Education and Sport Development

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NORTH WEST PROVINCE

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages and 4 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.
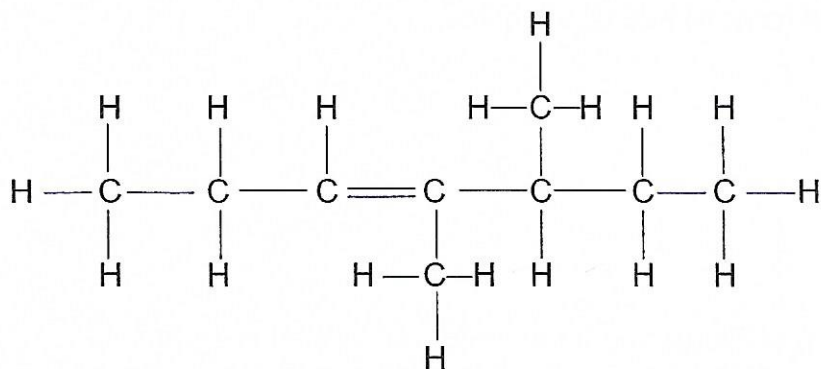
1.1   Which ONE of the following is the general formula of alkenes?

   A $C_{2n}H_{2n}$

   B C_nH_{2n-n}

   C C_nH_{2n+2}

   D C_nH_{2n} (2)

1.2   Which ONE of the following isomers has the LOWEST boiling point?

   A $CH_3CH_2CH_2CH_2CH_2CH_3$

   B $CH_3CH(CH_3)CH_2CH_2CH_3$

   C $CH_3CH_2C(CH_3)_2CH_3$

   D $CH_3CH_2CH(CH_3)CH_2CH_3$ (2)

1.3 The structural formula of an organic compound is shown below:

Which ONE of the following is the correct IUPAC name of this compound?

   A   4-methyl-5-ethylhex-3-ene

   B   4,5-dimethylhept-3-ene

   C   3,4-dimethylhept-4-ene

   D   3-methyl-4-ethylhept-4-ene   (2)

1.4   Which ONE of the following statements about neutralisation is CORRECT?

        Neutralisation is …

        A   a reaction in which water reacts with itself to form ions.

        B   a process in which ionic compounds split into ions.

        C   the reaction of an acid with a base to form salt and water.

   D   a solution of a known concentration.   (2)

1.5   The sketch graph below represents the change in potential energy
        for an hypothetical chemical reaction: K ⟶ L

Course of reaction
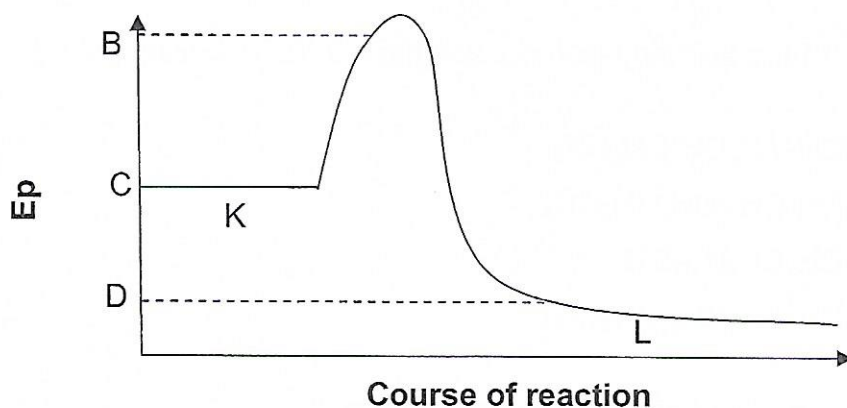
        ΔH for the forward reaction is given by:
        A   B – C
        B   C – D
        C   D – B
        D   D – C   (2)

1.6   Initially 2 mol CO(g) and 2 mol H_2(g) are sealed in a container. The reaction
        reaches equilibruim according to the following balanced equation:

                $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$
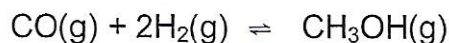
        At equilibruim the amount of CH_3OH(g) in the mixture will be …

        A   1 mol.

