UACE
CHEMISTRY
2023-2025

0777 023 444

525/1

S6 CHEMISTRY

Exam 1

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.

Where necessary use the following:

Molar gas constant, R	= $8.31JK^{-1}mol^{-1}$
Molar volume of a gas at s.t.p	= 22.4litres
Standard temperarue	= 273K
Standard pressure	= $10125Nm^{-2}$

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

SECTION A

1. Write a balanced overall ionic equation for the following reactions:

(a) $MnO_2(s) + HCl\ (aq) \longrightarrow MnCl_2\ (aq) + H_2O(l) + Cl_2(g)$

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(b) $KIO_3(aq) + HCl(aq) + KI(aq) \longrightarrow I_2(aq) + H_2O(l)$

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(c) $K_2Cr_2O_7(aq) + H^+(aq) + SO_2(g) \longrightarrow SO_4^{2-}(aq) + H_2O(l) + Cr^{3+}(aq)$

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2. The osmotic pressure of an aqueous solution of a non- electrolyte containing 5.43 gdm^{-3} of solution is 7.093 x $10^4 Nm^{-2}$ at 25^0C. Calculate the freezing point of solution. (Kf for water = 18.6^0C per $100gmol^{-1}$)

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3. (a) Define the term “disproportionation.”

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(b) Write the ionic equation for the disproportionation of the following species.

(i) MnO_4^{2-} in acidic media.

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(ii) copper (I) in aqueous solution.

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(iii) hlorine in hot concentrated sodium hydroxide solution

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4. The following data was obtained for the reaction between hydrogen peroxide and iodine ions and hydrogen ions

Expt. No.	Concentration ($moldm^{-3}$)			Rate of reaction ($moldm^{-3}s^{-1}$)
	I-(aq) ion	H_2O_2(aq)	H+(aq) ions	
1	0.010	0.010	0.010	1.76×10^{-6}
2	0.010	0.030	0.010	5.25×10^{-6}
3	0.020	0.030	0.010	1.05×10^{-5}
4	0.020	0.030	0.020	1.05×10^{-5}

(i) State the order of reaction with respect to

H_2O_2

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I^-

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H^+

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(ii) Write the rate equation for the reaction:

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(iii) Calculate the rate constant (K) for the reaction and indicate its units.

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5. Complete each of the following equations and write the accepted mechanism.

(i) $CH_3\text{-}CH_2\text{-}CHO \xrightarrow[10\text{-}20^0C]{KCN/\ dil\ H_2SO_4}$

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(ii) $CH_3CH{=}CHCH_3 + HBr\ (g) \longrightarrow$ (2 ½ marks)

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6. (a) Define the term "standard enthalpy of atomization"

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(b) Bond energies for some bonds are given below.

Bond	Bond energy
C-O	358
C-H	413
O-H	464

Calculate the standard enthalpy of atomization of methanol

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(d) Explain why ammonium nitrate is readily soluble in water even though the standard enthalpy of solution has a positive value.

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7. Name the reagent that can be used to distinguish between Co^{2+} and Mn^{2+} ions. State what is observed when the aqueous solution of each ion is separately treated with the reagent.

Reagent

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Observations:

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(b) Cobalt forms a complex of formula $Co(NH_3)_n^{3+}3Cl^-$.

5 x 10^{-3} moles of a complex were heated in excess alkali and the ammonia liberated was absorbed in 50 cm^3 of dilute sulphuric acid of concentration 0.5M. The excess acid remaining after the absorption required 20.00cm^3 of 1M sodium hydroxide for complete neutralization. Calculate the value of N in the formula of the complex.

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8(a) Explain what is meant by the term "**condensation polymerization?**"

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(b) Nylon6,10 can be made by reacting 1,6-diaminohexanewith decanedoiyl chloride $ClOC(CH_2)_8COCl$.

Write the structural formula of:

(i) 1.6-diaminohexane

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(ii) Nylon 6,10

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(c) State one use of nylon 6,10.

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9. Ammonium carbamate (NH_4CONH_2) decomposes according to the following equation:

NH_4CONH_2 (s) $\rightleftharpoons$ $2NH_3(g) + CO_2(g)$ $+\Delta H^0$ ($kJmol^{-1}$)

(a) Write the expression for the equilibrium constant (Kp)

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(b) At equilibrium, the total pressure of the system is 0.36 atm. at 40^0C. Calculate the value of Kp for the reaction at 40^0C (indicate units).

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(c) State what happens to the Kp calculated in (a)(i) if

(i) More solid ammonium carbamate is added to the equilibrium mixture.

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(ii) The temperature is increased to 80^0C.

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SECTION B

10 Show how the following organic conversions can be effected. (Indicate suitable reagents and conditions of reaction's n each). (3marks each)

(a) $(CH_3)_3COH$ from CH_3COCH_3

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(b) $H_2C_2O_4$ from $CH_2=CH_2$

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(c) CH_3NH_2 from CH_3COOH

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11. Explain the following observations

(a) Silicon and phosphorus are both covalent substances, but the melting of silicon is much higher than that of phosphorus. (3marks)

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(b) Magnesium oxide (MgO) has the same crystalline structure as sodium chloride (NaCl) but the lattice energy of MgO is more exothermic than that of NaCl. (3marks)

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(c) A concentrated solution of calcium chloride forms a precipitate with sodium hydroxide but no precipitate form with aqueous ammonia. (3marks)

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12.(a) Phenylamine was mixed with concentrated hydrochloric acid and sodium nitrite at 0-5^{0}C. The resultant solution Y was then treated with a mixture of phenol in aqueous sodium hydroxide. State what is observed and write the equation of reaction that takes place between:

(i) Phenylamine and a mixture of concentrated hydrochloric acid and sodium nitrite.

Observation (½ mark)

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Equation: (1½ marks)

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(ii) Y and phenol in aqueous sodium hydroxide

Observation (½ mark)

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Equation: (1 ½ marks)

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(b) 20 cm^3 of 0.05M aqueous phenylamine was mixed with 50ccm^3 of 1M sodium bromide and electrolyzed at current of 0.2A. The first permanent bromine color was observed after 49.93 minutes; then electrolysis was stopped. (Faradays constant =96500$Cmol^{-1}$).

(i) Calculate the moles of bromine that reacted with 1 mole of phenylamine (3 ½ marks)

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(iii) Hence write equation of the reaction between bromine and phenylamine. Name the product (1 ½ marks)

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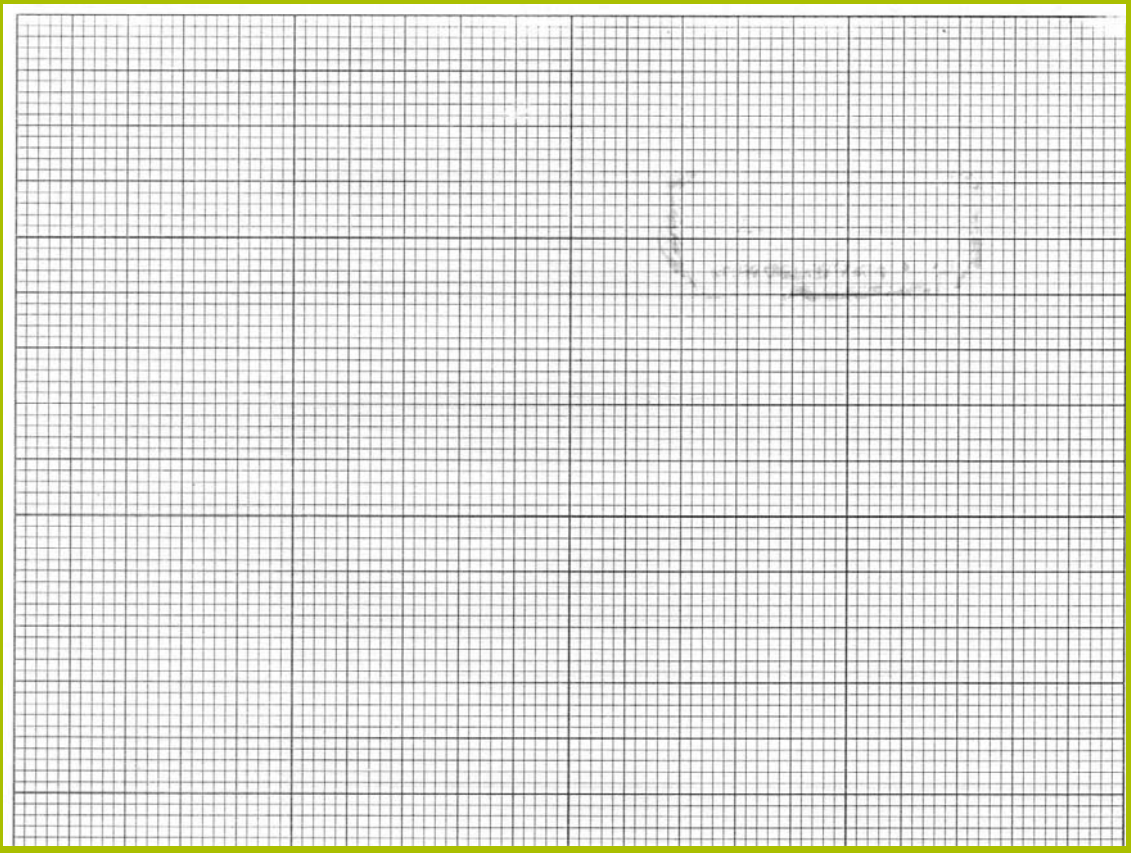
13. The table below gives data obtained when 100cm^3 of propanoic acid was titrated with 1.0M sodium hydroxide solution.

Volume of 1M NaOH added/ cm^3	0.0	1.0	5.0	9.0	10.5	11.0	15.0
pH of solution	2.94	3.92	4.87	5.82	11.70	12.00	12.70

(a) (i) Plot a graph of pH against volume of 1M sodium hydroxide (3marks)



(ii) Using the graph determine the pH and volume 1.0M sodium hydroxide used at equivalent point (1mark)

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(iii) Name the suitable indicator that can be used for the titration (½ mark)

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(b) Explain the shape of the graph.

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14. The table below shows formulae of oxides of silicon, Aluminium and phosphorus. (Indicate the chemical nature, bonding type and the structure adopted by the oxide)

Oxide	Chemical nature	Bonding	Structure
SiO_2			

Al_2O_3			
P_4O_{10}			

(c) Write equations of reaction to illustrate the chemical nature of

(i) P_4O_{10}

Equation

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(ii) Al_2O_3

Equation

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15 (a) Define the term "Phase" (1mark)

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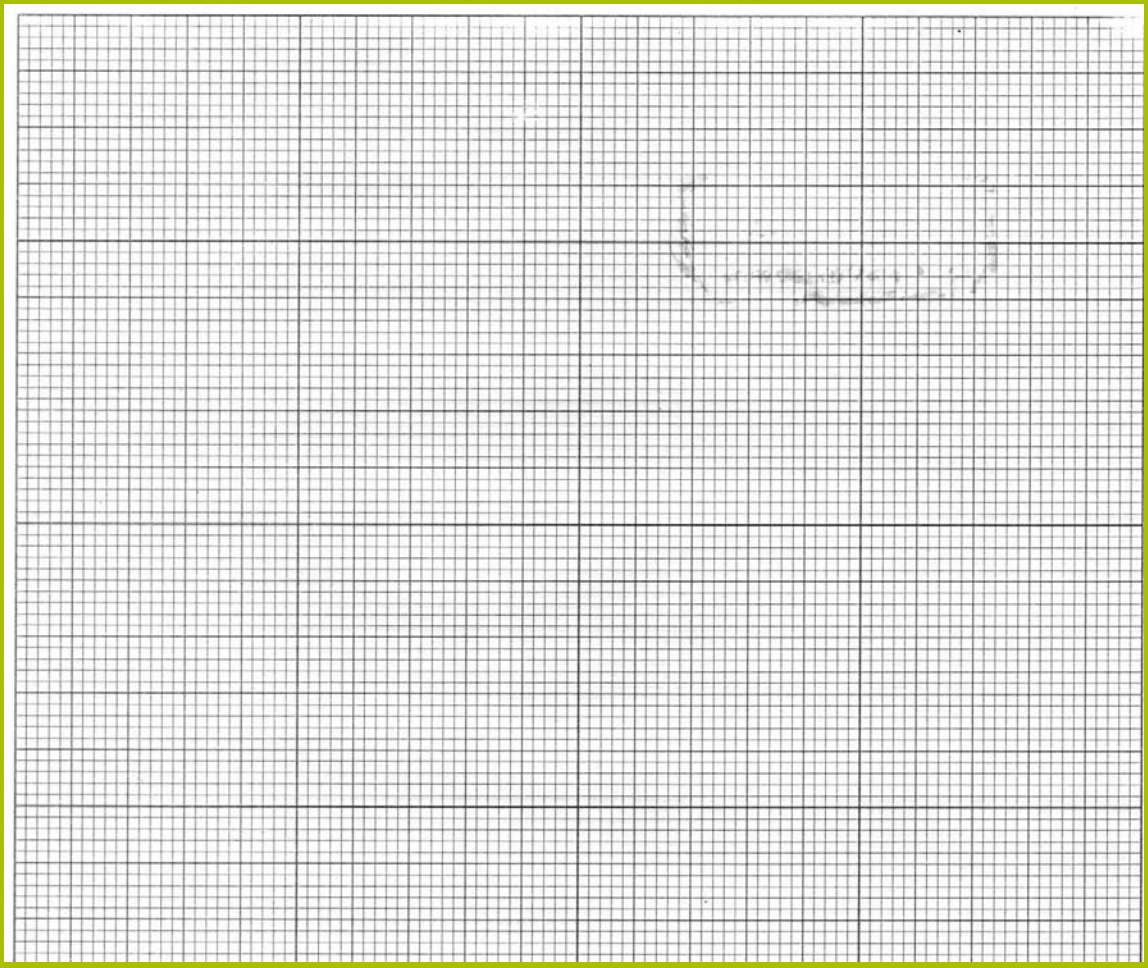
(b) The melting points of various composition of Naphthalene-biphenyl system are given below:

Mole fraction of Naphthaleine	0.800	0.625	0.275	0.125
Melting points/^{0}C	72.6	58.0	56.0	64.5

Naphthalene-biphenyl system form a eutectic mixture of composition of 0.47 mole fraction of naphthalene at temperature of 41.0^{0}C

(i) Plot a phase diagram for naphthalene-biphenyl system and label all regions. Melting point pure Naphthalene = 80^{0}C and mpt. Of biphenyl = 71^{0}C) (5marks)



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(ii) Describe what happens when a mixture containing 0.70 mole fraction of biphenyl is Cooled. (2marks)

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(c) State one application of eutectic mixture (½ mark)

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16. 3.70g of an organic compound Q containing carbon, hydrogen and oxygen was exploded in excess oxygen, 4.50g of water and 6.48dm^3 of gaseous substance were passed through sodium hydroxide solution, 2.0dm^3 of oxygen was found unreacted. (All volumes of gaseous substances were measured at stp).

(a) (i) Determine the empirical formula of Q: (4marks)

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(iii) If the vapor density of Q is 37, determine the molecular formula of Q (1½ marks)

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(d) Q reacts with a mixture of sodium hydroxide and iodine solution to give a yellow precipitate

(i) Identify Q (1mark)

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(ii) Name the reagent(s) used to confirm the functional group in Q. (½ marks)

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17. (a) Explain what is meant by the term "salt hydrolysis" (1½ marks)

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(b) Sodium sulphide undergoes hydrolysis. Write the

(i) equation for hydrolysis of sodium sulphide

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(iii) expression for hydrolysis constant (K_h), for sodium sulphide.

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(c)(i) Calculate the pH of solution containing 3.9gdm^{-3} of sodium sulphide (Hydrolysis constant at 25^{0}C of sodium sulphide = 1.25 x 10^{-10} moldm^{-3}) (4marks)

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(iv) State whether the resultant solution in (a)(i) is basic, neutral or acid (Give a reason for your answer) (1marks)

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Exam 2

PAPER 1

DURATION: 2 HOUR 45 MINUTES

INSTRUCTIONS TO CANDIDATES

Attempt All questions

1. (a) Name three radiations emitted by radioisotopes (1 ½ marks)

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(b) What is meant by the following terms:

(i) Decay constant. (1 mark)

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(ii) Half life (1mark)

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(c) The half-life for $^{223}_{88}R$ is 1620 years. Calculate the time taken for 90% of radium to disintegrate. (2 ½ mark)

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2.(a) What is meant by the term first electron affinity. (1mark)

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(b) The first electron affinities of some elements of period 3 are given below

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

(i) State how the electron affinities vary (1mark)

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(ii) Explain your answer in (i) (3marks)

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3. Complete the following reactions and name the main product.

(a) $CH_3CH_2COOH \xrightarrow[\text{heat}]{\text{Soda lime}}$ (2marks)

(b) CaC_2 (s) + H2O(l) $\longrightarrow$ (2marks)

(c) $CH_3C{\equiv}CH \xrightarrow[\text{Lindlar's catalyst}]{H_2}$ (2marks)

4. (a) What is meant by the term boiling point elevation constant . (1marks)

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(b) (i) The boiling point of benzene under certain pressure condition is 80.0^0C. Calculate the boiling point of a solution containing 5g of 2,4,6-trinitrophenol ($HOC_6H_2(NO_2)_3$ in 100g of benzene under these pressure conditions. Kb = 2.6^0C per 1000g of benzene) (3mks)

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(iii) State any three assumptions made in the calculation (1 ½ mark)

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5. (a) When prop-1-ene was reacted with hydrogen chloride in the presence of a peroxide 1-chloropropane is formed but when the reaction occurs in absence of a peroxide, 2-chloropropane is the main product. Write the mechanisms leading to the formation of the two products.

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(b) Explain why the products are different in (a) (2marks)

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. 6 State what's observed and write equation for the reactions when

(a) Dilute sodium hydroxide is added drop wise to a solution of chromium (III) sulphate (3mks)

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(b) Potassium iodide is added to aqueous copper (II) sulphate (2 ½ marks)

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7 (a) (i) Explain what is meant by the term electronic configuration; (01mark)

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(ii) State two deductions that can be made from electronic configurations (2marks)

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(iv) Write electronic configuration of copper (Cu atomic number 29) (2marks)

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8. Name one reagent(s) that can be used to differentiate between the following species. In each case state what is observed if each species is separately treated with the reagent.

(a) $H_2C=CH_2$ and $HC\equiv CH$

Reagent ……

Observations

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(b) Al^{3+} and Pb^{2+}

Reagent ……

Observations

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9. $100cm^3$ of concentrated hydrochloric acid were diluted to $1dm^3$ with distilled water. $26.8cm^3$ of the diluted solution required $25cm^3$ of 0.5M sodium carbonate solution, with methyl orange indicator for complete neutralization. Calculate the molar concentration of the concentrated hydrochloric acid. (3 marks)

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10. (a) Explain what is meant by the term colligative property. (2marks)

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(c) 0.72g of a compound M was dissolved in 80g of water and the resultant solution had a freezing point of -0.14^0C. When 2.9g of the same compound was dissolved in 111g of benzene the freezing point was depressed by 0.6^0C.

(K_f for water =1.86^{0}Cmol^{-1}kg^{-1} and K_f for benzene is 5.5^{0}Cmol^{-1}kg^{-1})

(i) Calculate the apparent molecular mass of M in

Water (2 ½ mark)

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Benzene (2 ½ marks)

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(ii)Explain why the molecular mass of M differs in the solvents. (2 mark)

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S6 CHEMISTRY

Exam 3

PAPER 1

DURATION: 2 HOUR 45 MINUTES

INSTRUCTIONS

Attempt all questions in Section A and only six in Section B.

SECTION A

1. (a) Explain why an azeotrope is a mixture and not a compound

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(b) Name three methods for separating azeotropic mixtures

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(b) Naphthalene ($C_{10}H_8$) distils in steam at 98.3^0C under a pressure of 753mmHg. The vapor pressure of water at this temperature is 715mmHg. Calculate the percentage by mass of Naphthalene in the distillate.

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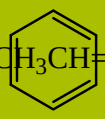
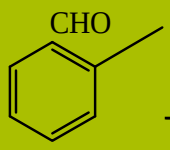
2. (a) complete the following equations and name the major product.

(i) +  $CH_3CH{=}CH_2$ $\xrightarrow[AlCl_3]{HCl}$

Name of the product .....

(i) 

$\xrightarrow{PCl_5}$

Name of the product .....

(b) Write the mechanism for the reaction in a (i)

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3. (a) State three properties of beta particles.

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(b) Complete the following nuclear transformations

(i) $^{39}_{94}P + ^{1}_{0} \rightarrow ^{2}_{34}S + ^{86}_{60}N + _____$

(ii) $^{35}_{96}C + ^{4}_{2}H \rightarrow _____$

(iii) $^{35}_{92}U + ^{1}_{0}n \rightarrow ^{148}_{57}L + _ + 3^{1}_{0}$

(c) Francium isotope ($^{223}_{87}Fr$) emits beta particles. the rate of emission reduces from 14.0 to 7.5 counter in 80 second. Calculate the half life of isotopes.

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4. (a) Draw the structures and name the shapes of the following species

Species	Structure	shape
HCO_3^-		
NO_2^-		
SO_3^{2-}		

(b) Explain why the nitrite ion (NO_2^-) adopts the shape you have named in (a)

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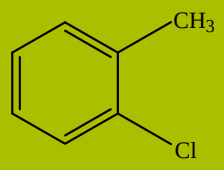
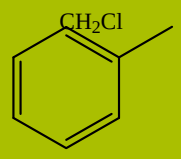
5. Name the reagent(s) that can be used to distinguish between the following compounds. In each case state what would be observed when each compound is separately treated with the reagent.

(a) 

and 

Reagents ……

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Observations(s)

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(b) CH_3COCH_3 and CH_3CH_2CHO

Reagents ……

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Observations(s)

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6. The graph below was obtained when nitric acid was gradually added to 50cm^3 of 0.72M potassium hydroxide in a calorimeter of negligible heat capacity

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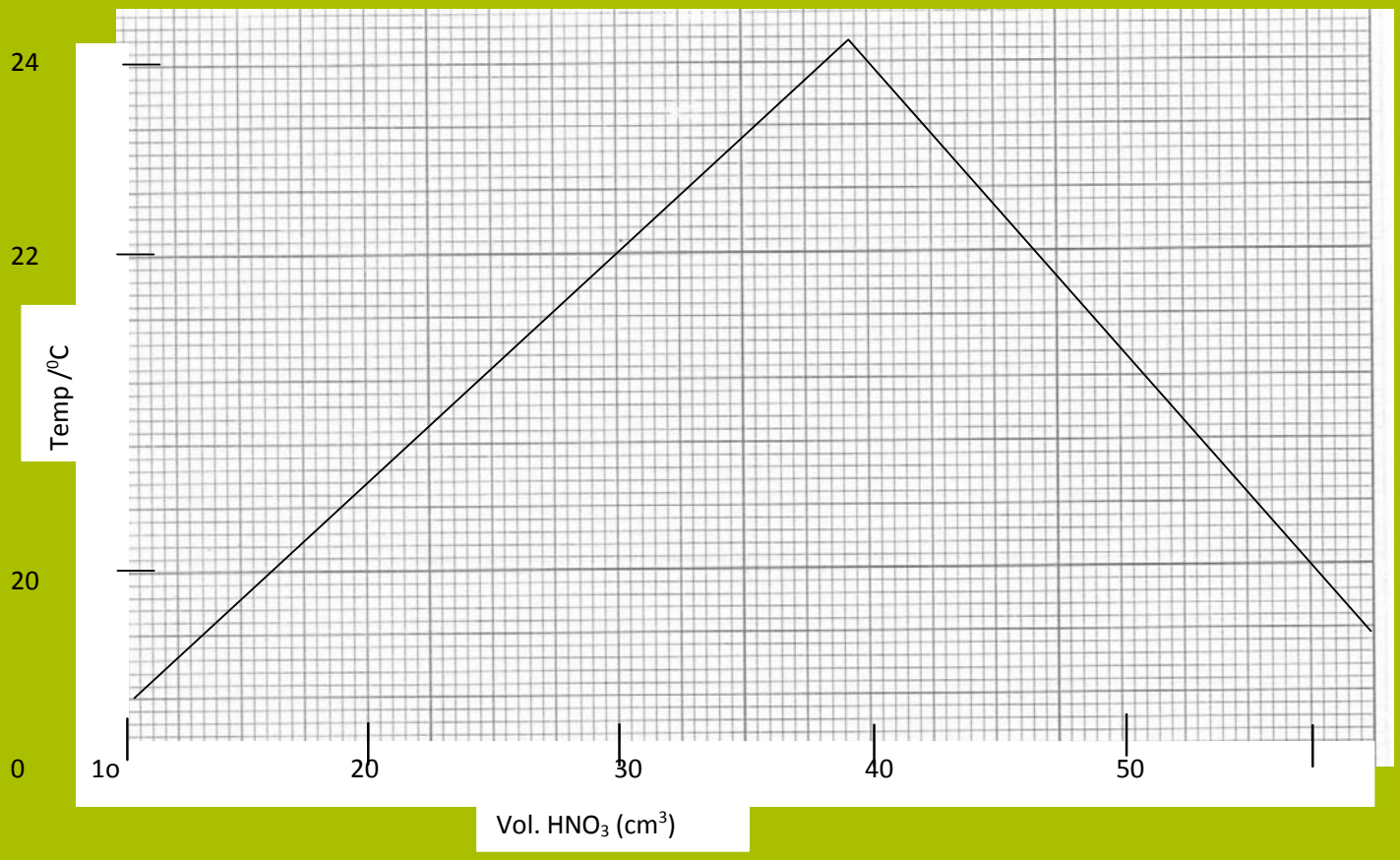

(a) Determine the volume of nitric acid required to neutralize potassium hydroxide?

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(b) Calculate

(i) Molarity of nitric acid

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(ii) Heat of neutralization of nitric acid by potassium hydroxide (Density of solution = 1.0gcm^3)

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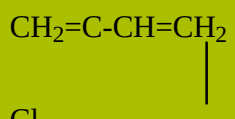
7. (a) A synthetic rubber, Z, was made from (n) monomers with structure



(i) State the condition for the reaction

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(ii) Write the equation leading the formation of Z.

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(b) Name the type reaction in a (i).

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(c) A solution containing 5.0g of Z in 200cm^3 of benzene is found to have an osmotic pressure of 34kPa at 17^{0}C. Calculate the:

(i) Molar mass of Z

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(ii) Number of moles of monomers

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8. (a) State Raoult's law of relative lowering of vapour pressure.

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(b) (i) Calculate the vapour pressure of a solution containing 18g of glucose ($C_6H_{12}O_6$) in 50g of water at 60^{0}C. (vapour pressure of water at 60^{0}C is 150mmHg.)

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(ii) State any assumptions made in (b)(i)

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9. (a) State three properties in which boron resembles silicon (1 ½ mark)

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(b) Write equation(s) for the reaction of the chloride of boron and silicon with water (3marks)

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SECTION B

Attempt any six questions from this section

10. Bauxite is the principal ore used for the extraction of aluminium.

(a) (i) Write the formula of bauxite. (½ mark)

…… Name **two** impurities in bauxite (1mark)

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(b) Briefly explain how pure aluminium can be obtained from bauxite.
(Include appropriate equations where necessary) (3marks)

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…… Sodium carbonate solution was added to an aqueous solution of aluminium chloride

(i) State what was observed (1mark)

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(ii) Write equation of the reaction that took place (1 ½ mark)

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11. (a) State three reasons why fluorine differs in some of its properties from the rest of group (VII) elements. (3marks)

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(b) Write equation for ionization of hydrogen fluoride in aqueous solution that are

(i) Dilute (1 ½ marks)

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(ii) Concentrated (1 ½ marks)

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(c) Explain why hydrogen fluoride is a weaker acid than hydrogen chloride (3marks)

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12. (a) State three characteristics of a chemical equilibrium

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(b) Hyddrogen and iodine react according to the following equations

$H_2(g) + I_2(g) \rightleftharpoons 2HI(aq)$

Write the expression for the equilibrium constant Kc.

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(c) 0.5 molar quantities of hydrogen and iodine were sealed in a glass bulb at445^{0}C until equilibrium was reached. The glass bulb was then rapidly cooled and broken under alkali.

(i) Explain why the glass bulb was rapidly cooled and broken under alkalis.

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…… The equilibrium mixture was found to contain 0.78moles of hydrogen iodide. Calculate the value of the equilibrium constant, Kc for the reaction at 445^{0}C.

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(d) State what would happen to the position of equilibrium of the reaction in (b) when

(i) Sodium thiosulphate solution is added to the equilibrium mixture.

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(ii) Argon gas is added at constant volume.

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13. (a) A compound Z contain 19.1% nitrogen, 43.6% oxygen and rest manganese.

(i) Calculate the empirical formula of Z.

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(ii) 10g of Z in 1000g of water lowered the freezing point by 0.127^0C. Calculate the molecular formula of Z . (kf for water is $1.86^0Cmol^{-1}kg^{-1}$) .

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(b) When Z was strongly heated brown fumes were given off. Z dissolved in water to form a pink solution which decolorizes acidified potassium permanganate (VII). Identify Z.

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(c) State what would be observed and write equation(s) for the reaction(s) that took place in the reaction in

13

(b) when:

(i) Concentrated nitric acid and lead (IV) oxide was added and the mixture boiled.

Observation

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…… Equation

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(ii) Sodium carbonate solution was added

Observation

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(iii) Equation

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14. Complete the following equations and in each case write acceptable mechanism of the reaction.

(3marks each)

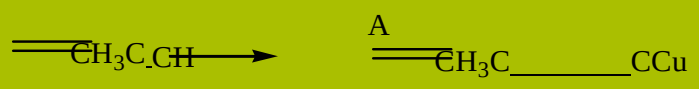
(a) $CH_3CH_2CHO + NaHSO_3 \xrightarrow{H^+}$

14

(b)

(c) Identify condition and reagent A and product B in the following equation

15



16

$(CH_3)_2CHCl$ B $\longrightarrow$

Reagent A …… Product B

……..

15. Show how the following conversions can be attained. In each case indicate the reagent and conditions for the reaction. (3marks each)

(a)

(b)

(c) $(CH_3)_2CO$ from CH_3CH_2OH

16. (a) The solubility of lead (II) iodide is 0.122g in 100cm^3 of water at 40^{0}C.

(i) Write equation for the solubility of lead (II) iodide in water.

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(ii) Write expression for the solubility product of lead (II) iodide.

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(iii) Calculate the solubility product of lead (II) iodide.

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(c) 50cm^3 of 0.001M lead (II) nitrate was mixed with 50cm^3 of 0.001M potassium iodide. Deduce whether lead (II) iodide will be precipitated or not. Show your working.

