Candidate's Name: .....

Random No.					Personal No.		

Signature: .....

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

P525/1
CHEMISTRY
(Theory)
Paper 1
Nov. /Dec. 2019.
2¾ hours.

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(THEORY)

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 = $8.31\ JK^{-1}mol^{-1}$
Molar volume of gas at s.t.p. is 22.4 litres
Standard temperature = 273 K
Standard pressure = $101325\ Nm^{-2}$

For Examiners' 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)

Answer **all** *questions from this section.*

1. **(a)** Complete the following nuclear reaction equations.

(i) $^{27}_{13}Al + {}^{4}_{2}He \longrightarrow \ldots\ldots\ldots + {}^{1}_{0}n$. *(01 mark)*

(ii) $^{113}_{48}Cd + \ldots\ldots\ldots \longrightarrow {}^{114}_{48}Cd + \gamma$. *(01 mark)*

(iii) $^{233}_{91}Pa \longrightarrow \ldots\ldots\ldots + {}^{0}_{-1}e$. *(01 mark)*

(iv) $^{7}_{3}Li + \ldots\ldots\ldots\ldots\ldots \longrightarrow {}^{4}_{2}He + {}^{4}_{2}He$. *(01 mark)*

2. State what would be observed and write equation(s) for the reaction(s) that would take place to a solution of iron(II) sulphate when;

(a) aqueous sodium hydroxide was added drop-wise until in excess and the mixture was allowed to stand. *(3½ marks)*

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(b) a few drops of concentrated sulphuric acid was added followed by concentrated nitric acid and the mixture was boiled. *(03 marks)*

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3. A hydrocarbon Z, with molecular formular C_xH_y, reacts with oxygen according to the following equation:

$$C_xH_y + (x + \frac{y}{4})O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O.$$

When 20 cm^3 of Z was exploded in 200 cm^3 of an excess amount of oxygen, it burnt completely with a sooty flame. The volume of the residual

gas after cooling to room temperature was 160 cm^3.
When aqueous potassium hydroxide was added, the volume of the gas that finally remained was 20 cm^3.

(a) Calculate the molecular formula of *Z*. *(2½ marks)*

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(b) When Z was treated with bromine in the presence of iron(III) bromide, the bromine was decolorised. Identify *Z*. *(01 mark)*

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(c) Write equation(s) to show how *Z* can be synthesized from ethyne. *(1½ marks)*

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4. The data in the Table 1 was obtained for the reaction between an alkylhalide, *R* and sodium hydroxide solution.

Table 1

Experiment	[R] (mol dm^{-3})	[$\bar{O}H$] (mol dm^{-3})	Rate (mol dm^{-3} s^{-1})
1	0.100	0.50	2.0×10^{-3}
2	0.100	0.25	2.0×10^{-3}
3	0.050	0.25	1.0×10^{-3}
4	0.025	0.25	5.0×10^{-4}

(a) Determine the order of the reaction with respect to:

(i) Alkyl halide, *R*. *(01 mark)*

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(ii) Sodium hydroxide. *(01 mark)*

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(b) Write the rate equation for the reaction. *(01 mark)*

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(c) (i) State the class of the alkylhalide. *(01 mark)*

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(ii) Give a reason for your answer in (c)(i). *(01 mark)*

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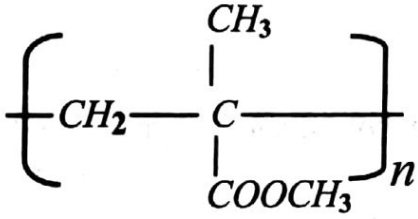
5. (a) Perspex is a synthetic polymer with a structure;



(i) Name the type of reaction that leads to the formation of perspex. *(½ marks)*

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(ii) Write the structure of the monomer of perspex. *(01 mark)*

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(b) When 1.25×10^{-3} moles of perspex were heated strongly with silicon(IV) oxide as a catalyst, 4.85 g of the monomer was produced. Calculate the;

(i) value of n. *(02 marks)*

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(ii) molar mass of perspex. *(01 mark)*

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(b) State **one** use of perspex. *(½ mark)*

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6. (a) When manganese(II) nitrate was heated, a black solid *R*, was formed.

Write equation for the reaction that took place. *(1½ marks)*

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(b) *R* was heated with excess potassium hydroxide:

(i) State what was observed. *(01 mark)*

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

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(c) To the mixture in (b), chlorine gas was bubbled. Write equation for the reaction that took place. *(1½ marks)*

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7. The standard electrode potentials for some redox systems are shown below.

$Fe\,O_4^{2-}(aq) + 8H^+(aq) + 3e^- \rightarrow Fe^{3+}(aq) + 4H_2O(l)$ $\quad E^o = +2.20\ V$

$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$ $\quad E^o = +1.23\ V$

(a) Write:

(i) The cell notation for the cell formed when the half cells are combined. *(01 mark)*

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(ii) The overall equation for the reaction. *(1½ marks)*

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(b) (i) Calculate the e.m.f. of the cell in (a). *(01mark)*

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(ii) State whether the cell reaction in (a)(ii) is feasible or not. Give a reason for your answer. *(01 mark)*

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8. Write equation(s) to show how the following conversions can be effected:

(a) CH_3CH_2CHO to $CH_3CH_2NH_2$. *(3½ marks)*

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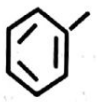
(b)  to  . *(2½ marks)*

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9. (a) Write equation for the reaction between fluorine and;

(i) water. *(1½ marks)*

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(ii) hot concentrated sodium hydroxide. *(1½ marks)*

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(b) Although fluorine is an element in group(VII) of the Periodic Table, it behaves differently from the other members of the group.