        B   2 mol.

        C   less than 1 mol.

        D   greater than 1 mol.   (2)

1.7   Which ONE of the following metals will react MORE spontaneously than the other with hydrochloric acid?

        A   Cu

        B   Ag

        C   Pt

        D   Mg   (2)

1.8   Given the following solutions:

        •   Solution A: pH of 10

        •   Solution B: pH of 7

        •   Solution C: pH of 5

        Arrange the above solutions in order of increasing H^+ concentration?

        A   A, B, C

        B   B, A, C

        C   C, A, B

        D   C, B, A   (2)

1.9   A small piece of Mg is added to 5 cm³ of a dilute hydrochloric acid solution in a test tube. Which ONE of the following changes will affect the rate at which hydrogen gas is produced in this reaction?

        A   Using 10 cm³ of the same dilute hydrochloric solution

        B   Increasing the concentration of the hydrochloric solution

        C   Decreasing the concentration of the hydrochloric solution

        D   Decreasing the temperature of the hydrochloric solution   (2)

1.10   A gardener needs a fertiliser with the highest percentage of the relevant nutrient to obtain quality flowers and fruit.

        Which ONE of the following NPK fertilisers will produce the best results?

        A   7 : 1 : 5

        B   1 : 5 : 7

        C   2 : 3 : 4

        D   1 : 5 : 3   (2)
                                                                                          [20]

QUESTION 2 (Start on a new page.)

Study the organic compounds represented by the letters **A** to **F** below and answer the questions that follows.

A		B	
	C_4H_{10}		$CH_3CH_2CH_2CH_2COOH$
C		**D**	
	$CH_3CH_2CHCH_2$		$CH_3CH_2CH_2CH_2CH_3$
E		**F**	CH_3
	C_5H_{12}		$CH_3 — C — CH_3$ CH_3

2.1   Define the term *chain isomer*.   (2)

2.2   Write down:

         2.2.1   The letters of TWO compounds that are chain isomers of compound **E**.   (2)

         2.2.2   The IUPAC name of compound **F**.   (2)

2.3   Jane adds a few drops of bromine water (Br_2) to compounds **C** and **D** in separate test tubes in a dark room. She observes that one compound decolourises the bromine water immediately, whilst the other one only reacts after placing the test tube in direct sunlight.

     Write down the following:

         2.3.1   What is the purpose of this test in a laboratory?   (1)

         2.3.2   Name the type of reaction that takes place in the test tube containing compound **C**.   (1)

         2.3.3   Give the letter of the compound that decolourises the bromine water spontaneously. Explain your answer.   (2)

2.4   Write down the structural formula and the IUPAC name of the ester formed when methanol reacts with compound **B**.   (4)

   **[14]**

QUESTION 3 (Start on a new page.)

Learners investigate the factors which influence the boiling points of alcohols.

They use equal volumes of each of the alcohols and heat them separately in a water bath. The temperature at which each type of alcohol boils, is measured. The results obtained, are shown in the table below:

ALCOHOL	BOILING POINTS OF ALCOHOL (°C)
Butan-1-ol	117,7
Pentan-1-ol	138,5
Hexan-1-ol	157,0

3.1 Define the term *vapour pressure*. (2)

3.2 Which ONE of the alcohols above will have the highest vapour pressure? (1)

3.3 The boiling points of the alcohols are compared with each other.

    3.3.1 What structural requirements must the alcohols meet to make it a fair comparison? (2)

    3.3.2 Fully explain the trend in the boiling points. (3)

3.4 How will the boiling point of pentan-1-ol be affected if the volume of pentan-1-ol used, is halved? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

3.5 During a combustion reaction in a closed container of adjustable volume, 10 cm^3 of compound butane reacts in excess oxygen according to the following balanced equation:

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g)$$
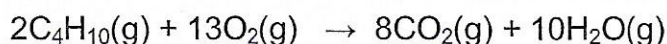
The initial volume of oxygen in the container is given as 70 cm^3.
(Assume that ALL the gases in the container are at the same temperature and pressure.)