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17. (a) State factors that can affect standard electrode potential of an element.

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(b) The standard electrode potential $M^{2+}(aq)/M(s)$ for group II elements are given in the table below:

Element	Be	Mg	Ca	Sr	Ba
S.E.P $M^{2+}(aq)/M(s)$	-1.85	-2.37	-2.87	-2.89	-2.91

(i) State and explain the trend in the variation of standard electrode potential

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(ii) Explain why the values of standard electrode potentials are negative.

18

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(c) Electrode potential for some cells are given below

Half cell	E^0/V
$Pt(s)/SO_4^{2-}, SO_3^{2-}$	-0.90
$Cu^{2+}(aq), Cu(s)$	+0.34

(i) Write the equation of reaction that takes place at the Anode

…….

Cathode

…… Overall equation

…….

(ii) Calculate the emf of the cell.

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(iii) State whether the reaction in (a)(ii) above is feasible or not. Give a reason for your answer.

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END

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S6 CHEMISTRY

Exam 4

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions:
- Attempt all questions in section A and six questions in section B
- All questions are to be answered in the spaces provided.

SECTION A:
Attempt all questions in this section .

1. The standard electrode potential E of lead and magnesium are shown below

	E^{θ} /Volts
$Pb^{2+} + 2e^{-} \longrightarrow Pb$	– 0.13
$Mg^{2+} + 2e^{-} \longrightarrow Mg$	– 2.40

(a) Write the cell convention for the cell that can be formed (1m)
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……

(b) Write the equation for the
(i) reaction taking place at each electrode (2m)
……
……
……
……
(ii) overall reaction (1m)
……
……

(c) Calculate the e.m.f of the cell (1m)
……
……

2. Complete the following equations and in each case write a mechanism for the reaction

(a) $H_3CH_2CH_2OH \xrightarrow[180^oC]{\text{Conc. } H_3PQ_4}$ (3m)

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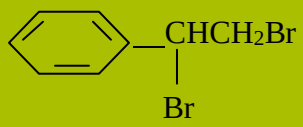
(b) 

$\xrightarrow[\text{heat}]{\text{EtO}^-\text{/Et OH}}$ (2)

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3. (a) (i) What is meant by the term ionisation energy of an element? (2)

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(ii) Write an equation to show the first ionisation of magnesium (1 ½)

(b) The second and third ionisation energies of magnesium are 1450 $Kjmol^{-1}$ and 7730 $Kjmol^{-1}$ respectively. Give a reason for the large difference between the second and the third ionisation energies of magnesium. (2)

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4. Name one reagent that can be used to distinguish between each of the following pairs of compounds and state what would be observed in each case if the reagents reacted with components

(a)

and

(3)

Reagent

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Observation

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(b) $CH_3CH_2CH_2CH_2OH$ and $(CH_3)_3$ COH. (3 m)

Reagent

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Observation

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5. The Ostotic pressure of a solution containing 1.4g of a polymer x per $100cm^3$ of a solution is 1200 Nm^{-2} at 25^oC.

(a) Calculate the relative molecular mass of x

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(b) Determine the number of monomers in x (The molecular mass of the monomer of x is 28) (1m)

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6. (a) One of the properties of transition metals complex ion formation

(i) Define the term 'Complex ion' (2m)

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(ii) Explain why transition metals form many complexes (2m)

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(b) $Fe(CN)_6^{3-}$ and $(CuCl_4)^{2-}$ are complexes formed by iron and copper respectively. State:

(i) the oxidation state of

iron

……

copper

……

(1m)

(ii) the co-ordination number of

iron

……

copper

……

(1m)

7. 1.00dm^3 of aqueous solution contains 5.00g of butanoic acid. Calculate the mass of butanoic acid extracted when the solution was shaken:

(a) with 50cm^3 of a solvent R. (The distribution coefficient K_D of butanoic acid between R and water is 40) (2 ½)

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(b) Twice with 25cm^3 of solvent R (2)

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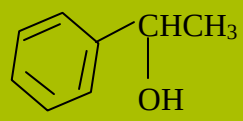
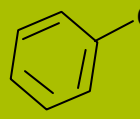
8. Name one reagent that can be used to distinguish between each of the following pairs of compounds and state what would be observed in each case if the reagent is reacted with the compounds

(a) 

and 

(2 ½ m)

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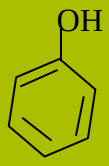
(b) 

and $CH_3CH_2CH_2CH_2OH$

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9. When 14.2cm^3 of a hydrocarbon Q, of molecular mass 58 was exploded with excess oxygen and cooled to room temperature, the volume of the residual gas was 694cm^3. After addition of concentrated potassium hydroxide, the volume decreased to 126cm^3

   (a) Determine the molecular formula of Q (3m)

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   (b) Write the names and the structural formulae of all isomers of Q (2m)

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   ……

SECTION B:

Answer only six questions in this section

10. (a) An organic compound A contains carbon, hydrogen and oxygen only. On combustion, 0.463g of A gave 1.1g carbondioxide and 0.563g of water. Determine the empirical formula of A (3 ½)

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(b) When vaporised 0.1g of A occupies 54.5cm^3 at 208°C and 98.3 Kpa. Determine the molecular formula (2 ½)

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(c) A reacts with sodium metal with evolution of a gas. Write the structural formula of all possible isomers of A. (2)

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(d) A reacts with anhydrous zinc chloride and concentrated hydrochloric acid to give a cloudy solution in about 5 minutes

(i) identify A

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(ii) show how A could be synthesised from but 2 – ene (½)

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11. The solubility product, Ksp, of zinc hydroxide is 4.5 x 10^{-17} at 25ºC.

(a) Write an expression for the solubility of zinc hydroxide

(b) Determine the concentration in moles per litre of zinc and hydroxide ions in a saturated solution of zinc hydroxide at 25ºC. (3)

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(c) State how the solubility of zinc hydroxide would change if its saturated solution is treated separately with

(i) aqueous zinc sulphate (1)

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(ii) ammonia (1)

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(d) Briefly explain your answers in (c) (3)

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12. (a) Name a reagent that can be used to distinguish between the following pairs of ions. In each case, state what is observed if each ion is separately treated with the reagent.

(i) Ba^{2+} and Ca^{2+} (3)

Reagent

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Observation

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(ii) NO^{-} and NO_3^{-} (3)

Reagent

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Observation

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(b) Write ionic equations for the reaction between sodium hydroxide and

(i) BeO (1 ½)

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(ii) SiO_2 (1 ½)

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13. A compound, B has an empirical formula of C_3H_6O. Oxygen gas diffuses 1.345 times faster than B.

(a) (i) Determine the molecular formula of B (2)

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(ii) Write the structural formulae of all the possible isomers of B (1)

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(b) (i) Using equations, show how B can be formed from propene (2 ½)

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(ii) Write an equation for the reaction of B with sodium hydrogen sulphite and write the mechanism (2 ½)

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14. (a) Define the term a 'buffer solution'. (2)

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(b) Calculate the mass of sodium ethanoate that should be added to 1 litre of a 0.1M ethanoic acid solution in order to produce a solution of pH = 4.0

(ka for ethanoic acid = 1.8×10^{-5}) (5)

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(c) State what would happen to the pH of the solution in (b) if a small amount of the following were added

(i) sodium hydroxide solution

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(ii) hydrochloric acid

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(d) State one biological application of a buffer solution

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15. Compound Y, C_3H_6O reacts with 2,4 – dinitro phenyl hydrazine to give a yellow solid.

(a) Write the structural formulae and JUPAC names of all the isomers of Y

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(b) When Y is heated with Fehling's solution, a red precipitate is formed

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(c) Write a mechanism for the reaction that would take place between Y and hydroxylamine, NH_2OH (3)

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(d) Write equations to show how Y can be converted to an alkene (3)

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16. (a) An aqueous solution containing 7.2g of a non-cyclic substance Q in 250g of water freezes at 1– 0 .744ºC. The freezing point constant, K, for water is 1.86ºC mol^{-1} kg^{-1}

Calculate the molecular mass of Q (3)

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(b) If Q contains carbon, 66.7% hydrogen 11.1% and oxygen 22.2%;

(i) Calculate the simplest formula of Q (2)

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(ii) Determine the molecular formula of Q (1)

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(iii) Write the structures of all the possible isomers of Q (1 ½)

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(c) Q forms a yellow precipitate with phenylhydrozine and iodine solution in the presence of sodium hydroxide. Identify Q. (½)

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17. State what would be observed and write equations for the reactions that take place when the following compounds are reacted.

(a) Aqueous potassium dichromate (VI) with hydrogen sulphate (3)

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(b) Aqueous iron (III) chloride with sodium carbonate (3 ½)

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(c) Aqueous copper (II) sulphate with potassium iodide (2 ½)

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END

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S6 CHEMISTRY

Exam 6

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

1. Write a balanced overall ionic equation for the following reactions:

(a) $MnO_2(s) + HCl\ (aq) \longrightarrow MnCl_2\ (aq) + H_2O(l) + Cl_2(g)$

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(b) $KIO_3(aq) + HCl(aq) + KI(aq) \longrightarrow I_2(aq) + H_2O(l)$

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(c) $K_2Cr_2O_7(aq) + H^+(aq) + SO_2(g) \longrightarrow SO_4^{2-}(aq) + H_2O(l) + Cr^{3+}(aq)$

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2. The osmotic pressure of an aqueous solution of a non- electrolyte containing 5.43 gdm^{-3} of solution is 7.093 x $10^4 Nm^{-2}$ at 25^0C. Calculate the freezing point of solution. (Kf for water = 18.6^0C per $100gmol^{-1}$)

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3. (a) Define the term "disproportionation."

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(b) Write the ionic equation for the disproportionation of the following species.

(i) MnO_4^{2-} in acidic media.

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(ii) copper (I) in aqueous solution.

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(iii) hlorine in hot concentrated sodium hydroxide solution

4

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4. The following data was obtained for the reaction between hydrogen peroxide and iodine ions and hydrogen ions

Expt. No.	Concentration ($moldm^{-3}$)			Rate of reaction ($moldm^{-3}s^{-1}$)
	I-(aq) ion	H_2O_2(aq)	H+(aq) ions	
1	0.010	0.010	0.010	1.76×10^{-6}
2	0.010	0.030	0.010	5.25×10^{-6}
3	0.020	0.030	0.010	1.05×10^{-5}
4	0.020	0.030	0.020	1.05×10^{-5}

(i) State the order of reaction with respect to

H_2O_2

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I^-

……

……

H^+

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(ii) Write the rate equation for the reaction:

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(iii) Calculate the rate constant (K) for the reaction and indicate its units.

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5. Complete each of the following equations and write the accepted mechanism.

(i) $CH_3\text{-}CH_2\text{-}CHO \xrightarrow[10\text{-}20^0C]{KCN/\ dil\ H_2SO_4}$

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(ii) $CH_3CH{=}CHCH_3 \xrightarrow{HBr(g)}$ (2 ½ marks)

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6. (a) Define the term "standard enthalpy of atomization"

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6

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(b) Bond energies for some bonds are given below.

Bond	Bond energy
C-O	358
C-H	413
O-H	464

Calculate the standard enthalpy of atomization of methanol

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(d) Explain why ammonium nitrate is readily soluble in water even though the standard enthalpy of solution has a positive value.

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7. Name the reagent that can be used to distinguish between Co^{2+} and Mn^{2+} ions. State what is observed when the aqueous solution of each ion is separately treated with the reagent.

7

Reagent

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Observations:

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(b) Cobalt forms a complex of formula $Co(NH_3)n^{3+}3Cl^-$.

5 x 10^{-3} moles of a complex were heated in excess alkali and the ammonia liberated was absorbed in 50 cm^3 of dilute sulphuric acid of concentration 0.5M. The excess acid remaining after the absorption required 20.00cm^3 of 1M sodium hydroxide for complete neutralization. Calculate the value of N in the formula of the complex.

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8(a) Explain what is meant by the term "**condensation polymerization?"**

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(b) Nylon6,10 can be made by reacting 1,6-diaminohexanewith decane doiyl chloride $ClOC(CH_2)_8COCl$.

Write the structural formula of:

(i) 1.6-diaminohexane

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(ii) Nylon 6,10

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(c) State one use of nylon 6,10.

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9. Ammnonium carbamate (NH_4CONH_2) decomposes according to the following equation:

9

NH_4CONH_2 (s) $\rightleftharpoons$ $2NH_3(g) + CO_2(g)$ $+\Delta H^0$ ($kJmol^{-1}$)

(a) Write the expression for the equilibrium constant (Kp)

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(b) At equilibrium, the total pressure of the system is 0.36 atm. at 40^0C. Calculate the value of Kp for the reaction at 40^0C (indicate units).

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(c) State what happens to the Kp calculated in (a)(i) if

(i) More solid ammonium carbamate is added to the equilibrium mixture.

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(ii) The temperature is increased to 80^0C.

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SECTION B

10 Show how the following organic conversions can be effected. (Indicate suitable reagents and conditions of reaction's n each). 3marks each

10

(a) $(CH_3)_3COH$ from CH_3COCH_3

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(b) $H_2C_2O_4$ from $CH_2=CH_2$

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(c) CH_3NH_2 from CH_3COOH

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11

11. Explain the following observations

(a) Silicon and phosphorus are both covalent substances, but the melting of silicon is much higher than that of phosphorus. (3marks)

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(b) Magnesium oxide (MgO) has the same crystalline structure as sodium chloride (NaCl) but the lattice energy of MgO is more exothermic than that of NaCl. (3marks)

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(c) A concentrated solution of calcium chloride forms a precipitate with sodium hydroxide but no precipitate form with aqueous ammonia. (3marks)

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12

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12.(a) Phenylamine was mixed with concentrated hydrochloric acid and sodium nitrite at 0-5^{0}C. The resultant solution Y was then treated with a mixture of phenol in aqueous sodium hydroxide. State what is observed and write the equation of reaction that takes place between:

(i) Phenylamine and a mixture of concentrated hydrochloric acid and sodium nitrite.

Observation (½ mark)

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Equation: (1 ½ marks)

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(ii) Y and phenol in aqueous sodium hydroxide

Observation (½ mark)

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Equation: (1 ½ marks)

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(b) 20 cm^3 of 0.05M aqueous phenylamine was mixed with 50ccm^3 of 1M sodium bromide and electrolyzed at current of 0.2A. The first permanent bromine color was observed after 49.93 minutes; then electrolysis was stopped. (Faradays constant =96500$Cmol^{-1}$).

(i) Calculate the moles of bromine that reacted with 1 mole of phenylamine (3 ½ marks)

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(iii) Hence write equation of the reaction between bromine and phenylamine. Name the product (1 ½ marks)

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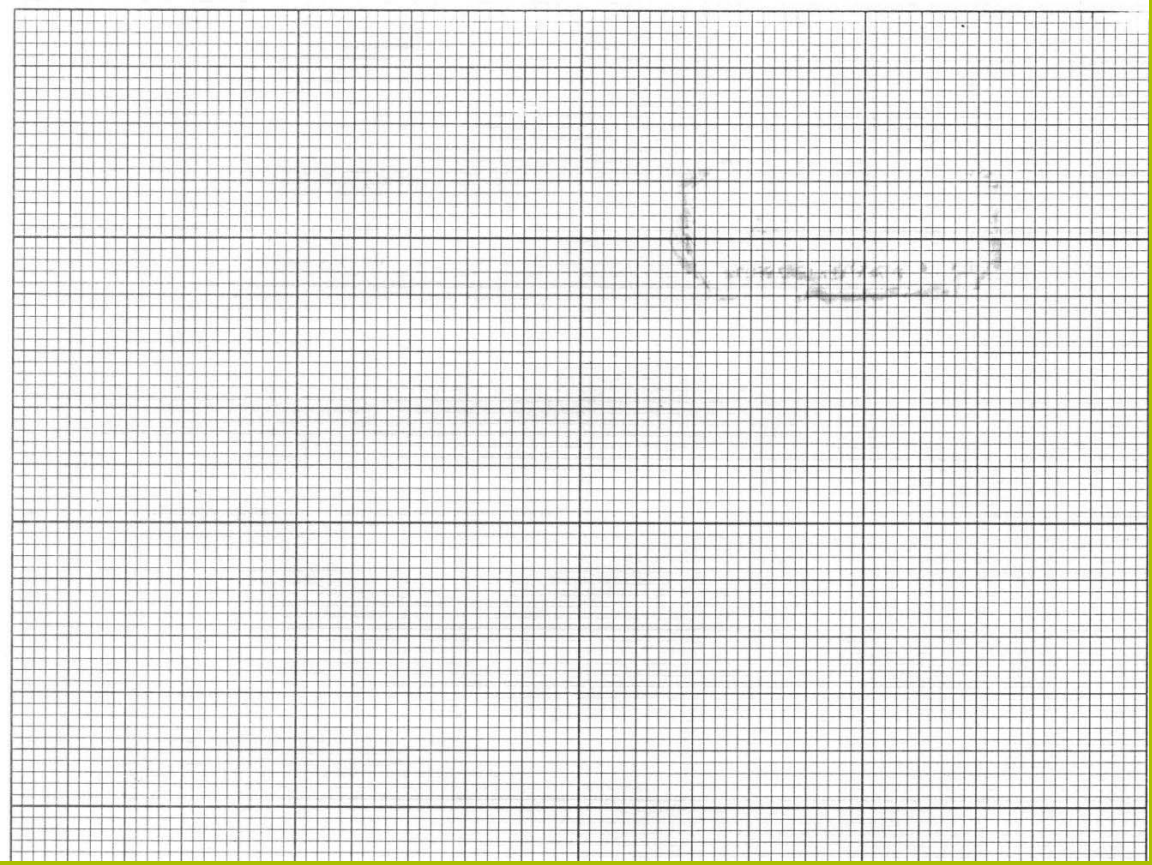
13. The table below gives data obtained when 100cm^3 of propanoic acid was titrated with 1.0M sodium hydroxide solution.

Volume of 1M NaOH added/ cm^3	0.0	1.0	5.0	9.0	10.5	11.0	15.0
pH of solution	2.94	3.92	4.87	5.82	11.70	12.00	12.70

(a) (i) Plot a graph of pH against volume of 1M sodium hydroxide (3marks)



(ii) Using the graph determine the pH and volume 1.0M sodium hydroxide used at equivalent point (1mark)

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……

(iii) Name the suitable indicator that can be used for the titration (½ mark)

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(b) Explain the shape of the graph.

15

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14. The table below shows formulae of oxides of silicon, Aluminium and phosphorus. (Indicate the chemical nature, bonding type and the structure adopted by the oxide)

Oxide	Chemical nature	Bonding	Structure
SiO_2			
Al_2O_3			
P_4O_{10}			

(c) Write equations of reaction to illustrate the chemical nature of

(i) P_4O_{10}

16

Equation

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……

(ii) Al_2O_3

Equation

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15 (a) Define the term "Phase" (1mark)

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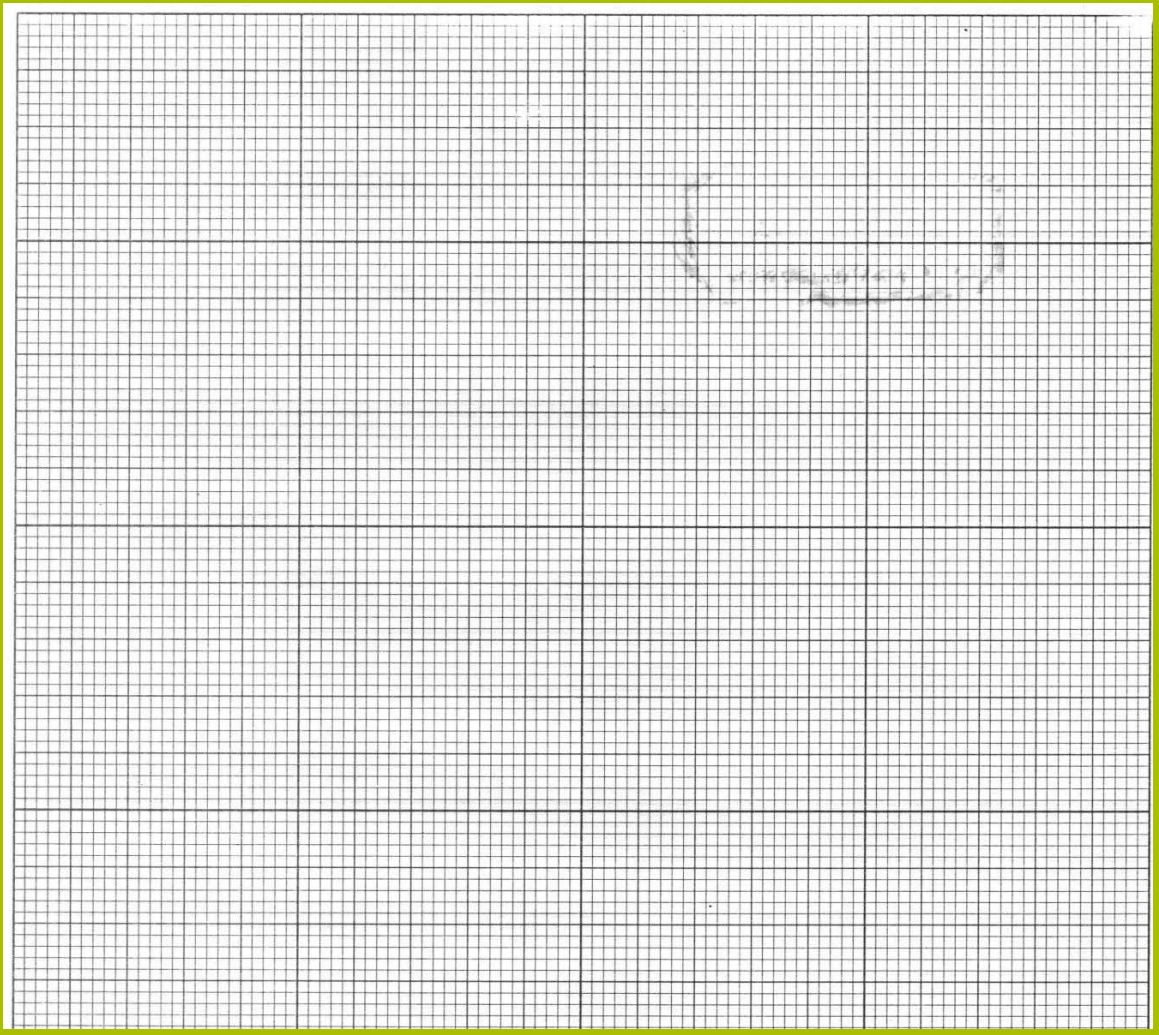
(b) The melting points of various composition of Naphthalene-biphenyl system are given below:

Mole fraction of Naphthaleine	0.800	0.625	0.275	0.125
Melting points/^{0}C	72.6	58.0	56.0	64.5

Naphthalene-biphenyl system form a eutectic mixture of composition of 0.47 mole fraction of naphthalene at temperature of 41.0^{0}C

(i) Plot a phase diagram for naphthalene-biphenyl system and label all regions. Melting point pure Naphthalene = 80^{0}C and mpt. Of biphenyl = 71^{0}C) (5marks)

17



(ii) Describe what happens when a mixture containing 0.70 mole fraction of biphenyl is Cooled. (2marks)

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(c) State one application of eutectic mixture (½ mark)

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16. 3.70g of an organic compound Q containing carbon, hydrogen and oxygen was exploded in excess oxygen, 4.50g of water and 6.48dm^3 of gaseous substance were passed through sodium hydroxide solution, 2.0dm^3 of oxygen was found unreacted. (All volumes of gaseous substances were measured at stp).

(a) (i) Determine the empirical formula of Q: (4marks)

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(iii) If the vapor density of Q is 37, determine the molecular formula of Q (1 ½ marks)

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(d) Q reacts with a mixture of sodium hydroxide and iodine solution to give a yellow precipitate

(i) Identify Q (1mark)

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(ii) Name the reagent(s) used to confirm the functional group in Q. (½ marks)

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17. (a) Explain what is meant by the term "salt hydrolysis" (1 ½ marks)

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(b) Sodium sulphide undergoes hydrolysis. Write the

(i) equation for hydrolysis of sodium sulphide

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(iii) expression for hydrolysis constant (K_h), for sodium sulphide.

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(c)(i) Calculate the pH of solution containing $3.9gdm^{-3}$ of sodium sulphide (Hydrolysis constant at 25^0C of sodium sulphide = 1.25×10^{-10} $moldm^{-3}$) (4marks)

20

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(iv) State whether the resultant solution in (a)(i) is basic, neutral or acid (Give a reason for your answer) (1marks)

……

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S6 CHEMISTRY

Exam 7

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. The standard reduction electrode potentials (E^{2}) for some half cells are given in the table below.

Half cell	Em(v)
$Fe^{3+}_{(aq)}$. $Fe^{2+}_{(aq)}$	+0.77
Sjs + H	+0.14

a) Write the

i) Cell rotation (lmk)

(ii) Equation of reaction that takes place at the anode and cathode (2mks)

Anode

Cathode

ii) Equation for the overall cell reaction. (1Yz mks)

(b) State whether the reaction is feasible or not and give a reason for your answer. (lmk)

2. (a) State what is observed and write equation of reaction in each case when the following compounds are mixed.

a) Methanoic acid and ammoniacal silver nitrate solution heated

Observation

Equation

.....

.....

2

(b) Benzoic acid and aqueous sodium bicarbonate solution.
Observation;

Equation;

c) Propanone and Brady's solution.

Observation;

Equation;

3. Calculate the boiling point of a solution formed by mixing 8g of glucose with 120g of water. (Kb for water= 5.2 °Cmor kg)

3

4. a) State three reasons for the diffeence in properties between fluorine and other group(VII) elements. (3mks)

.....

.....

.....

b) Write equation for the reaction that takes place between the following compou s.

i) Silicon (iv) oxide and hydrofluoric acid. (I) r:nks)

ii) Fluorine and water (1 ½ mks)

5. Complete the following reactions and write the accepted mechanism.

(a) Conc H_2SO_4 _____

(b) $CH_3-\overset{O}{\overset{\|}{C}}-CH_3$ Na_2SO_3 _____

6. State what would be observed and write equation(s) for the reaction(s) that would take pla ce i

(a) When aqueous sodium sulphite solution is added to acidified potassium manganate (vii) solutio

Observation.

Equation

(b) When aluminium powder is added to iron (iii) chloride.

Observation.

Equation.

7. a) Write the electronic configuration of
i) Nitrogen (lmk)

ii) Phosphorus (lmk)

b) Explain why nitrogen only forms {NCl_3) whereas phosphorus forms the chlorides PCl_3 and PCI5.

.....

c) Write equation(s) for the hydrolysis of phosphorus chlorides by water.

i) phosphorus chloride (3mks)

equation

.....

ii) phosphorus (III) chloride

5

equation

.....

8. (a) When $20cm^3$ of a hydrocarbon Z was exploded in $200cm^3$ of oxygen (excess), it completely burnt with a sooty flame. The volume of residual gas after cooling to room temperature was $160cm^3$. On addition of aqueous potassium hydroxide to the residual gas, the final volume of gas was $20cm^3$. Calculate the molecular formula of Z. (3mks)

(b) When Z was heated with alkaline potassium manganate (VII) solution forms a colourl ss solution which cooled in the presence of dilute sulphuric acid to form a crystalline solid P.

i) identify;

Z (lmk)

.....

p

(ii) Write equations to show how P is formed. (1Yz mks)

.....

9. (a) Explain why diffusion in solution is very much slower than in gases.

.....

.....

.....

(b) 141.4cm^3 of gas X diffused through a porous plug in the same time as it took 50cm^3 of oxygen to diffuse through the same plug under identical conditions.
Calculate the reactive molecular mass of X

SECTION B

Attempt only six questions in this section

10. State what is observed and write equation for the reaction that takes place when
    a) Potassium iodide is added to acidified hydrogen peroxide solution
    Observation;

    Equation;

    (b) Concentrated hydrochloric acid is added drop wise until in excess to aqueous solution containing cobalt {II) ions.
    Observation;

    Equation;

(c) Aqueous sodium hydroxide is added drop wise to aqueous solution containing beryllium (II) ions.

Observation;

.....

Equation;

.....

11. a) A compound Y contains mass of 22.86% oxygen, 8.57% hydrogen and the rest is carbon.

i) Calculate the empirical formula of Y. (2 mks)

ii) When 0.30g of Y is vaporized at 80°C and 700mmHg pressure, it occupied a volume of 134.77cm^3. Determine the molecular formula of Y. (3 mks)

b) Y forms a yellow precipitate with 2,4-dinitrophenyl-hydrazine and does not react with Tollen's reagent. (1mk)

c) Write equation for the formation of a yellow precipitate in (b). (2mks)

.....

.....

12. a) State three characteristics of chemical equilibrium. (1 ½ mks)

.....

.....

c) Phosphorus (V) chloride when heated decomposed according to the following equatidn.

PCis(g) ., PCl_3!sl + Cl_2!sl

i) Write the expression for the equilibrium constant KC. (1mk)

.....

ii) When 1mole of phosphorus (V) chloride was heated in a closed vessel at 350°C, the equilibrium mixture was found to contain 38.4% of chlorine. Calculate the equilibrium constant Kc at 350°C. (3Y2mks)

iii) the equilibrium constant of 250°C is 1.54. State whether the reaction is exoth fmk'o endothermic. Give a reason for your answer. (1Y2mks)

.....

c) State what would happen to the concentration of chlorine if the pressure is the I(essel was decreased while the temperature is maintained at 350°C. Give a reason for your answer. (1 mks)

13. Write equation to show the following conversions can be effected. {Include conditions for tHe reactions.) (3mk',s)

a) Benzoic acid to phenylamine

b) Ethene to Butan-z-ol

c) I-chloro ethane to ethanamide

14. a) i) Explain what is meant by an acid-base indicator. (1mk)

ii) Explain why titration experiments only one or two drops of are used (1mk)

b) The table gives data obtained when 100cm^3 of propanoic acid was titrated with I.OM sodium hydroxide solution.

Volume of NaoH{1M) added (em^3)	0.0	1.0	5.0	9.0	9.5	10.5	11.0	15.0
PH of solution	2.94	3.92	4.87	5.82	6.15	11.70	12.00	12.70

i) Draw a graph of PH against the volume o sodium hydroxide. (2. mks)

ii) Explain the shape of the graph, you have drawn in b(i). (2 Y2 mks)

iii) Determine the pH of the solution at equivalence point. (1mk)

iv) Which of following indicators would be sutable for the titration? Give a reason for your answer.

Indicator	Methyl red	Bromothymol blue	Phenol red
PH range	4.2 – 6.3	6.0-7.6	6.8-8.4.

