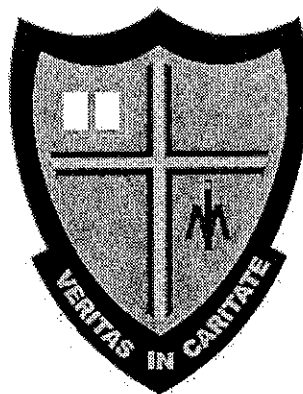




eduresourceza.com



ST BENEDICT'S

SUBJECT	Physical Sciences	PAPER	Paper 2: Chemistry
GRADE	12	DATE	14 July 2017
EXAMINER NAME	Mrs Esterhuizen	MARKS	200
		MODERATOR	Mrs U Visentin Mr S Graham (Reddam)
CLASS		DURATION	3 hours
LOW ORDER	55 %	HIGH ORDER	45 %

INSTRUCTIONS

1. This examination consists of 21 pages.
2. It is in your own interest to write legibly and to present your work neatly.
3. Answer all questions on the folio paper.
4. Start each question at the top of a new page.
5. An approved calculator (non-programmable, non-graphical) may be used.
6. Show your working in all calculations.
7. Rough work and planning may be done as long as it is clearly indicated as rough work. Rough work will not be marked.
8. Round all final answers to 2 decimal places unless otherwise instructed.
9. An information sheet is provided.

Question	1	2	3	4	5	6	7	8	Total
Marks	20	22	21	19	26	28	16	48	200

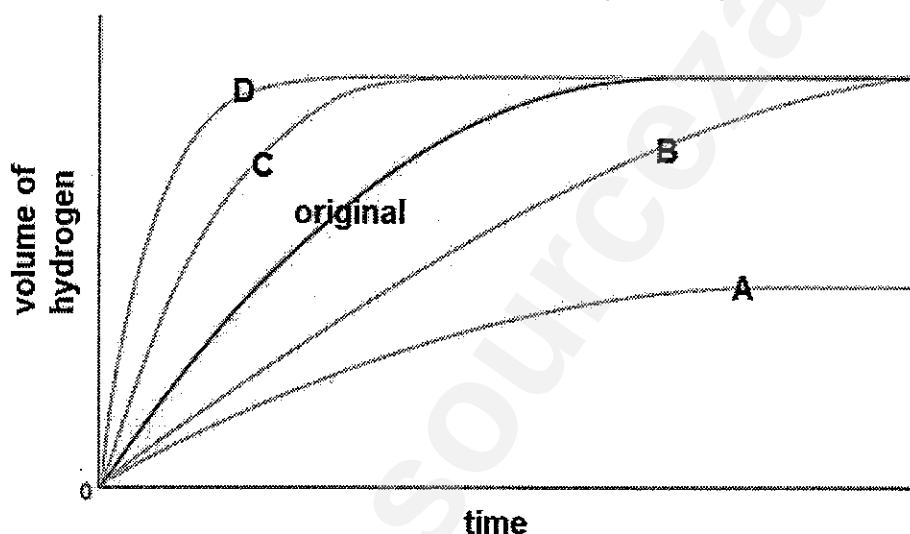
QUESTION 1 – MULTIPLE CHOICE**20 MARKS**

Write down only the question number and the letter of your choice of correct answer on your folio.

- 1.1 Which of the following is the correct chemical formula for sodium dichromate? (2)

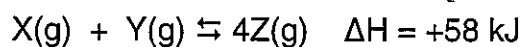
- A. NaCr_2O_7
- B. $\text{Na}_2\text{Cr}_2\text{O}_7$
- C. NaCrO_4
- D. Na_2CrO_4

- 1.2 Acid is reacted with a metal and the hydrogen gas that is released is measured every minute. The graph labelled "original" is produced.



Which graph (A – D) represents the same reaction as the original but where the amount of limiting reagent has been halved? (2)

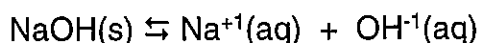
- 1.3 The equation describes an equilibrium reaction occurring in a closed system.