Calculate the TOTAL volume of the gases that are present in the container by the end of the reaction. (5)

[14]

QUESTION 4 (Start on a new page.)

The flow diagram below shows how an alkane can be used to prepare other organic compounds. The letters **A** to **G** represent different organic reactions.
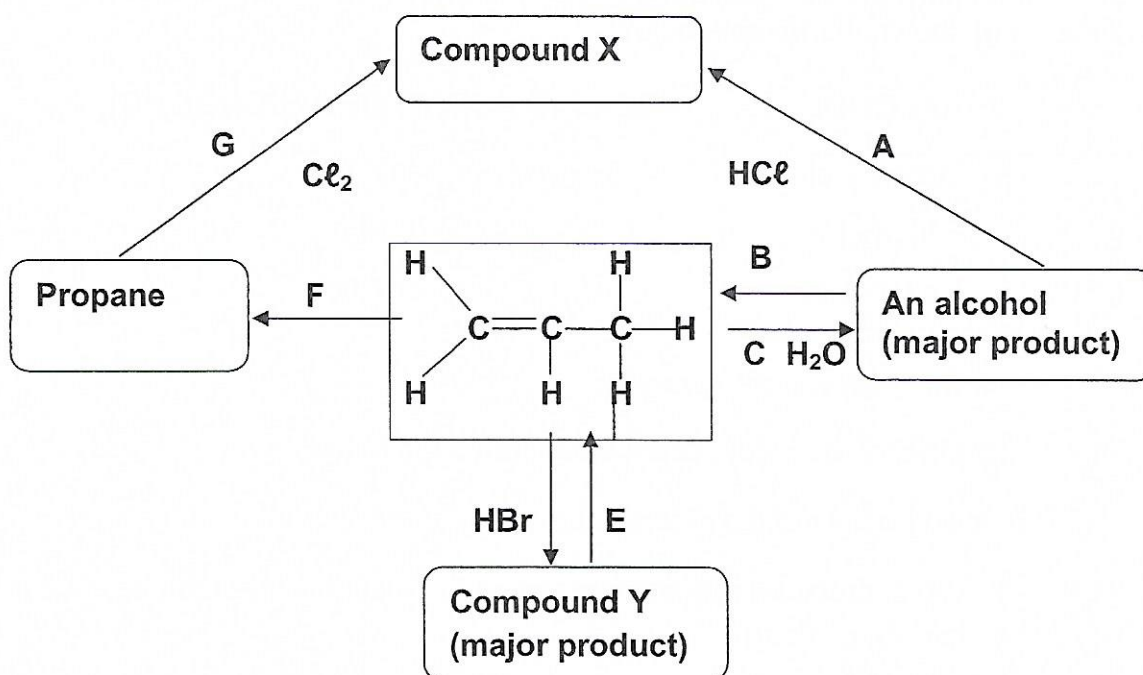

4.1 Write down the type of reactions represented by:

    4.1.1 **F** (1)

    4.1.2 **G** (1)

    4.1.3 **B** (1)

4.2 Write down the IUPAC name of compound **Y**. (2)

4.3 For reaction **E**, write down:

    4.3.1 The type of elimination reaction (1)

    4.3.2 TWO reaction conditions (2)

4.4 Write down the:

    4.4.1 FORMULA of an inorganic reactant needed for reaction **C** (1)

    4.4.2 Balanced chemical equation for reaction **A**, using STRUCTURAL FORMULAE (4)

4.5 There are natural polymers and man-made polymers like plastics. Polythene is a plastic polymer that is widely used.

    4.5.1 Describe *addition polymerisation*. (2)

    4.5.2 Write down ONE use of polythene. (1)

[16]

QUESTION 5   (Start on a new page.)