Indicator;..... . (½ mk)

Reason (½ mk)

15. a) Compare the following properties of group (U) and group (I) elements. In each case give a reason for your answer. (i"}hiiksf ·

i) first ionization energy

11

i) melting points

iii) electro positivity

b) The decomposition temperatures of the carbonates of group (II) elelemnts are given below

Carbonate	$MgCO_3$	$CaCO_3$	$SrCO_3$	$BaCO_3$
Decomposition temperature (^0C)	404	826	1098	1370

i) State how the decomposition temperatures vary. (Hhk)

ii) Explain your answer in b(i). {3 *Yl* hiks)

16. Name a reagent that can be used to differentiate between the following pairs of compounds. State what would be observed if each compound is treated with the regent you have narned.
Name of reagent (s)

@ and 0

Observation(s)

12

.....

(b) $H-\overset{O}{\overset{||}{C}}-OH$ and $HO-\overset{O}{\overset{||}{C}}-\overset{O}{\overset{||}{C}}-OH$

Name of reagent

.....

.....

Observation(s)

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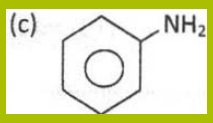
(c) 

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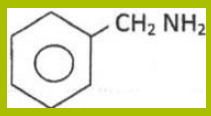

Name of reagent;

Observations

.....

17. Ethanol can be produced by fermentation of molasses.

a) i) Name two other raw materials from which ethanol can be produced by fermentation.

iii) Write equations to show how crude ethanol can be obtained from the materials named above. (3mks)

.....

b) Describe how 100% (absolute) ethanol can be produced form crude ethanoFprpouced in (a) (ii). r2mk.s)

c) Write equation(s) to show each of the following compounds could be obtained frt;im ethanol.

i) polyethene (1Yz mk }

iii) ethoxyethane (1 ½ mks)

END

525/1

S6 CHEMISTRY

Exam 8

PAPER 1

DURATION: 2 HOUR 45 MINUTES

For Marking guide contact and consultations: Dr. Bbosa Science 0776 802709.

Attempt all numbers

1. Complete the following organic reaction and name the major organic products.

(a) $CH_3CH{=}CH_2 \xrightarrow{MnO_4^-/OH^-}$ ..... (1 ½)

Name .....

(b) OH $\xrightarrow{Cr_2O_7^-/H^+,\ heat}$ ..... (1 ½)

Name .....

(c) $(CH_3)_2CHCOONa + NaOH(s) \xrightarrow{CaO,\ heat}$ ..... (1 ½)

Name .....

(d)

2. (a) Explain what is meant by the term steam distillation?

.....

.....

(b) A mixture of nitrobenzene and distilled water boiled at 99^0C at one atmosphere. Calculate the percentage composition of the distillate. The saturate vapor pressure of water at 99^0C is 723mmHg.

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……

3. Draw the structures and namethe shapes of the following species.

Structure Name

(a) HCO_3^-

(b) Cl_2O^-

(c) SO_3^{2-}

4. State what is observed and write equation that occur when

(a) Dilute sulphuric acid is added to aqueous solution of potassium manganate (VI).

Observation……

Equation

……
……

(b) Bromine water is added to hydroxylbenzene

Observation……

Equation

……
……

5. (a) state Raoult's law.

2 Mg

……
……

(c) At 50^0C an aqueous solution of carbamide (CH_3CONH_2) of concentration 60.93gdm-3 has a vapor pressure of $12100Nm^{-2}$. Determine the vapor pressure of water at this temperature. (4marks)

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……

6. Complete the following organic reactions and outline the accepted mechanism.

(a) NH_2 + CH_3COCl ⟶

(b) CH_3CH_2Br + $CH_3C\equiv CH$ $\xrightarrow{Na/Liq.\ NH_3}$

7. (a) Write electronic configuration of copper (I) and copper (II) ions

(i) Copper (I) ion …….

(ii) Copper (II) ion …….

(b) The electrode potentials for the following reactions are given below

	E^0/V
$Cu^+(aq) + e \longrightarrow Cu(s)$	0.52
$Cu^{2+}(aq) + e \longrightarrow Cu^+(aq)$	0.52

Use the information given above to calculate the e.m.f value for the reaction given below

$2Cu+(aq) \longrightarrow Cu(s) + Cu^{2+}(aq)$

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……

(c) What can you deduce from your answer

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……

8. Write equations for the reactions that occur between each of the following compounds with hot concentrated sodium hydroxide solution
   (a) Chromium (III) oxide

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……

   (b) Fluorine

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……

   (c) Lead (IV) oxide

……
……

9. Define the term buffer solution

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……

   (c) A 0.1M solution of sodium hydroxide was added to $50cm^3$
   (d) of 0.1M ethanoic acid until when the acid is half way neutralized. Determine the pH of the resultant solution formed. (Ka for ethanoic acid is 1.8×10^{-5})

   (d) State one application of a buffer.

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SECTION B (54MARKS)

(Attempt six questions only)

10. (a) during manufacture of nitric acid, ammonia is catalytically oxidized with air in presence of a catalyst R.

(i) Name the catalyst R

(ii) Write equation for the reaction in (a)(i) above

(b) State other conditions applied in the reaction above

(c) Write equation to show how nitric acid is formed from the product (s) in (a) above

(d) A few drops of concentrate nitric acid were added to aqueous solution of manganese (II) salt in presence of solid Q. A purple was formed.

(i) Name solid Q

(ii) Write equation for the reaction

11. Name the reagent(s) that can be used to distinguish between the following pairs of compounds. In each case state the observations made.
    (a) Phenylethanol and 2-phenylethanol

    (b) 2- aminopropane and dimethylamine

    (c) Ethanol and methanol
12. (a)Explain in what is meant by the term anomalous behavior

(b) State any two anomalous behavior of fluorine as compared to other group (VII) elements. Use equations to illustrate your answer.

(c) Give reasons(s) why fluorine exhibit the type of behaviors mentioned in (b) above.

(d) The acid strength of the following acids are in order: $HClO_2 < HClO_3 < HClO_4$. Explain your answer.

13. (a) Explain what is meant by each of the following terms.

(i) Order of the reaction

(ii) Molecularity of the reaction

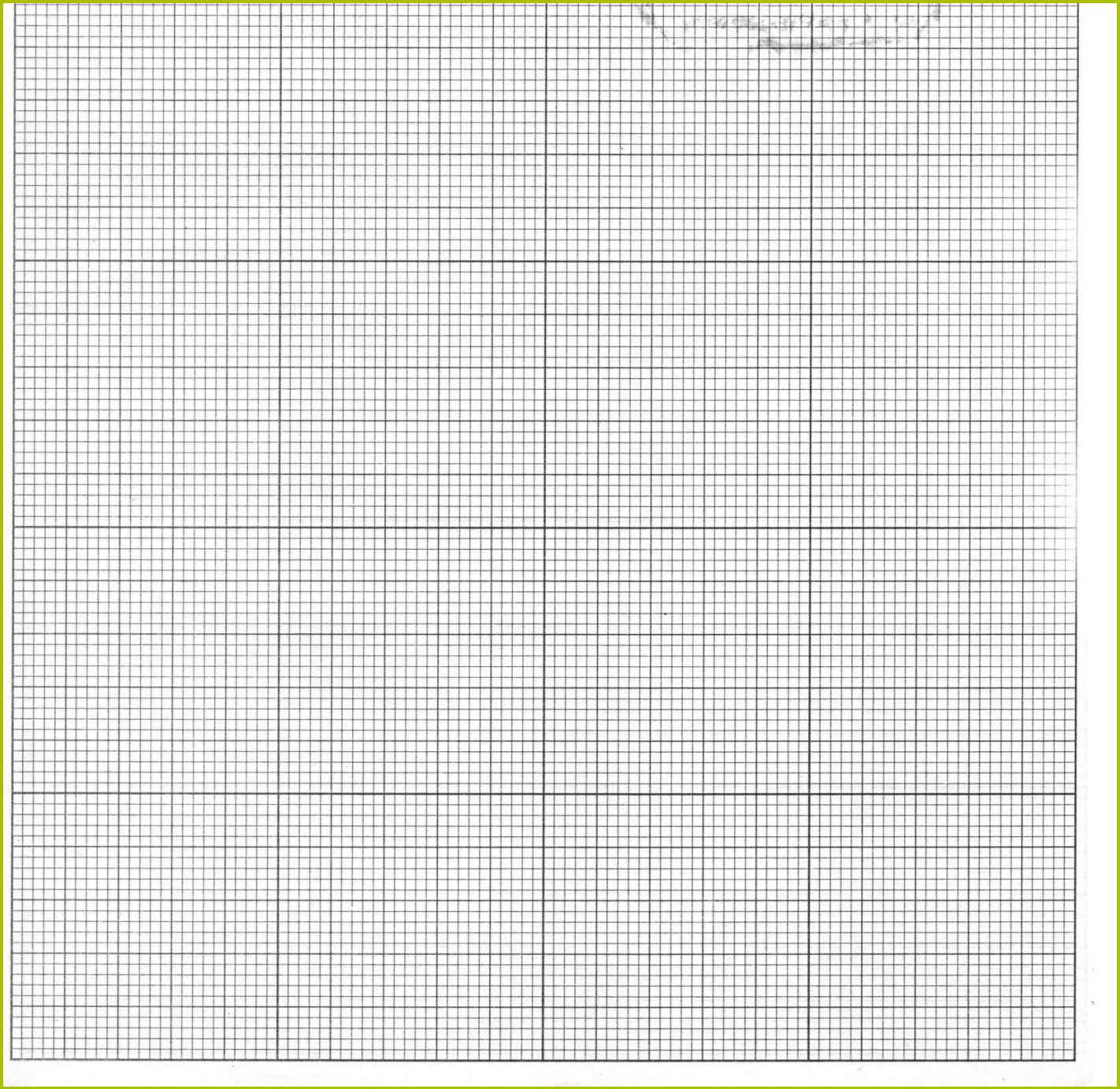
(b) Hydrogen peroxide decomposes as shown below

$2H_2O_2\ (aq) \longrightarrow 2H_2O(l) + O_2\ (g)$

The reaction is catalyzed by adding a known volume of iron (III) chloride. The order of this reaction can be determined by titrating the mixture with standard solutions of acidified potassium permanganate (VII). The following results were obtained during the experiment

Time/min	5	5	10	15	20	25	30
Vol of $KMno_4$	30	23.4	18.3	14.7	14.2	8.7	6.8

(i) Plot a graph of volume of potassium permanganate (VII) against time



(ii) Determine the order of reaction. Give reasons for your answer

(iii) Determine the rate constant for the reaction.

14. (a) State Grahams' law of gaseous diffusion.

(b) quimolar amounts of an amine, W and oxygen were allowed to diffuse through the same porous medium under the same conditions of pressure and temperature. The amine W diffuses 1.19 times as fast as the time taken by oxygen

(i) Determine the molecular mass of W.

(iii) Determine the molecular formula of W.

(c)(i) Write equation for the reaction that occur when compound W is dissolved in water

(iii) Determine the pH of 0.1M aqueous solution of compound W. the base dissociation constant Kb for compound W is 1.85×10^{-5} and Kw for water at 250C is 1.0×10^{-14}.

15. Write equations to show how the following synthesis can be carried out. In each case indicate the necessary reagents and conditions.

(a) $=NNH_2$ from cyclohexene

(b) Ethylamine from ethanol

8

(c) Methylbenzene from benzene sulphonic acid

16. State what is will be observed and write equations for the reactions that occur when

(a) Sodium hydroxide solution is added drop wise until in excess to an aqueous solution of chromium (III) salt followed by hydrogen peroxide solution and the solution warmed

(b) Acidified potassium permanganate solution is added to aqueous solution of tin (II) chloride

17. (a) Boron and silicon show diagonal relationship

(i) What is diagonal relationship

(ii) Briefly explain why silicon and boron show diagonal relation ship

(c) Given any four ways in which both boron and silicon exhibit diagonal relationship

(d) State two other pairs of elements in the periodic table that exhibit diagonal relationship.

(e) Excess hot concentrated sodium hydroxide solution was added to 2.5g of a mixture of aluminium metal and magnesium metal. If the volume of the gas liberated at stp was 2.24cm3. calculate the percentage of magnesium in the mixture.

1

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S6 CHEMISTRY

Exam 9

PAPER 1

DURATION: 2 HOUR 45 MINUTES

For Marking guide contact and consultations: Dr. Bbosa Science 0776 802709.

Answer all question in part I and six questions in part II
All questions are to be answered in the spaces provided
Periodic table, with relative atomic masses, is supplied at the end of the paper.
Simple calculator may be used

For Examiners use only

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total

SECTION A
(Answer all questions)

1. Complete the following equation of radioactive decay

(a) $^{233}_{91}Pa \longrightarrow -\beta + \ldots\ldots\ldots\ldots \longrightarrow {}^{4}_{2}He + \ldots\ldots\ldots\ldots\ldots$ (2marks)

(b) $^{223}_{88}Ra \longrightarrow \ldots\ldots + {}^{219}_{86}Rn \longrightarrow \ldots\ldots\ldots\ldots + {}^{215}_{84}Po$ (2marks)

(c) $^{207}_{81}Ti \longrightarrow \ldots\ldots\ldots + {}^{207}_{82}Pb$ (1 mark)

2. Draw the shapes and name the structure of each of the following species (2marks each)

2

Species	Shape	name of the shape
i. H_2O		
ii. CO_2		
iii. H_3O^+		

3. Write an equation for dissolution of each of the following salt in water. State whether the resulting solution would be neutral, basic or acidic

(a) chromium (III) chloride (2marks)

……

……

(b) Magnesium chloride (1mark)

……

……

(c) ammonium methanoate (2marks)

……

……

4. (a) Complete the following equations

i. $CH_3CH_2COCH_3 + H_2NNH\text{-}C_6H_5 \longrightarrow$ ……(1mark)

ii. $C_6H_5COOH + CH_3OH \xrightarrow{H^+}$ …… (1½ mark)

iii. $nCH_2{=}\underset{\underset{Cl}{|}}{C}H\text{-}C = CH_2 \longrightarrow$ …… (1mark)

3

iv. $(CH_3)_3C\text{-}Br + OH^-(aq) \longrightarrow$ ……. (1mark)

(b) State the name of the mechanism of the reaction in (a)(iv) (2marks)

……

……

5. 20.0cm^3 of 0.02M sodium hydroxide was added to 30 cm^3 of 0.025M sulphuric acid. Calculate

a. Molar concentration of the hydrogen ions in the initial sulphuric acid (1 ½ mark)

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……

……

b. Concentration of hydrogen ions in the resultant solution (3marks)

……

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……..

c. The pH of the resultant solution (1mark)

……

……

6. (a) Write the electron configuration of an atom of aluminium (1mark)

……

……

(b) State the possible oxidation number of aluminium (½ mark)

……

……..

(c) Write an ionic equation for the reaction between aluminium and sodium hydroxide (1½ marks)

4

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……

7. Name one regent that can be used to distinguish between each of the following pairs of compound and state what would be observed in each case if the reagents reacted with the compounds.

(a) $_6H_5COCH_2CH_3$ and $C_6H_5COCH_3$ (3marks)

Reagent

……
……

Observations

……
……
……
……

(b) $CH_2CH_2CH_2OH$ and $(CH_3)_3COH$ (3marks)

Reagent

……
……

Observations

……
……
……
……

8. The convention of a cell is given below

$Pt/Fe^{2+}(aq), Fe^{3+}(aq) \| MnO_4^-(aq)\ Mn^{2+}(aq), H^+(aq)/Pt.$

(a) rite equation for the half cell reaction at

(i) anode (1marks)

……
……

(ii) cathode (1marks)

……
……

(b) Write the overall equation for the cell reaction (1½ marks)

5

……

……

(c) The electrode potential of system $Fe^{3+}(aq)/Fe^{2+}(aq)$ and .$MnO_4^-(aq)/Mn^{2+}(aq)$ are +0.76 and 1.51 volts respectively. Deduce whether the reaction in (b) is feasible or not and give a reaction for your answer. (1mark)

……

……

9. Write an

(i) equation for the reaction between hydrogen and nitrogen. (1 marks)

……

……

(ii) expression for equilibrium constant (Kp) of the reaction in (a)(i) above. And state its units (2marks)

……

……

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……

(b) When hydrogen was reacted with nitrogen at 895K, the total pressure for the system at equilibrium was 30 atmospheres, and the partial pressure of nitrogen and hydrogen were 2 and 6 atmospheres respectively.

(i) Determine the partial pressure of ammonia in equilibrium mixture (1mark)

(ii) Calculate equilibrium constant (1 ½ marks)

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……

……

SECTION B

Answer six questions from this section

10. (a) State the oxidation state of chromium in

(i) Potassium chromate (1mark)

6

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……

(i) Potassium dichromate (1mark)

……

……

(b) Acidified potassium dichromate was reacted with potassium iodide

(i) State what was observed (1mark)

……

……

(ii) Write half equations and overall equations for the reactions. (3marks)

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(c) otassium chromate solution was added to aqueous Lead (II) nitrate

(i) State what was observed (1½ mark)

……

……

(ii) Write the ionic equation for the reaction (1½ mark)

……

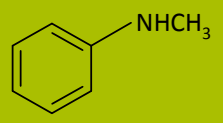
……

11. Complete the following reactions and suggest mechanisms for the reaction

(a) $(CH_3)_2CO \xrightarrow[\text{Room temp.}]{\text{dil NOH}}$ (3 ½ marks)

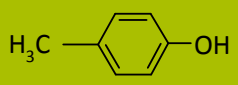
Mechanism

7

(b) 

+ $(CH_3CO)O$ ⟶ (3 marks)

Mechanism

(c) 

+ CH_3CH_2Br $\xrightarrow{\text{NaOH(aq), Heat}}$ (2 ½ marks)

Mechanism

12 Explain the following:

(a) Aqueous solutions of chromium (II) and chromium (III) are colored while that of copper (I) is not (3marks)

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(b) Manganese, iron, cobalt and nickel form ions in the $^{+}2$ oxidation states. State which decrease in size from manganese to nickel. (2 marks)

8

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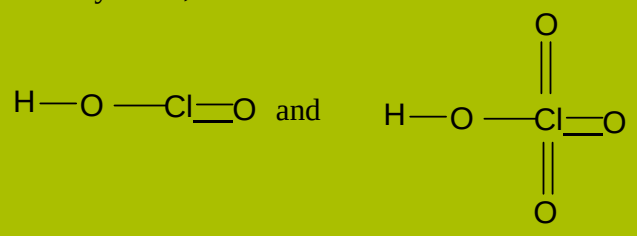
(c) The oxy-acids, $HClO_2$ and $HClO_4$ have the following respective structures.



Explain why $HClO_4$ is stronger acid than $HClO_2$
(Assume that oxygen is more electronegative than chlorine (2 marks)

……
……

(d) Iron III sulphate solution changes litmus paper red (2 marks)

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……
……

13 (a) State Kohlrausch's law of independent Conductivity of ions (1 mark)

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……
……

(b) Some ionic conductivity at infinite dilution at 250C are shown below

Ion	Ionic conductivity ($\Omega^{-1}cm^2$)
OH^-	198.6
Cl^-	76.4
NH_4^+	73.6
Na^+	50.1

9

Calculate the molar conductivity of ammonium hydroxide at infinite dilution (2marks)

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……

(c) The ionic radii and ionic conductivities at infinite dilution of some ions are shown in the table below:

Ion	Ionic radius/nm	Ionic conductivity/$\Omega^{-1}cm^2$
Li+	0.060	38.7
Na+	0.095	50.1
K+	0.133	73.5

Explain the values in the table (3 marks)

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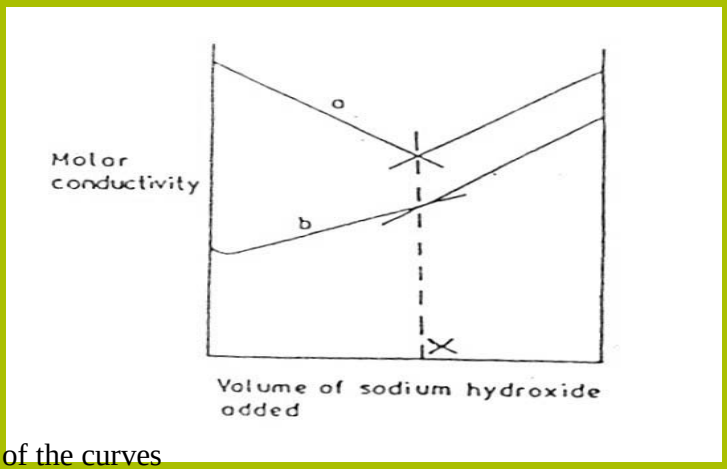
(d) The diagram below shows curves a and b obtained when aqueous sodium hydroxide was gradually added separately to equimolar solution of hydrochloric and ethanoic acid separately



Explain the shape of the curves

(i) curve a (1½ marks)

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10

(ii) Curve b (1½ marks)

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14. Compound Y, C_3H_6O reacts with 2, 4-dinitrophenylhydrazine to give a yellow solid.

(a) Write the structural formulae and IUPAC names of all isomers of Y. (2 marks)

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……

(b) When Y is heated with Fehling's solution, a red precipitate is formed, Identify Y (1 mark)

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……

(c) rite a mechanism for the reaction that would take place between Y and hydroxylamine, NH_2OH. (3 marks)

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(d) Write equations to show how Y can be converted to an alkene (3marks)

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15. (a) An aqueous solution containing 7.2g of a non-cyclic substance Q in 250g of water freezes at -0.744^0C; the freezing point constant, K, for water is $1.86mol^{-1}kg^{-1}$. (3marks)

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(b) If Q contains carbon, 66.7%, hydrogen, 11.1% and oxygen 22.2%

(i) Calculate the simplest formula of Q (2 mark)

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……

(ii) Determine the molecular formula of Q (1 mark)

……
……

(iii) Write the structures of all possible isomers of Q (1½ mark)

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(d) Q forms a yellow precipitate with phenyl hydrazine and iodine solution in presence of sodium hydroxide. Identify Q. (1½ mark)

……

16. The solubility product, Ksp, of zinc hydroxide is 4.5×10^{-17} at 25^0C

(i) Write an expression for solubility product of zinc hydroxide (1½ marks)

……
……

(b) Determine the concentration in moles per litre of zinc hydroxide ions in a saturated solution of zinc hydroxide at 25^0C (3marks)

12

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(c) tate how solubility of zinc hydroxide would change if its saturated solution is treated separately with

(i) aqueous zinc sulphate (1 mark)

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……

(ii) ammonia (1mark)

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(d) Briefly explain your answer in (c). (3marks)

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17. Figure 2 is a phase diagram for a certain substance

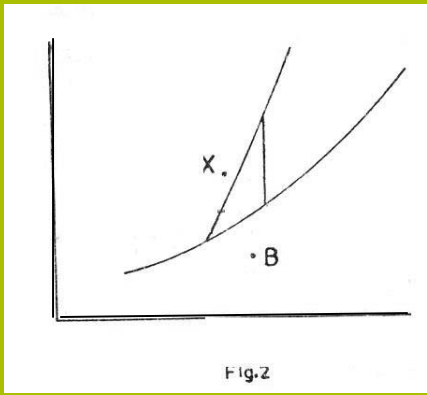

Fig.2

13

(a) Label the following on the diagram (4marks)

(i) the axes

(ii) the phases present

(iii) the critical temperature

(iv) the triple point

(b) Define the term

(i) Critical point (1½ marks)

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(ii) triple point (1½ mark)

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(c) Explain what would happen when the substance at point X changes to point B (2marks)

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Periodic Table

1	2											3	4	5	6	7	8
1.0 H 1																1.0 H 1	4.0 He 2
6.9 Li 3	9.0 Be 4											10.8 B 5	12.0 C 6	14.0 N 7	16.0 O 8	19.0 F 9	20.2 Ne 10
23.0 Na 11	24.3 Mg 12											27.0 Al 13	28.1 Si 14	31.0 P 15	32.1 S 16	35.4 Cl 17	40.0 Ar 18
39.1 K 19	40.1 Ca 20	45.0 Sc 21	47.9 Ti 22	50.9 V 23	52.0 Cr 24	54.9 Mn 25	55.8 Fe 26	58.9 Co 27	58.7 Ni 28	63.5 Cu 29	65.7 Zn 30	69.7 Ga 31	72.6 Ge 32	74.9 As 33	79.0 Se 34	79.9 Br 35	83.8 Kr 36
85.5 Rb 37	87.6 Sr 38	88.9 Y 39	91.2 Zr 40	92.9 Nb 41	95.9 Mo 42	98.9 Tc 43	101 Ru 44	103 Rh 45	106 Pd 46	108 Ag 47	112 Cd 48	115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
133 Cs 55	137 Ba 56	139 La 57	178 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76	192 Ir 77	195 Pt 78	197 Au 79	201 Hg 80	207 Ti 81	207 Pb 82	209 Bi 83	209 Po 84	210 At 85	222 Rn 86
223 Fr 87	226 Ra 88	227 Ac 89															
			139 La 57	140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	159 Tb 65	162 Dy 66	165 Ho 67	167 Er 68	169 Tm 69	173 Yb 70	175 Lu 71
			227 AC 89	232 Th 90	231 Pa 91	238 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	254 Es 99	257 Fm 100	256 Md 101	254 No 102	260 Lw 103

525/1

S6 CHEMISTRY

Exam 10

PAPER 1

DURATION: 2 HOUR 45 MINUTES

For Marking guide contact and consultations: Dr. Bbosa Science 0776 802709,

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. Oxygen diffused through a porous partition in 1.87 minutes. Under similar conditions the same volume of an alkene T diffused in 2.15 minutes

   (a) Determine the formula of T (2 ½ marks)

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(b) Write equation and outline the mechanism for the reaction between T and benzene.

Indicate the condition (s) for the reaction (3marks)

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2. (a) define the term heat of reaction (1mark)

3

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(c) Calculate the standard enthalpy of hydrogenation of ethane from the data

(i) $C_2H_6(g) + 3\frac{1}{2} O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(l)$ $\Delta H = -1550 kJmol^{-1}$

(ii) $C_2H_4(g) + 3 O_2(g) \longrightarrow 2CO_2(g) + 2H_2O(l)$ $\Delta H = -1390 kJmol^{-1}$

(iii) $H_2(g) + \frac{1}{2} O_2(g) \longrightarrow H_2O(l)$ $\Delta H = -285.8 kJmol^{-1}$ (4marks)

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3. (a) Aluminium and phosphorus both form compounds in which the oxidation state of the element is +3

(a) Briefly explain in terms of electron structure why aluminium conducts electricity but the common allotropes of phosphorus do not.

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(b) Write equation for the reaction of each of these elements with sodium hydroxide (3mark)

4

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4. Name one reagent that can be used to distinguish between each of the following pairs of compounds and state what would be observed in each case if the reagent is reacted with the compounds;

(a) $CH_3CH_2NH^2$ and $(CH_3CH_2)_2NH$ (3marks)

Reagent

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Observation:

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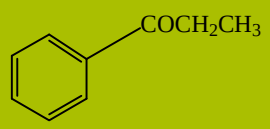
(b) 

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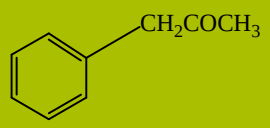

Reagent

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Observation:

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5. (a) Explain the order of increasing basicity for the following compounds. (2marks)

$C_6H_5NH_2 < NH_3 < CH_3NH_2$

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(b) When one mole of methylamine is dissolved in water, the hydrogen ion concentration is found to be 2.5×10^{-10} $moldm^{-3}$.

(i) Write an equation for the reaction between water and methylamine (1 mark)

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(ii) Calculate the base dissociation constant, Kb, for methylamine. (2 ½ marks)

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6. The convention of a cell is given below.

$Pt/Fe^{2+}(aq),Fe^{3+}(aq)\ //MnO_4^-(aq),Mn^{2+}(aq),H^+(aq)/Pt$

(a) Write equation for the half-cell reaction at:-

(i) Anode (1mark)

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(ii) Cathode (1mark)

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(b) Write the overall equation for the cell reaction. (1 ½ marks)

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(c) The electrode potentials for the system $Fe^{2+}(aq)/Fe^{3+}(aq)$ and $Mn^{2+}(aq)/MnO_4^-(aq)$ are +0.76V and -1.51V respectively. Deduce whether the reaction in (b) is feasible or not and give a reason for your answer. (2marks)

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7. (a)Define the term boiling point elevation constant of a substance. (1mark)

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(b) The boiling point of benzene under certain pressure condition is 80.0^0C. Calculate the boiling point elevation constant of benzene, if a solution containing 5g of 2,4,6-trinitrophenol, ($HOC_6H_2(NO_2)_3$ in 100g of benzene, boils at 80.568^0C. (4marks)

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8. 2.00g of phosphorus pentachloride allowed to reach equilibrium at 200^0C in a vessel of $1dm^3$ capacity. If the equilibrium constant of the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ is $0.008moldm^{-3}$ at this temperature and in the conditions stated; calculate the percentage dissociation of phosphorus pentachloride at equilibrium. (4marks)

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9. The first ionization energies of some group II metals of the periodic table and the melting points of their chlorides are given below.

	Mg	Ca	Sr	Ba
First ionization energy /kJmol^{-1}	738	590	549	505
Melting point of chlorides (^{0}C)	708	772	873	967

Explain

(i) Why ionization decreases with increase in atomic number. (2marks)

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(ii) Why the melting points of the chlorides of these metals increase with increase in atomic number of the metal. (2marks)

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SECTION B (54 MARKS)

(Attempt any six questions from this section)

10. (a) (i) Define the term "molar conductivity at infinite dilution, Λ_0. (1mark)

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(iii) State how you would expect the molar conductivity of sodium chloride solution to vary as the dilution of the solution is increased. Give a reason for your answer (2marks)

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(c) The values of Λ_0 at 25^0C for some electrolytes are as follows

Electrolyte	Λ_0/Sm^2mol^{-1}
HCOONa	104.7
NaCl	126.5
HCl	426.2

(i) Calculate Λ_0 at 25^0C for methanoic acid, HCOOH. (2marks)

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(ii) If the value of molar conductivity, Λ, for 0.01M methanoic acid is $50.5Sm^2mol^{-1}$ at 25^0C. Calculate the acid dissociation constant, Ka, for methanoic acid. (4marks)

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11. (a) (i) Explain the term solubility product. (1mark)

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(ii) Write an expression for the solubility product of silver chloride in water (1mark)

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(b) Ionic conductivity of silver ions and chloride ions at infinite dilution are 6.2 x 10^{-2} and 7.6 x 10^{-2} Sm^2mol^{-1} respectively at 298K. The electrolytic conductivity of silver chloride at 298K is 1.22 x $10^{-2}Sm^2mol^{-1}$.

