(ii) Calculate the enthalpy of solution of calcium iodide. *(1½ marks)* *(The hydration energies of calcium and iodide ions are −1562 and −307 kJ mol^{-1} respectively).*

(iii) Comment on the solubility of calcium iodide. *(01 mark)*

(d) Explain the trend in the lattice energies of the halides of potassium. *(The lattice energies of KF, KCl and KI are = −813, −710 and −643 kJ mol^{-1} respectively).* *(02 marks)*

7. Describe how the following conversions can be effected. ✓ *(Equations are **not** required.)*

(a) *Ethanol* to *methanal.* *(5½ marks)*

(b) Calcium carbide to *ethane−1, 2− diol.* *(05 marks)*

(c) *Ethanol* to *methane.* *(04 marks)*

(d) *Propanoic acid* to *propan−2−ol.* *(5½ marks)*

8. Explain each of the following observations and illustrate your answer with equations where necessary.

(a) The boiling point of *propan−1−ol* is 98 °C, whereas butane with approximately the same formula mass boils at −0.5 °C. *(2½ marks)*

(b) Concentrated sulphuric acid cannot be used to prepare hydrogen bromide from sodium bromide. ✓ *(2½ marks)*

(c) The solubility of the hydroxides of elements in group II of the Periodic Table increases in the order;

Be(OH)$_2$ < Mg(OH)$_2$ < Ca(OH)$_2$ < Sr(OH)$_2$ < Ba(OH)$_2$. ✓

(3½ marks)

(d) Phenol is sparingly soluble in water but it is readily soluble in dilute sodium hydroxide. *(04 marks)*

(e) The bond angles in water and ammonia molecules are 105° and 107° respectively. *(3½ marks)*

(f) The first ionisation energy of magnesium is greater than that of ✓ aluminium. *(The atomic numbers of Mg and Al are 12 and 13 respectively).* *(04 marks)*

END

SECTION B (40 MARKS)

*Answer **two** questions from this section.*
*Any additional question answered will **not** be marked.*

15. (a) The boiling points and the atomic numbers of group VII elements in the Periodic Table are given in the Table 1.

Table 1

Element	Flourine	Chlorine	Bromine	Iodine
Boiling point (°C)	−188	−34.7	58.8	184.0
Atomic Number	9	17	35	53

   (i) Draw a graph to show how the boiling points of the elements vary with atomic number. *(03 marks)*

   (ii) Explain the shape of your graph. *(2½ marks)*

   (b) Describe the reaction of group VII elements with sodium hydroxide. *(Your answer should include conditions and equations).* *(10 marks)*

   (c) Explain how silver nitrate can be used to distinguish chloride, bromide and iodide ions. *(4½ marks)*

6. (a) State what is meant by the following terms:

   (i) lattice energy. *(01 mark)*
   (ii) hydration energy. *(01 mark)*
   (iii) enthalpy of solution. *(01 mark)*

   (b) Describe an experiment that can be carried out to determine the enthalpy of solution of calcium iodide. *(08 marks)*

   (c) Some thermochemical data are shown below:

   Enthalpy of atomisation of iodine = $+106.8$ kJ mol^{-1}.
   First ionisation energy of calcium = $+590$ kJ mol^{-1}.
   Second ionisation energy of calcium = $+1145$ kJ mol^{-1}.
   Enthalpy of atomisation of calcium = $+178.2$ kJ mol^{-1}.
   Enthalpy of formation of calcium iodide = -533.5 kJ mol^{-1}.
   Electron affinity of iodine = -295.4 kJ mol^{-1}.

   (i) Draw an energy level diagram for the formation of calcium iodide and use it to calculate the lattice energy of calcium iodide. *(4½ marks)*

4

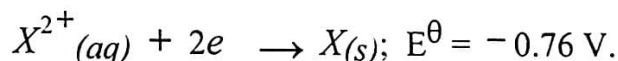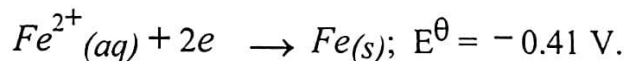3. Carbon, silicon, tin and lead are some of the elements in group IV of the Periodic Table.

