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P525/1

CHEMISTRY

Paper 1

Uganda Advanced Certificate of Education

RESOURCE EXAMINATIONS 2016

CHEMISTRY

Paper 1

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **all** *questions in Section* **A** *and any* **six (6)** *questions in Section* **B.**

All *questions* **must** *be answered by writing clearly your answers and workings in the spaces provided.*

Silent non-programmable scientific electronic calculators may be used.

No paper should be given for rough work and any extra paper attached to this booklet will **not** *be considered.*

The periodic table, with relative atomic masses and atomic numbers of different elements is attached at the end of this booklet.

Mathematical tables (3 – figured) are to be provided.

Illustrate your answers with equations where applicable. Molar gas constant,

$R = 8.31\ JKg^{-1}mol^{-1}$. Molar volume of gas at s.t.p is 22.4 litres.

For Examiner's use only																	
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	**Total**

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SECTION A (46 MARKS)

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 ($2\frac{1}{2}$ 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 (3 marks)

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

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(b) Calculate the standard enthalpy of hydrogenation of ethane from the data: (4 marks)

(i) $C_2H_6\,(g) + \frac{7}{2}O_2(g) \longrightarrow 2CO_2\,(g) + 3H_2O\,(l)$ $\quad \Delta H = -1550 KJmol^{-1}$

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

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

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

(a) Briefly explain in terms of electronic structure why aluminium conducts electricity but the common allotropes of phosphorus don't. (3 marks)

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

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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 $(CH_3CH_2)_2NH$ (3 marks)

Reagent:

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Observation:

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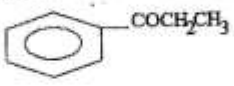
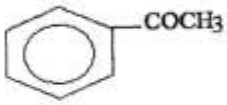
(b)  and  (3 marks)

Reagent:

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Observation:

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

$C_6H_5NH_2 < NH_3 < CH_3NH_2$

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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, K_b for methylamine ($2\frac{1}{2}$ 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 the:

(i) Anode (1 mark)

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(ii) Cathode (1 mark)

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(b) Write the overall equation for the cell reaction. ($1\frac{1}{2}$ 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 -0.76 and -1.51 volts respectively. Deduce whether the reaction in (b) is feasible or not and give a reason for your answer. (2 marks)

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

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

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8. 2.00g of phosphorus pentachloride are allowed to reach equilibrium at 200^0C in a vessel of $1dm^3$ capacity.

$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

If the equilibrium constant of the reaction above is 0.008 $moldm^{-3}$ at this temperature and in the conditions stated; calculate the percentage dissociation of the phosphorus pentachloride at equilibrium. (4 marks)

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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.

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

Explain;

(i) Why ionization energy decreases with increasing atomic number. (2 marks)

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

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SECTION B (54 MARKS)

*Answer any **six** questions in this section.*

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

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(ii) State how you would expect the molar conductivity of sodium chloride solution to vary as the dilution of the solution is increased. (2 marks)

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(b) The values of Λ_0 at 25^{0}C for some electrolytes are as follows.

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

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

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

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

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

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

(i) Calculate the solubility in moldm-3 of silver chloride at 298K. ($3\frac{1}{2}$ marks)

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(ii) Calculate the solubility product, K_{sp}, of silver chloride at 298K. ($1\frac{1}{2}$ marks)

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

(i) Addition of aqueous ammonia. (1 mark)

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

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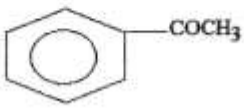
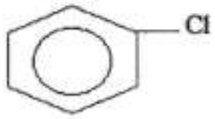
12. Write equations to show how the following compounds can be synthesized.

(a)  from  ($3\frac{1}{2}$ marks)

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(b) $(CH_3)_3 COH$ from $(CH_3)_2 CHOH$ ($2\frac{1}{2}$ marks)

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

13. (a) Explain each of the following observations:
(i) Chromium (III) sulphate dissolves in water to form a solution whose P^H is less than seven. ($2\frac{1}{2}$ marks)

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

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(b) To a dilute solution of chromium (III) sulphate was added dilute aqueous sodium hydroxide dropwise until in excess followed by 3 drops of hydrogen peroxide and the mixture warmed. Explain the reaction(s) that took place. (4 marks)

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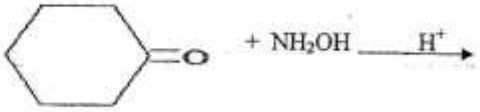
14. Complete the following equations and in each case write a mechanism for the reaction.

(a)  (3 marks)

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(b) $(CH_3)_3\ CBr \xrightarrow[C_2H_5OH,\ Heat]{NaOH}$ (3 marks)

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(c) $CH_3CH = CH_2 + \text{Conc. } H_2SO_4 \xrightarrow[\text{Warm}]{H_2O}$ (3 marks)

15. Vegetable oils have great economic and social importance.

(a) (i) Explain what is meant by the term vegetable oils. (1 mark)

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

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

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

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

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

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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). ($2\frac{1}{2}$ marks)

Observation:

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Equation:

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

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. (2 marks)

Observation:

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Equation:

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(d) A spatula end-ful of sodium hydrogencarbonate is added to iron (III) chloride solution. ($2\frac{1}{2}$ 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 the other halogens. ($2\frac{1}{2}$ marks)

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(ii) Give **three** causes for the anomalous behavior of fluorine. (3 marks)

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

Hydride	HF	HCl	HBr	HI
Ka/ moldm^{-3}	5.6×10^{4}	1×10^{7}	1.0×10^{9}	1.0×10^{11}

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

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THE END

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Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 86	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 117	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key:
atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

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