Under which set of conditions would the highest yield of Z(g) be obtained? (2)

	Temperature (°C)	Pressure (kPa)
A	50	100
B	50	200
C	300	100
D	300	200

- 1.4 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? (2)

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

- 1.5 Which row in the table below correctly lists the name of the industrial process and an important product of the process? (2)

	Process Name	Product
A	Haber	Ammonia
B	Contact	Nitric Acid
C	Ostwald	Sulphur
D	Electro-refining	Sodium hydroxide

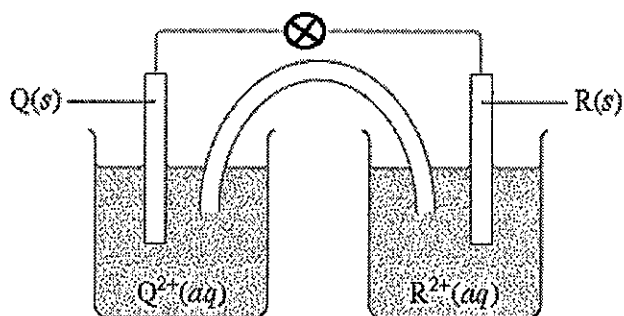
- 1.6 Which of the following solutions has the highest pH? (2)

- A. 1,0 M phosphoric acid
- B. 0,1 M phosphoric acid
- C. 1,0 M sulphuric acid
- D. 0,1 M sulphuric acid

- 1.7 What is the concentration - in mol.dm^{-3} - of hydroxide ions $[\text{OH}^-]$ in a $0,05 \text{ mol.dm}^{-3}$ solution of sulphuric acid ($\text{H}_2\text{SO}_4(\text{aq})$)? (2)

- A. 2×10^{-13}
- B. 1×10^{-13}
- C. 5×10^{-16}
- D. 1×10^{-15}

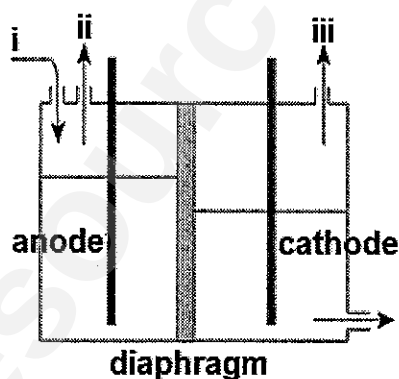
1.8 An electrochemical cell is set up as represented by the diagram below:



Which of the following would NOT increase the capacity of the cell to deliver current? (2)

- A. Increasing the surface area of the electrodes.
- B. Increasing the concentration of the $Q^{2+}(aq)$ and $R^{2+}(aq)$ ions.
- C. Making the salt bridge wider.
- D. Increasing the atmospheric pressure.

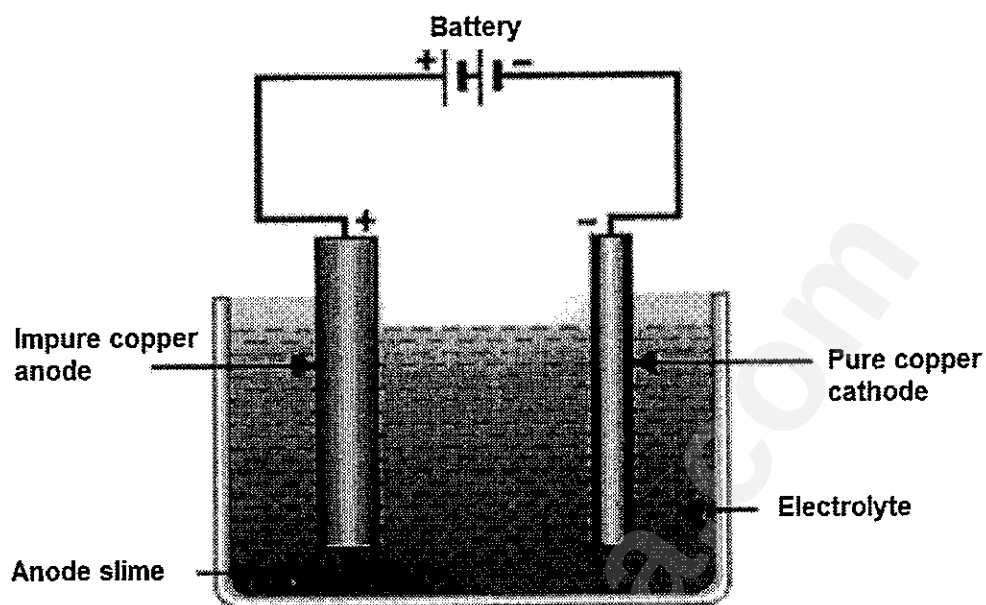
1.9 The cell in the schematic diagram below is used in the chlor-alkali industry.



