



eduresourceza.com



ST BENEDICT'S

SUBJECT	CHEMISTRY EXAMINATION
GRADE	12
EXAMINER	Mr McCoy
MODERATOR	Mr Hilder
DATE	26 July 2024
MARKS	200
DURATION	3 hours

%

LEARNER NAME:

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 32 pages and a separate Data Sheet and Periodic Table. Please check that your question paper is complete.
2. Read the questions carefully.
3. Answer **ALL** the questions on the question paper and hand it in at the end of the assessment. Remember to write your name and surname in the space provided above.
4. Use the data and formulae sheet whenever necessary.
5. Show your working in all calculations.
6. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
7. Answers must be expressed in decimal format, not left as proper fractions.
8. Where appropriate, express answers to TWO decimal places.
9. It is in your own interest to write legibly and to present your work neatly.
10. A Blank page is included at the end of the paper. If you run out of space for a question, use this space. Clearly indicate the question number of your answer should you use this extra space.

FOR OFFICE USE ONLY: MARKER TO ENTER MARKS

Question	1	2	3	4	5	6	7	8	9	10	Total
Mark											
Moderated Mark											
Question Total	20	17	17	14	13	27	29	16	25	22	200

Comment:

QUESTION 1

20 MARKS

Answer these questions on the multiple-choice answer sheet below. Make a cross (X) in the box corresponding to the letter that you consider to be correct.

A	B	☒	D
---	---	-------------------------------------	---

Here the option C has been marked as an example.

1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D

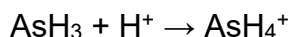
1.1 Which of the following is the correct chemical formula for sodium dichromate?

- A. NaCr_2O_7
- B. $\text{Na}_2\text{Cr}_2\text{O}_7$
- C. NaCrO_4
- D. Na_2CrO_4

1.2 The bonds between the atoms in the nitrate ion, NO_3^- can best be classified as:

- A. Ionic bonds
- B. Pure covalent bonds
- C. Polar covalent bonds
- D. London bonds

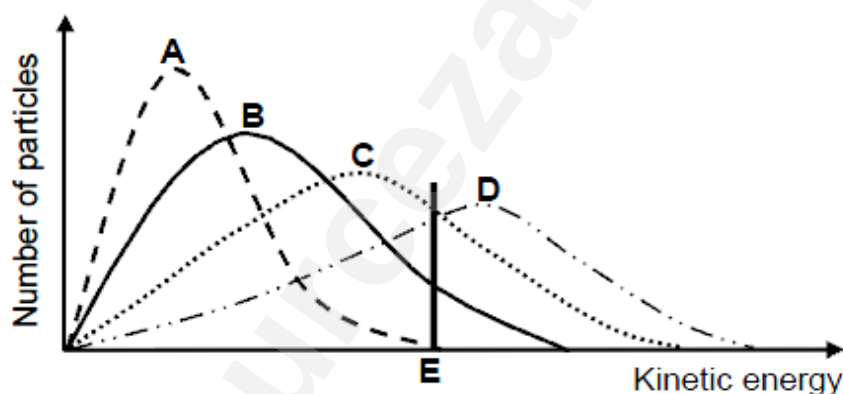
- 1.3 The equation for a reaction is



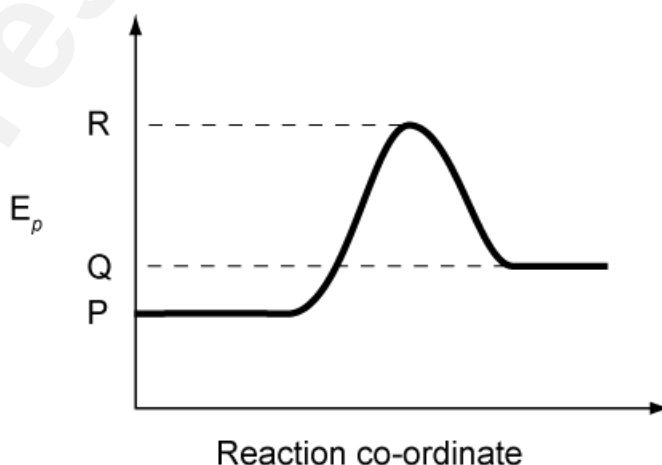
What type of interaction forms in this reaction?

- A. Dipole–dipole force
 - B. Hydrogen bond
 - C. Ionic bond
 - D. Dative covalent bond
- 1.4 The Maxwell-Boltzmann energy distribution curves below show the number of particles as a function of their kinetic energy for a reaction at four different temperatures. The minimum kinetic energy needed for effective collisions to take place is represented by E.

Which ONE of these curves represents the reaction with the highest rate?



