QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 Which ONE of the homologous series below contains a carbonyl group?

A   Alcohols

B   Alkenes

C   Esters

D   Haloalkanes   (2)

1.2 The reaction for a saturated salt solution is shown below :

$$NaC\ell(s) \rightleftharpoons Na^+(aq) + C\ell^-(aq)$$

Which ONE of the following actions will favour the reverse reaction?

A   Heat the solution.

B   Increase the pressure on the system.

C   Add concentrated hydrochloric acid ($HC\ell$).

D   Bubble chlorine ($C\ell_2$) gas through the solution.   (2)

1.3 What is the concentration of hydronium ions $[H_3O^+]$ in a solution if the concentration of hydroxide ions is $1,0 \times 10^{-3}$ M?

A $1,0 \times 10^{-7}$ M

B $1,0 \times 10^{-11}$ M

C $1,0 \times 10^{-8}$ M

D $1,0 \times 10^{-1}$ M   (2)

1.4 Consider the electrochemical cell with the following cell notation:

$$Pt \mid H_2 \mid H^+(aq)(1 \text{ mol·dm}^{-3}) \parallel Fe^{3+}(aq)(1 \text{ mol·dm}^{-3}) \mid Fe^{2+}(aq) \mid Pt$$

Which ONE of the following equations represents the cathode half-cell reaction?

A $Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$

B $Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e^-$

C $H_2(g) \rightarrow 2H^+(aq) + 2e^-$

D $2H^+(aq) + 2e^- \rightarrow H_2(g)$ (2)

1.5   The potential energy diagram for a reversible reaction is shown below.
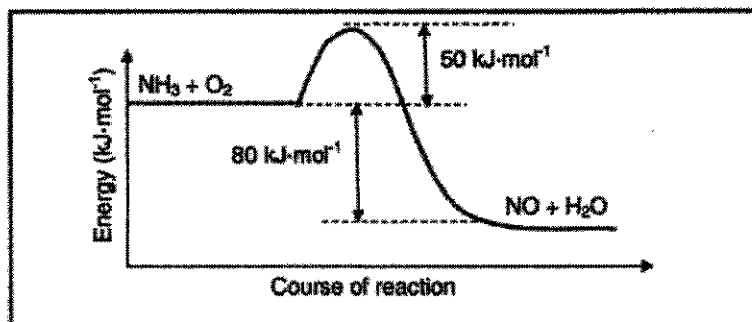
The activation energy of the reverse reaction is:

Ⓐ $130 \ kJ \cdot mol^{-1}$

Ⓑ $30 \ kJ \cdot mol^{-1}$

Ⓒ $50 \ kJ \cdot mol^{-1}$

Ⓓ $80 \ kJ \cdot mol^{-1}$ (2)

1.6   Consider the chemical reaction represented by the equation below:

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

Which ONE of the following changes will increase the rate of production of $H_2(g)$?

Ⓐ   Increase in pressure

Ⓑ   Increase in volume of $HCl(aq)$

Ⓒ   Decrease in concentration of $HCl(aq)$

Ⓓ   Increase in temperature   (2)

1.7   Consider the following statements about the Contact process:
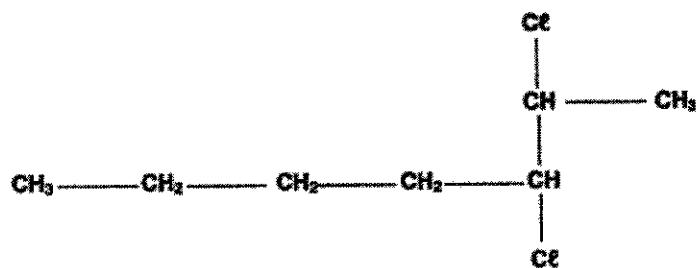
(i)   The catalyst used is platinum.

(ii)   The chemical formula for oleum is $H_2S_2O_7$.

(iii)   The reaction is endothermic and takes place at low temperatures.

Which of the statement(s) above is/are CORRECT?

Ⓐ   (i) only

Ⓑ   (ii) only

Ⓒ   (i) and (iii) only

Ⓓ   (ii) and (iii) only   (2)

1.8 The formula for an organic compound is shown below:

$$
\begin{array}{c}
C\ell \\
| \\
CH \text{———} CH_3 \\
\\
CH_3 \text{———} CH_2 \text{———} CH_2 \text{———} CH_2 \text{———} CH \\
| \\
C\ell
\end{array}
$$

The CORRECT IUPAC name for this compound is ...

Ⓐ 5,6-dichloroheptane.

Ⓑ 4-chloro-5-chloro-5-ethylpentane.

Ⓒ 2,3-dichloroheptane.