(i) Calculate the solubility in moldm-3 of silver chloride at 298K (3 ½ marks)

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(ii) Calculate the solubility product, Ksp, of silver chloride at 298K (1 ½ marks)

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(c) State the effect of the following actions on the solubility of silver chloride. Explain your answers.

(i) Addition of aqueous ammonia (1mark)

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(ii) Addition of potassium chromate (VI) solution. (1mark)

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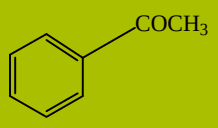
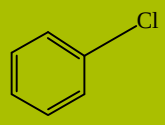
12. Write equations to show how the following compounds can be synthesized.

(a) 

from 

(3½ marks)

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(b) $(CH_3)_3COH$ from $(CH_3)_2CHOH$ (2½ marks)

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(c) $CH_3CH_2CH{=}CH_2$ from ethyne (3marks)

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13. (a) Explain each of the following observations:

(i) Chromium (III) sulphate dissolves in water to form a solution whose pH is less than seven. (2 ½ marks)

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(ii) Lead does not form lead (IV) bromide. (2marks)

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(b) To a dilute solution of chromium (III) sulphate was added dilute sodium hydroxide drop wise until in excess followed by 3 drops of hydrogen peroxide and mixture warmed.

State what was observed and use equations to explain the observations. (4 ½ marks)

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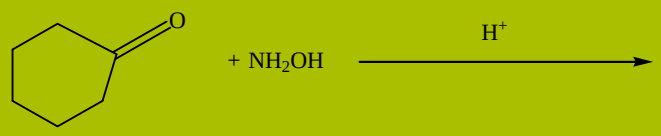
14. Complete the following equations and in each case write a mechanism for the reaction.

(a) 

(3marks)

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(b) $(CH_3)_3CBr \xrightarrow[C_2H_5OH,\ Heat]{NaOH}$ (3marks)

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(c) $CH_3CH{=}CH_2 + CocH_2SO_4 \xrightarrow[warm]{H_2O}$ (3marks)

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15. Vegetable oils have great economic and social importance

(a)(i) Explain what is meant by the term <u>vegetable oils</u> (1mark)

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(ii) Name two main sources of vegetable oils. (1mark)

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(iii) Describe briefly how vegetable oil can be obtained on a large scale from one of the sources you have named in (a)(i) above. (technical details are not required) (2marks)

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(b) (i) State the name given to the reaction leading to the formation of soap from oil. (1mark)

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(ii) Write a general equation for the formation of soap from oil. (1mark)

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(iii) Outline how soap is manufactured, (technical details not required). (3marks)

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16. State what would be observed and write the equation for the reaction that would take place when:

(a) Hydrogen sulphide gas is passed through an acidified solution of potassium dichromate (VI).

15

Observation (2 ½ mark)

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Equation:

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(b) 2,3 drops of ammoniacal copper (I) chloride is added to phenylethyne. (2marks)

Observation

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Equation:

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(c) Neutral iron (III) chloride solution is added to 1 cm^3 of propanoic acid (2marks)

Observation

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Equation:

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(d) A spatula end ful of sodium hydrogen carbonate is added to iron (III) chloride solution (2 ½ marks)

Observation

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Equation:

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17. (a) Fluorine is the first member of the halogen group of elements in the periodic table and it shows anomalous behavior among the halogens.

(i) State **three** major differences between fluorine and other halogens. (2½ marks)

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(ii) Give **three** causes for the anomalous behaviour of fluorine. (3mmarks)

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(c) The acid dissociation constants Ka for the hydrides of elements of group (VII) elements are given in the table below:

17

Hydride	HF	HCl	HBr	HI
Ka ($moldm^{-3}$)	5.6×10^{-11}	1×10^{-9}	1×10^{-7}	1×10^{-4}

State and explain the trend in variation of acid strength of the hydrides (4marks)

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1	2											3	4	5	6	7	8
1.0 H 1																1.0 H 1	4.0 He 2
6.9 Li 3	9.0 Be 4											10.8 B 5	12.0 C 6	14.0 N 7	16.0 O 8	19.0 F 9	20.2 Ne 10
23.0 Na 11	24.3 Mg 12											27.0 Al 13	28.1 Si 14	31.0 P 15	32.1 S 16	35.4 Cl 17	40.0 Ar 18
39.1 K 19	40.1 Ca 20	45.0 Sc 21	47.9 Ti 22	50.9 V 23	52.0 Cr 24	54.9 Mn 25	55.8 Fe 26	58.9 Co 27	58.7 Ni 28	63.5 Cu 29	65.7 Zn 30	69.7 Ga 31	72.6 Ge 32	74.9 As 33	79.0 Se 34	79.9 Br 35	83.8 Kr 36
85.5 Rb 37	87.6 Sr 38	88.9 Y 39	91.2 Zr 40	92.9 Nb 41	95.9 Mo 42	98.9 Tc 43	101 Ru 44	103 Rh 45	106 Pd 46	108 Ag 47	112 Cd 48	115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
133 Cs 55	137 Ba 56	139 La 57	178 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76	192 Ir 77	195 Pt 78	197 Au 79	201 Hg 80	207 Ti 81	207 Pb 82	209 Bi 83	209 Po 84	210 At 85	222 Rn 86
223 Fr 87	226 Ra 88	227 Ac 89															
			139 La 57	140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	159 Tb 65	162 Dy 66	165 Ho 67	167 Er 68	169 Tm 69	173 Yb 70	175 Lu 71
			227 AC 89	232 Th 90	231 Pa 91	238 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	254 Es 99	257 Fm 100	256 Md 101	254 No 102	260 Lw 103

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S6 CHEMISTRY

Exam 11

PAPER 1

DURATION: 2 HOUR 45 MINUTES

For Marking guide contact and consultations: Dr. Bbosa Science 0776 802709,

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.
- Where applicable

  Gas constant, R, = 8.31 JK-1mol-1

  Molar volume at s.t.p is 22.4liters
-

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

SECTION A

1(a) Define the term "standard heat of reaction."

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(b) Given the following data:

Enthalpy of formation of magnesium chloride	= - 641.62kJmol^{-1}
Lattice energy of Magnesium chloride	= +2495.6 kJmol^{-1}
Hydration energy of chloride ions	= -378.0 kJmol^{-1}
Enthalpy of solution of hydrogen chloride gas	= -74.8 kJmol^{-1}
Heat of formation of hydrogen chloride gas	= -92.32 kJmol^{-1}
Hydration energy of magnesium ions	= -1926 kJmol^{-1}

Calculate the enthalpy of the reaction;

$Mg(s) + 2HC1\ (a\ q) \longrightarrow MgCl^2\ (aq) + H_2\ (g)$ (4 marks)

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2. A gaseous oxide of sulphur SO_n diffused through a porous partition in 2.68 minutes while an equal vaolume methane at the same temperature diffused in 1.1985 minutes.

(a) Determine the value of n in the oxide SO_n, (2 ½ marks)

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(b) The oxide in (a) above reacts with benzene via an electrophilic substitution mechanism.

(i) Stale whether the oxide in (a) above acts as an electrophile or nucleophile. Give a reason for your answer. (1½ marks)

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(ii) Write equation for the reaction with benzene and outline the mechanism. (2 ½marks)

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3. Give the reagent(s) that can be used to distinguish between each of the following pairs of compounds and state what would be observed in each case if the reagent is reacted with each compounds. (2marks each)

$CH_3CH(NH_2)CH_3$ and $(CH_3)_2NH_2$

(2 marks)

Reagent

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_____

Observations.

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(b) NiO and CuO (2 marks)

Reagent

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Observations.

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(c) $Na_2C_2O_4$ (aq) and Na_2SO_3 (aq)

Reagent

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Oobservations

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3. Boron and nitrogen form chlorides in oxidation state +3

(a) Draw the structure and name of the shape adopted by each of the chloride (2marks)

(b) Explain why the molecules formed by booron in (a) above is non-polar. (2marks)

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(c) Write an equation for the reaction of each compound in 9a) above with water. (2marks)

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4. The standard redox potentials of $Fe^{3+}(aq)/Fe^{2+}$ and $Sn^{2+}(aq)/Sn^{4+}(aq)$ are -+0.76 V and -0.15V respectively.

(a) Write an equation for the half-cell reaction at the:

(i) the cathode (2marks)

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(ii) anode (2marks)

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……(b) State two conditions under which the electrode potentials above are measured (2marks)

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(c) Deduce if the overall reaction is feasible or not. Give a reason for your answer. (2 marks)

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5. (a)Define the term freezing point depression constant of a solvent. (1mark)

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(b) In an experiment, a 5 per cent solution of glucose , $C_6H_{12}O_6$ in water found give the same freezing point depression as a 3.3% aqueous solution of $C_nH_{2n}O_n$.

(i) Determine the molecular formula of $C_nH_{2n}O_n$• (3 marks)

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(ii) The compound in b(i) above forms a crystalline white precipitate with saturated sodium hydrogen sulphite solution but no observable change with ammoniacal silver nitrate solution. It also reacts with ethanoic acid in the presence of concentrated sulphuric acid to give a product with a sweet fruity smell.

Write the structural formulae and I U PAC name of one of the isomers of $C_nH_{2n}O_n$.

(l mark)

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6. The first ionization energies of group II metals and the melting point of their

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ionization energies of group Il metals and the melting points of their chl€l

MetalMgCaSr				
[First ionisation energy ((KJmol -l)738590549505				
Melting point of chloride CC)	708	772	873	967

Explain.

(a) why the ionisation energy decreases from Mg to Ba. (2 marks)

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(b) why melting points of the chlorides of the metals increase With increase in acornžc numbera (2 marks;

I .7g of ammoniagas were into of water at In a closed sy stern The mixture was maintained at equilibrium was establishcd and the equali brium mixture found to contain I .67 i7í34g 01 unionised arnrnonta,

(i) Write an equation for the ionisation of ammonia in water. (l mark)

(ii) Calculate the degree of Ionisation of ammonia in water at 25 ^{0}C. (l mark)

(b) Deduce the basic dissociation constant of ammonia at 25 ^{0}C from your answer a(il) above (1½ mark)

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(c) The basic dissociation constant of methylarnme is 4.38 x 10 ^{4} mol dill ^{3} at 2

(i) Compare the basic strength of ammonia and methylamine. ('/9. mark)

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(ii) Give a reason for your answer in c(i) above. _rrlarks)

A solid mixturc of manganese (IV) oxide, potassium chlorate (V) and potass hydroxide was fused an Il-on crucible. Hot water was added (o the produci to form a green solution.

(i) Name the green solution. (^{1}p, mark)

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(ii) Write an equation leading to the formation of the green solution (j mark)

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(b) Carbondloxide gas was bubbled through the green solution in a(i) abovc .

(i) State what was observed. (1 mark)

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(ii) Explain your observation in b(i) above. (2 rnarksj

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SECTaON g

Attempt any six questions from this section.

20cm of an organic compound Q belonging to C Il series were mixed with 200cm ox vgcm. The _rruxt-urc was sparked and the residual gaseous product absorbed in Lo oncentŸated potassium hydroxide solution. The final volume of gas at room 'temperatu re was found to be 30.0cm3

(a) Determinc the molecular formula of Q. (3 marks)

(b) Q react with bromine water and also decolourises acidified potassium ganate(Vll) (Mole ratio Q:Br_2 = 1

(l) Identifv Q. (1/2 mar-IQ)

(n) Write an equation for the reaction between Q and Brorrllne water. mark)

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(c) Q reacts with 1101 water in the presence of Conc. to form P which is oxidised to R by acidified potassium dichromate (VI).

(i) Identify P and R. (l mark)

(ii) Suggcsl a ii-ablc mcchanlsyxı for ⁱ he reaction lociwccn 'l? and hydroxylamine

in Ûhc presence of arı acid. (3 111 arks)

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(İ i İ) Namc thc final product for thc rcaction in c(ii) abovc. mark j

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(a) Thc soluıbility product Ksp of calcİurn fluoridc can be determirıcd by conduc1İvİiY rncasuırcrncni at [25 ⁰ C. ᵀhc cicctrolytic corıdıiclivitjcs of watcr amcı a salı: water

soluıiion of ca]cıuıvn fluoriclc arc2 75 x 10 ^{4} ç) cm 554 x 1 0 rcspccüıvcly. Gıyen thaf -[hc molar conducfivitics of calcıum ions and fluoride ions ai infinite di]ution arc 1 19,0 and 5 5.41) ^{Â} cm ^{2} mo! respectivcly .

[Definc tYıc terrrı solutbilitv prod

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(ii) Calculate the solubility -produci of calcium fluoride at 2 5 ^{0} C. State any assumption s) made. (5 marks)

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(b) Compare the solubilitv of calcium fluoride in pure water and its golubility in

O. 1M potassium fluoride solution at 25 °c (: 2 mark)

(11 Explain your answer In b(i) above. (2 marks)

(c) State one other factor that can affect the solu bility of calcium fluoride. (rnarl<)

Group (Vll) elements rcact with hydrogen gas to form hydrides of thc formula HX (X = F, Cli and I).

(a) Describe thc reaction of the hydrides with:

Sodium carbonate solution. (1 1/9 marks)

(ii) Sulphuric acid marks)

Phe boiling points and bond dissociation encrgics of the hydrides (HX) are in the table below.

Hydride (HX)	HF	HCl	HBr	HI
Bond energy ($(KJmol^{-1})$	562	431	366	298
Boiling point (°C)	+19.9	-85.0	-67.0	-35.0

the table below.

State and explain the variation In:

Boiling points of the hydri(hns.

Bondenergy oi Pi X bond flom PIF 1.0 (2 marks)

\vVrite equations to show how the following compounds can bc synthesized.

Iodoetharyc to Iodomethane. (3½ marks)

(b) Phenol 4 -bromobcnzencsulphonic acid. (3 marks)

cnzoic acid to (2½ marks)

Explain each of the following observations.

a) Methanol are misciblel in all proportions however hexan-l-ol is immiscible with water (2 i 2 marks)

(b) The boiling points of water and brornobenzene are 100 ^{o}c and 1 56 ^{0}C rcspecUEQiv however a mixture of water and bromobcnzene boils below 100 ^{o}c at atmospheric

pressure. (3 1/7, marks)

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monia solution added to aqueous nickel (I l) sulphate solution, a precipitate soÀüble in excess ammonia to íorrn a blue solution. (3 marks)

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[Ivdrooen -peroxidc can act as an oxidisinø or reducing agent.

(a) State the condition(s) under which hydrogen peroxide acts as.

(i) an oxidising agent. (½ mark}

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(ii) a reducing agent. (½ mar ve

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(b) Write half reactions to show how hydrogen peroxidc acts as a;

(i) reducing agent. (i tnavk)

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(ii) Oxidising agent. (l mal k)

In an experiment if) deterrnme the volu me strength of Hydrogen peroxide (volume of oxygcngas at s l. liberated by the decomposition of of sob Itian), of I lydrogcn pcrox

(x volumes were diluted to make 250 cyn of aqueous solution labellcd FAI . 20 cm of FAwerc pipette followed by an equal volume of 1M Ii2S(W Thc mixture was titrated with exact/ v 30cm³ of 0.02M potassium manganate (V Il) solution.

O) Write the redox reaction that occurs during the titration (l mark)

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_____

(ii) Give a reason why the titration of hydrogen peroxide is done with potassium man ᵃanate (VIl) but not a solution of Iron (Il) ions. (l marks)

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(iii) Calculate the volume strength of the hydrogen peroxide used in the above experiment.

2 [1202 (aq) $\longrightarrow 2H_2O(l)$ molar gas volume at s. t. p 22400cm³

(3 5/2 marks

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Chloroethcne and hcxane- l , 6-dioic acid and hexane-1 6-diaminc are monorncrs of two svnt betic polymers namely; polvvjnyl chloride and nylon respectivelv .

(a) Define the tcrvn "Polymer (1 marks)

(b) Write the structural formula of;

(i) chloroethcne (^{1}/O mark)

(ii) hexane- I ,6-dioic acid and hexane- l ,6-diarnine. / > rnark)

(c) Write the structural formula of each of the polymers in (b) above and state the tv pc of polyrncrisation involved. (3 marks}

(d) State one use of each of the polymers in (c) above (2 marks)

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(c) Name one natural polymer formed by the same reaction as •

(i) Polyvinyl chloride. (½ mark)

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(ii) nylon, 6, 6. ma rk)

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18

Ethyl bromide reacts with sodium hvdroxidc according to the equation

$CH_3CH_2Br(l) + NaOH(aq) \longrightarrow CH_3CH_3CH_2OH(aq)$ + Na/3r(aq)

• he -rate equation IS (Yiven by s

Rai e KIC/13C//È/3rl X iNaC)//l Y wherc x and y are the respective orders of reactio) 02M cíhvtbrornide and sodium hydroxide •were mixed and refluxed in a flask. 20cm samples were withdrawn at regular time Intervals and poured in excess cold water then titrated against 0.05M hydrochloric acid as shown below.

| Time (minutes) | o | 25 | 1 | | |

Rate = Cl[2Brl ^{x} [NaOH]

(i!) Deduce the value of x in ratc equation if t_hc overall order of the reaction IS J (l mark)

d Brieflv explain how the rate of reaction would be affected by temperaturc if the concentrations of both reactants were maintained constant (l marks)

525/1

S6 CHEMISTRY

Exam 12

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions to candidates;

- *Answer all questions in Section A and any six in Section B.*
- *All questions must be answered in spaces provided.*
- *Illustrate your answers with equations where applicable.*
- *Molar gas constant, R=8.314jk^{-1}mol^{-1}*
- *Molar volume for a gas at s.t.p is 22400cm^{3}*
- *Standard temperature =273k*
- *Standard pressure =101325 Nm^{-2}*

SECTION A

Answer all questions from this section.

1. State the condition(s) and write equation for the reaction of aluminium and;
i) water (2marks)

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ii) Iron (III) oxide (2marks)

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2. a) State what is meant by the term ebullioscopic constant. (1mark)

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b) 0.40g of camphor when disoolved in 33.5g of trichloromethane produces a solution boiling at 0.30^0C above the boiling point of pure solvent. Calculate the ebullioscopic constant of trichloromethane. (Molar mass of camphor = 155).

(3marks)

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3. a) State what is observed and write equation for the reaction when;

i) Ethanal is mixed with a saturated solution of sodium bisulphite. (2marks)

Observation:

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Equation

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ii) Neutral iron(III) chloride solution is added to aqueous solution of hydroxybenzene. (2marks)

Observation;

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Equation;

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b) Write the mechanism for the reaction in a(i). (2 ½ marks)

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4. a) State what is meant by the term electrode potential. (1mark)

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b) The electrode potential of some half cells are given below.

		(E^{C}V)
$S_2O_8^{2-}(aq) + 2e^-$	$\longrightarrow$ $2SO_4^{2-}(aq)$	$+2.01$
$I_2(aq) + 2e^-$	$\longrightarrow$ $2I^-(aq)$	$+0.54$

Write;

i) The cell notation of cell formed when the half cells are combined.

(1mark)

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ii) equation for the overall cell reaction. (1½ marks)

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iii) Calculate the e.m.f of cell. (1mark)

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iv) State whether the cell reaction is feasible or not. Give a reason for your answer. (1mark)

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5. a) State two properties in which beryllium shows diagonal relationship with aluminum. (2marks)

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b) Write equations to illustrate the properties stated in (a) (3marks)

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6. State what would be observed and write equation for the reaction that takes place when

a) Chlorine gas is passed through a solution of potassium manganate(VI) (2 ½ marks)

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b) A few drops of hydrogen peroxide solution is added to acidified potassium dichromate(VI) solution. (2 ½ marks)

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7. Write equations to show how the following conversions can be effected.

(2½ marks)

a) $(CH_3)_2COH$ to $(CH_3)_3COH$

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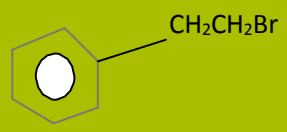
b) 

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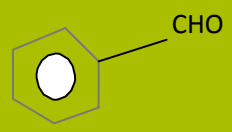

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8. 30cm³ of a hydrocarbon Q was exploded with 200cm³ of oxygen in excess. The volume of the residual gas on cooling to room temperature was found to be 155cm³. When the residual gas was treated with concentrated potassium hydroxide solution, the volume reduced to 35cm³.

a) Calculate the molecular formula of Q. (3marks)

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b) Write the structures of all possible open chain isomers of Q. (1mark)

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c) Q reacts with ammoniacal copper(I) chloride solution.

i) State what is observed. (1mark)

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ii) Write equation for the reaction that takes place. (1½ marks)

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9. The molar conductivity of a 0.093M solution of ethanoic acid at 25^0C is 5.34 x 10^{-4} sm^2mol^{-1}. The molar conductivity at infinite dilution of H^+ and CH_3COO^- ions are 3.51 x 10^{-2} and 0.4 x $10^{-2}Sm^2mol^{-1}$ respectively. Calculate the;

i) molar conductivity of ethanoic acid at infinite dilution. (1 ½ marks)

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ii) degree of dissociation , α of ethanoic acid. (1 ½ marks)

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iii) acid dissociation constant, Ka at 25^0C (1 ½ marks)

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SECTION B

Attempt only six questions from this Section

10. a) An organic compound Z has a molecular formula $C_3H_6Br_2$.
Write down the structural formula and IUPAC names of all isomers of Z.

(3marks)

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b) When Z was heated with sodium metal in ethanol a compound Y was formed. Y reacts with water in the presences of sulphuric acid and Mercurous sulphate at 60^0C to form a compound X. X does not react with Fehling's solution but forms an orange precipitate with Brady's reagent. Identify compound X, Y and Z.

(1½ marks)

X .....

Y .....

Z .....

c) Write the equation and suggest the mechanism for the reaction between
i) Z and sodium metal in ethanol.

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ii) X and Brady's reagent. (2 ½ marks)

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11. Explain each of the following observations (Your answer should include balanced equations if any). (3marks each)

a) When hydrogen iodide is treated with concentrated sulphuric acid, iodine is liberated whereas when hydrogen chloride is similarly treated, chlorine is not evolved.

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b) An aqueous solution of sodium sulphite has a pH greater than 7 whereas that of sodium hydrogen sulphite is less than 7.

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c) When hydrogen sulphide is bubbled through an aqueous solution of iron(III) chloride a yellow precipitate is observed.

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12. a) State Raoults law as applied to binary liquid systems. (1mark)

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b) The mixture of water and nitric deviates negatively from Raoults law. The mixture form an azeotropic mixture at 68.2% nitric and boiling point 121^0C.

i) Sketch a labeled boiling point – composition diagram for the mixture above. (Bpts of HNO_3 and H_2O respectively are 78.2^0C and 100^0C at 760mmHg pressure.) (3marks)

ii) Describe briefly what happens when a mixture containing 50% nitric acid is distilled. (2½ marks)

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c) Explain why the mixture deviates negatively from Raoults law.

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d) Name one method of obtaining pure nitric acid from the azeotropic mixture. (1mark)

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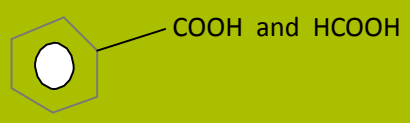
13. Name the reagents that can be used to distinguish between the following pair of organic compounds. In each case state what is observed when the compounds are separately treated with the reagent. (3marks)

a)



Reagent

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Observation

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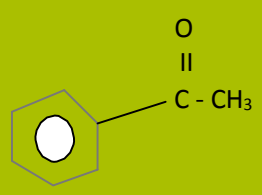
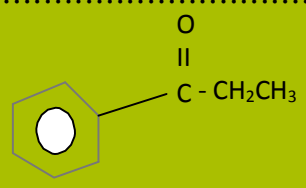
b) 

and 

Reagent

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Observations

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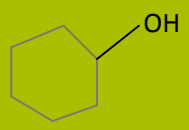
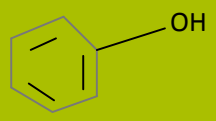
c) 

and 

Reagent

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Observations

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14. a) 0.111g of a vaporized sample of an organic compound R occupied 48.0cm^3 at 20^{0}C and 700mmHg pressure. Calculate the relative molecular mass of R.

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b) R consists 59.9% carbon, 26.6% oxygen and the rest is hydrogen. Determine;

i) the empirical formula of R (2marks)

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ii) the molecular formula of R (1½ marks)

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c) Write down the structural formulae and give the IUPAC names of all isomers of R. (3marks)

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15. a) State two characteristic properties exhibited by manganese as a transition element.

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b) i) Write the electronic configuration of manganese. (½ mark)

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ii) State the common oxidation states exhibited by manganese in its compounds. (1 ½ marks)

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c) i) Manganese (IV) oxide reacts with concentrated hydrochloric . Write the equation of reaction that takes place. (1 ½ marks)

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d) Lead(V) oxide was added to an aqueous solution of manganese (II) chloride, followed by concentrated nitric acid. The mixture was then heated.

i) State what was observed. (1½ marks)

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ii) Write equation of reaction that takes place. (1½ marks)

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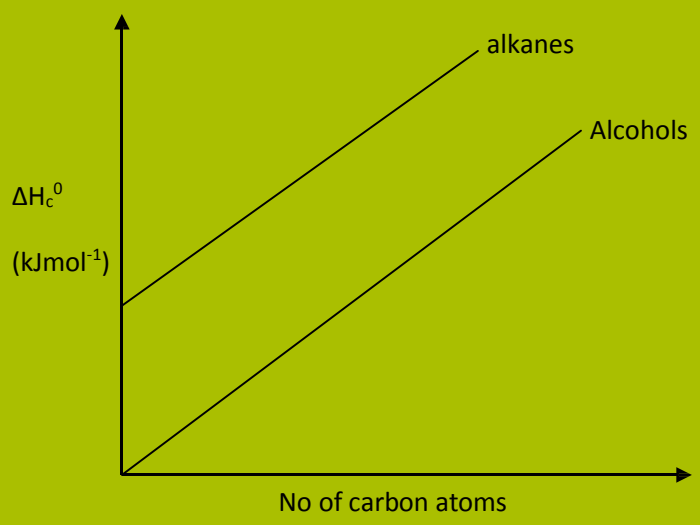
16. a) The standard enthalpies of combustion of some straight chain alkanes and alcohols against number of carbon atoms is shown below.



i) Explain the shape of the graph(s)

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ii) The graph for alcohol passes through the origin. Explain why this is so.

(1½ marks)

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iii) The graph for alkanes has an intercept. What is the siginificance of the intercept? (1 ½ marks)

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b) Energy changes for some reactions are shown below;

			$\Delta HO/Kjmol^{-1}$
i) $CO(g) + ½ O_2(g)$	$\longrightarrow$	$CO_2(g)$	-283
ii) $H_2(g) + ½ O_2(g)$	$\longrightarrow$	$H_2O(l)$	-286
iii) $CH_3OH(l) + {}^3/_2O_2(g)$	$\longrightarrow$	$CO_2(g) + 2H_2O(l)$	-715

Calculate the enthalpy change for the reactions

$CO(g) + 2H_2(g) \longrightarrow CH_3OH(l)$ (3marks)

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17. a) Explain what is meant by the term complex ion. (1mark)

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b) i) Some complex ions are given below. In each case state the coordination number and oxidation state of the central atom. (3marks)

Formulae of complex ion	Coordination number	Oxidation state
$CoCl_4^{2-}$		
$Fe(CN)_6^{3-}$		

+

$Ag(NH_3)_2$		

ii) Explain why transition metals form complex ions.

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c) In each case write equation catalyzed by the following ions/species.

(1 ½ marks @)

i) Vanadium pentoxide

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ii) Manganese II ions

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**END **

525/1

S6 CHEMISTRY

Exam 14

PAPER 1

DURATION: 2 HOUR 45 MINUTES

This paper c

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.

Where necessary use the following:

Molar gas constant, R	= $8.31JK^{-1}mol^{-1}$
Molar volume of a gas at s.t.p	= 22.4litres
Standard temperarue	= 273K
Standard pressure	= $10125Nm^{-2}$

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 questions from this section

1. (a)(i) The decay law is give in the expression below

$-\frac{d\text{[illegible]}}{d\text{[illegible]}} = \lambda N$

State what the symbols represent. (1 ½ marks)

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(ii) Using the above expression derive the expression for relating the half-life ($t_{½}$) and a decay constant. (2marks)

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

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

Name of the particle (1mark)

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Equation:

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

(the half-life of nickel is 120 years) (2marks)

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2. (a) state conditions for the reaction between aluminium oxide and sulphuric acid and write the equations 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 was observed and write equation for the reaction that took place.

Observation (2 ½ mark)

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Equation

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3. The following experimental results were obtained for the reaction

A + 2B $\longrightarrow$ products

Experiment number	Initial concentration ($moll^{-1}$)		Rate ($moll^{-1}s^{-1}$)
	A	B	
1	3.0×10^{-2}	3.0×10^{-2}	2.7×10^{-5}
2	3.0×10^{-2}	6.0×10^{-2}	5.4×10^{-5}
3	6.0×10^{-2}	3.0×10^{-2}	10.8×10^{-5}

(a) Deduce the order of reaction with respect to

(i) A

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(ii) B

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(iii) Write the expression for the rate equation (½ mark)

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

(i) The concentration of 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 is removed by precipitation, without affecting the concentration of A

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(c) Calculate the value of the rate constant and state its units (2marks)

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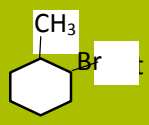
4. Complete the following reaction equations and write the IUPAC names of the main organic product in each case. (1 ½ mark each)



$$\xrightarrow[\text{heat}]{CH_3CH_2O^-K^+/CH_3CH_2OH}$$

(a)

Name of the product

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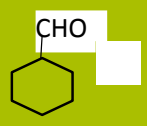
(b) 

$\xrightarrow[\text{Zn/Hg}]{\text{Conc. HCl}}$

Name of the product

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

Name of the product

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5. (a) Write half equation (s) to show the action of hydrogen peroxide as

(i) Oxidizing agent (1mark)

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(ii) Reducing agent.

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(b) State what is observed and in each case write equation of the reaction that takes place when hydrogen peroxide is added to the following mixtures: (1½ mark each)

(i) Acidified potassium chromate (VI) solution)

Observations

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Equation

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(ii) Iron (II) sulphite in dilute sulphuric acid

Observations

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Equation

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(c) Give one reason why hydrogen peroxide is not used to estimate the concentration of iron (II) ions in volumetric analysis. (1mark)

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6. (a) Explain what is meant by the term first electron affinity? (1mark)

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(b) State three factors that can affect electron affinity. (1 ½ mark)

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(d) The first electron affinities of some of period 3 elements in the periodic table are shown below

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

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

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(ii) Explain your answer in c(i) above (2marks)

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

(i) $C(s) + O_2(g) \longrightarrow CO_2(g)$ $\Delta H^0_1 = -393.5\ kJmol^{-1}$.