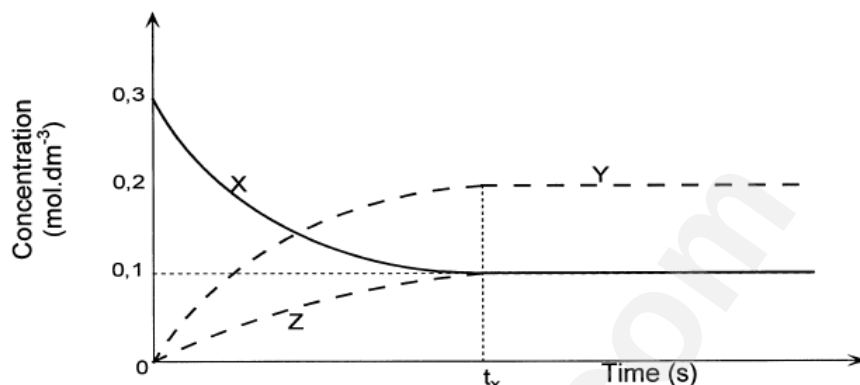
- 1.5 The graph below shows the change in potential energy (E_p) as a function of the course of a reaction:



Which one of the following statements is correct?

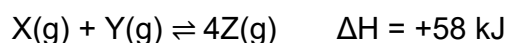
- A. The forward reaction is exothermic
- B. The heat of the reaction for the forward reaction is given by $Q - P$
- C. The activation energy for the forward reaction is given by $R - Q$
- D. The activation energy for the reverse reaction is given by $R - P$

- 1.6 A gas X is placed in a sealed container at $t = 0$ s. The gas decomposes into gases Y and Z. A chemical equilibrium between the three gases is reached at $t = t_x$. The following graph of concentration versus time shows the changes that occurred during the reaction:



The equation for the reaction is:

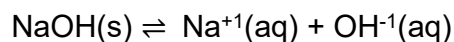
- A. $3X \rightleftharpoons 2Y + Z$
 B. $X \rightleftharpoons Y + Z$
 C. $X \rightleftharpoons 2Y + Z$
 D. $2X \rightleftharpoons 2Y + Z$
- 1.7 In which one of the following reactions does HPO_4^{2-} act as a Lowry-Bronsted base?
- A. $\text{HPO}_4^{2-} + \text{HPO}_4^{2-} \rightarrow 2\text{HPO}_4^{2-}$
 B. $\text{HPO}_4^{2-} + \text{H}_2\text{O} \rightarrow \text{PO}_4^{3-} + \text{H}_3\text{O}^+$
 C. $\text{HPO}_4^{2-} + \text{H}_2\text{O} \rightarrow \text{H}_2\text{PO}_4^- + \text{OH}^-$
 D. $\text{HPO}_4^{2-} + \text{H}^+ \rightarrow \text{H}_2\text{PO}_4^-$
- 1.8 The equation describes an equilibrium reaction occurring in a closed system.



Under which set of conditions would the highest yield of Z(g) be obtained?

	Temperature ($^{\circ}\text{C}$)	Pressure (kPa)
A.	50	100
B.	50	200
C.	300	100
D.	300	200

1.9 A saturated sodium hydroxide solution can be represented by the following equation:



How will the K_b and the pH of the sodium hydroxide solution be affected if a few drops of a concentrated sodium chloride solution are added to the solution without affecting the temperature of the solution?

	K_b	pH
A.	Increase	Decrease
B.	Decrease	Increase
C.	No Change	Decrease
D.	No Change	Increase

1.10 Which alcohol when dehydrated forms a mixture of alkenes?

- A. propan-1-ol
- B. propan-2-ol
- C. pentan-1-ol
- D. pentan-2-ol

QUESTION 2

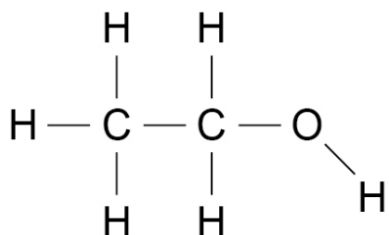
17 MARKS

- 2.1 Complete the diagram to show how one molecule of **ammonia** can form a hydrogen bond with one molecule of ethanol.

Include all lone pairs of electrons;

and partial charges on atoms involved in the hydrogen bond.

(4)



- 2.2 **Table 1** shows the electronegativity values of atoms of some elements.

Table 1

Atom	H	C	N	O	Br
Electronegativity	2,1	2,5	3,0	3,5	2,8

- 2.2.1 Define the term *electronegativity*.

(2)

- 2.2.2 Deduce the two atoms from **Table 1** that will form the most polar bond.

(1)

- 2.2.3 The C–Br bond is polar

Explain why CBr_4 is not a polar molecule.

(2)

- 2.2.4 Suggest, in terms of the intermolecular forces for each compound, why CBr_4 has a higher boiling point than CHBr_3 . (5)