A Grade 12 learner investigates the effect of surface area of a solid reactant on the rate of a chemical reaction. The investigation was done by adding 1,5 g of $CaCO_3$ to excess hydrochloric acid. The balanced chemical equation for the reaction is:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$
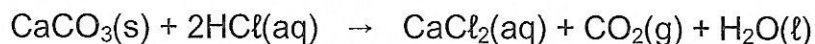
5.1   Define the term *rate of reaction*.   (2)

5.2   In this investigation, write down the dependent variable.   (1)

5.3   In which state of division of the $CaCO_3$ (lumps or powder) will it take a shorter time for the reaction to reach completion? Explain your answer.   (3)

5.4   Assume that all $CaCO_3$ reacted and calculate the mass of carbon dioxide formed during the reaction.   (4)

	Mass of $CaCO_3$(s)	State of $CaCO_3$(s)	Concentration of HCl (mol.dm^{-3})	Temperature of HCl (°C)
Experiment 1	2	Lumps	0,5	30
Experiment 2	2	Powder	0,5	30
Experiment 3	2	Powder	0,5	30

5.5   The learners repeat the investigation above, but now the temperature of the HCl is increased from 30 °C to 40 °C in Experiment 1.

   5.5.1   How will the change in temperature affects the rate of the reaction?   (2)

   5.5.2   Use the collision theory to explain the observation in QUESTION 5.5.1.   (3)
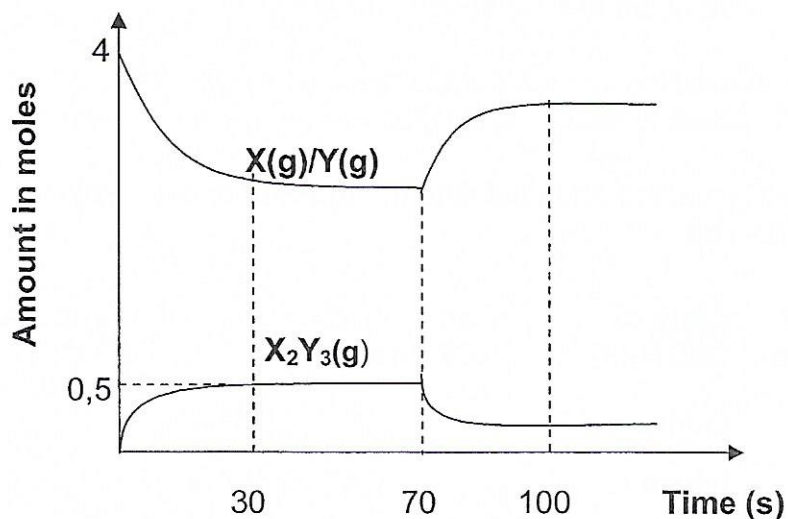   **[15]**

QUESTION 6   (Start on a new page.)

Gases **X** and **Y** are pumped into a 2 dm³ container. When the container is sealed, 4 moles of gas **X** and 4 moles of gas **Y** are present. The following equilibrium is reached at a certain temperature (400 °C):

$$2X(g) \ + \ 3Y(g) \ \rightleftharpoons \ X_2Y_3(g)$$
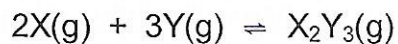
The graph below shows the number of moles of gases **X**, **Y** and **X₂Y₃** present in the container at different times.

6.1   How many moles of gas X_2Y_3 are formed by the time the reaction reaches equilibrium after 30 seconds?   (1)

6.2   Calculate the value of the equilibrium constant at t = 30 s.   (7)

6.3   At t = 70 s, the temperature is increased. Is the forward reaction ENDOTHERMIC or EXOTHERMIC? Explain your answer in terms of Le Chatelier's principle.   (3)

6.4   How will this increase in temperature affect the value of the equilibrium constant? Choose from INCREASE, DECREASE or NO EFFECT.   (1)
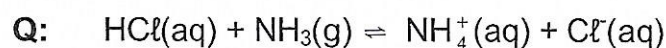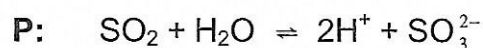
[12]

QUESTION 7 (Start on a new page.)

The Arrhenius and Lowry-Brønsted theories can be used to define an acid or a base.