(a) (i) Write the formulae of the hydrides of the elements. *(02 marks)*

   (ii) Carbon can combine with hydrogen to form a wide variety of compounds, silicon forms fewer compounds with hydrogen while hydrogen compounds of lead and tin are very limited in number. Explain. *(02 marks)*

(b) Discuss the reaction of the hydrides of the above elements with;

   (i) dilute hydrochloric acid. *(2½ marks)*
   (ii) sodium hydroxide. *(02 marks)*
   (iii) water. *(02 marks)*

(c) Explain how;

   (i) chlorine reacts with tin and lead. *(04 marks)*
   (ii) nitric acid reacts with carbon and lead. *(5½ marks)*

4. (a) (i) Explain what is meant by the term **standard electrode potential**. *(03 marks)*

   (ii) State **three** factors that affect the value of electrode potential. *(1½ marks)*

(b) With the aid of a labelled diagram, describe how a standard hydrogen electrode works. *(06 marks)*

(c) Some half-cell reactions are shown below

$$Fe^{2+}_{(aq)} + 2e \longrightarrow Fe_{(s)}; \ E^{\theta} = -0.41 \text{ V.}$$

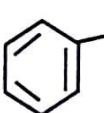$$X^{2+}_{(aq)} + 2e \longrightarrow X_{(s)}; \ E^{\theta} = -0.76 \text{ V.}$$

Write the;

   (i) cell notation for the overall cell. *(01 mark)*
   (ii) equation for the overall cell reaction. *(1½ marks)*

(d) Calculate the e.m.f for the cell in (c) and predict whether the reaction is feasible or not. *(03 marks)*

(e) A steady current of 12.0 A was required to electroplate a substance Q with 15.0 g of iron using iron(II) sulphate as electrolyte. Calculate the time taken for Q to be electroplated. (1 F = 96,500 C; Fe = 56). *(03 marks)*

(f) State **two** industrial applications of electrolysis other than electroplating. *(01 mark)*

Turn Over

SECTION A (60 MARKS)

*Answer **three** questions from this section.*
*Any additional question answered will **not** be marked.*

1. (a)   Explain what is meant by the term;

    (i)   pH.   *(03 marks)*

    (ii)   buffer solution.   *(03 marks)*

    (b)   State **two** practical applications of buffer solutions.   *(01 mark)*

    (c)   Calculate the pH of a;

    (i)   0.1 M aqueous ethanoic acid.   *(3½ marks)*

    (ii)   buffer solution made by dissolving 16.4 g of sodium ethanoate, CH_3COONa in 1 dm^3 of a 0.1 M ethanoic acid.
    (The dissociation constant, K_a of ethanoic acid is 1.75×10^{-5} mol dm^{-3}).   *(2½ marks)*

    (d)   (i)   Draw a sketch graph showing the variation in pH of a solution when a 0.1 M aqueous sodium hydroxide is gradually added to 25.0 cm^3 of a 0.1 M aqueous ethanoic acid.   *(02 marks)*

    (ii)   Explain the shape of the graph which you have drawn in (d) (i).
    (05 marks)

2.   Complete each of the following reaction equations and in each case, outline a mechanism for the reaction.

    (a) $CH_3 CO Cl + CH_3CH_2 NH_2 \longrightarrow$ *(04 marks)*

    (b) $CH_2 Cl CH_2 Cl \xrightarrow[\text{heat}]{KOH_{(aq)}/CH_3CH_2OH}$ *(04 marks)*

    (c) $+ Br_2 \xrightarrow{CCl_4}$ *(03 marks)*

    (d) $CH_3 COOH + CH_3 OH \xrightarrow[\text{heat}]{Conc. H_2SO_4}$ *(5½ marks)*

    (e) $+ \xrightarrow[\text{warm}]{Fuming\ H_2SO_4\ (aq)}$ *(3½ marks)*

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P525/2
CHEMISTRY
(Theory)
Paper 2
Nov./Dec. 2020
2½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(THEORY)

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **five** *questions including* **three** *questions from section* **A** *and any* **two** *from section* **B**.

Write the answers in the answer booklet(s) provided

Begin each question on a fresh page.

Mathematical tables and squared paper are provided.

Silent non-programmable scientific electronic calculators may be used.

Use equations where necessary to illustrate your answers.

Where necessary use the following:

$[H = 1; C = 12; N = 14, O = 16]$

Turn Over