Ⓓ 2-chloro-1-chloro-1-ethylpentane. (2)

1.9 The following equation represents a chemical reaction:

$CH_3 - CH_2 - CH_2C\ell \rightleftharpoons CH_3 - CH = CH_2 + HC\ell$

What type of reaction is represented by the above equation?

Ⓐ Dehydrogenation

Ⓑ Dehydration

Ⓒ Dehalogenation

Ⓓ Dehydrohalogenation (2)

1.10 A standard solution is a solution ...

Ⓐ which is neutral.

Ⓑ for which the concentration is known.

Ⓒ with a concentration of 1 mol·dm^{-3}.

Ⓓ where all the solids are not dissolved in the solvent. (2)

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QUESTION 2 (Start on a new page.)

The letters R to W in the table represent six organic compounds. Use the information in the table to answer the questions that follow.

R	S
Ethyl ethanoate	
T $CH_3CH_2CH_2C\text{-}O\text{-}H$	U
V Polyvinyl chloride (PVC)	W

2.1.   Write down the molecular formula for compound S.   (2)

2.2   Explain the term *functional isomer*.   (2)

2.3   Write down the letters for TWO compounds that are functional
       isomers.   (2)

2.4   Draw a structural formula for compound R.   (2)

2.5   Write down the IUPAC name of the reactants of compound S.   (2)

2.6   Give the IUPAC name of compound U.   (2)

2.7   Which homologous series does compound R belong to?   (1)

2.8   Write down the NAME of the monomer in compound V.   (1)

2.9   Draw the structural formula of the monomer in compound W.   (2)

2.10   What type of polymerisation occurs in compound W?
        Write down only ADDITION or CONDENSATION.   (1)
   [17]

QUESTION 3 (Start on a new page.)

The boiling points of a number of organic compounds are given in the table below.

	Compound	Boiling point (°C)
A	Propane	-42
B	Propan-1-ol	98
C	Propanoic acid	141
D	Propan-2-ol	83
E	Propanal	49
F	1-bromopropane	59

3.1   Write down the functional group in compound:

        3.1.1 B   (1)

        3.1.2 C   (1)

3.2   Define the term *boiling point*.   (2)

3.3   Use information from the table to explain the difference in boiling points
        of compounds A and F.   (3)

3.4   Which ONE of the two compounds A and B has the higher vapour
        pressure?   (2)

3.5   Explain your answer in QUESTION 3.4 by referring to FUNCTIONAL
        GROUP, TYPE OF INTERMOLECULAR FORCES and ENERGY.   (4)
                                                                   [13]

QUESTION 4 (Start on a new page.)

The flow diagram below shows a series of reactions leading to the production of a compound A. Compound A is a haloalkane.
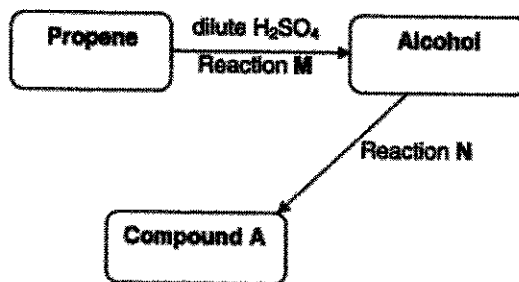
4.1 Name reaction M. (1)

4.2 Write down the structural formula of the alcohol formed in the reaction. (3)

4.3 Is the alcohol in QUESTION 4.2 a primary, secondary or a tertiary alcohol? (2)

4.4 Use structural formulae to write down a balanced chemical equation for the preparation of compound A. (5)

4.5 Write down the IUPAC name of compound A. (2)

[13]

QUESTION 5 (Start on a new page.)

Learners investigate some of the factors which affect the rate of a chemical reaction. For each experiment, they use the reaction between solid zinc and excess hydrochloric acid (HCℓ) solution.

The balanced chemical equation is shown below:

$$Zn(s) + 2HCℓ(aq) → ZnCℓ_2(aq) + H_2(g)$$

The condition for each experiment is shown in the table below:

	Mass of Zn (g)	State of Zn (s)	Concentration of HCℓ (mol·dm⁻³)	Temperature of HCℓ (°C)
Experiment 1	4	Lumps	0,5	25
Experiment 2	4	Powder	0,5	25
Experiment 3	4	Powder	0,2	25

5.1 Define the term *rate of reaction*. (2)

5.2 Use the information from **Experiment 2** and **Experiment 3** to write down the:

5.2.1 Investigative question for the investigation (2)

5.2.2 Factor influencing the rate of the reaction (1)

5.2.3 Dependent variable (1)

5.2.4 Controlled variable (1)

5.3 How does the rate of the reaction in **Experiment 1** compare to that of **Experiment 2**? Write down only HIGHER THAN, LOWER THAN or SAME AS. (1)

5.4 The learners repeat **Experiment 1**, but now the temperature of the HCℓ is 40 °C.

5.4.1 State the effect of the increased temperature on the rate of the reaction. (1)

5.4.2 Use the Collision Theory to explain the answer to QUESTION 5.4.1. (3)

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QUESTION 6 (Start on a new page.)

