P525/1 CHEMISTRY Paper 1 August, 2024 $2\frac{3}{4}$ hours.



NATIONAL EDUCATION RESEARCH & EXAMINATIONS BUREAU UACE NEREB NATIONAL MOCKS 2024

CHEMISTRY

(Principal Subject)

Paper 1

2 hours 45 minutes.

INSTRUCTIONS TO CANDIDATES:

- Answer ALL questions in part A and Six questions from part B.
- All questions are to be answered in the spaces provided.
- The Periodic Table with relative atomic masses is provided at the back.

For Examiner's Use Only

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

PART A (46 MARKS)

Attempt all questions in this section

- 1. (a) State how in a mass spectrometer;
 - (i) Positive ions are formed.

(ii) Peaks are obtained.

(b) Bromine has two isotopes 79_{Br} and 81_{Br} and the mass spectrum shows peaks at m_e of 158, 160 and 162.

Write the formulae of the ions corresponding with the peaks. $(1 \frac{1}{2} \text{ mark})$

Peak of ^m / _e	Formula of ion
158	
160	
162	

- (c) Calculate the percentage abundance of 79_{Br} and 81_{Br} (The relative atomic mass of bromine in 79.91) (2 marks)
- 2. (a) A synthetic polymer has the structure



Name;

(i) the monomer used to make the polymer. (1 mark)

(ii) the process leading to the formation of the polymer. (1 mark)

(1 mark)

(1 mark)

*(***1 1)**

(b) The osmotic pressure of an aqueous solution of 6.2b % polymer at 23	^o C is
0.43mm	Hg.
Calculate the value of n.	(2½ marks)
	• .
(c) Explain why the freezing point depression method is not suitable for dete	ermination
of the relative molecular mass of polymers.	$(1 \frac{1}{2} \text{ marks})$
(d) State one use of the polymor in (e)	(1/2 morls)
(d) State one use of the polymer in (a).	(72 mark)
3. State conditions and write equation for the reaction between carbon and	
(i) water	$(2\frac{1}{2} \text{ marks})$
	· · ·

(ii) nitric acid

 The standard enthalpy change of formation of tin(IV) chloride is -508 KJmol⁻¹. The standard enthalpy changes of atomization of tin and chloride are +301 and +121 KJmol⁻¹

respectively.

(a) Use the above data to construct a Born-Haber cycle for formation of tin(IV) chloride.

(3 marks)

(2 ¹/₂ marks)

(b) Calculate the average bond energy of the Sn-Cl bond. (2 marks)

5. Name the following complex ions and in each case state the coordination number and oxidation state of the central metal atom. (6 marks)

Complex ion	Name	Oxidation	Co-ordination
		state	number
$Ag(NH_3)_2^+$			
$Fe(OH)_2(H_2O)_4^+$			
<i>CoCl</i> ₄ ²⁻			

- 6. Explain the following observations.
 - (a) The solubility of lead(II) halides increases in the order $PbI_2 < PbBr_2 < PbCl_2$

(3 marks)

(b) A 0.01M aqueous solution of sodium chloride has the same freezing point as a 0.02M aqueous solution of glucose. (2 marks)

7. Write equations to show how the following conversions can be effected.(a) phenylamine from hydroxybenzene. (2 ¹/₂ marks)

(b) Phenylhydrazine from phenylamine. (2 marks)

8. Potassium chromate solution was added to barium chloride solution followed by dilute nitric acid dropwise until in excess.

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

(ii) Write equation(s) for the reaction(s) that took place. (3 marks)

9. Reduction potentials for some halfcell reactions are given below. Sn⁴⁺_(aq) + 2e⁻ → Sn²⁺_(aq) + 0.15v PbO_{2(s)} + 4H⁺_(aq) + 2e⁻ → Pb²⁺_(aq) + 2H₂O_(l) + 1.46v (a) Write the overall equation for the cell reaction that occurs when the half cells are combined.

(1 ¹/₂ mark)

(b) (i) Calculate cubs free energy for the cell reaction (Faraday's constant = 96500c) (2 marks)

(ii) State whether the cell reaction is feasible or not and give reason for your answer.

(1 mark)

SECTION B: (54 MARKS) Attempt only six questions in this section

10. (a) State what would be observed and write equation(s) for the reaction(s) that would take place if:

(i) A mixture of ethanol and propanoic acid containing a few drops of concentrated

sulpuric acid is heated and the hot contents poured into a beaker of cold water.

(2 ¹/₂ marks)

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

(3 marks)

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

(3 ¹/₂ marks)

11. An organic compound W contains 22.8% N, 28% O 8.5% H and the rest Carbon.
(a) Calculate the empirical formula of W. (2¹/₂ marks)

(b) 0.5g of W dissolved in 80g of water forming a solution that freezes at -0.197° C. Calculate the molecular formula of W.