(ii) $H_2(g) + ½\ O_2(g) \longrightarrow H_2O(l)$ $\Delta H^0_2 = -285.9\ kJmol^{-1}$

(iii) $C_6H_5OH(s) + 7O_2(g) \longrightarrow 6CO_2(g) + 3H_2O(l)$ $\Delta H^0_2 = -3009\ kJmol^{-1}$

Calculate the standard enthalpy of formation of phenol from its elements (3marks)

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

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

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(c) Write equation (s) to show how phenol can be synthesized from chlorobenzene. (1½ mark)

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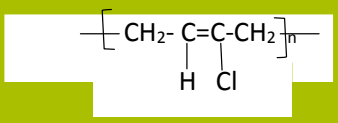
8. (a) Neoprene is a synthetic polymer which has the following structure.



(i) Name they type of polymerization reaction which leads to formation of neoprene. (½ marks)

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(ii)

(i) Write the structure and name the neoprene. (1marks)

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

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(c) State one use neoprene (½ mark)

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9. Calculate the pH of $0.1moldm^{-3}$ solution of aluminium nitrate.
(Acid dissociation constant, Ka, at 25^0C for $Al(H_2O)_6^{3+}$ $moldm^{-3}$) (3marks)

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SECTION A

(Attempt only questions in this section)

10 (a) Explain what is meant by the term common ion effect. (1mark)

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(b) Silver chromate is sparingly soluble in water

Write

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

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

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(c) A saturated solution of silver chromate contains 2.4 x 10^{-2}g per liter at 20^{0}C. Calculate the value for the solubility product, Ksp, for silver chromate at 20^{0}C.

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(d) chloride ions is solution can be determine 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 reacted (01marks)

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(ii) 25cm^3 of a solution containing 0.1moles of potassium chloride and 0.001 moles of chromate ion is 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^{-1}0mol^{2}l^{-1}]

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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 84cm^3 of nitrogen at 15^{0}C and 760mmHg.

Calculate the empirical formula of Y (4 ½ marks)

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(b) When Y was vaporized, it took 38seconds to diffuse through the same porous partition under similar conditions whereas oxygen takes 28s. calculate the molecular formula of Y (03minutes)

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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 (½ mark)

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(ii) Write equation for the reaction that takes place (1mark)

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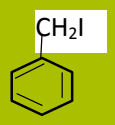
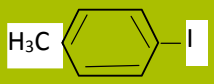
12. Name the reagents that can be used to distinguish between the following pairs of compounds. In each case state what would be observed if each member of the pair is separately treated with the reagent. (03marks)

(i) 

and 

Name of reagent(s)

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Observations

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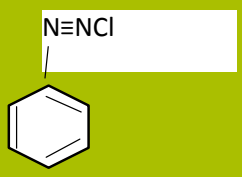
(ii) 

and $CH_3CH_2N{\equiv}NCl$

Name of reagent(s)

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Observations

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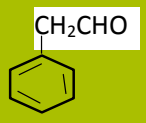
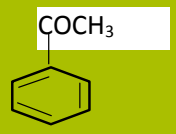
(iii) 

and 

Name of reagent(s)

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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 takes place if any) (04marks)

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(i) Give a reason for the difference in reactivity shown by the hydrides in (a)(i) above. (1mark)

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

Hydride	HF	HCl	HBr	HI
Bond length (Å	0.86	1.28	1.42	1.60

(i) State the trend in the variation of bond length of the hydrides. (1mark)

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(ii) Explain your answer in (b)(i) above (3marks)

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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. (1 ½ mark)

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(ii) e expression for the equilibrium constant (Kc) (½ mark)

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

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(c) the percentage of ammonia in equilibrium mixture of gases was found to be 15% at 600^0C.

Calculate the equilibrium constant (Kc) for the reaction at 600^0C. (4marks)

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(d) State what would happen to 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. (1 ½ mark)

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15. Write equation to show how the following conversions can be effected. (3marks each)

(a) Ethanol to benzene

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(b) 1,2-dibromoethane to ethanol

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(c) Phenylpropane to phenol

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

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(ii) Explain why zinc is not considered to be a transition element. (2marks)

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

(i) Write equation for the decomposition of cobalt (II) nitrate. (1 ½ marks)

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(ii) Name the species responsible for the pink color of the solution. (1mark)

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(c) to the aqueous solution in (b) was added concentrated hydrochloric acid dropwise until in excess. State what was observed and write equation for the reaction that took place.

(i) observation

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(ii) equation

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17. (a) Explain is meant by partition coefficient. (2marks)

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(b) The table below shows the concentrations of iodine in the two layers shaken with a mixture of carbon tetrachloride and water at 25^0C.

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 tetrachloride against concentration of iodine in water. (03marks)

(ii) from the graph determine the partition coefficient for iodine distributed between carbon tetrachloride and water. (02 mark)

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(c) State two applications of partition coefficient (2marks)

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END

525/1

S6 CHEMISTRY

Exam 16

PAPER 1

DURATION: 2 HOUR 45 MINUTES

For Marking guide contact and consultations: Dr. Bbosa Science 0776 802709.

Instructions to candidates;

- *Answer all questions in Section A and any six in Section B.*
- *All questions must be answered in spaces provided.*
- *Illustrate your answers with equations where applicable.*
- *Molar gas constant, R=8.314jk^{-1}mol^{-1}*
- *Molar volume for a gas at s.t.p is 22400cm^{3}*
- *Standard temperature =273k*
- *Standard pressure =101325 Nm^{-2}*

SECTION A

Answer all questions from this section.

1. State the condition(s) and write equation for the reaction of aluminium and;
i) water (2marks)

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ii) Iron (III) oxide (2marks)

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2. a) State what is meant by the term ebullioscopic constant. (1mark)

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b) 0.40g of camphor when dissolved in 33.5g of trichloromethane produces a solution boiling at 0.30^0C above the boiling point of pure solvent. Calculate the ebullioscopic constant of trichloromethane. (Molar mass of camphor = 155).

(3marks)

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3. a) State what is observed and write equation for the reaction when;

i) Ethanal is mixed with a saturated solution of sodium hydrogen sulphite. (2marks)

Observation:

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Equation

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ii) Neutral iron(III) chloride solution is added to aqueous solution of hydroxybenzene. (2marks)

Observation;

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Equation;

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b) Write the mechanism for the reaction in a(i). (2 ½ marks)

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4. a) State what is meant by the term electrode potential. (1mark)

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b) The electrode potential of some half cells are given below.

		(E^{C}V)
$S_2O_8^{2-}(aq) + 2e^-$	$\longrightarrow$ $2SO_4^{2-}(aq)$	$+2.01$
$I_2(aq) + 2e^-$	$\longrightarrow$ $2I^-(aq)$	$+0.54$

Write;

i) The cell notation of cell formed when the half cells are combined.

(1mark)

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ii) equation for the overall cell reaction. (1½ marks)

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iii) Calculate the e.m.f of cell. (1mark)

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iv) State whether the cell reaction is feasible or not. Give a reason for your answer. (1mark)

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5. a) State two properties in which beryllium shows diagonal relationship with aluminum. (2marks)

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b) Write equations to illustrate the properties stated in (a) (3marks)

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6. State what would be observed and write equation for the reaction that takes place when

a) Chlorine gas is passed through a solution of potassium manganate(VI) (2 ½ marks)

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b) A few drops of hydrogen peroxide solution is added to acidified potassium dichromate(VI) solution. (2 ½ marks)

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7. Write equations to show how the following conversions can be effected.

(2½ marks)

a) $(CH_3)_2COH$ to $(CH_3)_3COH$

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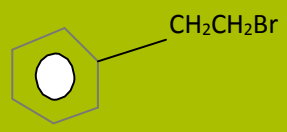
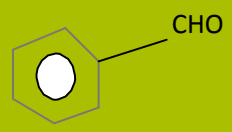
b) 

to 

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8. 30cm³ of a hydrocarbon Q was exploded with 200cm³ of oxygen in excess. The volume of the residual gas on cooling to room temperature was found to be 155cm³. When the residual gas was treated with concentrated potassium hydroxide solution, the volume reduced to 35cm³.

a) Calculate the molecular formula of Q. (3marks)

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b) Write the structures of all possible open chain isomers of Q. (1mark)

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c) Q reacts with ammoniacal copper(I) chloride solution.

i) State what is observed. (1mark)

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ii) Write equation for the reaction that takes place. (1½ marks)

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9. The molar conductivity of a 0.093M solution of ethanoic acid at 25^0C is 5.34 x 10^{-4} sm^2mol^{-1}. The molar conductivity at infinite dilution of H^+ and CH_3COO^- ions are 3.51 x 10^{-2} and 0.4 x $10^{-2}Sm^2mol^{-1}$ respectively. Calculate the;

i) molar conductivity of ethanoic acid at infinite dilution. (1 ½ marks)

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ii) degree of dissociation , α of ethanoic acid. (1 ½ marks)

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iii) acid dissociation constant, Ka at 25^0C (1 ½ marks)

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SECTION B

Attempt only six questions from this Section

10. a) An organic compound Z has a molecular formula $C_3H_6Br_2$.
Write down the structural formula and IUPAC names of all isomers of Z.
(3marks)

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b) When Z was heated with sodium metal in ethanol a compound Y was formed. Y reacts with water in the presences of sulphuric acid and Mercurous sulphate at 60^0C to form a compound X. X does not react with Fehling's solution but forms an orange precipitate with Brady's reagent. Identify compound X, Y and Z.
(1½ marks)

X .....
Y .....
Z .....

c) Write the equation and suggest the mechanism for the reaction between
i) Z and sodium metal in ethanol.

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ii) X and Brady's reagent. (2 ½ marks)

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11. Explain each of the following observations (Your answer should include balanced equations if any). (3marks each)

a) When hydrogen iodide is treated with concentrated sulphuric acid, iodine is liberated whereas when hydrogen chloride is similarly treated, chlorine is not evolved.

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b) An aqueous solution of sodium sulphite has a pH greater than 7 whereas that of sodium hydrogen sulphite is less than 7.

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c) When hydrogen sulphide is bubbled through an aqueous solution of iron(III) chloride a yellow precipitate is observed.

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12. a) State Raoults law as applied to binary liquid systems. (1mark)

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b) The mixture of water and nitric deviates negatively from Raoults law. The mixture form an azeotropic mixture at 68.2% nitric and boiling point 121^0C.

i) Sketch a labeled boiling point – composition diagram for the mixture above. (Bpts of HNO_3 and H_2O respectively are 78.2^0C and 100^0C at 760mmHg pressure.) (3marks)

ii) Describe briefly what happens when a mixture containing 50% nitric acid is distilled. (2½ marks)

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c) Explain why the mixture deviates negatively from Raoults law.

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d) Name one method of obtaining pure nitric acid from the azeotropic mixture. (1mark)

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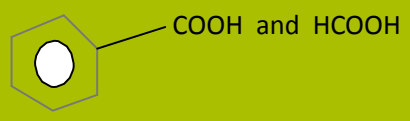
13. Name the reagents that can be used to distinguish between the following pair of organic compounds. In each case state what is observed when the compounds are separately treated with the reagent. (3marks)

a)



Reagent

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Observation

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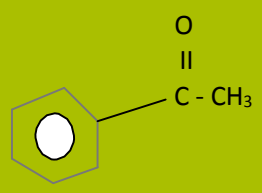
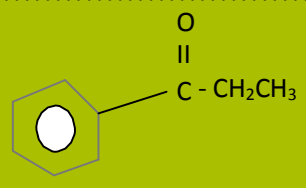
b) 

and 

Reagent

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Observations

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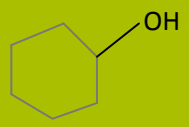
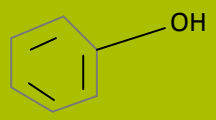
c) 

and 

Reagent

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Observations

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14. a) 0.111g of a vaporized sample of an organic compound R occupied 48.0cm^3 at 20^{0}C and 700mmHg pressure. Calculate the relative molecular mass of R.

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b) R consists 59.9% carbon, 26.6% oxygen and the rest is hydrogen. Determine;

i) the empirical formula of R (2marks)

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ii) the molecular formula of R (1½ marks)

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c) Write down the structural formulae and give the IUPAC names of all isomers of R. (3marks)

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15. a) State two characteristic properties exhibited by manganese as a transition element.

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b) i) Write the electronic configuration of manganese. (½ mark)

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ii) State the common oxidation states exhibited by manganese in its compounds. (1 ½ marks)

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c) i) Manganese (IV) oxide reacts with concentrated hydrochloric . Write the equation of reaction that takes place. (1 ½ marks)

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d) Lead(V) oxide was added to an aqueous solution of manganese (II) chloride, followed by concentrated nitric acid. The mixture was then heated.

i) State what was observed. (1½ marks)

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ii) Write equation of reaction that takes place. (1½ marks)

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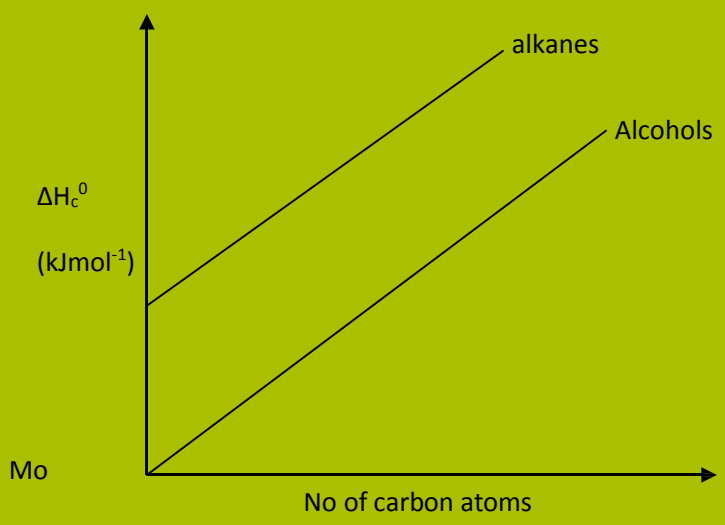
16. a) The standard enthalpies of combustion of some straight chain alkanes and alcohols against number of carbon atoms is shown below.



i) Explain the shape of the graph(s)

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ii) The graph for alcohol passes through the origin. Explain why this is so. (1½ marks)

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iii) The graph for alkanes has an intercept. What is the siginificance of the intercept? (1 ½ marks)

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b) Energy changes for some reactions are shown below;

		$\Delta HO/Kjmol^{-1}$
i) $CO(g) + ½ O_2(g) \longrightarrow$	$CO_2(g)$	-283
ii) $H_2(g) + ½ O_2(g) \longrightarrow$	$H_2O(l)$	-286
iii) $CH_3OH(l) + {}^3/_2O_2(g) \longrightarrow$	$CO_2(g) + 2H_2O(l)$	-715

Calculate the enthalpy change for the reactions

$CO(g) + 2H_2(g) \longrightarrow CH_3OH(l)$ (3marks)

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17. a) Explain what is meant by the term complex ion. (1mark)

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b) i) Some complex ions are given below. In each case state the coordination number and oxidation state of the central atom. (3marks)

Formulae of complex ion	Coordination number	Oxidation state
$CoCl_4^{2-}$		
$Fe(CN)_6^{3-}$		

$Ag(NH_3)_2^+$		

ii) Explain why transition metals form complex ions.

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c) In each case write equation catalyzed by the following ions/species.

(1 ½ marks @)

i) Vanadium pentoxide

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ii) Manganese II ions

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**END **

525/1

S6 CHEMISTRY

Exam 17

PAPER 1

DURATION: 2 HOUR 45 MINUTES

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Instructions to candidates

- The paper consists of nine questions in section A and 6 questions in section B
- All questions are compulsory
- Answer the questions in the spaces provided only.

SECTION A:

1. Draw the structures and give the name of the shapes of the following chemical species.

Species	**Structure**	**Name**
(i) IF_5		
(ii) BCl_3		
(iii) CO_3^{2-}		

2

(iv)NH_4^+		

2 (a) Define the term buffer solution (1 mark)

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(b) Determine the pH of a solution made by adding 25cm^3 of 0.2M nitric acid to 80 cm^3 of 0.2M ammonia solution.

(K_b for NH_4OH = 1.8 x 10^{-5} moldm^{-3}) (5 marks)

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3. (a) What is meant by the term steam distillation? (1 ½ marks)

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(b) A compound P is immiscible with water and forms a mixture which boils at 92°C. If the total vapour pressure of the mixture is 101.3kPa and the vapour pressure of water at the same temperature is 88.2 kPa, determine the percentage composition by mass of the mixture given that P has RFM of 125. (3 ½ marks)

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4. Complete the following organic reactions and name the main organic products in each case

(a) $H_3CH_2C(=O)CH_3 \xrightarrow[\text{Zn/Hg}]{\text{ConcHCl}}$

Name of product

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(b) $CH_3 - CH = CH_2 \xrightarrow[\text{Heat}]{\text{Br/H}_2\text{O}}$

Name of product

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(c) $H_3CH_2CH_2I \xrightarrow[\text{Heat}]{\text{NaOH/CH}_3\text{CH}_2\text{OH}}$

Name of product

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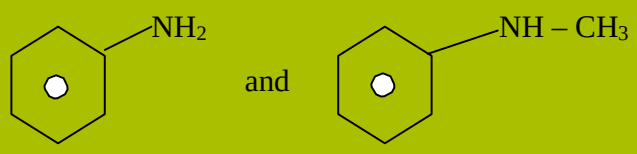
5. Name the reagents that can be used to distinguish between the following pairs of compounds and state what is observed in each case when the compounds are separately

treated with the reagent

(a)



Reagent

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Observation

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(b) $CH_3CH_2COOCH_3$ and $CH_3\ CH_2CH_2COOH$

Reagent

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Observation

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6. (a) Iron is extracted by the reduction of the ore in the blast furnace.

(i) State the principle ore of iron (1 mark)

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(ii) Write an equation to show how the ore is converted to iron. (1½ marks)

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(b) Briefly describe how iron reacts with

(i) water (3½ marks)

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(ii) chlorine (3marks)

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7 Carbon, silicon, germanium, tin and lead are in group ;(iv) of the periodic table

(a) (i) Write the general outermost electronic configuration of the elements.

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(ii) State the common oxidation states exhibited by the elements in their ions or compounds.

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(b) State what would be observed and write the equation for the reaction that would take place, if any, when the following compounds are treated with water.

(i) CCl_4 (1 mark)

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(ii) $SiCl_4$ (3 marks)

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8 Write an ionic equation for the reaction between aqueous sodium hydroxide and

(a) aluminium (III) oxide (1 ½ marks)

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(b) Tin (iv) oxide (1 ½ marks)

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(c) hromium (III) oxide (1 ½ marks)

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9. The first ionization energies and melting points of the chlorides of some elements of group II of the periodic table are given in the table below

Element	Mg	Ca	Sr	Ba
1st ionization energy ($kjmol^{-1}$)	734	594	548	506
Melting point (^{o}c)	708	772	873	967

(a) Explain

(i) Why ionization energy decreases with increase in the atomic number. (2 marks)

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(ii) Why the melting points of the chlorides increase with increase in atomic number of the elements (2 marks)

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(b) How would you expect the solubility of the chlorides in water to vary with atomic number of the elements? Give a reason for your answer. (2 marks)

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SECTION B:

10. When tri-lead tetraoxide, Pb_3O_4 is reacted with nitric acid, a dark brown solid was formed.

(a) rite an equation for the reaction which took place. (1 ½ marks)

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(b) The resultant mixture obtained in the reaction was filtered and the residue warmed with concentrated hydrochloric acid. The filtrate was divided into two parts.

State what was observed and write equation(s) for the reaction which took place. (2 ½ marks)

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(c) To the first part of the filtrate was added a few drops of potassium chromate solution followed by dilute nitric acid.

9

(i) State what was observed (1 ½ marks)

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(ii) Write ionic equation(s) for the reaction. (2 ½ marks)

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11. (a) Define the terms

(i) Radioactivity (1 mark)

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(ii) Nuclear fission (1 mark)

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(b) (i) What is meant by the term binding energy of a nucleus? (2 marks)

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(ii) Copper has relative atomic mass 63.5. Determine the binding energy of the copper atoms given that the mass number of copper is 64. (2 marks)

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(c) A radioactive element Q has a half life of 24 years. Given 8g of Q, what mass of Q will be left after 72 years? (2 marks)

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(d) Give two uses of radioactive isotopes. (1 mark)

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12. (a) Define the terms:

(i) Activation energy. (1 mark)

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(ii) Enthalpy of atomization (1 mark)

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(b) Lattice energy of rubidium chloride = 665 $KJmol^{-1}$

Enthalpy of bond dissociation of chlorine = 226$KJmol^{-1}$

Enthalpy of atomisation of rubidium = 84$KJmol^{-1}$

Ionisation energy of rubidium atom = 397$KJmol^{-1}$

Standard enthalpy of formation of solid rubidium chloride = – 439KJmol^{-1}

Calculate the electron affinity of chlorine (4 marks)

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(c) odium chloride and potassium chloride have lattice enthalpies – 788 and – 718KJmo^{-1} respectively.

Explain the difference. (3 marks)

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13. 3.7g of an organic compound Q containing carbon, hydrogen and oxygen was exploded in excess oxygen. 4.5g of water and 6.48dm^3 of gaseous substances were passed through sodium hydroxide solution. 2dm^3 of oxygen was found unreacted (All volumes of gaseous substances were measured at s.t.p)

(a) (i) Determine the empirical formula of Q

(C = 12, H = 1, O = 16)

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(ii) If the vapour density of Q is 37, determine the molecular formula of Q and write all the possible structural formulae of Q

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(b) Q reacts with a mixture of sodiumhydroxide and iodine solution to give a yellow precipitate.

(i) Identify Q

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(ii) Name the reagent(s) used to confirm the functional group in Q

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(iii) Starting from but – 1 – yne and using equations, outline methods by which Q could be prepared.

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14. (a) Acidified potassium manganate (VII) reacts with ethanedioic acid.

Write:

(i) the half equations for the reaction (2 marks)

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(ii) The overall equation for the reaction (2 marks)

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(b) 20.2 cm^3 of a 0.01M manganate (VII) ion solution required exactly 16.55 cm^3 of a solution containing 4.8 gl^{-1} of an oxalate $(COO^- X^+)_2 . 2H_2O$

Calculate the atomic mass of X. (5 marks)

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15. (a) Phenylamine was mixed with concentrated hydrochloric acid and sodium nitrite at a temperature of 0° – 5^oC. The resultant solution (Y) was then treated with a mixture of phenol in aqueous sodiumhydroxide. State what is observed and write the equation of reaction that takes place between

(i) phenyl amine and a mixture of concentrated hydrochloric acid and sodium nitrite.

Observation

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Equation

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(ii) Y and phenol in aqueous sodiumhydroxide

Observation

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Equation

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(b) 20cm^3 of 0.05M aqueous phenyl amine was mixed with 50cm^3 of 1M sodium bromide and electrolysed by a current of 0.2A. The first permanent bromine colour was observed after 49.93 minutes when electrolysis was stopped
(Faraday's constant = 96500)

(i) Calculate the number of moles of bromine that reacted with 1 mole of phenylamine

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(ii) Hence write equation of reaction between bromine and phenylamine. Name the product.

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16

END

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S6 CHEMISTRY

Exam 18

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions to candidates:

Answer all questions in section A and six questions in section B.
All questions are to be answered in the spaces provided.
The periodic table, with relative atomic masses, is supplied at the end of the paper.
Mathematical tables (3 figure tables are adequate) or non-programmable scientific electronic calculators may be used.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total

SECTION A: (46 MARKS)

1. (a) Complete the following nuclear equations (2 marks)

(i) $^{31}_{15}P + ^{2}_{1}H \longrightarrow \ldots\ldots + ^{1}_{1}H$

(ii) $^{7}_{3}Li + \ldots\ldots \longrightarrow 2\,^{4}_{2}He$

(iii) $^{14}_{7}C \longrightarrow ^{14}_{7}N + \ldots\ldots$

(iv) $^{214}_{83}Bi \longrightarrow ^{0}_{-1}e + \ldots\ldots$

(b) The half life of bismuth is 19.7 minutes. Determine the time taken for 75% by mass of the bismuth to decay (3 marks)

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2. (a) Explain what is meant by the term oxidation number (1 m)

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(b) Determine the oxidation number of

(i) sulphur in $S_2O_8^{2-}$ and SO_4^{2-}

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(ii) Manganese in MnO_4^-

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(c) rite the half equation for the conversion of $S_2O_8^{2-}$ to SO_4^{2-} (1 mark)

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(d) Complete the following and balance the equations

(i) $S_2O_8^{2-} + I^- \longrightarrow$

(ii) $MnO_4^- + Fe^{2+} + H^+ \longrightarrow$

3. (a) Complete the following equations and in each case give the IUPAC name of the main organic product (@ 1 mark)

(i) $(CH_3)_2CBrCH_3 \xrightarrow[\text{heat}]{C_2H_5O^-K^+/C_2H_5OH}$

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(ii) $CH_3C \equiv CH + H_2O \xrightarrow[H_2SO_4]{Hg^{2+}(aq)}$

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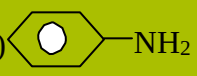
(iii) 

$\xrightarrow[\text{dil HCl } 0^oC]{NaNO_2}$

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(b) Complete the following equations and in each case write a mechanism for the reaction (@ 1 ½ marks)

(i) $CH_3CH = CH_2 \xrightarrow{Cl_2/H_2O}$

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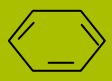
(ii)  $+ Cl_2 \xrightarrow{AlCl_3}$

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4. (a) Sketch and name the shape of each of the following species (4 marks)

Species	Shape	Name of shape
SO_2		
NH_4^+		
PCl_5		
NCl_3		

(b) The atomic number of element X is 26.

(i) Write the outermost electron configuration of x (½ mark)

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(ii) State the possible oxidation states X can show (1 ½ marks)

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5. (a) Define what is meant by the term partition coefficient (1 mark)

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(b) 100 cm^3 of aqueous solution contained 50g of S. Calculate the mass of S that remained in the aqueous layer when the solution was shaken with

(i) 100 cm^3 of solvent A (1 ½ marks)

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(ii) Twice with 50 cm^3 of solvent A (The partition coefficient of S between A and water is 10:1) (2 ½ marks)

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(c) omment on your results in b (i) and (ii) (1 mark)

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6. (a) What is meant by

(i) atomisation energy (2 marks)

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(ii) bond energy

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(b) Carbon reacts with hydrogen

(i) Write an equation for the reaction

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(ii) Draw a labelled Born Haber cycle and identify the energy changes involved at each step when carbon react with hydrogen (1 mark)

(c) Given the enthalpy of formation of methane and atomisation energy of carbon and hydrogen are – 75 $Kjmol^{-1}$, 715 $Kjmol^{-1}$ and 436 $Kjmol^{-1}$ respectively, calculate the bond energy for C – H bond (2 marks)

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7. (a) A mixture of water and Bromobenzene when steam distilled at standard pressure boils at 95.7^{o}C whereas the b.p of water and Bromobenzene at standard pressure is 100°C and 155°C respectively. Explain why the mixture boils at 95.7^{o}C (2marks)

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(b) Calculate the percentage by mass of Bromobenzene in the distillate from the mixture in (a). (The saturated vapour pressure of water at 95.7^{o}C is 655mmHg).

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8. (a) Why does the vapour pressure of a given mass of solvent decrease when a known mass of non-volatile solute is added to the solvent?

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(b) A solution was prepared by dissolving 7.5g of propan – 1,2,3- triol (glycerol), $C_3H_8O_3$ in 200g of water at 25°C and at standard pressure. Calculate the boiling point of the solution at standard pressure (Kb of water = 0.52 K kgmol – 1) (3 marks)

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9. (a) Acidified potassium dichromate was reacted with potassium iodide
(i) State what was observed (1 mark)

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(ii) Write the half ionic equation and overall equation for the reaction (2 marks)

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SECTION B: (54 MARKS)

10. (a) What is meant by (@ 1 ½ marks)
(i) first ionisation energy
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(ii) electron affinity
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(b) The first ionisation energies and first electron affinities of group (VII) elements are given in the table below.