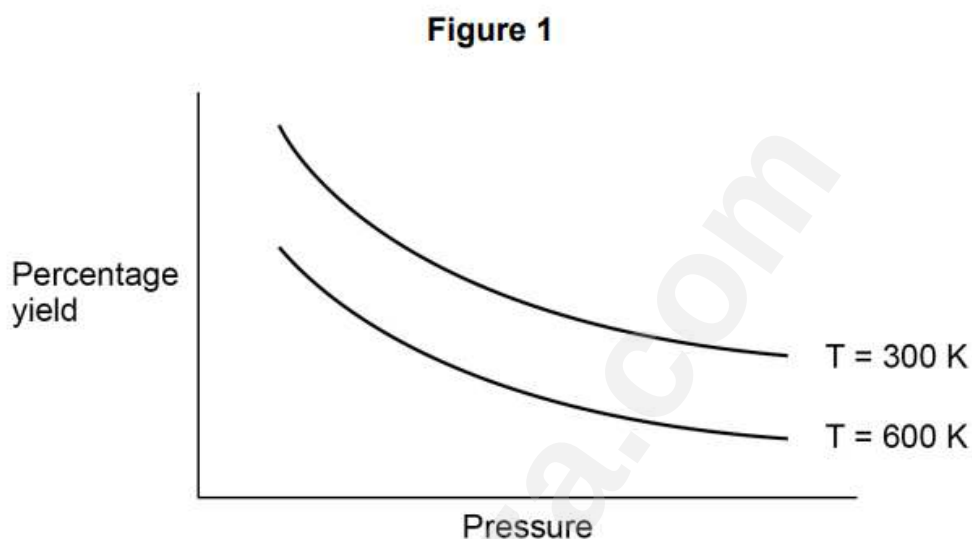
- 2.2.5 Name the physical form of carbon that can conduct electricity. (1)

- 2.2.6 Explain how it is possible for carbon to conduct electricity in this form. (2)

QUESTION 3

17 MARKS

- 3.1 **Figure 1** shows the effect of pressure on the percentage yield of a reaction at equilibrium at two different temperatures.



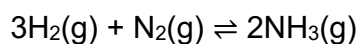
- 3.1.1 Explain how **Figure 1** shows that the forward reaction in this equilibrium is exothermic. (2)

- 3.1.2 State whether the forward reaction in this equilibrium results in an **INCREASE, DECREASE OR NO CHANGE** in the amount, in moles, of gas. Circle the correct answer. (1)

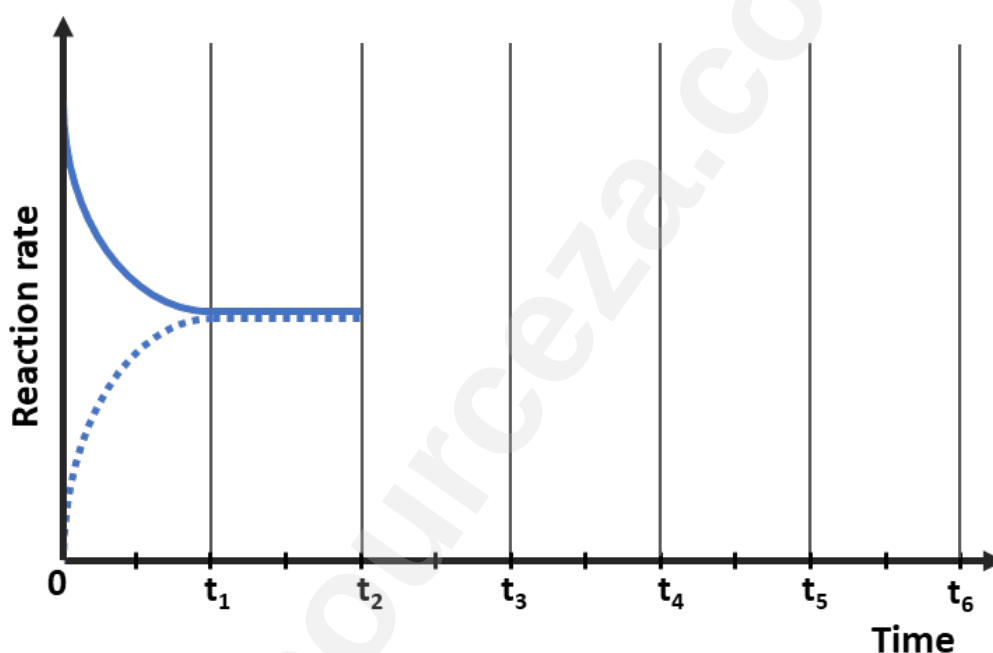
- 3.1.3 Explain your answer to question 3.1.2. (2)

- 3.1.4 Explain why using a catalyst has no effect on the percentage yield (1)

- 3.2 Hydrogen and nitrogen react to form ammonia. Ammonia is placed in a vessel and sealed.

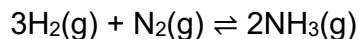


A graph of reaction rate vs time of the reaction is shown below.



- 3.2.1 Draw lines on the graph to show how the forward and reverse reaction rates would change, if the amount of N_2 is decreased at t_2 , and reaches equilibrium at t_3 and continues at equilibrium until t_4 . (2)
- 3.2.2 The pressure of the system was increased at t_4 , draw lines to show the effect of this change on both reaction rates between t_4 and t_6 . (2)

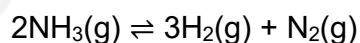
3.3 Hydrogen and nitrogen react to form ammonia.