7.1.   Define the term *acid* according to the Arrhenius theory.   (2)

7.2   Consider the following chemical reactions:

        P: $SO_2 + H_2O \rightleftharpoons 2H^+ + SO_3^{2-}$

        Q: $HC\ell(aq) + NH_3(g) \rightleftharpoons NH_4^+(aq) + C\ell^-(aq)$

7.2.1   From reactions **P** and **Q**, identify the reaction that illustrates the Arrhenius theory.   (1)

7.2.2   The ammonium ions (NH_4^+) in chemical reaction **Q** undergoes hydrolysis.

    (a)   Write down a balanced chemical equation for the hydrolysis of the ammonium ions.   (3)

    (b)   Will the resultant solution be ACIDIC, BASIC or NEUTRAL? Explain your answer by referring to QUESTION 7.2.2(a) above.   (2)

7.3   A sodium hydroxide solution (NaOH) is prepared by dissolving 4 g of sodium hydroxide in water to make a 500 cm^3 solution.

7.3.1   Calculate the concentration of the sodium hydroxide solution.   (3)

During a titration, 12,5 cm^3 of a sodium hydroxide (NaOH) solution neutralises 25 cm^3 of a sulphuric acid (H_2SO_4) solution, according to the following balanced chemical equation:

    $2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell)$
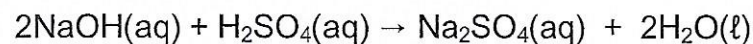
7.3.2   Calculate the pH of the H_2SO_4 solution.   (7)

                                                       [18]

QUESTION 8 (Start on a new page.)

The following THREE unknown half-cell reactions under standard conditions are given in the table below. Metal **X** displaces Y^{2+} ions in a YSO_4(aq) solution and metal **Z** displaces X^{2+} ions in a XSO_4(aq) solution.

NUMBER	HALF-CELL	ELECTROLYTE
1	X/X^{2+}(aq)	XSO_4(aq)
2	Y/Y^{2+}(aq)	YSO_4(aq)
3	Z/Z^{2+}(aq)	ZSO_4(aq)

Use the information above to answer the following questions:

8.1   Define the term *electrolyte*.   (2)

8.2   Write down TWO conditions needed for these half-cell reactions to function under standard conditions.   (2)

8.3   When metal **X** displaces Y^{2+} ions in a YSO_4 solution, will Y^{2+} be oxidised or reduced? Give a reason for your answer.   (2)

8.4   Arrange metals **X**, **Y** and **Z** in order of increasing reducing ability.   (1)

8.5   Suppose metals Mg, Cu and Ni replace metals **X**, **Y** and **Z** and are now used to set up a galvanic cell under standard conditions.

       8.5.1   Referring to the standard reduction potentials table, use calculations to identify (from the metals above) a suitable pair of electrodes that will produce an emf of 2,7 V.   (4)

       8.5.2   Write down the cell notation of the cell in QUESTION 8.5.1 above.   (3)

       8.5.3   Is this cell reaction EXOTHERMIC or ENDOTHERMIC?   (1)
                                                                                        [15]

QUESTION 9 (Start on a new page.)

The sketch below shows a cell used in the purification of copper. Study the sketch below and then answer the given questions.
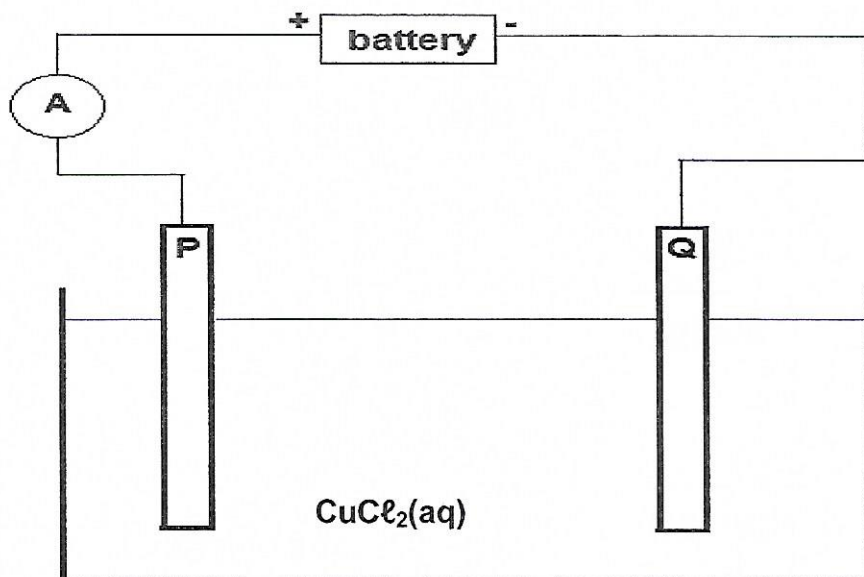
9.1   State the type of energy conversion taking place when the above cell is in operation.   (2)