Name of element	First ionistion energy/Kjmol $^{-1}$	First electron affinity/Kjmol $^{-1}$
Fluorine	1681	– 328
Chlorine	1250	– 349
Bromine	1139	– 325
Iodine	1007	– 295

(i) State how the first electron affinities of group (VII) elements generally vary with their first ionisation energies (1 mark)
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(ii) Explain the trend in first electron affinity of group (VII) elements (3 marks)

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(c) The boiling point of group ;(VII) elements increases down the group. Explain this observation (2 marks)

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11. (a) Write an expression for the

(i) acid dissociation constant , Ka, for ethanoic acid (2 marks)

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(ii) relationship between acid dissociation Ka and the degree of ionisation of an acid (1 mark)

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(b) The molar conductivity at infinite dilution of ethanoic acid at 20ºC is 3.5×10^{-2} Sm^2 mol^{-1} while a 1.6×10^{-2} molar conductivity of ethanoic acid at 20ºC is 1.225×10^{-3} Sm^2 mol^{-1} . Calculate

(i) The degree of ionisation of the acid at 20ºC (1 mark)

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(ii) The pH of the acid (3 marks)

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(c) Besides concentration, state one other factor that can affect the pH of the acid (1 mark)

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12. State what would be observed and write equations for the reactions that take place when the following compounds are reacted

(a) Aqueous iron (III) chloride with sodium carbonate (3 marks)

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(b) Iron (II) ions and hydrogen peroxide in acidic conditions. (3 marks)

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(c) Chromium (III) sulphate with sodium hydroxide dropwise until in excess (3 marks)

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13. Write equations to show how the following conversions can be made

(a) ethyne from ethanol (4 marks)

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(b) Benzoic acid from benzene (2 marks)

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(c) ropane from 1 bromobutane (3 marks)

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14. (a) Phenylamine hydrochloride $C_6H_5NH_3^+Cl^-$ undergoes hydrolysis when dissolved in water . Write an

(i) equation for the reaction (2 mark)

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(ii) expression for the hydrolysis constant Kh (1 mark)

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(b) A 0.2 molar solution of phenylamine hydrochloride has a pH = 3.5, calculate:
(i) the concentration of hydrogen ions in solution (3 marks)
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(ii) the hydrolysis constant, Kh of phenylamine hydrochloride (3 marks)

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15. The table below gives some data on substances A to D

Substance	A	B	C	D
Melting point (^oC)	1610	– 183	2015	98
Conduction of electricity in molten state	Deos not	Does not	Does	Does

(a) Classify the solid formed by eac substance according to its structure and type of bonding

Substance	A	B	C	D
Type of structure				
Type of bonding				

(b) In the series Na, Mg, Al, Si, P, S and Cl
State element with

	Element
(i) highest melting point	
(ii) Smallest atomic radius	

(iii) largest ionisation energy	
(iv) smallest electronegativity	

(2 marks)

(c) Explain why the element you have stated in (b) (i) has the highest melting point (3 marks)

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16. Hydrogen iodide decomposes when heated according to the equation

$2HI(g) \rightleftharpoons Hz(g) + I_2(g)$ $\Delta H = +11.3\ Kjmol^{-1}$

(a) Write an expression for the equilibrium constant Kc for the reaction (½ mark)

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(c) 1.54g of hydrogen iodide was heated in a 600cm^3 bulb at 530°C. When equilibrium was attained, the bulb was cooled to room temperature and broken under potassium iodide solution. The iodine formed from the decomposition required 67.0cm^3 of 0.1M sodium thiosulphate solution for complete reaction. Calculate

(i) the number of moles of hydrogen iodide in 1.54g (1 mark)

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(ii) the number of moles of iodine formed when hydrogen iodide was decomposed (3 ½ marks)

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(iii) the value of Kc at 530°C. (2 ½ marks)

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(c) tate what would be the effect on the value of Kc if

(i) the temperature was raised from 530°C to 800°C (1 mark)

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(ii) the volume of the bulb was increased to 1200 cm^3 (1 mark)

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17. In the extraction of iron, haematitie is mixed with coke and limestone and then heated in a blast furnace.
(a) State the purpose of adding
(i) coke (2 marks)

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(ii) limestone (2 marks)
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(b) Explain why iron can be extracted by the ;method described above (2 mark)
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(c) (i) Name one other method that could be used to extract iron from its ore (1 mark)

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(ii) Suggest a reason why the method you have named in c (i) is not commonly used in the production of iron (1 mark)
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(d) Write any one equation that illustrates the reduction of the ore in the blast furnace. (2 marks)
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END

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Exam 19

S6 CHEMISTRY

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions to candidates;

- *Answer all questions in Section A and any six in Section B.*
- *All questions must be answered in spaces provided.*
- *Illustrate your answers with equations where applicable.*
- *Molar gas constant, R=8.314jk^{-1}mol^{-1}*
- *Molar volume for a gas at s.t.p is 22400cm^{3}*
- *Standard temperature =273k*
- *Standard pressure =101325 Nm^{-2}*

SECTION A

Answer all questions from this section.

1. State the condition(s) and write equation for the reaction of aluminium and;

i) water (2marks)

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ii) Iron (III) oxide (2marks)

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2. a) State what is meant by the term ebullioscopic constant. (1mark)

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b) 0.40g of camphor when disoolved in 33.5g of trichloromethane produces a solution boiling at 0.30^0C above the boiling point of pure solvent. Calculate the ebullioscopic constant of trichloromethane. (Molar mass of camphor = 155).

(3marks)

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3. a) State what is observed and write equation for the reaction when;

i) Ethanal is mixed with a saturated solution of sodium bisulphite. (2marks)

Observation:

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Equation

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ii) Neutral iron(III) chloride solution is added to aqueous solution of hydroxybenzene. (2marks)

Observation;

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Equation;

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b) Write the mechanism for the reaction in a(i). (2 ½ marks)

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4. a) State what is meant by the term electrode potential. (1mark)

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b) The electrode potential of some half cells are given below.

		(E°V)
$S_2O_8^{2-}(aq) + 2e^-$	$\longrightarrow$ $2SO_4^{2-}(aq)$	$+2.01$
$I_2(aq) + 2e^-$	$\longrightarrow$ $2I^-(aq)$	$+0.54$

Write;

i) The cell notation of cell formed when the half cells are combined.

(1mark)

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ii) equation for the overall cell reaction. (1½ marks)

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iii) Calculate the e.m.f of cell. (1mark)

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iv) State whether the cell reaction is feasible or not. Give a reason for your answer. (1mark)

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5. a) State two properties in which beryllium shows diagonal relationship with aluminum. (2marks)

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b) Write equations to illustrate the properties stated in (a) (3marks)

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6. State what would be observed and write equation for the reaction that takes place when

a) Chlorine gas is passed through a solution of potassium manganate(VI)

(2 ½ marks)

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b) A few drops of hydrogen peroxide solution is added to acidified potassium dichromate(VI) solution.

(2 ½ marks)

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7. Write equations to show how the following conversions can be effected.

(2½ marks)

a) $(CH_3)_2COH$ to $(CH_3)_3COH$

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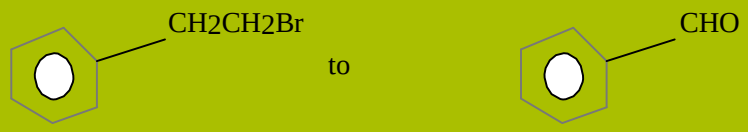
b) 

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8. $30cm^3$ of a hydrocarbon Q was exploded with $200cm^3$ of oxygen in excess. The volume of the residual gas on cooling to room temperature was found to be $155cm^3$. When the residual gas was treated with concentrated potassium hydroxide solution, the volume reduced to $35cm^3$.

a) Calculate the molecular formula of Q. (3marks)

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b) Write the structures of all possible open chain isomers of Q. (1mark)

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c) Q reacts with ammoniacal copper(I) chloride solution.

i) State what is observed. (1mark)

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ii) Write equation for the reaction that takes place. (1½ marks)

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9. The molar conductivity of a 0.093M solution of ethanoic acid at 25^0C is 5.34×10^{-4} sm^2mol^{-1}. The molar conductivity at infinite dilution of H^+ and CH_3COO^- ions are 3.51×10^{-2} and $0.4 \times 10^{-2} Sm^2mol^{-1}$ respectively. Calculate the;

i) molar conductivity of ethanoic acid at infinite dilution. (1 ½ marks)

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ii) degree of dissociation , □□ of ethanoic acid. (1 ½ marks)

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iii) acid dissociation constant, Ka at 25^0C (1 ½ marks)

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SECTION B

Attempt only six questions from this Section

10. a) An organic compound Z has a molecular formula $C_3H_6Br_2$.

Write down the structural formula and IUPAC names of all isomers of Z.

(3marks)

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b) When Z was heated with sodium metal in ethanol a compound Y was formed. Y reacts with water in the presences of sulphuric acid and Mercurous sulphate at 60^0C to form a compound X. X does not react with Fehling's solution but forms an orange precipitate with Brady's reagent. Identify compound X, Y and Z.

(1½ marks) X

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Y …….. Z

……..

c) Write the equation and suggest the mechanism for the reaction between

i) Z and sodium metal in ethanol.

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ii) X and Brady's reagent. (2 ½ marks)

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11. Explain each of the following observations (Your answer should include balanced equations if any). (3marks each)

a) When hydrogen iodide is treated with concentrated sulphuric acid, iodine is liberated whereas when hydrogen chloride is similarly treated, chlorine is not evolved.

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b) An aqueous solution of sodium sulphite has a pH greater than 7 whereas that of sodium hydrogen sulphite is less than 7.

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c) When hydrogen sulphide is bubbled through an aqueous solution of iron(III) chloride a yellow precipitate is observed.

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12. a) State Raoults law as applied to binary liquid systems. (1mark)

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b) The mixture of water and nitric deviates negatively from Raoults law. The mixture form an azeotropic mixture at 68.2% nitric and boiling point 121^0C.

i) Sketch a labeled boiling point – composition diagram for the mixture above. (Bpts of HNO_3 and H_2O respectively are 78.2^0C and 100^0C at 760mmHg pressure.) (3marks)

ii) Describe briefly what happens when a mixture containing 50% nitric acid is distilled. (2½ marks)

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c) Explain why the mixture deviates negatively from Raoults law.

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d) Name one method of obtaining pure nitric acid from the azeotropic mixture.

(1mark)

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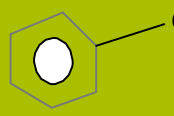
13. Name the reagents that can be used to distinguish between the following pair of organic compounds. In each case state what is observed when the compounds are separately treated with the reagent. (3marks)

a)



COOH and HCOOH

Reagent

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Observation

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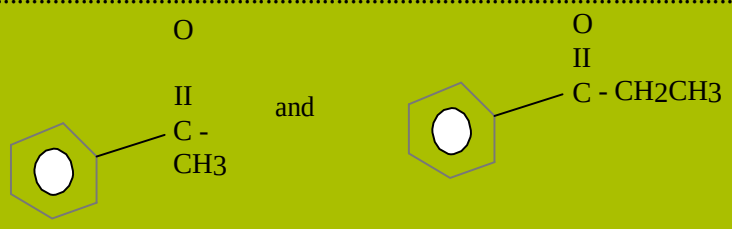
b) 

Reagent

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Observations

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c)

Reagent

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Observations

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14. a) 0.111g of a vaporized sample of an organic compound R occupied 48.0cm^3 at 20^{0}C and 700mmHg pressure. Calculate the relative molecular mass of R.

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b) R consists 59.9% carbon, 26.6% oxygen and the rest is hydrogen. Determine;

i) the empirical formula of R (2marks)

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ii) the molecular formula of R (1½ marks)

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c) Write down the structural formulae and give the IUPAC names of all isomers of R. (3marks)

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15. a) State two characteristic properties exhibited by manganese as a transition element.

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b) i) Write the electronic configuration of manganese. (½ mark)

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ii) State the common oxidation states exhibited by manganese in its compounds.

(1 ½ marks)

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c) i) Manganese (IV) oxide reacts with concentrated hydrochloric . Write the equation of reaction that takes place. (1 ½ marks)

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d) Lead(V) oxide was added to an aqueous solution of manganese (II) chloride, followed by concentrated nitric acid. The mixture was then heated.

i) State what was observed. (1½ marks)

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ii) Write equation of reaction that takes place. (1½ marks)

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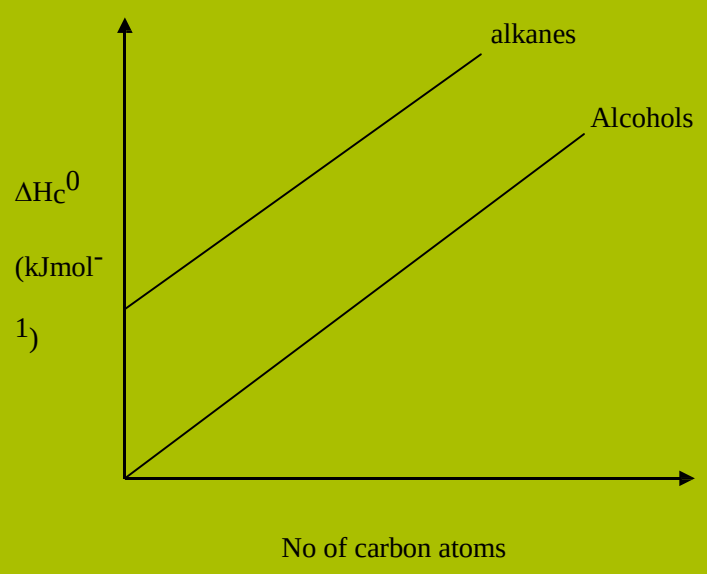
16. a) The standard enthalpies of combustion of some straight chain alkanes and alcohols against number of carbon atoms is shown below.



i) Explain the shape of the graph(s)

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ii) The graph for alcohol passes through the origin. Explain why this is so.

(1½ marks)

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iii) The graph for alkanes has an intercept. What is the siginificance of the intercept? (1 ½ marks)

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b) Energy changes for some reactions are shown below;

			$\Delta HO/Kjmol^{-1}$
i) $CO(g) + ½ O_2(g)$	$\longrightarrow$	$CO_2(g)$	-283
ii) $H_2(g) + ½ O_2(g)$	$\longrightarrow$	$H_2O(l)$	-286
iii) $CH_3OH(l) + {}^{3}/_{2}O_2(g)$	$\longrightarrow$	$CO_2(g) + 2H_2O(l)$	-715

Calculate the enthalpy change for the reactions

$CO(g) + 2H_2(g) \longrightarrow CH_3OH(l)$ (3marks)

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17. a) Explain what is meant by the term complex ion. (1mark)

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b) i) Some complex ions are given below. In each case state the coordination number and oxidation state of the central atom. (3marks)

Formulae of complex ion	Coordination number	Oxidation state
$CoCl_4^{2-}$		
$Fe(CN)_6^{3-}$		

+

$Ag(NH_3)_2$		

ii) Explain why transition metals form complex ions.

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c) In each case write equation catalyzed by the following ions/species.

(1 ½ marks @)

i) Vanadium pentoxide

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ii) Manganese II ions

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***END ***

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S6 CHEMISTRY

Exam 20

PAPER 1

DURATION: 2 HOUR 45 MINUTES

INSTRUCTIONS TO CANDIDATES

Answer all questions in section A and six questions in section B.
All questions must be answered in the space provided
The periodic table , with relative atomic masses, is supplied at the end of the paper
Mathematical tables (3 figure tables) are adequate or non-programmable scientific electronic calculators may be used.
Illustrate your answers with equations where applicable

For Examiners' use only

For examiner's use only																	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	

SECTION A: (46 MARKS)
Answer all questions in this section

1. (a) (i) Define the term "Osmotic pressure

(ii) State 4 conditions solutions should have in order to obey the laws of osmotic pressure

(b) The Osmotic pressure of an aqueous solution containing 3.22g of a polymer Q per 100 cm^3 of a solution is 5.637×10^{-2} Pa. Determine the molecular mass of Q

2. (a) Explain what is meant by "half life" of a radioactive substance.

(b) Complete the following equation for the decay of bismuth

$$^{214}_{83}Bi \; ^{0}_{-1}e + \ldots\ldots\ldots$$

(c) The half life of bismuth is 19.7 minutes. Determine the percentage by mass of bismuth which will be remaining after 16.0 minutes of decay of bismuth

3. Show how the following conversions could be carried out
(a) CH_3CO_2H from methanol

(b) From CH^2OH

4. State what is observed and write an equation(s) when the following compounds are reacted
   (a) Aqueous potassium dichromate (VI) with hydrogen sulphide

   (b) When lead (iv) oxide is heated with sulphurdioxide

   (c) Aqueous copper (II) nitrate with potassium iodide

5. (a) Define
   (i) enthalpy of hydration

   (ii) enthalpy of solution

   (b) The enthalpies of solution and lattice energies of salts AX and BX are given in the table below.

Salt	Enthalpy of solution/Kjmol $^{-1}$	Lattice energy/ Kjmol $^{-1}$
AX	+20	– 880
BX	– 10	– 790

   Calculate the enthalphy of hydration of each salt

   AX

   BX

(ii) State the salt which has a larger value of hydration energy

6. Complete the following equations and write the IUPAC name of the major organic product

(a) $H_3CH = CH_2 \xrightarrow{Br_2/H_2O}$

(b) $C_6H_5NH_2 \xrightarrow[\text{dil HCl } O^oC]{NaNO_2}$

(c) $(CH_3)_3 C Br + CH_3 \bar{O} Na^+ \xrightarrow[\text{heat}]{CH_3OH}$

7. The standard electrode potentials for some systems are given below

$Ca^{2+}(aq) + 2e \longrightarrow Ca(s)\ E^\theta = -2.87V$

$Mg^{2+}(aq) + 2e \longrightarrow Mg(s)\ E^\theta = 2.37V$

(a) Write the convention for the cell

(b) Write the equation for the overall reaction

(c) (i) calculate the cell voltage

(ii) What conclusion can you draw from the e.m.f value in c (i) above

8. (a) (i) Define the term "complex ion"

(ii) Explain why transition metals form many complexes

(b) (i) Write the structural formulae of the isomers of chromium (III) chloride $CrCl.6H_2O$

(ii) State one way of distinguishing the isomers

9. (a) (i) Explain what is meant by boiling point elevation constant

(ii) 2.8g of cadmium iodide CdI_2 was dissolved in 20g of water. Calculate the boiling point of an aqueous solution of cadmiumiodide at normal pressure.

(b) state four assumptions made in the calculation in (a)

SECTION b (54 MARKS)
Answer only six questions in this section

10. Complete the following equations and in each case write the mechanism for the reaction
    (a) CH3CH2I + KOH (aq)

    (b) CH3CHO + NH2OH H+(aq)

    (c) $+CH_3COCl$ $AlCl_3$

11. Explain why
    (a) The melting point of calcium oxide is much higher than that of calciumoxide

    (b) When solid lead (IV) oxide is added to water, white fumes are observed and a brown precipitate is formed

(c) An aqueous iron (III) chloride solution has a pH < 7

12. (a) State

(i) the distribution (partition) law

(ii) the conditions under which the distribution law is valid

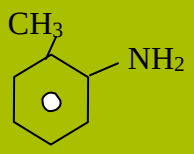
(b)1.00dm^3 of aqueous solution contains 5.00g of butanoic acid . Calculate the mass of butanoic acid extracted when the solution was shaken
(The distribution coefficient of acid between solvent Q and water is 4)

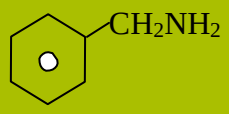
(i) with 50.0cm^3 of solvent Q

(ii) twice with 25.0cm^3 of solvent Q

13. Name one reagent that can be used to distinguish between each of the following pairs of compounds and state what would be observed in each case if the reagent is reacted with the compounds

(a) C_6H_5COOH and C_6H_5OH

(b) 

and 

(c) H_3OH and CH_3CH_2OH

14. (a) (i) Write an expression for the acid dissociation constant Ka, for ethanoic acid

(ii) Relationship between acid dissociation, Ka, and the degree of ionisation of an acid α

(b) The electrolytic conductivity of a 1.6 x 10 – 2MCH3COOH at 20oC is 1.96 x 10 – 2 Sm and its molar conductivity at infinite dilution is 3.5 x 10 – 2 Sm2 mol – 1
Calculate

(i) the molar conductivity of ethanoic acid at 20oC

(ii) the degree of ionisation of the acid at 20oC

(iii) the pH of the acid

(c) Besides concentration, state one other factor that can affect the pH of the acid

15. (a) Write the structural formulae and names of all possible isomers of an organic compound having the molecular formula C_3H_8O

(b) When one of the isomers p in (a) above was reacted with acidified potassium dichromate compound Q was formed. Q reacted with phosphorousj pentachloride to form compound R and hydrogen chloride gas
Identify
P
Q
R

(c) rite equation and indicate a mechanism for the reaction between P and concentrated sulphuric acid

16. (a) Write an equation for the hydrolysis of sodium ethanoate in water
(b) Write an expression for the hydrolysis costant K_h of sodium ethanate
(c) alculate
(i) the value of K_h for sodium ethanoate and indicate its units
(Ka for CH_3 COOH is 1.8×10^{-5}, Kw = 1×10^{-14})

(ii) The pH of a 0.1M sodium ethanoate solution

(d) State what would be the effect on pH of the solution in (c) (ii) if Icm^3 of 0.IM ethanoic acid was added to it

17. (a) In volumetric estimation of reducing agents, potassium dichromate (VI) is preferred to potassium manganate (VII) as an oxidant.

(b) 3.8 of solder containing tin was dissolved in excess hydrochloric acid. The solution was made up to $250cm^3$. $250cm^3$ of this solution required $23.5cm^3$ of a 0.01M potassiumdichromate (VI) solution for complete reaction

(i) write the half equation for potassium dichromate (VI) acting as an oxidising agent in acid medium

(ii) calculate the number of moles of potassium dichromate (VI) used

(iii) Calculate the number of moles of tin in the $250cm^3$ of solution

(iv) Determine the percentage, by mass, of tin in the solder

18.

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S6 CHEMISTRY

Exam 21

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions

Answer all questions in section A and six questions in section B.

All questions must be answered in the spaces provided.

Illustrate your answers with equations where applicable.

The periodic table is provided.

SECTION. A(46 MARKS)

Answer all questions from this section

1.a) i) State the conditions for steam distillation. (1 ½ marks)

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ii) State one advantage of steam distillation over fractional distillation. (1 mark)

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b) Substance A distills with steam at 98.3^{O}C under pressure of 753mmHg. Calculate the percentage by mass of A in the distillate. (The vapour pressure of water at 98.3^{O}C is 715mmHg; A =128) (03 marks)

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2.a) Write the electronic configuration of copper. (01 mark)

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b) State two properties of copper as a transition element. (04 marks)

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c) Hydrated copper (ii) sulphate was dissolved in water. Write equation (s) for the reaction (s) that took place. (03 marks)

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3. Complete the following equations and in each case write a mechanism for the reaction.

a) $CH_3CH_2CH_2OH \xrightarrow[180^0C]{\text{Conc } H_3PO_4}$ (03 marks)

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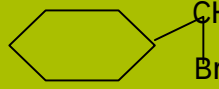
b) 

$\xrightarrow[\text{heat}]{\text{EtO/EtOH}}$ (02 marks)

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4.a) Define the term "partial pressure" (1 mark)

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b) The vapour pressures of pure chloroform and carbon tetrachloride are 199.1 and 114.5mmHg respectively at 25^oC.

(Assume that a mixture of the two liquids behave as an ideal gas and that it contains 0.96 mole of each pure liquid).

i) The partial pressure of each component in the mixture. (2 ½ marks)

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ii) The total pressure. (1 mark)

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c) Calculate the percentage of carbon tetrachloride in the vapour in equilibrium with the liquid mixture. (1 mark)

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5.Lithium is in group 1 and magnesium is in group II of the periodic table but the two elements show some common chemical properties.

a) State the name given to this type of relationship. (1 mark)

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b) Give four examples of the properties in which the two elements show similarities. (4 marks)

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c) Name two other pairs of elements that show similar type of relation as lithium and magnesium. (1 mark)

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6. Complete the following equations and write the IUPAC name of the main organic production each case.

a) $CH_3CH_2CO_2H$ + PCl_5 $\xrightarrow{\text{heat}}$ (1 ½ marks)

b) HC = CH $\xrightarrow{Ag(NH_3)_2^+ (aq)}$ (1 ½ marks)

7. The ionic radii of Na^+, Mg^{2+} and Al^{3+} are 0.095, 0.065 and 0.050 respectively.

a) Calculate the charge/ radius ratio per

i) Na^+ (01 mark)

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ii) Mg^{2+} (01 mark)

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iii) Al^{3+} (01 mark)

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b) Which of the ions has

i) The least polanising power? (½ marks)

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iii) The greatest polarizing power. (½ marks)

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c) Give reasons for your answers in c) i) and ii) above. (02 marks)

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8.a) State Graham's law. (01 mark)

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b) A certain volume of oxygen diffused through a porous membrane in 120s. under the same conditions the same volume of a gas. X diffuses in 112s. calculate the relative molecular mass of X. (3 ½ marks)

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9. The empirical formula of a fluoride of sulphur, Y 1 is SF_4 . 0.1g of Y occupied 22.10cm^3 when vapourised at 20^{0}C and 766mmHg.

a) Determine the molecular formula of Y. (3 ½ marks)

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b) Draw the structure of Y and name the shape (1 ½ marks)

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SECTION. B (54 MARKS)

Attempt six questions from this section

10. Write equations to show how the following compounds can be synthesized.

a) $CH_3CH_2CH_2COOH$ from $CH_3CH{=}CH_2$. (3 marks)

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b) C_6H_6 from CH_3CH_3. (3 marks)

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c) $CH_3CH_2CH_2OH$ to $CH_3CH(OH)CH_3$ (3 marks)

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11. State what would be observed and write equation for the reaction that would take place when

a) Copper is added to a solution of concentrated nitric acid. (2 ½ marks)

Equation

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Observation

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b) Potassium iodide is added to acidified solution of hydrogen peroxide. (02 marks)

Equation.

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Observation

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c) sodium sulphite is added to a solution of acidified potassium dichromate (VI)

Equation

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..... (2 ½ marks)

Observation

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d) aqueous iron (ii) sulphate is added to acidified potassium manganate (VII) solution.

(2 marks)

Equation

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Observation

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12. A compound P contains 52.2% of carbon, 13% of hydrogen the rest being oxygen

a) Determine the empirical formula of P

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.....(2 marks)

b) When vaporized 0.1g of P occupied 78.8cm^3 at 150^{0}C and a pressure of 740mmHg

i) Calculate the formula mass of P (2 ½ marks)

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ii) Determine the molecular formula of P. (1 ½ marks)

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iii) Write the structural formula of all the possible isomers of P. (1 mark)

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c) P does not react with sodium metal. Identify P. (0 ½ marks)

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d) Write an equation to show how P can be prepared from methanol. (1 ½ marks)

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13. Name the reagent (s) that can be used to distinguish between the following pairs of compounds and state what is observed in each case.

a) CH_3CH_2OH and $CH_3\overset{OH}{\overset{|}{C}}HCH_3$ (3 marks)

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b) $CH = CCH_3$ and $CH_3C= CCH_3$ (3 marks)

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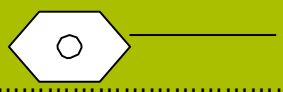
c) CH_3CH_2Cl and  Cl (3 marks)

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14.a) State what is meant by the term order of a reaction. (2 marks)

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b) Methly ethanoate is hydrolysed by water in the presence of an acid according to the following equation;

$$CH_3CO_2CH_3 + H_2O \xrightarrow{H^+} CH_3CO_2H + CH_3OH$$

i) State the molecularity of the reaction. (1 mark)

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ii) Determine the order of the reaction. (Assume that the acid takes part in the reaction. (01 mark)

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iv) State the conditions under which the reaction can be overall first order. (02 marks)

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c) The table below shows some kinetic data for the following reaction: 3A + B $\longrightarrow$ 2P.

Experiment	Initial conc'n of A ($Moldm^{-3}$)	Initial conc'n of B ($Moldm^{-3}$)	Initial rate ($moldm^{-3}s^{-1}$)
1	0.20	0.20	1.2×10^{-8}
2	0.20	0.60	1.2×10^{-8}
3	0.40	0.60	4.8×10^{-8}

i) Write the overall rate equation. (1 ½ marks)

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ii) Calculate the rate constant and give its units. (1 ½ marks)

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15.a) State Raoult's law (2 marks)

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b) The boiling point composition diagram of a mixture of water and substance X which is miscible with water is given below.

Composition of X (percentage)

i) State how the mixture deviates from Raoult's law . (1 mark)

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Explain how pure X can be obtained from a mixture containing 50% of water. (4 marks)

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ii) What name is given to the mixture containing 36% of X? (1 mark)

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iii) Name one substance that would behave in a different way from X. (1 mark)

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16. 0.9875g of an impure potassium manganate (vii) was dissolved in water to make 250cm^3 of solution. When 20.0cm^3 of this solution was acidified with dilute sulphuric acid, warmed and titrated against sodium ethanediate (oxalate) solution, made by dissolving 1.675g of anhydrous sodium ethanediate to make 250cm3 of solution, 24.40cm^3 of the sodium ethanediate solution was used.

($Na_2C_2O_4$ = 134 and $KMnO_4$ = 158)

a) Write an ionic equation for the reaction between sodium ethanedioate and potassium manganate (vii) (2 marks)

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b) Determine the molar concentration of manganate vii) ions. (3 ½ marks)

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c) Calculate the percentage purity of potassium manganate (vii) (2 ½ marks)

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d) Name one compound which is a common impurity in potassium manganate. (1 mark)

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17.a) State Hess's law of constant heat summation (2 marks)

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b) i) Use the data below to calculate the enthalpy change for the reaction

$CO(g) + 2H_2(g) \longrightarrow CH_3OH(l)$ at 298K

Data;

$CO(g) + ½ O_2(g) \longrightarrow CO_2(g)$ DH = -283KJmol^{-1}

$H_2(g) + ½ O_2(g) \longrightarrow H_2O(g)$ DH = -285. 8KJmol^{-1}

$CH_3OH(l) + 3/2 O_2(g) \longrightarrow CO_2(g) + 2H_2O$ DH = -715 KJ Mol^{-1}

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i) Name the type of reaction in b) i) above. (1 mark)

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S6 CHEMISTRY

Exam 22

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions to candidates:

1. Answer all questions in section A and six questions in section B
2. All questions are to be answered in the spaces provided

FOR EXAMINER'S USE ONLY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total

SECTION A (46 MARKS)

Answer all questions in this section

1. (a) Complete the following equation for the decay of bismuth.

$^{214}_{83}Bi \rightarrow {}^{0}_{-1}e + $ ---------- (1 mark)

(b) The half life of bismuth is 19.7 minutes. Determine the time taken for 43% by mass of bismuth to decay.

(3 marks)

2. Draw the shape and name the structure of each of the following species

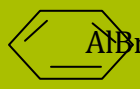
(i) H_2O (1 mark)

(ii) Cl_2O (1 mark)

(iii) H_3O^+ (1 mark)

(iv) PCl_5 (1 mark)

3. Complete the following equations and in each case write a mechanism for the reaction

(a) $+CH_3CH_2Br$  $AlBr_3$ (4 marks) $\longrightarrow$

(b) $CH_3CH_2Cl + HC \equiv CNa$ Liq.NH_3 (2 marks)

4. Write an ionic equation for the reaction between sodium hydroxide and

(a) Silicon IV oxide (1 ½ marks)

(b) Aluminium III oxide (1 ½ marks)

(c) Lead II oxide (1 ½ marks)

5. 2.910 of a compound Q was dissolved in 160g of ethanol. The boiling point of the solution was 78.97°C while that of pure ethanol was 78.8°C. (Kb for ethanol is1.15°C for 1 mole in 1000g). Calculate the molecular mass of Q in ethanol

6. (a) A crystalline solid T dissolved in water to give a pink solution. Addition of excess aqueous sodium hydroxide produced a dirty white precipitate which rapidly turned brown on standing. When nitric acid was added to the solution of T followed by sodium bismuthate solution, the solution changed from pink to purple.