At 745 K, the equilibrium constant, $K_c = 0,118$

3.3.1 At 745 K, $0,150 \text{ dm}^3$ of an equilibrium mixture contains $0,0285 \text{ mol}$ of hydrogen and $0,0870 \text{ mol}$ of nitrogen. Calculate the amount, in moles, of ammonia present in this equilibrium mixture. (5)

3.3.2 Calculate the value, at 745 K, for the equilibrium constant K_c for the reaction of ammonia to give hydrogen and nitrogen. (2)



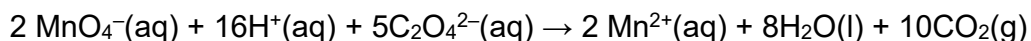
BLANK PAGE

eduresourceza.com

QUESTION 4

14 MARKS

- 4.1 Potassium manganate (VII), KMnO_4 , reacts with sodium ethanedioate, $\text{Na}_2\text{C}_2\text{O}_4$, in the presence of dilute sulfuric acid.



- The reaction mixture is purple at the start and goes colourless when all the MnO_4^- (aq) ions have reacted.
- The rate of reaction can be measured as $\frac{1000}{t}$ where t = the time taken for the mixture to go colourless.
- A student investigated how long it takes for this reaction mixture to go colourless at different temperatures.
- The same concentrations and volumes of each reagent were used in an experiment at each temperature. **Table 1** shows the results.

Table 1

Temperature ($^{\circ}\text{C}$)	32	38	44	54	67
Time t (s)	155	85	50	22	9
$\frac{1000}{t}$	6,45	11,8	20,0	45,5	

4.1.1 Complete Table 1. (1)

4.1.2 State the independent variable in this investigation. (1)

4.1.3 The student noticed that the temperature of each reaction mixture decreased during each experiment.

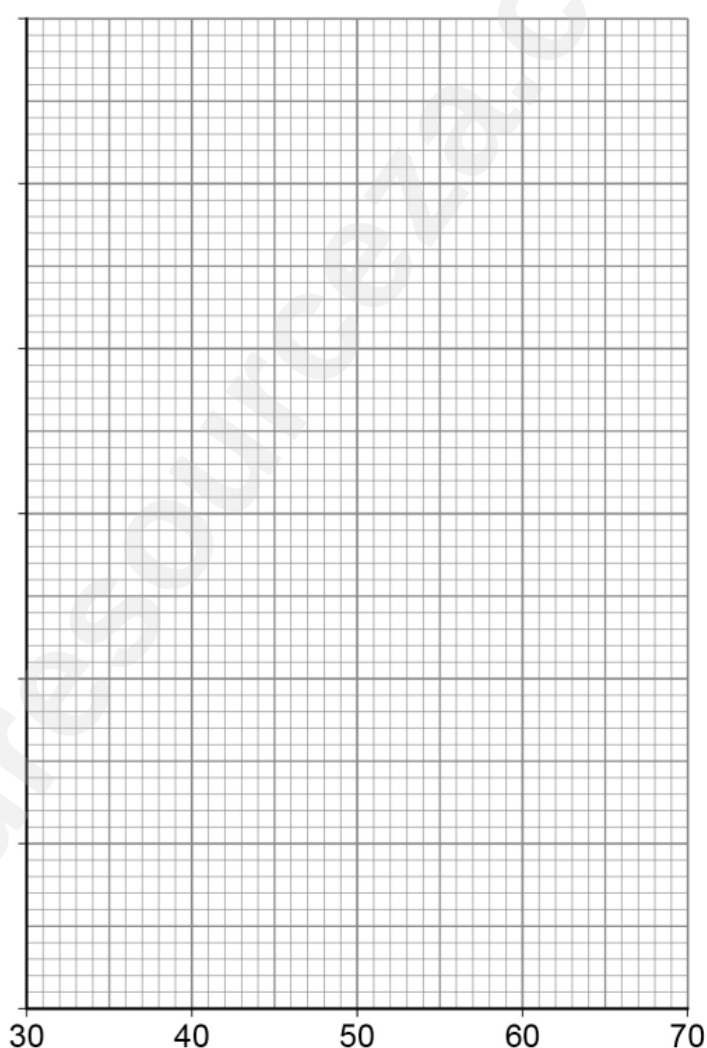
Suggest how the student calculated the temperature values in **Table 1**. (2)

4.1.4 The investigation shows that increasing the temperature causes the rate of reaction to increase. Use collision theory to explain why a small increase in temperature causes a large increase in the rate of reaction. (4)

4.1.5 Use the data in Table 1 to plot a graph of $\frac{1000}{t}$ against temperature.

No heading is needed.

(3)



4.1.6 Use your graph in Question 4.1.5 to find the time taken for the mixture to go colourless at 60 °C.

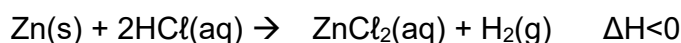
Show your working.