State **three** reasons why fluorine behaves differently from the other members. *(1½ marks)*

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SECTION B (54 MARKS)

Answer **six** *questions from this section. Any additional question(s) answered will* **not** *be marked.*

10. Complete the following equations and in each case outline a mechanism for the reaction.

(a) $(CH_3)_3C-Br \xrightarrow[CH_3CH_2\,OH/\,heat]{CH_3CH_2\bar{O}\,Na^+}$ ..... *(03 marks)*

Mechanism:

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(b)  + $CH_3COCl \xrightarrow{AlCl_3}$ ..... *(03 marks)*

Mechanism:

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(c) $HC \equiv CH \xrightarrow[(2)\ CH_3CH_2\,Br]{(1)\ Na/NH_3(l)}$ ..... *(03 marks)*

Mechanism:

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11. Table 2 shows acid dissociation constants, *Ka*, for some acids at 25°C.

Table 2

Acid	Ka (mol dm^{-3})
$H-COOH$	1.70×10^{-4}
CH_3COOH	1.70×10^{-5}
CH_3CH_2COOH	1.35×10^{-5}

(i) State the trend in acid strength of the acids in Table 2. *(01 mark)*

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(ii) Explain your answer in (a)(i). *(03 marks)*

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(b) Calculate the pH of a 0.5 M CH_3CH_2COOH solution. *(1½ marks)*

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(c) (i) 45.0 cm^3 of a solution in (b) was mixed with 35.0 cm^3 of a 0.5 M potassium hydroxide solution. Calculate the change in pH of the solution. *(2½marks)*

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(ii) Predict the effect of adding **two** drops of dilute hydrochloric acid to the solution in (c)(i). *(01 mark)*

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12. **(a)** The atomic number of aluminium is 13.

Write the;

(i) electronic configuration of aluminium. *(01 mark)*

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(ii) formula of the chloride of aluminium. *(01 mark)*

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(b) Write equation for the reaction between aluminium chloride and;

(i) water. *(1½ marks)*

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(ii) excess ammonia solution. *(1½ marks)*

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(iii) excess sodium hydroxide solution. *(03 marks)*

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(c) Name **one** reagent that can be used to distinguish between aluminium and lead(II) ions in solution. *(01 mark)*

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13. Name **one** reagent 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 you have named.

(a) $CH_3COOCH_2CH_3$ *and* CH_3CH_2COOH. *(03 marks)*

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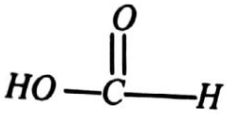
(b)  and  *(03 marks)*

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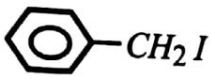
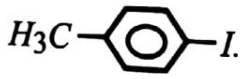
(c)  and  *(03 marks)*

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14. (a) Define the term **molar conductivity**. *(01 mark)*

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(b) (i) **Sketch a graph to show the variation of molar conductivity of sodium chloride with dilution.** *(02 marks)*

(ii) Explain the shape of the graph in (b)(i). *(2½ marks)*

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(c) The electrolytic conductivity of a saturated solution of silver chloride at 25°C is $1.5\times10^{-4}\ \Omega^{-1}m^{-1}$. The molar conductivities at infinite dilution of silver and chloride ions are 6.2×10^{-3} and $7.7 \times 10^{-3}\ \Omega^{-1}m^2\ mol^{-1}$ respectively.

Determine the solubility of silver chloride at 25 °C. *(3½ marks)*

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15. **Cobalt(II) nitrate dissolves in water to form a pink solution and decomposes on heating to form a green solid.**

(a) **Write equation to show the effect of heat on cobalt(II) nitrate.**

(1½ marks)

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(b) State what would be observed and write equation for the reaction that would take place when the following substances are added to the solution of cobalt(II) nitrate in water.

(i) Concentrated hydrochloric acid. ***(02 marks)***

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(ii) Aqueous ammonium thiocyanate solution. ***(02 marks)***

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(iii) Aqueous sodium hydroxide. ***(3½ marks)***

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16. **(a)** **(i)** **Draw the structure and name the shape of the following oxyanions.** *(04 marks)*

Oxyanion	Structure	Shape
SO_3^{2-}		
SO_4^{2-}		

(ii) **Explain the structure of the SO_3^{2-} ion.** *(1½ marks)*

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(b) **(i)** **Name the reagent(s) that can be used to distinguish between the oxyanions in (a)(i).** *(01mark)*

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(i) **State what would be observed; if a solution of each of the oxyanion is treated separately with the reagent(s) you have named in (b)(i).** *(01 mark)*

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(ii) Write the equation(s) for any reaction(s) that would take place when a solution of each of the oxyanions is treated separately with the reagent(s) you have named in (b)(i). ..... *(1½ marks)*

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17. (a) State **three** conditions that enable isolation of a solute from a mixture by solvent extraction. *(1½ marks)*

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(b) When one litre of an aqueous solution containing 25.0 g of solute X was shaken with 500 cm^3 of ethoxyethane, 9.7g of X was extracted in the ethoxyethane layer.

Calculate the partition coefficient of X between ethoxyethane and water. *(02 marks)*

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(c) The solution in (b) was shaken with two successive 250 cm^3 portions of ethoxyethane. Calculate the total mass extracted. *(04 marks)*

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(d) Comment on the result in (c). *(01 mark)*

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(e) State **one** application of solvent extraction. *(½ mark)*

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