Which row in the table correctly provides labels for i, ii and iii in the diagram? (2)

	i	ii	iii
A	brine	hydrogen	chlorine
B	sodium hydroxide	chlorine	hydrogen
C	sodium hydroxide	hydrogen	chlorine
D	brine	chlorine	hydrogen

1.10 The diagram below shows a cell used for the purification of copper.



The impure copper anode contains the following impurities:

nickel, platinum, zinc, aluminium, silver, gold

Which row in the table below correctly lists one substance that **does** and one substance that **does not** form a part of the anode slime? (2)

	Is in slime	Is not in slime
A	silver	nickel
B	zinc	gold
C	platinum	gold
D	zinc	aluminium

QUESTION 2 – START ON THE TOP OF A NEW PAGE 22 MARKS

- 2.1 Consider the following substances at room temperature represented by their chemical formulae.

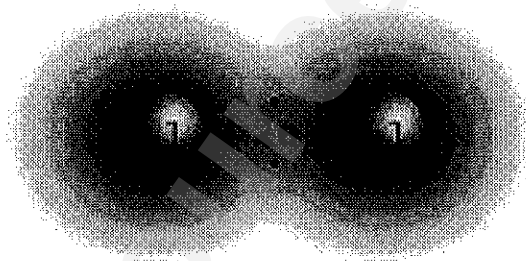


You may use the substances in the list once, more than once or not at all in response to the descriptions.

Give the formula of **ONE** substance from the above list which:

- 2.1.1 Experiences hydrogen bond forces when in the solid phase.
- 2.1.2 Is made of discrete molecules formed by non-polar covalent bonds only.
- 2.1.3 Ionises when placed in water.
- 2.1.4 Has molecules that contain double polar covalent bonds.
- 2.1.5 Conducts electricity well when dissolved in water.
- 2.1.6 Has a giant atomic lattice structure at room temperature. (6)

- 2.2 The structure of a molecule of hydrogen is represented below:



<https://www.boundless.com/chemistry/textbooks/boundless-chemistry-textbook/basic-concepts-of-chemical-bonding-9/lewis-dot-symbols-and-lewis-structures-71/introduction-to-lewis-structures-for-covalent-molecules-333-7499/>

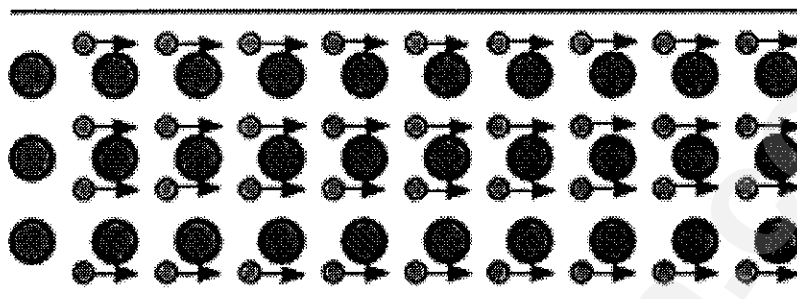
The hydrogen atoms are bound in the diatomic molecule by a pure covalent intramolecular bond.

- 2.2.1 Define *intramolecular bond*. (2)
- 2.2.2 Explain why the bond is classified as being “pure covalent”. (2)
- 2.2.3 Explain why hydrogen molecules in the liquid state have an extremely low boiling point. (4)

- 2.2.4 In January this year, scientists at Harvard University claim to have made metallically bonded hydrogen in a laboratory. It is believed that metallic hydrogen will be a superconductor.

(A superconductor can conduct electricity with almost zero resistance.)

The picture below represents the general microscopic structure of any metallically bonded substance conducting electricity:



wire with current
electricity

- (a) Define *metallic bond*. (2)
- (b) How does the composition of the kernels in metallic hydrogen differ from those in metallic copper? (2)
- (c) Use your answer to 2.2.4 (b) to suggest an explanation as to why metallic hydrogen might be a superconductor while metallic copper is not. (4)

QUESTION 3 – START ON THE TOP OF A NEW PAGE 21 MARKS

Alison investigates the rate of the reaction between marble chips (calcium carbonate) and dilute hydrochloric acid. She is given a bottle containing hydrochloric acid labelled $X \text{ mol.dm}^{-3}$.