(3)

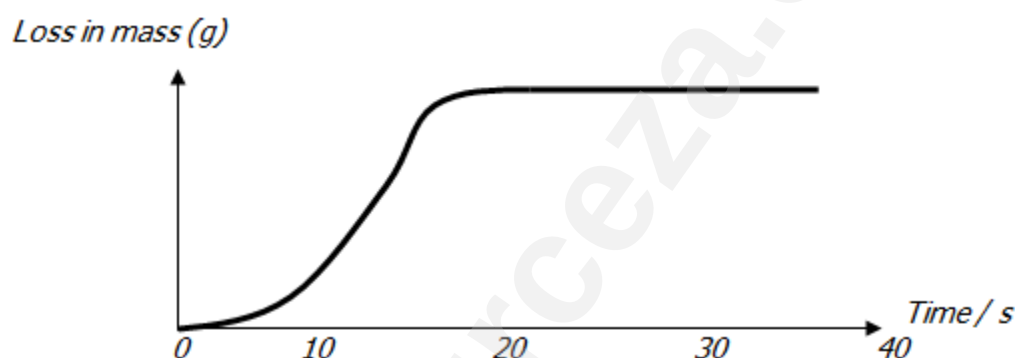
QUESTION 5

13 MARKS

- 5.1 Two students set up an investigation to determine the effect of temperature on reaction rate. They add pieces of zinc metal to hydrochloric acid in a conical flask. They measure the loss in mass of the system as shown in the diagram alongside. The zinc reacts with the hydrochloric acid according to the balanced chemical equation given below:



The graph below shows the loss in mass of the system as a function of time when the reaction is carried out at 40 °C.



- 5.1.1 Suggest why the reaction rate increases in the initial 10 s. (2)

- 5.1.2 Explain why the reaction rate decreases between 15 s and 20 s? (2)

- 5.1.3 On the graph above, draw in a line to represent the loss of mass when the reaction is repeated at 30 °C. All other reaction conditions remain the same. (2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

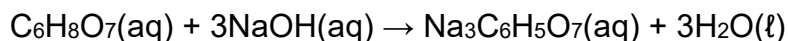
Downloaded from eduresourceza.com

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. A faint, diagonal watermark reading "sourceza.co.za" is visible across the center of the page.

QUESTION 6

27 MARKS

6.1 Citric acid reacts with sodium hydroxide.



6.1.1 A student makes a solution of citric acid by dissolving some solid citric acid in water.

Describe a method to add an accurately known mass of solid to a beaker to make a solution. (2)

6.1.2 The student dissolves 0,834 g of citric acid in water and makes the solution up to 500 cm³.

Calculate the concentration, in mol dm⁻³, of citric acid in this solution. (3)

6.1.3 **Table 1** shows the student's burette readings after the mistakes in the practical procedure have been corrected.

Table 1

	Rough	Run 1	Run 2	Run 3
Final reading (cm ³)	23,65	22,95	46,05	26,30
Start reading (cm ³)	0,00	0,00	22,95	3,40
Titre (cm ³)	23,65			

Complete **Table 1**.

Use the data in **Table 1** to calculate the mean titre (the minimum volume of a solution needed to reach the endpoint in a titration). (2)

- 6.1.4 The student transfers 25 cm³ of the citric acid solution into a conical flask.
Calculate the concentration of the sodium hydroxide solution. (3)

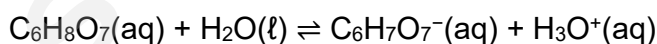
- 6.2 Citric acid reacts with sodium hydroxide.



Classify the acid in terms of the specific number of protons donated. (2)

The acid is _____ PROTIC.

- 6.3 Consider the ionisation reaction of the weak acid C₆H₈O₇ represented by the equation shown below:



- 6.3.1 Two K_a values are shown. Circle the value that is most likely for C₆H₈O₇. (1)

$$K_a = 7,1 \times 10^{-4} \quad \text{OR} \quad K_a = 6,5 \times 10^2$$

- 6.3.2 C₆H₇O₇⁻ is amphoteric.

Circle the correct option between the brackets: (1)

In the ionisation reaction shown above, C₆H₇O₇⁻ is acting as (an ACID / a BASE).

- 6.4 The salt Na₃C₆H₅O₇ dissociates completely in water.

- 6.4.1 Define *dissociation*. (2)

6.4.2 Write the balance equation for the dissociation of $\text{Na}_3\text{C}_6\text{H}_5\text{O}_7$ in water. (3).

6.4.3 Write the acid-base conjugates for each of the ions above. (2)



6.4.4 Define *hydrolysis of a salt*. (2)

6.4.5 Circle the correct answer between the brackets: (1)

$\text{Na}_3\text{C}_6\text{H}_5\text{O}_7$ is (an ACIDIC / a BASIC) salt.

6.4.6 Explain your answer to question 6.4.5. (3)

QUESTION 7

29 MARKS

- 7.1 Parth and Yuan are trying to place silver, lead, magnesium and cobalt in order of increasing strength of reducing agent. They perform three experiments and record the results in the table below:

Experiment	Result
Lead strip placed into a silver (I) nitrate solution	Shiny grey layer forms on the lead
Magnesium strip placed into a lead (II) nitrate solution	Grey solid deposits on the magnesium
Lead strip placed into a cobalt (II) nitrate solution	No reaction occurs

- 7.1.1 Define *reducing agent*. (2)

- 7.1.2 Give the chemical formula for lead (II) nitrate. (2)

- 7.1.3 Parth states that another similar experiment needs to be performed in order to be able to place all four metals in order.