9.2   Which of these electrodes (P or Q) is the impure copper?   (1)

9.3   Which electrode will show an increase in mass?   (1)

9.4   Write down the equation of the half-cell reaction that takes place at the anode.   (2)

9.5   Explain why the colour of the copper ions solution remains unchanged.   (2)

The electrodes are now replaced with carbon rods.

9.6   At which electrode will chlorine gas be formed (P or Q)? Use a chemical equation (half-reaction) to show the formation of chlorine gas.   (3)

9.7   When carbon rods are being used, state whether the concentration of the electrolyte INCREASES, DECREASES or REMAINS THE SAME.   (1)
                                                                                              [12]

QUESTION 10 (Start on a new page.)

Different types of fertilisers can be prepared directly from ammonia, nitric acid or sulphuric acid.

Reactions **K**, **L**, **M** and **N** in the flow diagram below represent the manufacturing of fertiliser **X**.
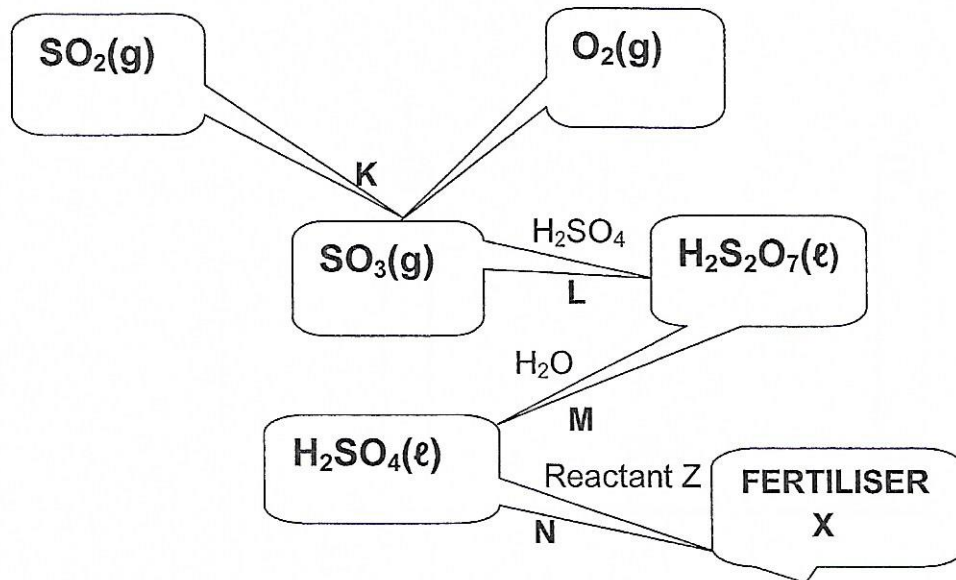
10.1 Write down the NAME of the process during which sulphuric acid is prepared. (1)

10.2 Write down:

    10.2.1 A balanced chemical equation for reaction **K** (3)

    10.2.2 The NAME or FORMULA of the catalyst used in reaction **K** (2)

10.3 In the following reaction the fertiliser ammonium sulphate could be prepared as follows:

    sulphuric acid + **Z** → ammonium sulphate

 Write down:

    10.3.1 The name of reactant **Z** (1)

    10.3.2 A balanced chemical equation for the reaction above (3)

10.4 Calculate the percentage of nitrogen in ammonium sulphate. (4)

[14]

TOTAL: 150