She uses the method below to find out how changing the concentration of the acid affects the rate of reaction.

- Place some marble chips and $250,0 \text{ cm}^3$ of dilute hydrochloric acid into the flask.
- Place the flask on a balance and start a timer.
- Record the time taken for the meter reading to decrease by $1,0 \text{ g}$.
- Repeat the experiment using different concentrations of hydrochloric acid.

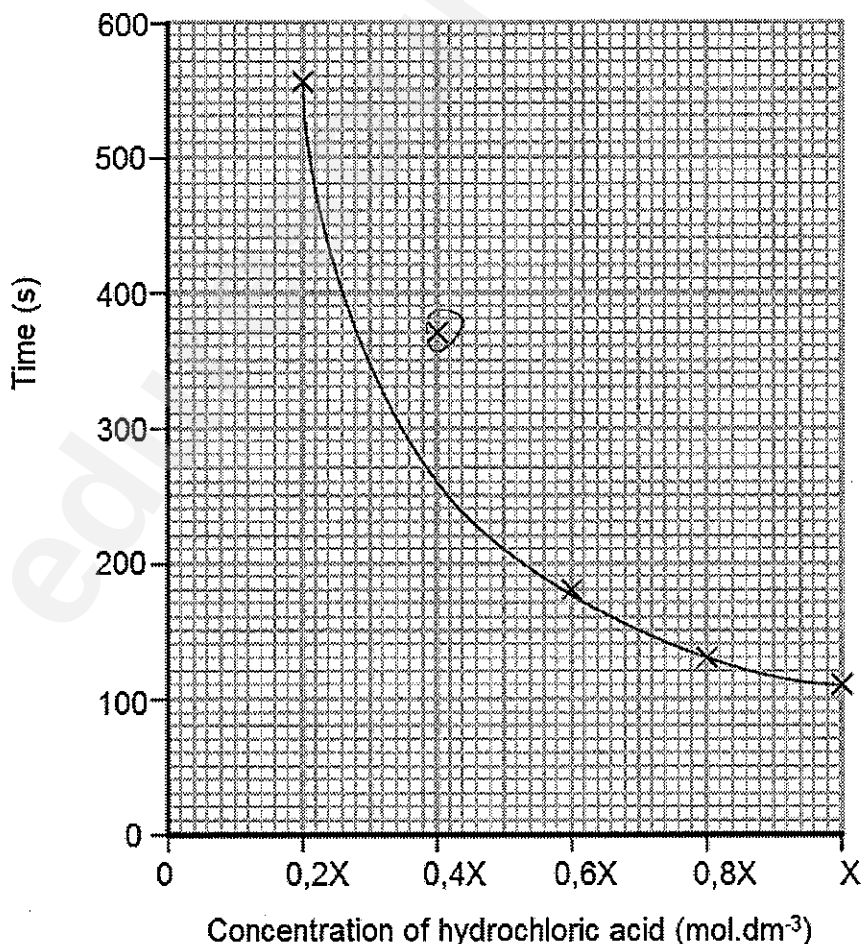
The chemical equation for this reaction is:



3.1 Suggest two physical properties of the marble chips that the student should control to ensure that the results are valid. (2)

3.2 Why does the mass of the flask and contents decrease during the experiment? (1)

The graph shows Alison's results for the decrease in the mass of the flask and contents by $1,0 \text{ g}$.



One of the points on the graph is an outlier (anomalous).

- 3.3 Which one of the following reasons (A – C) alone could have caused this result? Explain your choice briefly.