(b) Write

(i) the equation for the reaction that took place when sodium hydroxide was added to the solution. (1 ½ marks)

(ii) the formula of the species responsible for the purple colour (1 mark)

(iii) equation for the reaction leading to the formation of the brown solid (1 ½ marks)

7. (a) Define the term 'solubility of a salt

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(b) The solubility of calcium phosphate is 0.0011g per 100g of water at 25°C. Calculate the solubility product of calcium phosphate at 25°C (5 marks)

8. Name the reagent tht can be used to distinguish between the following pairs of compounds. In each case, state what would be observed if the reagent is treated separately with each pair of compounds

(a) HCOOH and CH_3COOH

Reagent

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…… Observation

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(b) OH and

Reagent: (1 mark)

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Observation (2 marks)

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9. 200cm^3 of an aqueous solution containing 40g of x was shaken once with 100 cm_3 of ether

(a) Calculate the mass of X extracted by ether. (The distribution coefficient KD, of X between ether and water is 4) (2 marks)

(b) Calculate the mass of X that would be extracted by shaking the solution twice with 50cm3 of ether. (4 marks)

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SECTION B (54 MARKS)

Attempt only six questions from this section

10. Complete the following reactions and suggest their mechanisms

(a) $2(CH_3)_2CO$ dil. NaOH (3 ½ marks)

Mechanism

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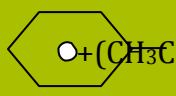
(b) $NHCH_3$  $+(CH_3CO)_2O$ ..... $\longrightarrow$

Mechanism

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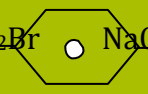
(c) $CH_3OH + CH_3CH_2Br$  NaOH(aq) $\xrightarrow[\text{Heat}]{}$

Mechanism

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(2 ½ marks)

11. (a) A piece of clean magnesium ribbon was added to a solution of iron III chloride solution

(i) State what was observed

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(ii) Explain your observation in a (i) above

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(iii) Write stepwise equations for the reactions that took place (4 marks)

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(b) State what would be observed if a few drops of iron III chloride was added to the solution of the following:

(i) sodium acetate (1 mark)

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(ii) phenol (½ mark)

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12. (a) Write an equation for the

(i) acid dissociation constant, Ka, for ethanoic acid (2 marks)

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(ii) relationship between acid dissociation constant, Ka, and degree of ionisation of an acid (1 mark)

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(b) The electrolytic conductivity of a 1.6×10^{-2} M CH3COOH at 20°C is 1.96×10^{-2} Sm^{-1} and its molar conductivity at infinite dilution is 3.5×10^{-2} $Sm^2 mol^{-1}$. Calculate

(i) The molar conductivity of the ethanoic acid at 20°C (2 marks)

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(ii) The degree of ionisation of the acid at 20°C (1 mark)

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(iii) The pH of the acid

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(c) Besides concentration, state one other factor that can affect the pH of the acid

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(1 mark)

13. Complete the following equations and in each case write the accepted mechanism for the reaction

(a) $CH_3CH = CHCH_3$ $\xrightarrow{H^+/H_2O}$

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(3 marks)

(b) $+CH_3OCl$ $AlCl_3$ $\longrightarrow$

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(c) $(CH_3)_3C - Br + CH_3O^- Na^+$ $\xrightarrow[\text{heat}]{CH_3OH}$

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14. (a) State the oxidation state of chromium in

(i) potassium chromate (1 mark)

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(ii) potassium dichromate (1 mark)

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(b) Acidified potassium dichromate was reacted with potassium iodide

(i) state what was observed (1 mark)

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(ii) Write the half equations and the overall equation for the reaction (4 marks)

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(c) Potassium chromate solution was added to aqueous lead II nitrate (1 marks)

(i) state what was observed

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(ii) write the ionic equation for the reaction (1 mark)

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15. (a) (i) Write an equation for the solubility of silver sulphate in water

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(ii) Determine the molar concentrations of silver and sulphate ions in a saturated solution of silver sulphate at 25°C. (The Ksp, of silver sulphate is 1.7×10^{-5} $moldm^{-3}$ at 25°C) (3 marks)

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(b) State how the solubility of silver sulphate would be affected if the following substances were added.

(i) Sodium sulphate solution (1 mark)

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(ii) Ammonia solution (1 mark)

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(c) Explain your answer in (b)

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(3 marks)

16. (a) Define the term 'Buffer solution" (2 marks)

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(b) Calculate the mass of sodium ethanoate that should be added to 1 litre of a 0.2M ethanoic acid solution in order to produce a solution of pH = 3.0 (ka for ethanoic acid = 1.8×10^{-5})

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(c) State what would happen to the pH of the solution in (b), if a small amount of the following were added.

(i) sodium hydroxide solution

(ii) hydrochloric acid

(d) State one biological application of a buffer solution (1 mark)

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17.(a) Write equation to show how ethanol can be formed from glucose (4 marks)

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(b) Write equations to show how ethyne can be

(i) prepared from ethanol (4 marks)

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(ii) converted to methylpropyne (1 ½ marks)

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(c) (i) Name one reagent that can be used to confirm the formation of methyl propyne (1 mark)

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(ii) State what would be observed if methyl propyne was reacted with the reagent you have named in C(i) and write equation for the reaction

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(1 ½ marks)

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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

$$-\frac{d\text{[illegible]}}{d\text{[illegible]}} = \lambda N$$

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 l^{-1})		Initial rate (mol l^{-1} S^{-1})
	A	B	
1	3.0×10^{-2}	3.0×10^{-2}	2.7×10^{-5}
2	3.0×10^{-2}	6.0×10^{-2}	5.4×10^{-5}
3	6.0×10^{-2}	3.0×10^{-2}	10.8×10^{-5}

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

   A;

4

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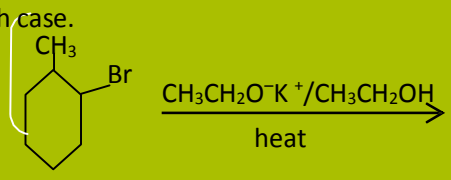
4. Complete the following reaction equations and write the IUPAC names of the main organic product in each case. (01½)

(a) 

Name of product;

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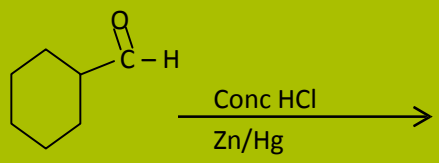
(b) 

Name of product;

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

6

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

ΔH^{θ}/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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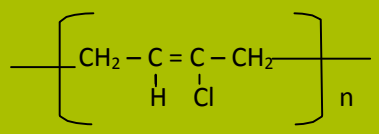
8. (a) Neoprene is a synthetic polymer which has the following structure



(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 9.89×10^{-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°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 2.4×10^{-2}g per litre at 20°C

Calculate the value for the solubility product Ksp for silver chromate at 20°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 1.6×10^{-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 $84cm^3$ 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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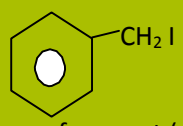
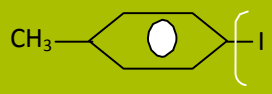
12. Name the reagents that can be used to distinguish between the following pairs of compounds. In each case state what would be observed if each member of the pair is separately treated with the reagent. (03 marks each)

(a) 

and 

Name of reagent (s)

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Observation(s)

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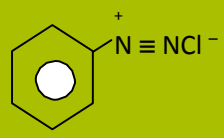
(b) 

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

Name of reagent

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Observation(s)

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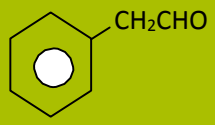
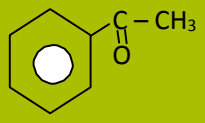
(c) 

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°)	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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16

(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°C. Calculate the equilibrium constant (Kc) for the reaction at 600°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°C.

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

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S6 CHEMISTRY

Exam 24

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions:
1. Answer all questions in the spaces provided
2. Illustrate your answers with equations wherever possible
3. A graph paper and periodic table are attached at the end of the paper.

1. Complete the following equations and give the IUPAC name of the main organic product

(a) $CH_3CH_2Br + HC \equiv CNa^+$ liq.$NH_3 \longrightarrow$ (2m)

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(b) $nCH_3CH = CH_2$ catalyst. $\longrightarrow$ (2m)

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2. Element X, Y and Z have the following ionisation energies ($kjmol^{-1}$)

Ionisation energy	1st	2nd	3rd	4th
X	738	1450	7730	10550
Y	495	4653	6912	9540
z	800	2427	3658	25024

Select the element that shows

(i) a valency of +2 (½ m)

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(ii) forms a covalent chloride (½ m)

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(iii) forms an ionic univalent chloride (1 m)

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(b) Explain why the first ionisation energy of Boron is less that that of Beryllium, whereas the second ionisation energy of Boron is greater than that of Beryllium (3m)

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3. (a) State Raoult's law (2)

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(b) The vapour pressure of a solution containing 4g of a sugar Q in 100g of water is 3.1545 Kpa at 25°C. Calculate the relative molecular mass of Q given that the vapour pressure of pure water at 25°C is 3.167 Kpa. (3m)

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4. The molecular formula of a hydrocarbon X is C_4H_8

(a) Write the IUPAC names and structural formula of all possible isomers of x (3)

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(b) Ozonolysis of x followed by hydrolysis gave only one compound. Identify the compound (1m)
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(c) Write equation to show how x can be converted to alkyne. (2m)
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5. (a) Define the term partition coefficient (2m)
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(b) 200cm^3 of an aqueous solution contains 8gm of Y. Calculate the mass of y left in the aqueous layer by shaking the solution with

(i) 50cm^3 of trichloromethane. (The partition coefficient of Y between trichloromethane and water is 12) (4m)
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(ii) twice with 25cm^3 of trichloromethane (4m)

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6. (a) (i) State what is meant by an azeotropic mixture (2m)

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(ii) Give two reasons why an azeotropic mixture is not considered a pure substance (1m)

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(b) ethanol and water forms an azeotropic mixture. Explain (3m)

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7. 2 -Bromo-2-methyl propane reacts with aqueous sodium hydroxide.

(a) (i) Write an equation for the reaction (1m)

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(ii) Write the rate equation for the reaction (1m)

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(iii) te the molecularity of the reaction (1m)

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(b) Draw the energy diagram for the reaction (3m)

8. (a) State Hess' law (2m)

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(b) State four factors that affect the enthalpy change of any system.

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(2m)

(c) The enthalpy of combustion of ethene is – 14411 $kJmol^{-1}$ while that of ethyne is – 1299.5 $kJmol^{-1}$ and that of hydrogen is – 285.8 $kJmol^{-1}$ Calculate the enthalpy change of hydrogenation of ethyne to ethene.

(4 m)

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9. Complete the following equations and in each case write a mechanism for the reaction

(a)

$+ OH^-_{(aq)}$ $\xrightarrow{heat}$ (3m)

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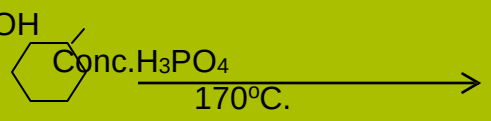
(b) 

(3m)

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10. (a) Explain what is meant by steam distillation. (Diagram not required (3m)

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(b) Calculate the percentage composition by mass of water when aniline ($C_6H_5NH_2$) is steam distilled at 760mm Hg and 98ºC and the vapour pressure of water at 98ºC is 734 mmHg. (3m)

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11. 0.80g of a metal oxide of the type MO was dissolved in 50.0cm^3 of 1M hydrochloric acid. The resulting mixture was made to 250cm^3 with distilled water. 25.0cm^3 of this solution required 21.4cm^3 of 0.1M sodium hydroxide solution for neutralisation. Calculate the

(a) the number of moles of excess hydrochloric acid in 250cm^3 (3m)

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(b) (i) The mass of oxide MO that reacted with the acid (2m)

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(ii) formula mass of MO (1m)

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(iii) the relative atomic mass of M (1m)

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12. Give reaction scheme by which the following conversions can be effected

(a) Methane from chloroethane (3m)

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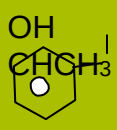
(b) 

from (3m)

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13. (a) Fill in the blanks in the following radioactive decay series

(i) $^{235}_{\ \ \ }U \xrightarrow{\alpha} \text{-----} \xrightarrow{\beta} \text{.....} \xrightarrow{\alpha} {}^{227}_{\ \ \ }AC$ (2m)

(ii) .....α $\xrightarrow{233}$ Pa $\xrightarrow{\beta}$ ------ $\xrightarrow{\alpha}$ (2m)

(b) A radioactive substance decays as follows:

Time (day)	0	1	2	3	4	5	6
Mass (g)	500	389	303	236	184	143	112

(i) Plot a graph of time against mass

(ii) Determine the decay constant and half life of the reaction

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END

Good luck

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S6 CHEMISTRY

Exam 25

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions:

- This paper consists of three sections (i.e. physical, inorganic and organic)
- Attempt all questions. Answers must be given in the spaces provided.
- Hand in the different sections separately.
- All working/calculations must clearly be shown.

1. (a) Steam distillation is one of the methods used for the separation of a component from a liquid mixture. State one requirement for the component to be separated by steam distillation. (1 mark)

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   ……

   (b) A mixture containing a substance Z was steam distilled at 760 mmHg and 95°C. The distillate contained 85% by mass of water. If the vapour pressure of water is 734mmHg at 95°C, calculate the formula mass of x. (3 marks)

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2. The table shows the rates of the reaction between substances A and B at different conditions.

Experiment	Initial concentration in moldm $^{-3}$		Initial rate of reaction in moldm $^{-3}$ s $^{-1}$
	A	B	
1	0.50	0.50	2.0×10^{-2}

3

2	1.00	0.50	8.0×10^{-2}
3	1.00	1.00	16.0×10^{-2}

(a) Determine

(i) the order of reaction with respect to A and B

A……

……

……

……

(1 mark)

B……

……

……

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(1 mark)

(ii) The overall order of the reaction (1 mark)

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(b) (i) Write an expression for the rate of the reaction (1 mark)

……

……

(ii) Calculate the rate constant for the reaction and state the units

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(2marks)

3. (a) (i) What is meant by the term colligative property? (1 mark)

(ii) 1.45g of compound Y was dissolved in 80g of ethanol. The boiling point of the solution was 78.97^0C while that of pure ethanol is 78.8^oC (Kb of ethanol is 1.15^oC for 1 mole in 1000g). Calculate the molecular mass of Y (4 marks)

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(c) (i) Explain the term mole fraction

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(ii) Calculate the mole fraction of sodium chloride in an aqueous solution containing 10g of sodium chloride per 100g of water.
(Na = 23, Cl = 35.5) (3 marks)

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4. (a) Define the term first ionization energy

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The table below gives four ionization energies in $kJmol^{-1}$ for four elements in the same short period.

Element	Ionization energies in $kJmol^{-1}$			
	First	Second	Third	Fourth
W	577	1816	2745	11575
X	738	1450	7730	10550
Y	495	4563	6912	9540
Z	1255	2297	3849	6540

One of the elements belongs to group (VII)

……

……

(b) (i) Arrange the elements in order of increasing atomic number (1 mark)

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……

(ii) Which of the elements will form an ionic compound 1:1 with each other. Give a reason.

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(iii) Which element will form an ion of +2 Oxidation State? Give a reason

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……

5. (a) Sketch and name the shape of the following species whose central atom has atomic number as shown

B = 5 N = 7 S = 16 P = 15

Species	Shape	Name of shape
BCl_3		
NO_2^-		
H_2S		
PCl_5		

(b) State the conditions and write equations for the reaction between hydrogen peroxide and

(i) Iron (II) ions.

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(ii) Iron (III) ions

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(iii) Iodide ions

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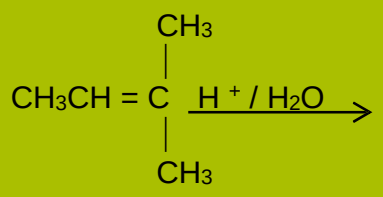
6. A sample of a divalent metal M, contaminated with its oxide was dissolved in 50.0cm^3 of 0.1 M hydrochloric acid. 30.0cm^3 of hydrogen measured at s.t.p was evolved. 20.0 cm^3 of 01M sodium hydroxide was required to neutralise the excess acid. Calculate the percentage of the metal, M.
(1 mole of gas occupies 22.4 dm^3 at s.t.p)

7. Complete the following equation and name the main organic product



8. Name one reagent that can be used to distinguish between the following pairs of compounds. In each case state what would be observed in each case if the reagents are reacted with the compounds.

(a) $(CH_3)_3COH$ and $CH_3CH_2CH_2OH$

Reagent

……

……

Observations

……

……

(b) $CH_3C \equiv C\ CH_3$ and $CH_3CH_2\ C \equiv CH$

Reagent
……
……

Observations
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……

9. State what would be observed and write the name of the product formed when the following pairs of substances are mixed.

(i) $CH_3CH = CH_2$ and a alkaline potassium permanganate solution
Observation
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Formula of product
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……

Name of product
……

(ii) HC ≡ CH and ammoniacal copper (I) chloride solution

Observation
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……

Formula of product
……
……

Name of product

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(iii) Phenol and bromine water

Observation

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Formula of product

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Name of product

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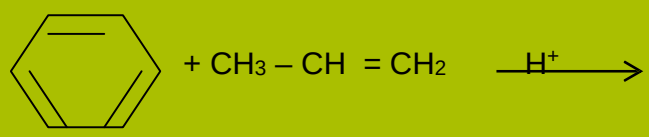
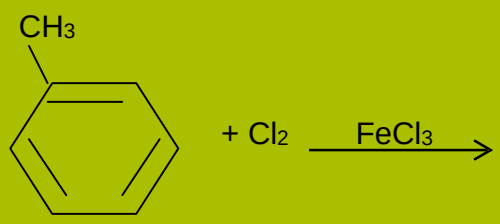
10. Complete the following reaction equations showing their mechanisms.

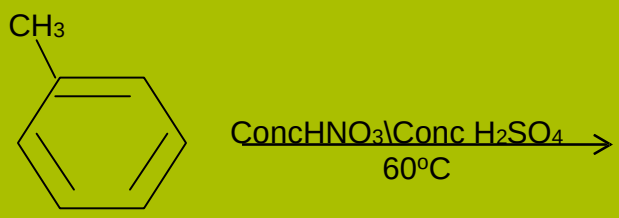
(i)



(ii)



(iii)



(b) Write the names of the products formed in 10. (a) above

END

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S6 CHEMISTRY

Exam 27

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions to candidates:

- Attempt all questions in section A and any six from section B
- All questions are to be answered in the spaces provided
- A periodic table with relevant atomic masses is supplied at the end of the paper.

FOR EXAMINER'S USE ONLY																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	TOTAL

1. (a) Define the term enthalpy of formation. (1 mark)

……

……

……

(b) alculate the enthalpy of formation sodium chloride from the following data.

	ΔH^{θ} (kJmol $^{-1}$)
$Na(s) \longrightarrow Na(g)$	+109
$Cl_2(g) \longrightarrow 2Cl(g)$	+242
$Na^+(g) + Cl^-(g) \longrightarrow NaCl(s)$	−771
$Cl(g) + e^- \longrightarrow Cl^-(g)$	−364

(3 marks)

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(c) Comment on the stability of sodium chloride. Give a reason for your answer. (1 mark)

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2. Complete the following reactions and in each case write the 1UPAC names of the major organic product. (1 ½ marks each)

(a)

$$\xrightarrow[\text{heat}]{MnO_4^- \mid OH^-(ag)}$$

……

……

(b) $BrCH_2CH(CH_3)CH_2CH_2Br \xrightarrow[\text{Heat}]{Et\bar{O}H \mid EtOH}$

……

……

(c) $CH_3CH(CH_3)C \equiv CH + H_2 \xrightarrow{\text{Lindlar's catalyst}}$

……

……

3. 0.02M methylamine solution is 4% ionized at 25°C.

(a) Write ;

(i) an equation for the ionization of methylamine in water. (1 mark)

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……

(ii) an expression for the base ionization constant K_b for methylamine. (1 mark)

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(b) Calculate the

(i) pH of the methylamine solution ($K_w = 1.0 \times 10^{-14}\ mol^2\ dm^{-6}$)

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(ii) base ionization constant; Kb for methylamine. (1 ½ marks)

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4. (a) Write the formula of the hydrides of sodium and sulphur, in each case state the type of bonds present in the compounds. (2 marks)

Elements	Formula of hydride	Type of bond
Sodium		
Sulphur		

(b) Write equations to show how the hydrides react with water. (3 marks)

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5. (a) Define the term Osmotic pressure. (1 mark)

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(b) polysaccharide has the formula $(C_{12}H_{12}O_{11})n$. A solution containing $5.00gdm^{-3}$ of the sugar has an osmotic pressure of $7.12 \times 10^2 Nm^{-2}$ at 20°C. Find the value of n.

(3 ½ marks)

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(c) State any two assumptions made in (b) above. (1 mark)

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6. A powdered element T was investigated as shown in the table below

Experiment	Results
(a) A mixture of T and lead (IV) oxide was heated	A colourless gas with a chocking smell and turned acidified potassium dichromate from orange to green was evolved.
(b) Concentrated nitric acid is added to heated T, the products were diluted and barium nitrate solution added.	T dissolved in nitric acid with effervescence of a brown gas. On addition of barium nitrate solution a white precipitate was formed

(i) Identify T (1 mark)

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(ii) Write equations for the reactions in experiments (a) and (b) (4 marks)

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7. (a) $20cm^3$ of hydrocarbon Q with general formula C_nH_{2n-2} were mixed with $100cm^3$ of oxygen. The mixture was ignited and the residual gaseous product at room temperature bubbled through concentrated potassium hydroxide solution. The final volume was found to be $20cm^3$.

(i) Calculate the value of n in Q. (2 marks)

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(ii) Deduce the molecular formula of Q. (½ mark)

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(b) Q has two isomers X and Y. X decolourises bromine water but it does not react with ammoniacal silver nitrate solution. Y forms a white precipitate with ammoniacal silver nitrate solution.

(i) Identify isomers X and Y (1 mark)

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(ii) Write an equation for the reaction between (1 mark) X and bromine water

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Y and ammoniacal silver nitrate solution. (1 mark)

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8. Name the reagent(s) that can be used to distinguish between each of the following compounds. State what would be observed in each case.

(a) KI(aq) and KCl(aq) (1 ½ marks)

Reagent(s)

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Observations

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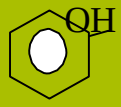
(b) COONa and  OH (1 ½ marks)

Reagent(s)

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Observations

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(c) $PbCO_3$(s) and $BaCO_3$(s) (1 ½ marks)

Reagent(s)

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Observations

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9. The electrode potentials of $S_2O_8^{2-}(aq) \mid SO_4^{2-}(aq)$ and $I_2(aq) \mid I^-(aq)$ are $^+2.01V$ and $^+0.54V$ respectively.

(a) Write an equation for the reaction that occurs at the;

(i) anode (1 mark)

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(ii) cathode (1 mark)

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(b) Write the ; (1 mark)

(i) Cathode

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(ii) Overall cell reaction (1 mark)

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(c) (i) calculate the e.m.f of the cell generated from the cell reaction in b(ii) above.

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(ii) State whether the above cell reaction is feasible or not. Give a reason for your answer (1 mark)

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SECTION B: (54 MARKS)

Answer only six questions from this section

10. Write equations to show how the following conversions can be effecte4d.
Indicate all reagents and conditions necessary for each reaction.

(a) 1 – methylcyclobutene to 2 – methyl cyclobutanol. (3 marks)

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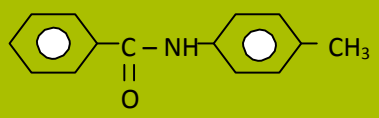
(b) 

From benzene and bromomethane (4 marks)

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(c) Butane – 2, – diol to 2,3 –butane dionedioxime. (2 marks)

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11.(a) $Be(OH)_2$, $Mg(OH)_2$, $Ca(OH)_2$ and $Ba(OH)_2$ are the hydroxides of group II elements. Briefly describe how the hydroxides react with ;

(i) sodium hydroxide solution (2 marks)

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(ii) hydrochloric acid solution (2 marks)

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(b) The solubilities of the hydroxides of group II elements of the periodic table at 25°C are given below

Hydroxide	$Be(OH)_2$	$Mg(OH)_2$	$Ca(OH)_2$	$Sr(OH)_2$	$Ba(OH)_2$
Solubility g/100g of water	Insoluble	0.002	0.150	0.900	4.000

(i) State and explain the trend in solubility of the hydroxides.

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(ii) Different masses of solid $Ca(OH)_2$ and $Ba(OH)_2$ containing the **same number of moles** were separately shaken with the same volume of water at 25°C. Identify the solution with higher pH value. Give a reason for your answer (1 ½ marks)

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12.(a) The partition coefficient of ammonia between water and trichloromethane at 25°C is 25.0,

(i) Define the term partition coefficient. (1 ½ marks)

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(ii) State two conditions under which the partition coefficient (K_D = 25.0) is valid other than constant temperature. (1 mark)

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(b) 25cm^3 of 0.0056M nickel (II) sulphate solution were added to an **equal** volume of ammonia solution at 25°C. The mixture was shaken with 50cm^3 of trichloromethane and allowed to stand until equilibrium was established. The trichloromethane layer required 32cm^3 of 0.0025M hydrochloric acid for complete neutralization. 7.060cm^3 of the aqueous layer required 20cm^3 of 0.02M hydrochloric acid. Nickel (II) ions react with ammonia according to the equation; $Ni^{2+}(aq) + nNH_3(aq) \longrightarrow [Ni(NH_3)_n]^{2+}(aq)$

Calculate

(i) Molar concentration of the free ammonia in the aqueous layer.(2 1/2marks)

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(ii) Molar concentration of ammonia that reacted with nickel (II) ions (2 marks)

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(iii) Use your answer b (II) above to determine the value of n in $[Ni(NH_3)_n]^{2+}$

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13.(a) Describe a simple chemical test to distinguish between CH_3COCH_3 and CH_3CH_2CHO (2 marks)

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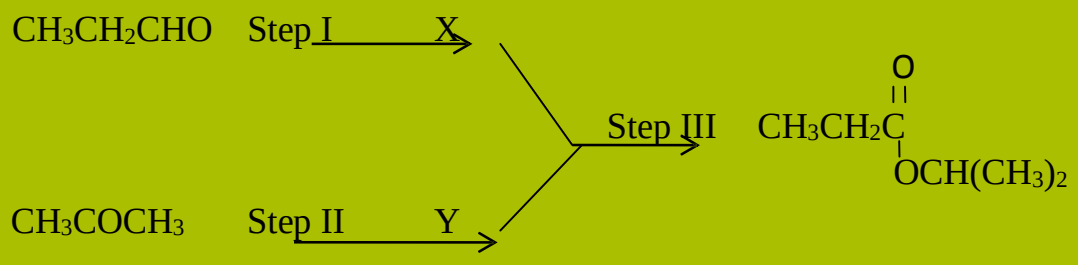
(b) Compound Z can be synthesized by the reaction between X and Y as shown below



(i) Identify compounds X and Y

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……

(ii) Name the type of reaction that occurs in steps I and I (1 mark)

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(c) Identify the reagents and state the conditions necessary for the reaction in

(i) step I (1 mark)

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(ii) step III (2 mars)

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(d) Write the mechanism for the reaction that occurs in step III

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14. Explain each of the following observations.

(a) An aqueous solution sodium sulphite when mixed with ammonium chloride produce a colourless gas that forms dense white fumes with concentrated hydrochloric acid on warming. (3 marks)

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(b) The acid dissociation constant (Ka) of chloric (1) acid is lower than the Ka for chloric (VII) acid at 25°C, (2 marks)

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(d) When refluxed with aqueous potassium hydroxide followed by acidified silver nitrate solution. Chloroethane forms a white precipitate which chlorobenzene gives no observable change. (4 mark)

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15. HF,HCl, HBr and HI are hydrides of group VII elements

(a) Explain the variation in boiling points of the hydrides. (3 marks)

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(b) Aqueous solutions of the hydrides of the same concentration at constant temperature have different ph values.

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(i) Identify the hydride whose solution in water has the lowest pH (1 mark)

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(ii) Give a reason for your answer in b(i) above. (2 marks)

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(c) Write an equation for the reaction between

(i) The hydride of fluorine and excess silicon (IV) oxide (1 mark)

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(ii) Potassium manganate (VII) solution and the hydride of chlorine. (1 mark)

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(iii) Concentrated sulphuric acid and the hydride of bromine. ` (1 mark)

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16. Lead (II) iodide is a sparingly soluble salt.

(a) Write an equation for the solubility of lead (II) iodide in water (1 mark)

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(b) The concentration of a saturated solution of lead (I) iodide at 40°C is 0.122g per $100cm^3$ of solution

State whether a mixture of $50cm^3$ of 0.01M lead (II) nitrate and $50cm^3$ of 0.001M potassium iodide forms a yellow precipitate of lead (II) iodide or not. (show your working clearly) (6 marks)

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(c) The saturated solution of lead (II) iodide of concentration 0.122g per $100cm^3$ of solution was heated to 60^oC in a closed system

(i) State whether the solution remains saturated at 60^oC (½ mark)

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(ii) Give a reason for your answer. (1 ½ marks)

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17. A mixture of methanol and water at 50^oC is an ideal solution. The partial vapour pressure of methanol in the vapour above the solution varies according to Raoult's law as shown in the table below.

Partial vapour pressure of methanol (mmHg)	40.0	100.0	200.0	260.0	320.0
Mole fraction of methanol in solution	0.10	0.25	0.50	0.65	0.80

(a) (i) Define the term ideal solution. (1 mark)

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(ii) State Raoult's law (1 mark)

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(b) On the same axes, plot a graph of;

(i) Vapour pressure of methanol

(ii) Total vapour pressure above the solution against mole fraction of methanol.

