

Candidate's Name:

.....

Signature:

| Random No. | | | | | Personal No. | | |
|------------|--|--|--|--|--------------|--|--|
| | | | | | | | |

(Do not write your School/Centre Name or Number anywhere on this booklet)

P525/1
CHEMISTRY
Paper 1
2 ¾ hours

Uganda Advanced Certificate of Education
CHEMISTRY
Paper 1
2 hours 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, is supplied.

Mathematical tables(3 – figure tables) are adequate or non-programmable scientific electronic calculators may be used

Illustrate your answers with equations where applicable.

Where necessary, use the following:

Molar gas constant $R = 8.31 \text{ JK}^{-1} \text{ mol}^{-1}$

Molar volume of a gas at s.t.p is 22.4 litres.

Standard temperature = 273 K

Standard pressure = 101325 N m^{-2}

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

Turn Over

SECTION A (46 MARKS)

1. a) Methylamine is a weak base

i) What is **weak base**?

(1 mark)

.....

.....

ii) Write the equation for the ionization of methylamine. *(1 mark)*

.....

.....

iii) Write the expression for the ionization constant of methylamine.

(1 mark)

.....

.....

b) i) Calculate the hydrogen ion concentration in a 0.02M solution of methylamine. ($K_b = 4.4 \times 10^{-4}$; $K_w = 1 \times 10^{-14}$ at 25°C).

(3 marks)

.....

.....

.....

.....

.....

.....

ii) Calculate the pH of the solution.

(1 mark)

.....

.....

2. Name the reagent that you would use to distinguish between the following pairs of compounds. In each case state what you would observe when the reagent is treated with each member of the pair.

a) $(\text{CH}_3\text{CH}_2)_2\text{NH}$ and $\text{CH}_3\text{CH}_2\text{NH}_2$ (2 marks)

Reagent:

.....

Observations:

.....

.....

.....

b) $\text{CH}_3\text{CH}_2\text{OH}$ and CH_3OH (2 marks)

Reagent:

.....

Observations:

.....

.....

.....

c) HCOOH and CH_3COOH (2 marks)

Reagent:

.....

Observations:

.....

.....

3. Write the ionic equation for the reaction between sodium hydroxide and
 (a) Silicon(IV) oxide (1 ½ marks)

.....

- (b) Aluminium (1 ½ marks)

.....

- (c) Zinc oxide (1 ½ marks)

.....

4. a) i) Define a ‘**complex ion**’. (2 marks)

.....

.....

- ii) Explain why transition metals form complexes. (2 marks)

.....

.....

.....

.....

- (b) Complete the following table about complexes of chromium and cobalt. (2 marks)

| Complex | Oxidation state of metal ion | Co-ordination number |
|---|------------------------------|----------------------|
| $[\text{Cr}(\text{NH}_3)_6]^{3+}$ | | |
| $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})_2]\text{Cl}_2$ | | |

5. State what you would observe and write an ionic equation for the reaction between aqueous copper(II) sulphate solution and:

(a) Excess concentrated hydrochloric acid

(2 ½ marks)

Observation

.....

Equation

.....

(b) Aqueous potassium iodide solution.

(2 ½ marks)

Observation

.....

Equation

.....

6. Excess magnesium was added to 100 cm³ of 0.2 M copper (II) sulphate solution. The temperature rose by 16.9 °C.

a) Write an equation for the reaction.

(1½ marks)

.....

(b) Calculate the enthalpy of the reaction. (*Density of the solution is 1.0 g/cm³. Specific heat capacity of the solution is 4.2 J/g/°C.*)

(2½ marks)

.....

.....

.....

.....

.....

7. a) Define:
i) **Bond energy.** (1 mark)

.....

.....

- ii) **Heat of formation.** (1 mark)

.....

.....

- (b) Given the following bond energies.

| Bond | Bond energy (kJ/mole) |
|-------|-----------------------|
| C – C | 337 |
| C – H | 414 |
| C – O | 360 |
| O – H | 123 |

Calculate the heat of conversion of gaseous methoxymethane to gaseous ethanol. (2 marks)

.....

.....

.....

.....

8. a) An alkyne X has molecular formula C_4H_6 . Write the names and structural formulae of all possible isomers of X. (2 marks)

.....

.....

- (b) **X** reacts with an ammoniacal solution of silver nitrate.
- i) State what is observed. (½ mark)

.....

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

.....

- c) Write equations to show how **X** can be synthesized from ethane. (4 marks)

.....

.....

.....

.....

9. Draw the molecular structures of the following species. (2 marks)

| species | Shape |
|-----------------------------------|-------|
| (a) SO ₃ | |
| (b) Cl ₂ | |
| (c) H ₂ S | |
| (d) SO ₄ ²⁻ | |

SECTION B: (54 MARKS)

*Answer **six** questions from this section.*

*Additional questions answered will **not** be marked.*

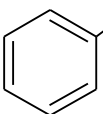
10. Write equations to show how the following compounds can be synthesized.
Indicate the reagents and conditions.

a) $(\text{CH}_3)_2\text{C} = \text{NOH}$ from propane – 2 – ol. (2 marks)

.....

.....

.....

b)  from benzene

(3 marks)

.....

.....

.....

c) $\text{CH}_3\text{CH}_2\text{C} \equiv \text{CCH}_2\text{CH}_2\text{CH}_3$ from But-1-ene. (2 marks)

.....

.....

.....

d) Benzoic acid from chlorobenzene. (2 marks)

.....

.....

11. (a) Write the formula and name of **one** ore of aluminium. (1 mark)

.....