Reason A: the concentration of acid was more than 0,4X

Reason B: the loss of mass was greater than 1,0 g

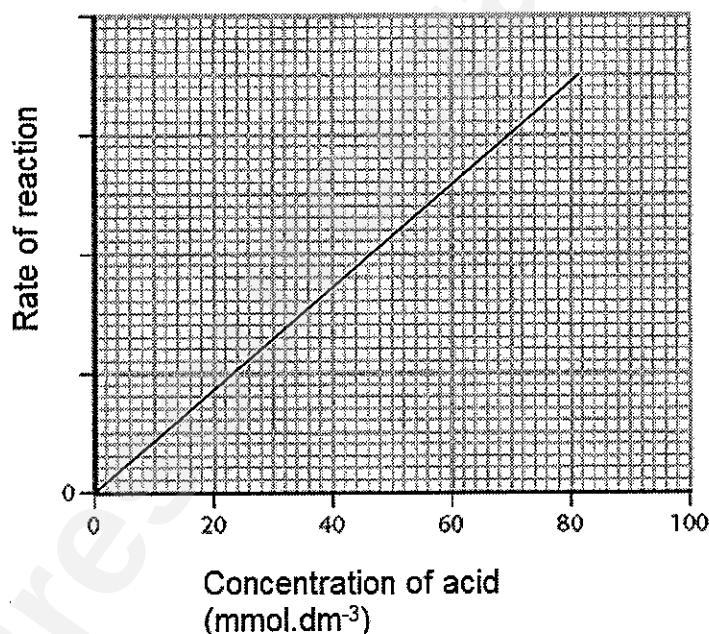
Reason C: the student started the timer too late. (2)

- 3.4 Remembering that the mass of the flask and contents must drop by 1,0 g, calculate the minimum concentration of the acid in the bottle ($X \text{ mol.dm}^{-3}$) given that the calcium carbonate was always in excess.

Work to three decimal places throughout your calculations. (6)

- 3.5 Alison repeats this investigation with a different original concentration of hydrochloric acid.

She calculates the rate of reaction for each experiment and draws the following graph:



- 3.5.1 Define *rate of reaction*. (2)

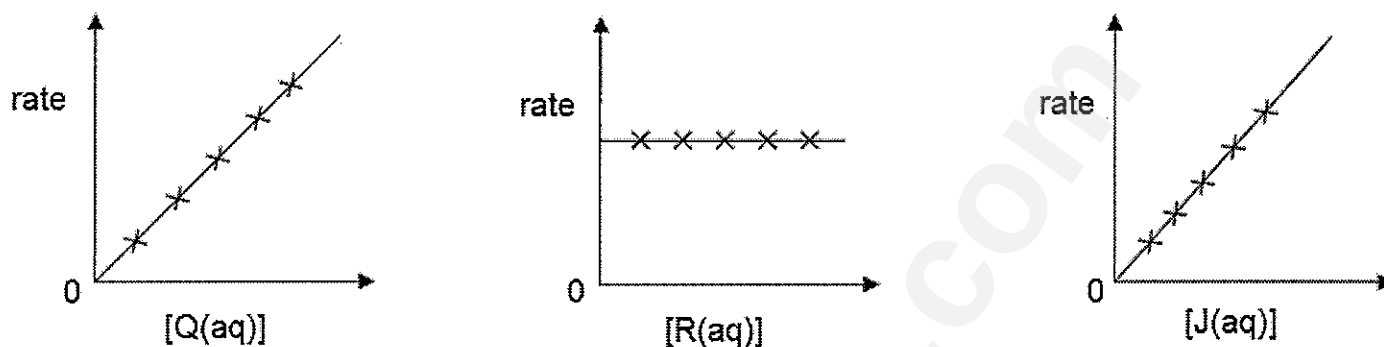
- 3.5.2 Suggest a unit for the y-axis based on the experimental method. (1)

- 3.5.3 The rate of reaction increases as the concentration of the acid increases. Explain this relationship using collision theory. (3)

- 3.5.4 Draw a sketch of this graph in your answer book. Now draw in the line graph you would expect to get if you repeated this experiment at a **lower temperature**. Label your line "lower temperature." (2)

3.6 Alison now follows a similar procedure to investigate the rate of a chemical reaction involving three aqueous substances: Q(aq), R(aq) and J(aq).

She varies the concentrations of these three chemicals in turn (while controlling the concentrations of the other chemicals) and produces the following three rate graphs:



Which one of the following mathematical relationships can be derived from these results? Write down the relationship of your choice.