The production of ammonia is represented by the equation below.

$$N_2(g) \ + \ 3H_2(g) \ \rightleftharpoons \ 2NH_3(g) + heat$$

6.1.   Is the above reaction EXOTHERMIC or ENDOTHERMIC? Explain your
       answer.   (3)

6.2   What will be the effect on the yield of ammonia (NH_3) if the:

       6.2.1 Temperature of the system is increased.   (1)

       6.2.2 Pressure on the system is increased.   (1)

6.3.   In the reaction, 5 moles of $N_2(g)$ and 8 moles of $H_2(g)$ is introduced into a
       sealed 5 dm^3 container. The reaction reaches equilibrium at 400 K.
       At equilibrium it is found that 2 moles of $NH_3(g)$ is present in the container.

       Calculate K_C at this temperature.   (7)

6.4   The temperature of the reaction is decreased to 300 K at equilibrium.

       6.4.1 State whether the value of K_C will INCREASE or DECREASE.   (1)

       6.4.2 Use Le Chatelier's principle to explain the answer in QUESTION 6.4.1.
                                                                                  (3)
                                                                                 [16]

QUESTION 7 (Start on a new page.)

7.1. Consider the reaction below:

$$H_2O(\ell) + NH_3(g) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

In the reaction, ammonia is a weak base.

7.1.1 Define the term *weak base*.   (2)

7.1.2 Use the information in the equation to explain why ammonia is a Lowry-Brønsted base.   (2)

7.1.3 Identify the conjugate acid of NH_3 in the reaction.   (1)

7.1.4 Write down an equation to show the hydrolysis of ammonium ions in the solution.   (2)

7.2. An environmental disaster threatens a rural school. There is a spillage of concentrated hydrochloric acid (HCℓ) into the only water storage tank at the school.

The acidity of a sample of water is tested and the pH is found to be 3,5.

7.2.1. State which ions (OH^- or H_3O^+) were in excess in the sample.   (1)

7.2.2. Calculate the concentration of H_3O^+ ions in the sample.   (3)

The science teacher at the school decided to add sodium carbonate (Na_2CO_3) to the sampled water in the school tank in order to restore the pH to a value close to 7.

$$Na_2CO_3(s) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + H_2O(\ell) + CO_2(g)$$
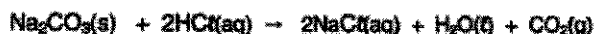
7.2.3 Define the term *neutralisation*.   (2)

7.2.4 Calculate the mass of sodium carbonate (Na_2CO_3) required to neutralise each 1 dm^3 of the sample water.   (6)

7.2.5 After the neutralisation, the water tasted salty. Give a reason for the salty taste of the water. Refer to the equation above.   (2)

7.3. An aqueous solution of sodium carbonate (Na_2CO_3) is prepared by adding distilled water.

$$CO_3^{2-}(aq) + H_2O(\ell) \rightarrow HCO_3^-(aq) + OH^-(aq)$$

7.3.1. Is the solution ACIDIC, BASIC or NEUTRAL?   (1)

7.3.2. Use information from the equation to explain the answer to QUESTION 7.3.1.   (2)

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QUESTION 8 (Start on a new page.)

8.1   A Grade 12 Science teacher stores a copper sulphate solution in an aluminium container. After some weeks the aluminium container was leaking, because the reaction between the copper sulphate solution and the aluminium container.

     8.1.1   Use information from the table of standard reduction potentials to explain why the container developed leaks.   (3)

     8.1.2   Write down a balanced ionic equation to show the reaction that takes place in QUESTION 8.1.1.   (3)

     8.1.3   What colour changes occur in the copper sulphate as the reaction takes place?   (1)

8.2   The diagram below represents a galvanic (voltaic) cell functioning under standard conditions using silver (Ag) and an unknown metal M as electrodes. The initial reading on the voltmeter is 0,93 V.
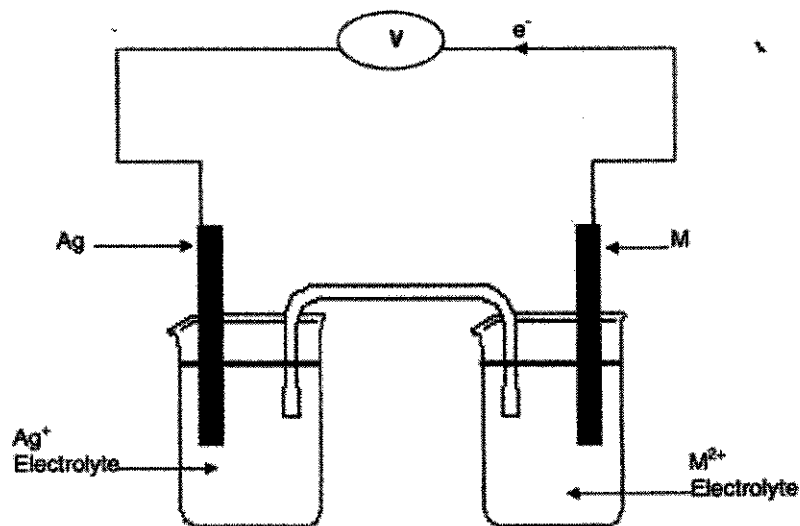
     8.2.1   Which electrode is the cathode?   (1)