(b) In the extraction of aluminium, the ore is first digested with sodium hydroxide solution. Describe what happens and write equations for the reactions that take place. (3 marks)

.....

.....

.....

.....

.....

(c) Name the steps that are carried out after digesting the ore with sodium hydroxide. (3 marks)

.....

.....

.....

.....

.....

(c) Describe how pure aluminium is obtained from the purified ore. Write the equation for the reaction. (2 marks)

.....

.....

.....

12. a) Define
i) **Conductivity.** *(1 mark)*

.....

.....

- ii) **Molar conductivity** *(1 mark)*

.....

.....

- (b) The electrolytic conductivity of a 0.1 M ethanoic acid at 20° C is $1.96 \times 10^{-2} \text{ Sm}^{-1}$. Its molar conductivity at infinite dilution is $3.52 \times 10^{-2} \text{ S m}^2 \text{ mol}^{-1}$.

Calculate:

- i) The molar conductivity of ethanoic acid at 20°C. *(2 marks)*

.....

.....

- ii) The degree of ionization of the acid at 20°C. *(1 mark)*

.....

.....

- iii) The pH of the acid *(2 marks)*

.....

.....

- (c) State **two** other factors other than concentration that can affect the pH of the acid. *(2 marks)*

.....

.....

13. a) State **three** properties exhibited by chromium as a transition metal. (3 marks)

.....

.....

.....

- (b) An aqueous solution of iron (II) salt was added to an acidified solution of chromium in the oxidation state of +6.

i) State what was observed. (1 mark)

.....

ii) Write half equations and the overall equation for the reaction that took place (3 ½ marks)

.....

.....

.....

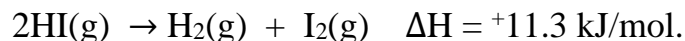
(c) i) State **one** application of chromium in the oxidation state of +6 in organic synthesis. (½ mark)

.....

ii) Write the equation to illustrate your answer. (1 mark)

.....

14. Hydrogen iodide decomposes according to the equation.



a) Write an expression for the equilibrium constant (K_c) of the reaction. (½ mark)

.....

- (b) 2.56 g of hydrogen iodide was heated in a 600 cm^3 bulb at 500°C . At equilibrium the bulb was rapidly cooled to room temperature and broken under potassium iodide solution. The iodine liberated required 33.5 cm^3 of 0.2 M sodium thiosulphate for complete reaction. Calculate

i) The number of moles of hydrogen iodide that were heated.

(1 mark)

.....

.....

ii) The number of moles of iodine that were formed from the decomposition.

(2½ marks)

.....

.....

.....

.....

iii) The value of K_c for the reaction at 500°C .

(3½ marks)

.....

.....

.....

.....

.....

.....

- (c) i) State what would happen to the value of K_c if the temperature changed from 500°C to 200°C

(½ mark)

.....

ii) Explain your answer. (1 mark)

.....

.....

15. a) What is meant by “**hydrolysis of a salt**”? (1 mark)

.....

.....

(b) A solution was made by dissolving 2.675 g of ammonium chloride in water to make 1 litre of solution.

(i) Write the equation for the hydrolysis of ammonium chloride. (1½ marks)

.....

(ii) Calculate the hydrogen ion concentration and hence the pH of the solution in (b) above (5 marks)

.....

.....

.....

.....

.....

ii) The degree of hydrolysis. (1½ marks)

($K_w = 1 \times 10^{-14}$ at 25°C , $K_h = 1.75 \times 10^{-5}$)

.....

.....

16. a) Define **partition coefficient**. (1 mark)

.....

.....

(b) 50 cm³ of 1.5 M ammonia solution was shaken with 50 cm³ of trichloromethane. At equilibrium 20 cm³ of the trichloromethane layer required 23 cm³ of 0.05 M hydrochloric acid. Find the partition coefficient of ammonia between water and trichloromethane.

(3 marks)

.....

.....

.....

.....

.....

.....

(c) 25 cm³ of ammonia (excess) was added to 25 cm³ of 0.1 M copper(II) sulphate solution. 50 cm³ of trichloromethane was added. The mixture was shaken and allowed to stand. 20 cm³ of the trichloromethane layer required 10.2 cm³ of 0.05 M hydrochloric acid for complete reaction. 10 cm³ of the aqueous layer required 16.5 cm³ of 0.5 M hydrochloric acid.

i) Find the concentration of ammonia in the trichloromethane layer. (1½ marks)

.....

.....

.....

.....

- ii) Find the concentration of free ammonia in the aqueous layer
(1 mark)

.....

.....

.....

- iii) Find the concentration of ammonia in the complex.
(1½ marks)

.....

.....

.....

- iv) Determine the formula of the complex. (1 mark)

.....

.....

.....

17. Agricultural lime is manufactured by heating limestone strongly in a kiln. The product is allowed to cool and a calculated amount of water is added.

- a) Write the equations for the reactions that take place (2 marks)

.....

.....

.....

- b) Give one use of lime in agriculture. (1 mark)

.....

- c) Explain the trend in the thermal stability of carbonates of group (II) metals. (2½ marks)

.....

.....

.....

.....

.....

.....

- d) The mineral “Dolomite” has formula $\text{CaMg}(\text{CO}_3)_2$. 2.5 g of Dolomite was reacted with excess hydrochloric acid. 230 cm³ of carbon dioxide was evolved at room temperature.

i) Write the equation for the reaction.

(1 mark)

.....

ii) Calculate the percentage of ‘Dolomite’ in the sample.

(2½ marks)

.....

.....

.....

.....

THE 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 | 204 Tl 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 |

END