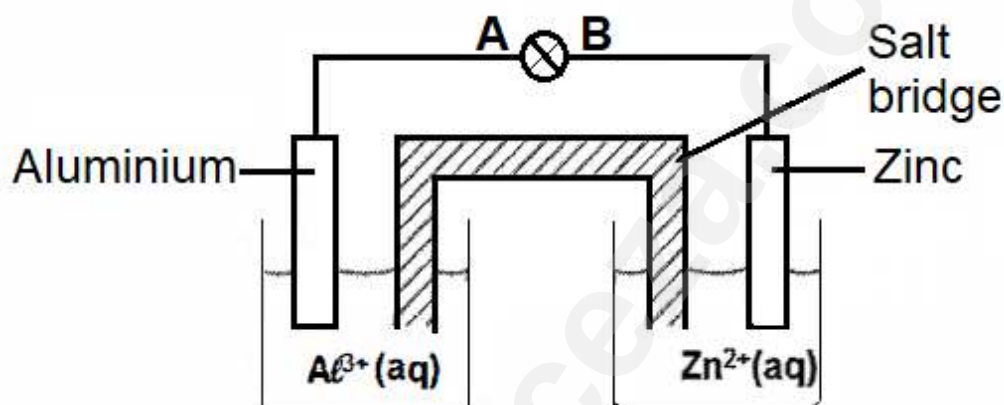
- a) Explain why Parth is correct. (1)

- b) Suggest a possible similar experiment that should be carried out. (2)

- c) State the result you would expect your experiment in (b) to produce. Give a reason for your answer. (2)

- 7.1.4 Write the net ionic equation for the reaction between the lead strip and silver nitrate solution. (3)

- 7.2 Consider the standard aluminium-zinc galvanic cell shown in the diagram below. The two half-cells are connected by a salt bridge which is an aqueous saturated solution of sodium nitrate. The bulb shines brightly.



- 7.2.1 State the energy conversion that occurs in this cell. (2)

- 7.2.2 Calculate the initial emf of this cell under standard conditions. (2)

- 7.2.3 Write the cell notation for this cell. You do not need to include standard conditions. (3)

7.2.4 As the reaction progresses:

- a) Describe what you will observe happening at the aluminium electrode. (1)

- b) Describe the direction that the sodium ions in the horizontal portion of the salt bridge will flow. Circle: **TO THE LEFT or TO THE RIGHT.** (1)

- c) Explain the chemistry behind your answer to 7.2.4 (b) in detail. (4)

- d) Write down the direction that the electrons will flow through the light bulb. Circle: **FROM A TO B or FROM B TO A.** (2)

Another cell is constructed identical to the first one except that the concentration of the electrolyte in the cathode half-cell is changed to 3 mol.dm^{-3} .

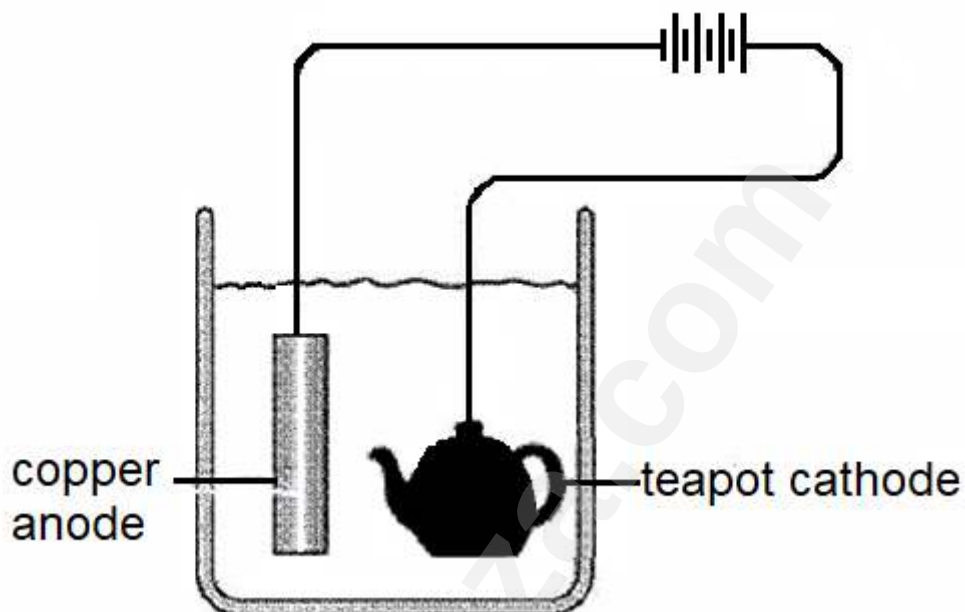
7.2.5 Complete the sentence by circling the correct answer.

The initial EMF of this new cell will be **GREATER THAN, THE SAME AS or LESS THAN** the initial EMF of the original cell. (2)

QUESTION 8

16 MARKS

Mihir is trying to plate a small metal teapot with 0,01 mol of copper using a 0,5 A current. He is given a picture (below) of how to set up the cell.