     8.2.2   Identify electrode M by performing the relevant calculations.   (5)

8.3   The salt-bridge is now filled with a sugar solution. What will the voltmeter reading be?   (1)

                                                       [14]

QUESTION 9 (Start on a new page.)

The diagram below represents an electrolytic cell that is used for the extraction of aluminium from aluminium oxide.
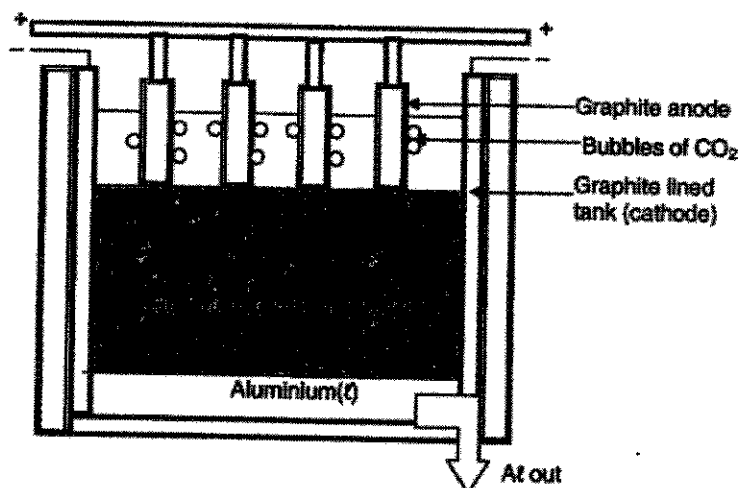

9.1 Which energy conversion takes place in this cell? (2)

9.2 The net reaction can be represented as follows:

$$2A\ell_2O_3(\ell) + C(s) \rightarrow 4A\ell(\ell) + 3CO_2(g)$$

9.2.1 Use the Table of Standard Reduction Potentials to write down the cathode half-reaction. (2)

9.2.2 What is the function of the cryolite in the molten aluminium oxide? (2)

9.3 The carbon electrodes in this cell must be replaced regularly. Explain this observation with the help of a balanced chemical equation. (4)

9.4 Give ONE negative economic impact of the extraction of Aluminium(Aℓ). (1)

[11]

QUESTION 10 (Start on a new page.)

The flow diagram below shows the processes involved in the industrial preparation of various fertilisers.
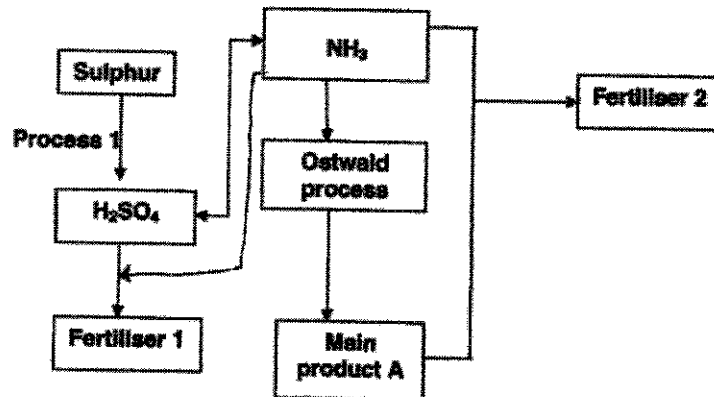
10.1 Write down the:

10.1.1 NAME of Process 1 from the diagram. (1)

10.1.2 Source of nitrogen (N_2) in the preparation of ammonia. (1)

10.1.3 NAME or FORMULA of the catalyst used when **main product A** is formed. (1)

10.2 Two types of nitrogen-containing fertilisers are produced in the above flow diagram. Give the NAME of EACH nitrogen-containing fertiliser. (2)

10.3 Why is **fertiliser 1** mixed with limestone after it is produced? (2)

10.4 STEP 2 of the Ostwald process is the oxidation of NO to form NO_2. Write down a balanced chemical equation for this reaction. (3)

[10]

TOTAL: 150