(The composition of methanol in the vapour is 50% when its mole fraction in solution is 0.19)

(c) Use your graphs in (b) above to determine the

(i) Saturated vapour pressure of methanol at 50ºC. (1 mark)

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(ii) Saturated vapour pressure of water at 50ºC

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(d) Compare the volatility of methanol and water at 50ºC. Give a reason for your answer. (1 mark)

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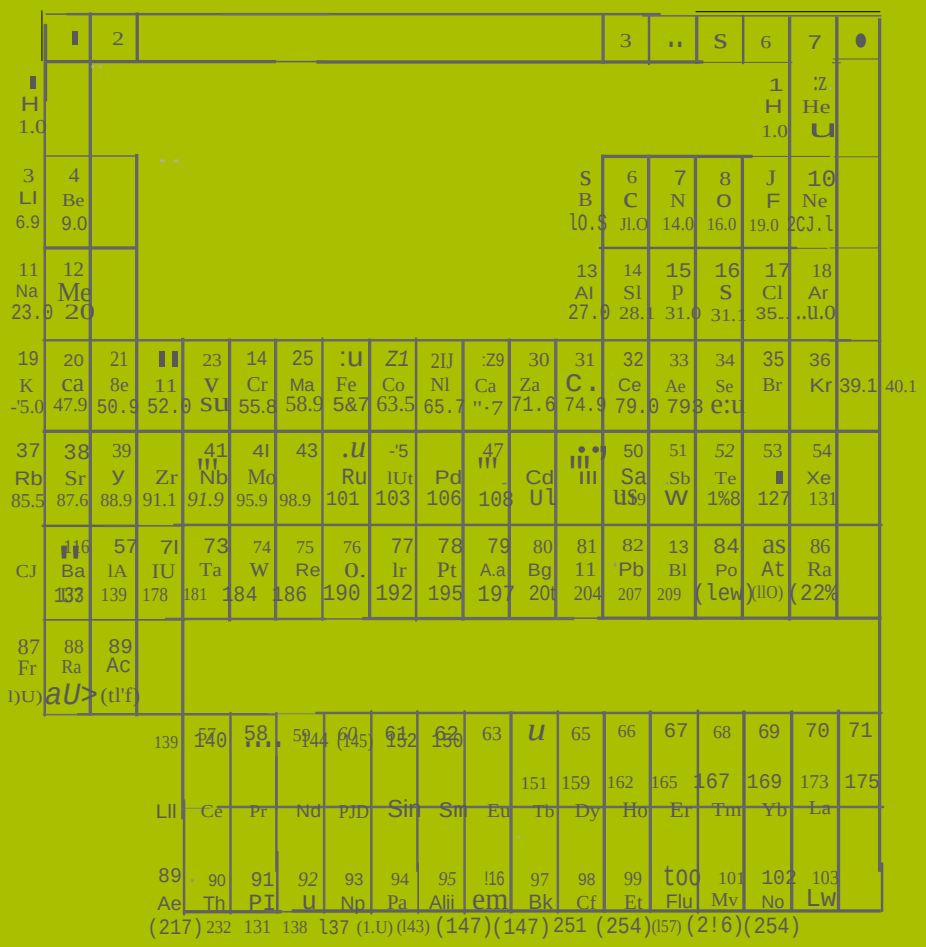
END

THE PERIODIC TABLE



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S6 CHEMISTRY

Exam 28

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
(All questions are compulsory)

1. (a) The freezing point of a solution containing 3.294g of sulphur in 100g of naphthalene was found to be – 0.830°C and another solution containing 1.67g of iodine in the same mass of naphthalene froze at – 0.84°C.
Calculate
(i) The freezing point depression constant for naphthalene
(molar mass of iodine is 127) (02 marks)
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(ii) The molar mass of sulphur in naphthalene. (02 marks)
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(b) (i) Determine the molecular formula of sulphur. (1 ½ marks)
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(ii) Draw the structure of sulphur. (01 mark)
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2. (a) Complete the following equations
(i) $HC \equiv CH \xrightarrow[\text{Na in liquid } NH_3]{CH_3Br}$

(ii) $CH_4 + H_2O \xrightarrow[\text{Heat (900°C)}]{\text{Ni}}$

(iii) $CH_3CH_2CH_2Cl \xrightarrow[\text{ethanol (reflux)}]{\text{Cu – Zn}}$

(iv) $CH_3COCH_3 \xrightarrow{NaHSO_3}$

(b) Write the mechanism for the reaction in (iv) (02 marks)

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3. (a) State three properties in which carbon differs from the rest of group (iv) elements. (1 ½ marks)

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(b) Write equations for the reaction between concentrated sulphuric acid and

(i) carbon

Equation

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(ii) Tin

Equation

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4. (a) Explain why hydrogen fluoride is a weaker acid than hydrogen chloride. (02 marks)

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(b) Molar conductivities at infinite dilution at 25°C for some compounds are shown on the table below.

Compound	Λ_0 (ohm $^{-1}$ m^2 mol $^{-1}$)
Nitric acid	0.0421
Potassium nitrate	0.0145
Potassium fluoride	0.0129

The conductivity of a 0.1 moldm $^{-3}$ aqueous solution of hydrogen fluoride is 3.15 x 10 $^{-3}$ ohm $^{-1}$ m $^{-1}$.

Calculate the:

(i) Molar conductivity of solution (1 ½ marks)

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(ii) Degree of ionization of hydrogen fluoride. (2 ½ marks)

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5. (a) Draw the structures and name the shapes of the following species. (4 ½ marks)

Species	Structure	Shape
$(CH_3)_3N$		
BF_3		
NO_2^-		

(b) Write equation for the reaction between

(i) Trimethylamine and borontrifluonde

……

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(ii) Acidified potassium manganate (VII) and nitrate ions.

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6. (a) Complete the following nuclear reactions and name the particles emitted in each case

(i) $^{238}_{92}U + ^{1}_{0}n \longrightarrow ^{239}_{93}$ ...

Name of particle; ……

(ii) $^{241}_{95}$ ... $+ ^{4}_{2}H \longrightarrow ^{243}_{97}$ ... +……

Name of particle; ……

(iii) $^{27}_{14}S \longrightarrow ^{27}_{13}$ ... + ... ….

Name of particle; ……

(b) The mass of a radioisotope, T, reduced by 32% in 40 days. Calculate the half life of T.

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(2 ½ marks)

7. Sulphur dioxide reacts with oxygen according to the following equation
$SO_2(g, + O_2(g) \rightleftharpoons 2SO_3(g)$, $\Delta H(- ve)$

(a) State conditions for the maximum yield of sulphur trioxide. (1 ½ marks)

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(b) Write equation (s) to show the conversion of

(i) Sulphur trioxide to sulphuric acid (03 marks)

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(ii) Sulphuric acid to calcium superphosphate (1 ½ marks)

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8. Complete the following reactions and write the accepted mechanism

(a) $CH_3CH_2CH = CH_2 \xrightarrow{Br_2/H_2O}$

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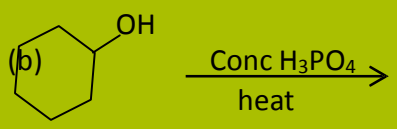
(b) 

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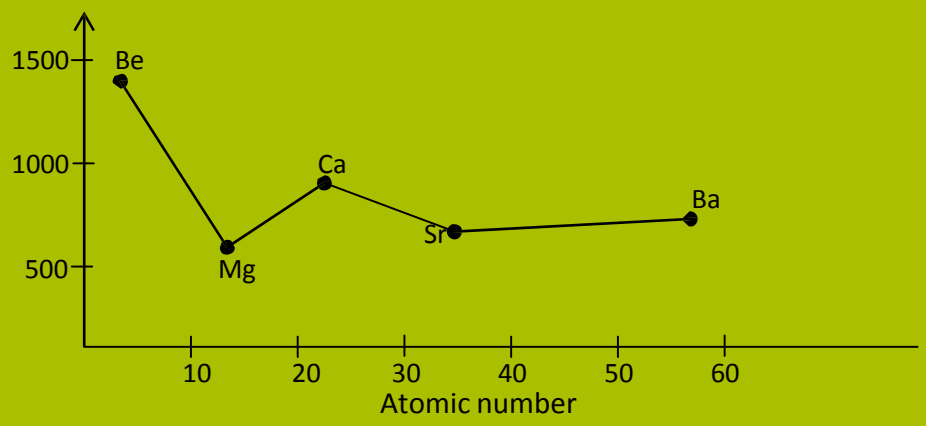
9. The graph below shows the variation of melting points of group (II) elements in the periodic table with atomic number



Explain why

(i) The melting points decrease from Be to Ba

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(ii) The melting point of calcium is higher than that of magnesium.

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SECTION B:

Attempt only **six** question

10. (a) Compare the reactivity of ethanol and phenol with phosphorus penta chloride. (Include equations for reactions if any) (03 marks)

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(b) Write equations to show how the following conversions can be effected.
(include conditions for the reactions)

(i) Ethanol to benzene

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(ii) 2 – phenyl propane to hydroxybenzene.

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11. State what would be observed and in each case write equation for the reaction that would take place if

(a) Hydrogen peroxide is added to a mixture acidified barium chromate solution and ether observation

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. Equation:

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(b) Excess chlorine is dissolved in aqueous sodium thiosulphate solution
Observation

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Equation

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(c) Aqueous potassium iodide is added to potassium peroxodisulphate;
Observation

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Equation

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(d) Neutral iron (III) chloride solution is added to hydroxybenzene
Observation

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Equation

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12. (a) An aqueous solution containing $2.8gdm^{-3}$ of R exerts an osmotic pressure of 380mmHg at stp.
Calculate the molar mass of R (02 marks)

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(b) An organic compound R contains carbon, oxygen. 3.4g of R burns with a sooty flame producing 5.04 dm^3 of carbon dioxide and 2.70g of water at stp.

(i) Calculate the empirical formula of R (2 ½ marks)

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(ii) Hence determine the molecular formula of R (01 marks)

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(c) R reacts with a mixture of anhydrous zinc chloride and concentrated hydrochloric acid but does not react with acidified potassium dichromate (VII)

(i) Identify R (01 mark)

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(ii) Write equation of reaction between R and a mixture of anhydrous zinc chloride and concentrated hydrochloric acid. (01 mark)

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(d) Write equations to show how R can be converted to an alkyne. (1 ½ marks)

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13. (a) Explain what is meant by the term acid-base indicator. (1 mark)

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(b) Explain how phenolphthalein acts as an indicator. (02 marks)

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(c) 25cm^3 of a solution containing a mixture of sodium hydroxide and sodium carbonate required 22.5cm^3 of 0.1M hydrochloric acid in the presence of phenolphthalein indicator. Another 25cm^3 of the same mixture required 36.5cm^3 of the same acid in the presence of methyl orange indicator.

Calculate the concentration in gl^{-1} in the mixture of

(i) Sodium hydroxide (4½ marks)

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(ii) Sodium carbonate

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(d) Explain why aqueous solution of sodium carbonate has a pH slightly above 7. (1½ marks)

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14. (a) Complete the following reaction and write the accepted mechanism.

$$\text{\textbf{\textbf{}}}_{3}\text{\textbf{\textbf{}}}_{2}\text{\textbf{\textbf{}}}_{2}H_{5(l)} + \bar{\text{\textbf{\textbf{}}}}H_{(a\text{\textbf{\textbf{}}})} \xrightarrow[\text{heat}]{H_2O}$$

Mechanism

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(b) The results obtained for the Kinetics of the reaction in (a) above are shown in the table below.

Expt.	$[CH_3CO_2C_2H_5]$ $moldm^{-3}$	$[OH^-]$ $moldm^{-3}$	Initial rate of reaction $moldm^{-3}\ s^{-1}$
1	0.076	0.076	1.13×10^{-3}
2	0.038	0.152	1.13×10^{-3}
3	0.019	0.152	5.65×10^{-4}

Deduce the order of reaction with respect to

(i) OH^- (1 ½ marks)

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(ii) $CH_3CO_2C_2H_5$

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(c) Write the rate equation for the reaction

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(d) Calculate the rate constant (K) for the reaction and state its units. (02 marks)

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15. The table below gives the first, second third and fourth ionization energies of elements P,Q and R

Element	Ionization energy ($KJmol^{-1}$)			
	First	Second	Third	Fourth
P	800	2,400	3,700	25,000
Q	900	1,800	1,4800	21,000
R	500	4,600	6,900	9,500

(a) State and explain the general trend in variation of ionization energies. (03 marks)

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(b) State the group and period to which element P belongs. In each case give a reason for your answer

Group:

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Reason :

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Period:

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Reason:

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(c) The wavelength at the start of the continuim in the sodium emission spectrum is 242nm. Calculate the first ionization energy of sodium in $KJmol^{-1}$
($C = 3.0 \times 10^{8} ms^{-1}$, Planks' constant = 6.626×10^{-34} Js and Avogdro's constant (L) = $6.023 \times 10^{23} mol^{-1}$) (03 marks)

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16. A compound K is a colourless crystalline solid. When K was heated strongly it gave off brown fumes and a black residue. K dissolved in water to give a colourless solution.

The solution of K was divided into two portions.

(a) To the first portion was added a few drops of concentrated nitric acid followed by a little solid lead (IV) oxide and then boiled.

(i) Identify the cation in the solution of K (01 marks)

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(ii) Write equation of reaction leading to the formation of the purple solution (1 ½ marks)

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(b) To the second portion was added sodium carbonate solution state what was observed and write equation of reaction that took place. (2 marks)

Observation

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Equation

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(c) On further elemental analysis K was found to contain 19.1% of nitrogen and 43.6% oxygen.

(i) Determine the empirical formula of K. (02 marks)

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(ii) 10g of K dissolved in 1000g of water lowered the freezing point of solution by 0.127°C. Calculate the molecular formula of K.
(Kf for water is 1.86°C mol^{-1} per 1000g) (2 ½ marks)

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17. Name the reagents that can be used to distinguish between the following pairs of ions. In each case state what is observed when each member of the pair is separately treated with the reagent. (3 marks)

(a) CrO_4^{2-} and $Cr_2O_7^{2-}$

Reagent

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Observation

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(b) SO_3^{2-} and $S_2O_3^{2-}$

Reagent

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Observation

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(c) COO^-
$|$ and CH_3COO^-
COO^-

Reagent

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Observation

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END

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S6 CHEMISTRY

Exam 30

PAPER 1

DURATION: 2 HOUR 45 MINUTES

INSTRUCTIONS
Attempt all questions in section A and six questions in section B

SECTION A

1. Both lithium and magnesium exhibit diagonal relationship
   (a) What is meant by the term diagonal relationship

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   (b) State two properties in which lithium and magnesium resemble.

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(c) Name two other pairs of elements that show diagonal relationship.

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2. The enthalpies of combustion of some substances are given below

Substance	ΔH combustion/kJmol $^{-1}$
Hydrogen	– 285.9
Graphite	– 393.5
Ethanol	– 1366.7

Calculate the enthalpy of formation of ethanol.

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3. Complete the following organic reactions and in each case name the main organic product

(a) $H_2 = CH_2$ $\xrightarrow[\text{Heat/high pressure}]{CO,H_2}$

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(b) $CH_3CH_2CONH_2$ $\xrightarrow[Br_2(aq)]{NaOH(aq)}$

……..

(c) H_3OH $\xrightarrow[\text{Conc } H_2SO_4\text{, warm}]{HCOOH}$

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4. A gas x diffuses four times as rapidly as sulphur dioxide under the same conditions Calculate the density of x

(The density of sulphur dioxide at a given temperature and pressure is 2.88 x $10^3 g/m^3$)

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5. (a) State conditions under which osmotic pressure laws are valid.

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(b) The osmotic pressure of an aqueous solution of a non-electrolyte containing 8.15g per $1.5dm^3$ of solution is 7.093×10^4 Nm^{-2} at 25ºC. Calculate the freezing point of solution. (cryscopic constant (K_f) of water is 1.86ºC per 1000g mol^{-1})

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6. (a) Complete the following nuclear reactions by writing balanced equations

(i) $^{23}_{11}Na \longrightarrow$ …….+ β

Balanced Equation:

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(ii) ……..+ α $\longrightarrow$ $^{13}_{7}N + ^{1}_{0}n$

Balanced equation:

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(iii) $^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{95}_{42}M_o$ + ……2 $^{1}_{0}n$ + 7β

Balanced equation:

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(b) The half life of a radioactive sample is 529 minutes. After 30 minutes the activity of was found to be 285 counts per second. Calculate the initial activity of sample.

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7. Name the class of compounds that is distinguished by the following reagents in each case state what is observed when each of the compounds in the class is reacted with the reagent(s)
   (a) aqueous sodium hydroxide and acidified silver nitrate
      - class of compounds

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      - observations,

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   (b) Anhydrous zinc chloride and concentrated hydrochloric acid
      Class of compounds)

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      Observations

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8. (a) Name the reagent that can be used to distinguish between Ca^{2+} and Mg^{2+} ions. State what is observed when the aqueous solution of each ion is separately treated with the reagent.
   - Reagent(s)

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Observation(s)
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(b) A solid inorganic sulphate contains 9.76% of magnesium 13.00% of sulphur and 51.22% of water

(i) Determine the empirical formula of the compound.

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(ii) Hence determine the molecular formula of the compound (the molecular mass of compound is 245)
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(c) ame the reagent(s) that can be used to confirm the ions present in the compound. In each case state what is observed.

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9. A is a black powder, when fused with a mixture of potassium hydroxide and potassium nitrate and then treated with water yields a green solution. The green solution turns purple when acidified with dilute sulphuric acid

(a) identify the compound A and the ions responsible the green and purple color of solution(s)

(i) A:……

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(ii)ion in green solutions.

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(iii) ion in purple solution

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(b) Write an ionic equation to show the reaction leading to the formation of a purple solution,

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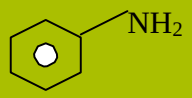
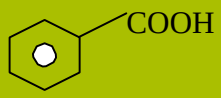
SECTION B:

10. By means of equations only and reaction condition show how the following conversions can be effected

(a) 

from 

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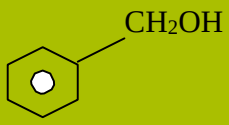
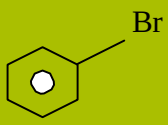
(b) 

from 

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(c) H_3COOH from CH_3OH

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11. The data below are for elements P,Q,R and S which belong to the same group in the periodic table.

Element	First ionization energy/kJmol $^{-1}$	Mpt/^{o}C
P	495	920
Q	580	2300
R	790	1610
S	1255	-20

(a) Which of the element(s) P,Q,R and S is a metal? Give a reason for your answer

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(b) State the type of bonding and structure of the oxides of elements P and S.

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(c) The second, third and fourth ionization energies of element Q are 1500, 7700 and 10,500 kJmol $^{-1}$ respectively.

To what group in the periodic table does Q belong? .Give reasons for your answer

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12. (a) Explain the principle of solvent extraction

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(b) $50cm^3$ of 1.5M ammonia solution was shaken with $50cm^3$ of trichloromethane in a separating funnel. After the layers had settled, $20cm^3$ of trichloromethane layer was pipetted and titrated with 0.05M hydrochloric acid. 22.9cm3 of the acid were required for complete neutralization.

(c) Write the expression for the partition coefficient (KD) for ammonia between water and trichloromethane.

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(i) Calculate the partition coefficient (KD) (State any assumptions made)

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(d) Explain why small portions of solvent is preferred to large portions in solvent extraction of solute.

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13. (a) Complete combustion of 7.50g of an organic compound Y containing carbon, hydrogen and oxygen gave 17.8g of carbon dioxide and 9.27g of water. Determine the empirical formula of Y.

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(b) When vaporized at 760mmHg and 400k, 0.225g of Y occupies $100cm^3$

(i) Calculate the molar mass of Y.

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(ii) Deduce the molecular formula of Y

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(iii) Write down the structural formulae and systematic names of five isomers of Y

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(c) One of the named isomers of Y in b(iii) above does not react with acidified solution of potassium dichromate (VII), but reacts readily with a mixture of anhydrous zinc chloride and concentrated hydrochloric acid to form a turbid solution within 0 – 5 minutes.

(i) identify Y

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(ii) Write equation and indicate the mechanism for conversion of Y to an alkene.

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14. (a) Silver carbonate is sparingly soluble in water
Write

13

(i) the equation for solubility of silver carbonate in water.

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(ii) the expression for Ksp(solubility product) for silver carbonate

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(b) The solubility of silver carbonate ate 15ºC is 0.03g dm^{-3}
Calculate the solubility product of silver
Carbonate at 15ºC.

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(c) tate what would happen to the solubility of silver carbonate when a 0.1M solution of silver nitrate is added to the saturated solution. Explain your answer.

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15. (a) What is meant by the term bond energy?

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(b) The bond energy of C = O, C – H , C – O, C – C and O – H bonds respectively are 743, 412, 360, 348 and 463. Calculate the enthalpy change for the reaction below

$$(CH_3)_2C=O + HCN \longrightarrow (CH_3)_2C(OH)CN$$

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(c) For each of the following compounds state the type of bonding and structure adopted

Compound	Bonding type	Structure
Iodine Calcium fluoride Silicon (IV) oxide		

16. The table below shows the melting points of period three elements

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Mpt /^{o}C	371	923	933	1680	317	392	172	84

Explain why:

(i) magnesium has a higher melting point than sodium. (3 marks)

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(ii) Silicon has the highest melting point (3 marks)

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(iii) Sulphur has a higher melting point than phosphorus (3 marks)

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17. 2.0g of phosphorus raise the boiling point of 37.4g carbon disulphide by 1.003ºC

(a) calculate the molar mass of phosphorus in carbon disulphide
(Kb for carbon disulphide = 2.35ºC mol^{-1} $1000g^{-1}$)

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(b) Hence determine the molecular formula of phosphorus in carbon disulphide.

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(i) State any two assumptions made in the calculation in (a) above

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(ii) comment on the result in (a) above.

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End

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S6 CHEMISTRY

Exam 31

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions to candidates:

- Answer all questions in section A and six questions in section B
- All questions must be answered in the spaces provided.
- The periodic table with relative atomic masses will be provided.
- Illustrate your answers with equations where applicable.

SECTION A:
Answer all questions in this section.

1. (a) Write balanced equations for the following nuclear changes. In each case identify particles X, Y and Z (1 mark)

(i) $^{27}_{14}Si \longrightarrow {}^{27}_{13}At + X$

Balanced equation

(ii) $^{235}_{92}U + {}^{1}_{0}n \longrightarrow 3{}^{1}_{0}n + Y + {}^{148}_{57}La$

Balanced equation:

(iii) $\alpha + {}^{54}_{26}Fe \longrightarrow Z + {}^{1}_{1}H$

2

Balanced equation

(b) A radioisotope was found to have $^{1}/_{8}$th of acts original activity after 42 days. Calculate the half-life of the isotope. (2 ½ marks)

2. $20cm^3$ of a gaseous hydrocarbon Q was exploded with $150cm^3$ of oxygen in excess. After complete combustion, the volume of residual gas was found to be $110cm^3$. When concentrated potassium hydroxide was added to the residual gas, the volume reduced to $30cm^3$.

(a) Determine the molecular formula of Q

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(b) Write the structures and IUPAC names of all possible isomars of Q.

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(c) Ozonolysis of Q leads to the formation of only one product. Write the mechanism of reaction between Q and alkaline potassium manganate (VII) solution.

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3. Explain the following observations:
(a) Both nitrogen and phosphorus belong to group (V) of the periodic table but nitrogen only from the chloride NCl_3 whereas phosphorus forms PCl_3 and $PC1_5$

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(b) Hydrogen fluoride boils at 20ºC whereas hydrogen chloride boils at – 84ºC.

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4. Name the reagents that can be used to distinguish between the following compounds. In each case state what would be observed of each compound is separately treated with the reagent.
(a) H_3COOH and CH_3COOCH_3 (2 marks)

Reagent(s)

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Observations

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(b) $(CH_3)_3N$ and $(CH_3)_2NH$ (2 marks)

Reagent(s)

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Observation(s)

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5 (a) State factors that can affect molar conductivity of an electrolyte.

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(b) The molar conductivities at infinite dilution at 25°C for some electrolytes are given in the table below.

Electrolyte	λ_∞ Scm^{2}mol^{-1} at 25^{0}C
Sodium nitrate	122
Nitric acid	421
Sodium ethanoate	91

Calculate the molar conductivity at infinite dilution for ethanoic acid.

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(c) The molar conductivity of a 0.016M CH_3COOH aqueous solution at 25°C is 13.0 S cm^2 mol^{-1}. Calculate the acid dissociation constant (ka for ethanoic acid).

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6 (a) Define the term bond energy. (01 marks)

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(b) Draw the structure and name the shape of phosphorus trichloride molecule (1 ½ marks)

(d) The heats of atomisation of phosphorus and chlorine are given below

		$\Delta H a/kgmol^{-1}$
$P(s) \longrightarrow$	$P(g)$	+314
$Cl_2(g) \longrightarrow$	$2Cl(g)$	+ 242

Calculate the average bond energy for P – Cl bond. (The heat of formation of PCl_3) is – 360 $Kjml^{-1}$ (2 ½ marks)

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7. A gaseous hydride of silicon with a formula $(Si_n H_{2n+n})$ diffuses through a narrow hole in 27.8s. The same volume of carbon dioxide diffuses through the same hole under identical conditions in 32.6s.

(a) (i) Calculate the relative molecular mass of the hydride. (1 ½ marks)

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(ii) Determine the molecular formula of the hydride (1 ½ marks)

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(b) Write equation for the reaction between the hydride in a (ii) above with water in the presence of sodiumhydroxide. (1 ½ marks)

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8. The results below were obtained in an experiment to investigate the rate of hydrolysis of methylmethanoate at 298K.

$[HCO_2CH_3]$ /Mol dm^{-3}	$[H^+]$ Moldm $^{-3}$	Initial rate X10^3/mol dm^{-3} S^{-1}
0.50	1.00	0.56
2.00	1.00	2.24
2.00	0.50	1.13

(a) Deduce the order of reaction with respect to

(i) Methlymethanoate

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(ii) Hydrogen ions

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(b) (i) Calculate the overall order of reaction

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(ii) Write the rate equation

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(c) Calculate the rate constant, K for the reaction at 298k. State its units.

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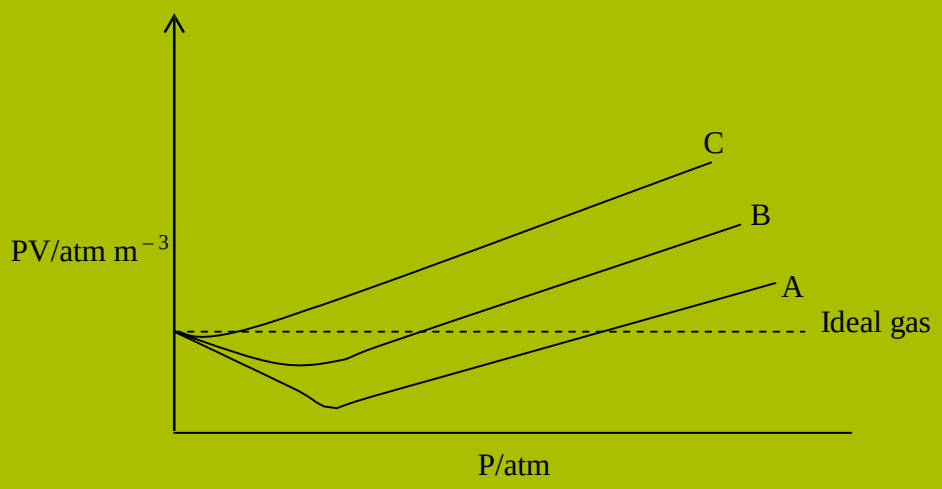
9.The figure below shows the PV against P plots for three gases, oxygen, nitrogen and carbon dioxide at 273K.



Identify giving reason(s) for your answer which gas is represented by each of the curves

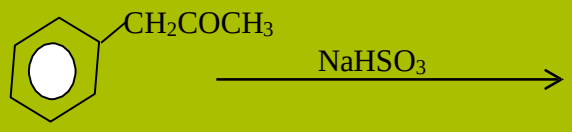
A: …….

B: ……..

C; ……

10.Complete the following organic reactions and write the accepted mechanisms (3 ½ marks)

(a)



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(b) $CH_3CH_2C(H)=CH_2 \xrightarrow{H^+/H_2O}$

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(c) $H_3CH_2CH_2Br \xrightarrow{CH_3COO^- Ag^+}$ (2 marks)

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11.

(a) (i) Write the electronic configuration of manganese. (01 marks)

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(ii) State the common oxidation states exhibited by manganese in its compounds or ions. (1 ½ marks)

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(b) Draw the structure and name the shape adopted by the manganate (VII) ions (2 marks)

(c) The manganate (vii) ions are strongly oxidizing in both alkaline or acidic media. Write equations to show the oxidizing action

(i) alkaline media

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(ii) acidic media

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(d) Curve a reason why potassium manganate (Vu) is not good primary standard. (1 mark)

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(e) Name one compound used to standardize the potassium manganate (vii) (½ mark)

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12. The data in table below was obtained for the reaction:

$A + H_2O \xrightarrow{H^+(cat)} 2P$

Time/Mins	0	10	20	30	40	50	60
$\log_{10}[A]$	0.398	0.199	0.041	– 0.200	– 0.377	– 0.602	– 0.796

(a) lot a graph of $\log_{10}[A]$ against time. (3 marks)

(b) From the graph, determine the order of the reaction

(c) alculate:

(i) the rate constant for the reaction

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(ii) the half life of the reaction

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13. Compound Y contains 71.05% silver, 7.89% carbon, the rest being oxygen (vapour density of Y is 152)

(a) (i) Calculate the empirical formula of Y (2 ½ marks)

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(ii) Determine the molecular formula of Y (2 marks)

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(b) In each case state what would be observed and write equation of reaction that took place when the following compounds are added to the aqueous solution of Y.

(i) aqueous potassium chromate: (2 ½ marks)

Observation

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Equation

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(ii) Hot acidified potassium permanganate solution observation: (2 marks)

Observation:

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Equation:

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14. Write equations to show how each of the following organic compounds can be synthesized. In each case indicate the reagents and conditions of reactions.

(a) $CH_3COOC_2H_5$ from ethanol

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(b) $CH_3CONHCH_2CH_3$ from Bromomethane.

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(c) $CH_3C{\equiv}CH$ from $CH_2 = CH_2$

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15. (a) Define the term molar enthalpy of hydration (01 mark)

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The enthalphy of hydration of ions M^{2+} and standard electrode potentials E^{θ}/v for group(II) elements are shown in the table below:

1ions	Be^{2+}	Mg^{2+}	Ca^{2+}	Sr^{2+}	Ba^{2+}
Enthalpy of hydration / $Kjmol^{-1}$	__	– 1930	– 1650	– 1480	– 136
Standard electrode potential E^{θ}/v	– 1.85	– 2.37	– 2.87	– 2.89	– 2.90

(b) State giving reason(s) for your answer which ion is:

(i) the least reducing

(ii) the least oxidizing

(c) Explain

(i) why the enthalpy of hydration of the ions have a negative value

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(ii) the trend in variation of the enthalpy of hydration

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16. Na, Si, P , S and Cl are some of the elements in period III of the periodic table

(a) rite the formula of the hydride of each element.

Element	**Formula of hydride**
Na	
Si	
P	
S	
Cl	

(b) Compare the reactivity of the hydrides with water. In each case write equation of reaction of any. (6 ½ marks)

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17. (a) Distinguish between thermoplastics and thermosetting plastics

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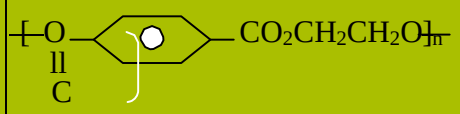
(b) For each of the following polymers, write the structure(s) of the monomer(s) from which they were synthesized.

Polymer	Structure(s) of monomers
$[CH_2 - CH - CH_2CH]_n$ l l Cl C ≡	
	

(c) solution containing 1.00g of polyphenyl ethane in 100cm^3 of benzene is found to have an osmotic pressure of 59 Pa at 27°C. Calculate the average relative molecular mass of polyphenylethene.

15

End