8.1 What is an *electrolyte*? (2)

8.2 Give the name of a solute Mihir could use to make a safe, suitable electrolyte for this process. (1)

8.3 Describe the error in the picture that Mihir was given. Explain the chemistry behind your answer. (3)

Mihir corrects the error.

- 8.4 Calculate the mass of copper that Mihir wants to plate onto the teapot. (2)

- 8.5 Calculate the time it would take to plate the teapot as required if the process was 100% efficient. (5)

- 8.6 How would the time taken to plate the teapot with 0,01 mol of silver - using the correct electrolyte and electrodes - compare to the time calculated in 8.5? Assume all other conditions and variables are the same. Justify your answer. (3)

QUESTION 9

25 MARKS

9.1 Hex-2-ene has the molecular formula C_6H_{12}

9.1.1 Define *structural isomers*. (2)

9.1.2 Draw the structural formula of a **chain** isomer of hex-2-ene. (2)

9.1.3 Write the condensed structural formula of a **position** isomer of hex-2-ene. (2)

9.1.4 Will hex-2-ene or hexanol have the higher boiling point? Explain your answer. (4)

9.2 Hexanol may be produced by two different reactions, shown below:

Reaction I hexene + **A** $\xrightarrow{H_3PO_4}$ hexanol

Reaction II **B** + KOH(aq) $\xrightarrow{\text{heat under reflux}}$ hexanol + KCl

9.2.1 Identify reactant **A**. (1)

9.2.2 Give the IUPAC name of reactant **B**. (1)

9.2.3 State the SPECIFIC reaction type for:

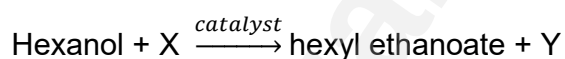
e) Reaction I _____ (1)

f) Reaction II _____ (1)

9.2.4 State if the concentration of KOH in reaction II is HIGH or LOW. (1)

9.2.5 Reaction II is heated under reflux. Explain why this is necessary. (2)

9.3 Hexanol can be used to prepare the compound hexyl ethanoate, which has a mild sweet odour.



9.3.1 Draw the **structural** formula of hexyl ethanoate. (3)

9.3.2 Name the homologous series to which hexyl ethanoate belongs. (1)

9.3.3 Give the IUPAC **name** of compound X in the above equation. (2)

9.3.4 Identify compound **Y** in the above equation. (1)

9.3.5 Identify a suitable catalyst for the reaction. (1)

QUESTION 10

22 MARKS

10.1 **Heptane** and **hept-1-ene** are both colourless liquids at room temperature. Five drops of red-brown bromine (Br_2) water is added to each liquid in a separate test tube.

10.1.1 Describe by means of observable changes how one can distinguish between heptane and hept-1-ene. (3)

10.1.2 Write a balanced chemical equation using condensed structural formulae for the reaction of **heptane** and bromine. Indicate the specific reaction condition. (4)

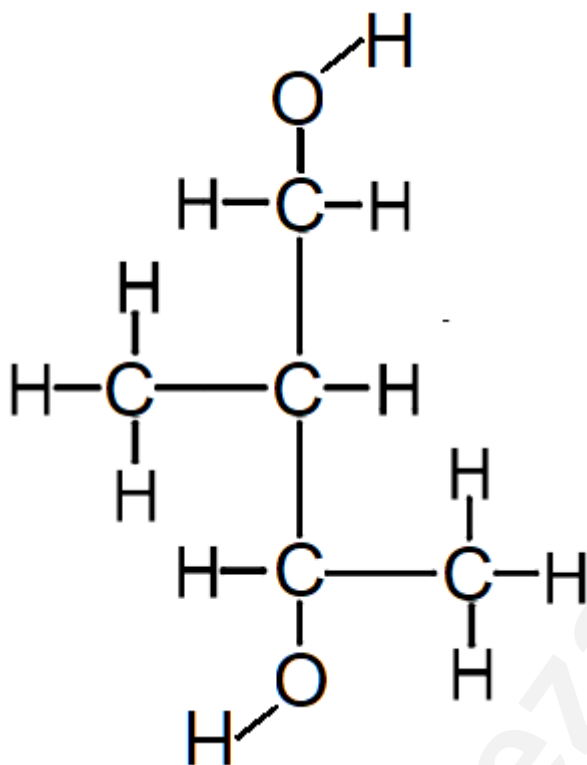
10.1.3 Give the SPECIFIC name for the type of reaction between **hept-1-ene** and bromine. (1)

