 90% of B is removed by precipitation, without affecting concentration of A.

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(c) Calculate the value of the rate constant and state its units. (02 )

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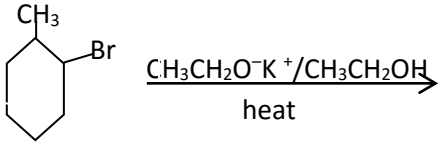
4. Complete the following reaction equations and write the IUPAC names of the main organic product in each case. (01½ )

(a) 


Name of product;

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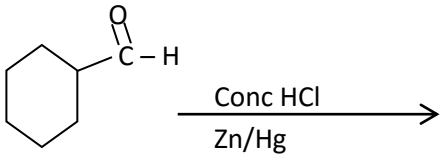
(b) 


Name of product;

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(c) $(CH_3)_3COH$ $\xrightarrow{\text{anhydrous } ZnCl_2/\text{Conc HCl}}$

Name of product.

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5. (a) Write half equation(s) to show the action of hydrogen peroxide as
(i) an oxidizing agent (01 mark each)

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(ii) a reducing agent

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(b) State what is observed and in each case write equation of reaction that take place when hydrogen peroxide is added to the following mixtures; (01 ½ marks each)

(i) Acidified potassium chromate (VI) solution

Observation

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Equation

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(ii) Iron (ii) sulphate in dilute sulphuric acid

Observation

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Equation

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(c) Give one reason why hydrogen peroxide is not used in estimation of concentration of iron (ii) ions in volumetric analysis (01)

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6. (a) Explain what is meant by the term first election affinity. (01)

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(b) State three factors that can affect electron affinity. (01 ½ )

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(c) The first electron affinities of some elements of period – 3 are given in the table below

| Element | Al | Si | P | S |
|---|---|---|---|---|
| First electron affinity ($KJmol^{-1}$) | – 44 | – 134 | – 71.7 | – 200 |

(i) State the trend in variation of electron affinities (0 ½ )

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(ii) Explain your answer in c (i) above (02)

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7. (a) The enthalpies of some reactions are given below

$\Delta H^{\theta}$/KJmol$^{-1}$

(i) $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H^{\theta}_1 = -393.5$

(ii) $H_2(g) + ½\ O(g) \longrightarrow H_2O(l)$ $\Delta H^{\theta}_2 = 285.9$

(iii) $C_6H_5OH(s) + 7O_2(g) \longrightarrow 6CO_2(g), +3H_2O\ (l)$ $\Delta H^{\theta}_3 = 3009$

Calculate the standard enthalpy of formation of phenol from its elements. (03)

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(b) (i) From your answer in (a) state whether phenol is a stable compound or not. (0 ½ )

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(ii) Give a reason for your answer in b (i0 above (01 mark)

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(d) Write equation'(s) to show how phenol can be synthesized from chloro benzene. (01 ½ mark)

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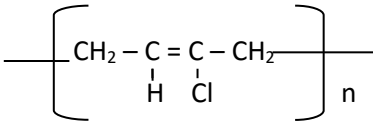
8. (a) Neoprene is a synthetic polymer which has the following structure




(i) Name the type of polymerization reaction which leads to formation of neoprene

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(ii) Write the structure and name of monomer of neoprene. (01)

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(b) When 350g of the monomer was polymerized $9.89 \times 10^{-2}$ moles of neoprene was formed. Calculate the relative molecular mass of neoprene. (2)

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(c) state one use of neoprene (0½ )

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9. Calculate the pH of a 0.1 moldm $^{-3}$ solution of aluminium nitrate

(Acid dissociation constant, Ka at 25$^{o}$C for $Al(H_2O)_6^{3+}$ is 1.4 x 10 $^{-5}$ moldm $^{-3}$ )

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**SECTION B**

**Attempt only six questions in this section**

10. (a) Explain what is meant by the term common ion effect. (01)

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(b) Silver chromate is sparingly soluble in water.

Write

(i) Equation for solubility of silver chromate in water (1 ½ )

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(ii) The expression for solubility product, Ksp for silver chromate. (0 ½ )

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(c) A saturated solution of silver chromate contains 2.4 x $10^{-2}$g per litre at 20$^{o}$C

Calculate the value for the solubility product Ksp for silver chromate at 20$^{o}$C. (02)

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(d) Chloride ions in solution can be determined by titration with silver nitrate in the presence of chromate ions. The end point is indicated by a red precipitate of silver chromate.