(Cryoscopic constant for water = 1.86° C Mol⁻¹ per 1000g of water) (3 ¹/₂ marks)

(c) When W was refluxed with potassium hydroxide, ethanoic acid and ammonia was (i) identify W (1 mark)

(ii) Write equations to show how W is obtained from a carbonyl compound.

(2 marks)

14. Successive ionization energies (KJMol⁻¹) for some elements in period 3 of the periodic table are

shown in the table below.

Element (atomic	Ionisation energy							
number)	1 st	2 nd	3 rd	4 th	5 th			
Si (14)	787	1577	3230	4355	16,090			
P (15)	1060	1896	2908	4954	6272			
S (16)	1000	2258	3381	4565	6995			

(a) State and explain the general trend in successive ionization energies. (3 marks)

(b) Explain why the;

(i) first ionization for sulphur is less than that of phosphorus. (3 marks)

(ii) third ionization energy of phosphorus is less than that of silicon. (3 marks)

13. (a) Calcium sulphate is sparingly soluble in water.
Write

(i) equation for the solubility of calcium sulphate in water.
(1 ¹/₂ mark)

(ii) the expression for the solubility product of calcium sulphate. $(\frac{1}{2} \text{ mark})$

(b) The molar conductivity of calcium chloride sodium phosphate and sodium chloride at infinite

dilution at 25°C are 271.8, 390.3 and 126.5 $\Omega^{-1}CM^2Mol^{-1}$ respectively. Calculate the;

(i) Molar conductivity of calcium phosphate at infinite dilution at 25°C. (2 marks)

(ii) Solubility product of calcium phosphate at 25°C. (electrolytic conductivity of calcium phosphate is $1.31 \times 10^{-2} \Omega^{-1} \text{Cm}^{-1}$) (3 ¹/₂ marks)

(c) State what would happen to the solubility of calcium phosphate when phosphoric(V) acid is added to its saturated solution. Give a reason for your answer. (1 ¹/₂ marks)

14. (a) Explain why transaction elements commonly act as catalysts. (2 marks)

(b) In each case write equation for the reaction catalysed by the following substances.

(i) Finely divided Iron

 $(1 \frac{1}{2} \text{ mark})$

(ii) Vanadium(V) oxide

(1 ¹/₂ marks)

(iii) Manganese(II) ions

(1 ¹/₂ marks)

(c) Explain the action of a positive catalyst. $(2 \frac{1}{2} \text{ marks})$

15. (a) Explain what is meant by the term azeotropic mixture. (1 mark)

(b) The boiling points and mole fractions of methanol in the liquid mixture and in the vapour above the mixture methanol and cyclohexane are given below.

Boiling point of mixture (°C)	Mole fraction of CH ₃ OH in liquid mixture	Mole fraction of methanol in the vapour above mixture		
	пплитс	vapour above mixture		
70	0.12	0.27		
60	0.31	0.47		
55	0.50	0.56		
57	0.82	0.69		
61	0.94	0.83		

(i) Use the data to plot a boiling point composition diagram for solutions of cyclohexane in methanol.

(Boiling points of pure cyclohexane and methanol are 81°C and 65°C respectively) (3 marks)

(ii) Use your graph to determine composition of the azeotropic mixture and azeotropic temperature. (2 marks)

(c) (i) state the type of deviation from Raoults law of cyclohexane and methanol. (1 mark)

(ii) Explain your answer in (i)

(2 marks)

16. 30cm³ of a gaseous hydrocarbon Z was exploded with 200cm³ of oxygen, which was in excess. The residual gas volume found to 155cm³ on cooling to room temperature.

(a) (i) Write the general equation for the reaction between Z and oxygen. $(1 \frac{1}{2} \text{ mark})$

(ii) Calculate the molecular formula of Z. $(2\frac{1}{2} marks)$

(b) When Z was treated with ammoniacal silver nitrate solution, a white precipitate was formed. (i) Identify Z (1 mark)

(ii) Write equation for the formation of a white precipitate. $(1 \frac{1}{2} \text{ mark})$

(c) Z was reacted with water in the presence of dilute sulphuric and miraculous sulphate $at 60^{\circ}$ C. Write equation for reaction and the accepted mechanism. (2¹/₂ marks)

17. (a) (i) Write the name and formula of the ore of Zinc. (1 mark)

(ii) Briefly describe how pure Zinc can be obtained from the ore you have named in (i) (3 marks) (b) 3.0g and Zinc ore was dissolved in excess concentrated ammonia and the solution was made upto 500cm3. The resultant solution was shaken with carbon tetrachloride

to stand. 25cm3 of the organic layer required 12.50cm3 of 0.025m

hydrochloric acid for complete neutralization. 12.5cm3 of the aqueous layer was neutralized by 20.0cm3 of 0.25M hydrochloric acid.

Calculate the percentage of Zinc in the ore.

[The partition coefficient of ammonia between carbon tetrachloride and water = 0.04] (4 marks)

(c) State <u>one</u> application of Zinc.

(1 mark)