10.2 Consider the reaction equation: $\text{C}_{13}\text{H}_{28} \xrightarrow{\text{heat}} \text{heptane} + 2\text{X}$

10.2.1 State the SPECIFIC reaction type. (1)

10.2.2 Give the IUPAC name of compound **X**. (3)

10.3 Study the compound below:



10.3.1 Is the compound a hydrocarbon? _____ (1)

10.3.2 Is the compound above SATURATED or UNSATURATED?
Circle your answer. (1)

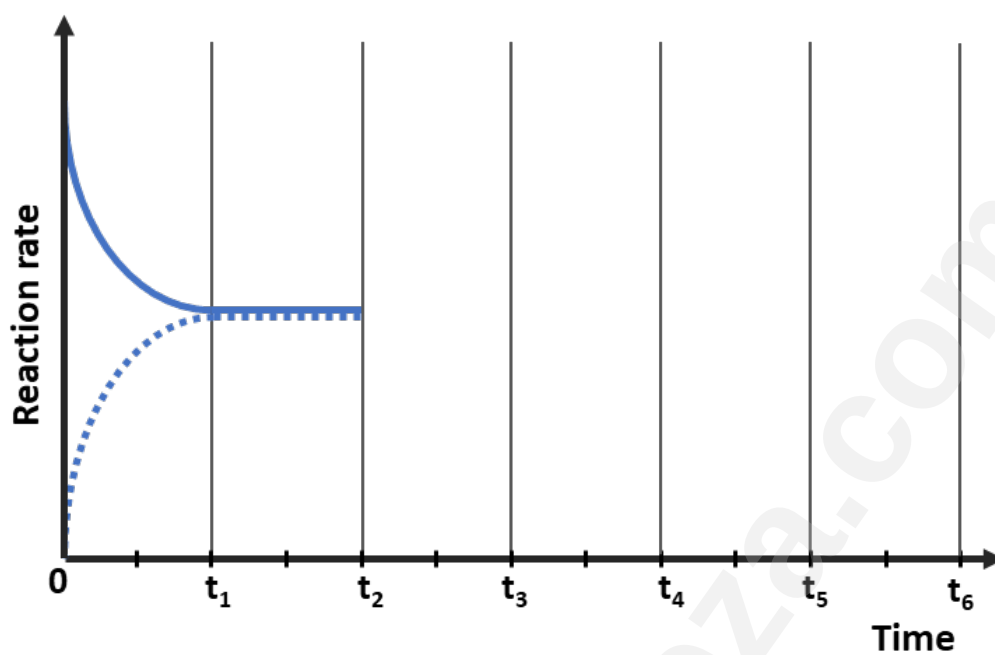
10.3.3 Circle the functional group/s of the compound above. (1)

10.3.4 Give the IUPAC name of this compound. (3)

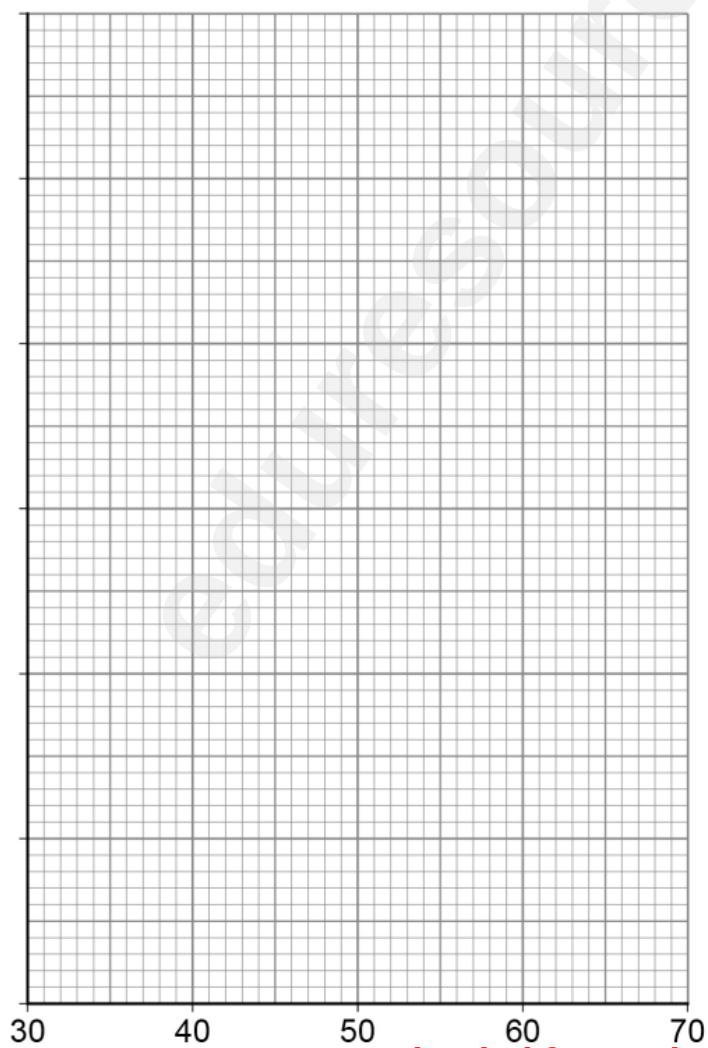
10.3.5 Write a balanced equation for the complete combustion of the compound above. (4)

ADDITIONAL GRAPHS

3.2



4.1.4



This image shows a blank sheet of white paper designed for writing. It features horizontal ruling lines spaced evenly down the page. A single vertical line runs along the left edge, creating a narrow margin. A prominent, light gray watermark with the text "eduresourceza.com" is oriented diagonally from the bottom-left towards the top-right, spanning most of the page's width and height.

[illegible]

[illegible]

[illegible]