(i) Explain why silver chromate does not precipitate until the end point is reached. (01)

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(ii) 25cm$^3$ of a solution containing 0.1 moles of potassium chloride and 0.001 moles of chromate ions required on titration 50cm$^3$ of 0.1M silver nitrate solution to reach the end point. Calculate the concentration of chloride ions at the end point
[solubility product for silver chloride is 1.6 x $10^{-10}$ mol$^2$ l$^{-2}$ ]

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11. (a) A compound Y contains carbon, hydrogen and nitrogen. On combustion, 0.72g of Y produced 1.615g of carbon dioxide and 0.42g produced 84$cm^3$ of nitrogen at 15$^oC$ and 760mmHg. Calculate the empirical formula of Y. (04 ½ )

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(b) When Y was vapourised, it took 38 seconds to diffuse through the same porous partition under similar conditions whereas oxygen takes 285. Calculate the molecular formula of Y (03)

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( c) Y reacts with a mixture of concentrated hydrochloric acid and aqueous sodium nitrite to form a yellow oily liquid.

(i) Identify Y (0 ½ )

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(ii) Write equation of reaction that takes place. (01 mark)

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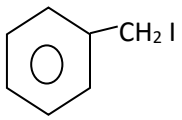
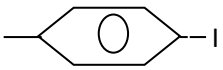
12. Name the reagents that can be used to distinguish between the following pairs of compounds. In each case state what would be observed if each member of the pair is separately treated with the reagent. (03 marks each)

(a)  and 

Name of reagent (s)

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Observation(s)

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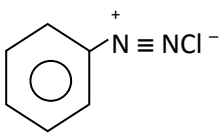
(b)  and $CH_3CH_2\overset{+}{N} \equiv NCl^-$

Name of reagent

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Observation(s)

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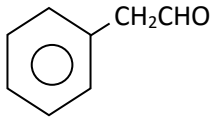
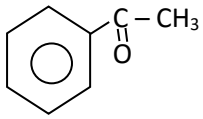
(c)  and 

Name of reagent;

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Observations

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13. (a) (i) Compare the reactivity of hydrides of group (VII) elements with concentrated sulphuric acid.
(Write equation(s) for the reaction(s) which take place if any) (04)

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(ii) Give a reason for the difference in reactivity shown by the hydrides in a(i) above. (01)

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(b) The bond lengths of the hydrides of group (VII) elements are given in the table below

| Hydride | HF | HCl | HBr | HI |
|---|---|---|---|---|
| Bond length ($A^o$) | 0.86 | 1.28 | 1.42 | 1.60 |

(i) State the trend in variation of bond length of the hydrides. (01)

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(ii) Explain your answer in b (i) above. (03)

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14. (a) Nitrogen reacts with hydrogen in a mole ratio of 1:3 to form ammonia.
Write;
(i) equation for the reaction that takes place. (01 ½ )

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(ii) the expression for the equilibrium constant (Kc) (0 ½ )

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(b) State the conditions used to obtain maximum yield of ammonia during it manufacture by the Habers process. (01½ )

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(c) The percentage of ammonia in the equilibrium mixture of gases was found to be 15% at 600$^{o}$C. Calculate the equilibrium constant (Kc) for the reaction at 600$^{o}$C. (04)

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(d) State what would happen to the equilibrium position of the reaction in a(i) above when hydrogen chloride gas is added to the equilibrium mixture. Give a reason for your answer. (01½ )

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15. Write equations to show how the following conversions can be effected. (03 marks each)

(a) Ethanol to benzene

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(b) 1,2 – dibromo ethane to ethanol .

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(c) Phenyl propane to phenol.

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16. (a) (i) State three characteristic properties exhibited by cobalt as a transition element. (01 ½ )

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(ii) Explain why zinc is not considered to be a transition element. (02)

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(b) Cobalt (II) nitrate decomposes on heating in the absence of air forming are green solid and dissolves in water forming a pink solution.

(i) Write equation for decomposition of cobalt (II) nitrate. (01 ½ )

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(ii) Name the species responsible for the pink colour of solution. (01)

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(c) To the aqueous solultion in (b) was added concentrated hydrochloric acid dropwise until in excess. State what is observed and write equation for the reaction that takes place. (03)

(i) Observation

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(ii) Equation;

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17. (a) Explain what is meant by the term partition coefficient. (02)

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(b) The table below shows the concentration's of iodine in the two layers when shaken with a mixture of carbon tetrachloride and water at 25$^{o}$C.

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|---|---|---|---|---|
| Concentration of $I_2$ in $CCl_4$/moldm $^{-3}$ | 6.12 | 12.24 | 15.20 | 22.38 |
| Concentration of $I_2$ in water/ moldm $^{-3}$ | 0.072 | 0.143 | 0.178 | 0.260 |

(i) Plot a graph of concentration of iodine in carbon tetra chloride against concentration of iodine in water

(ii) From the graph determine the partition coefficient for iodine distributed between carbon tetra chloride and water. (02)

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(c) State two applications of the partition coefficient. (02 )

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**END**