Rate $\propto$ [Q(aq)] $\times$ [R(aq)]

Rate $\propto$ [R(aq)] $\times$ [J(aq)]

Rate $\propto$ [Q(aq)] $\times$ [J(aq)]

Rate $\propto$ [Q(aq)] $\times$ [R(aq)] $\times$ [J(aq)]

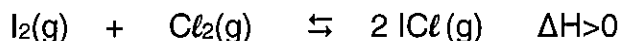
(2)

THIS PAGE IS DELIBERATELY LEFT BLANK

eduresourceza.com

QUESTION 4 – START ON THE TOP OF A NEW PAGE 19 MARKS

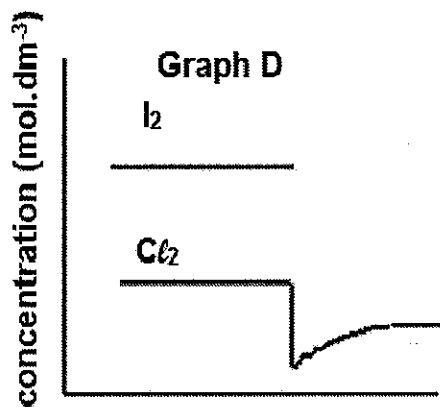
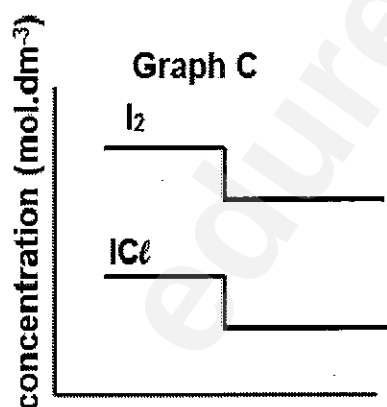
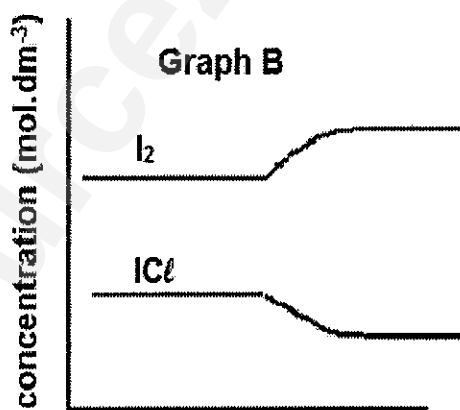
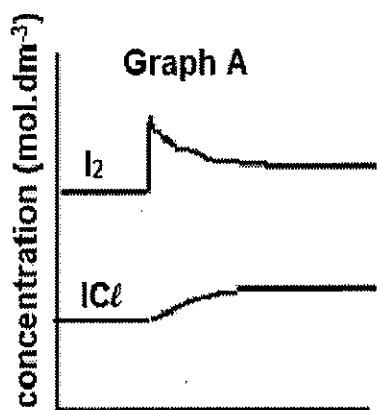
Consider the following reaction that reaches dynamic equilibrium in a 1 dm³ closed system:



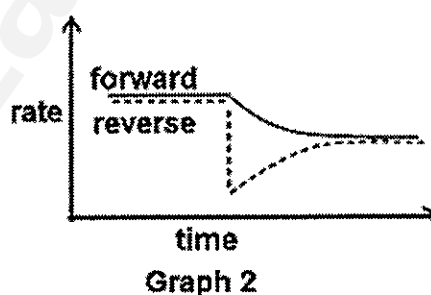
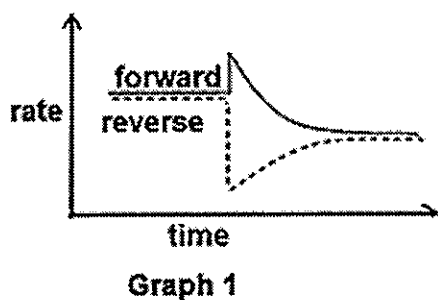
- 4.1 Explain what is meant by a *closed system*. (2)
- 4.2 When equilibrium is attained at a temperature T °C, the concentrations of all three of the chemical substances are found to be the same as each other.
- 4.2.1 Write down a mass action expression that can be used to calculate the equilibrium constant for this reaction. (2)
- 4.2.2 Calculate the equilibrium constant at T °C. (3)
- 4.3 Various stresses are placed on the system and the effect on the concentrations of the chemical species are recorded graphically.

Below are four different portions of the graph that was produced. Only TWO of the chemical substances are represented in each graph portion.

The graphs are labelled A – D.



- 4.3.1 Write down the specific stress that occurred to produce the change indicated in:
- Graph A. (2)
 - Graph B. (2)
- 4.3.2 Use Le Chatelier's principle to explain the change shown in graph C. (4)
- 4.3.3 Graph D is incomplete. Redraw this graph in your answer book and complete the shape of the graph for I_2 . Label the graph clearly. (2)
- 4.4 Which one of the two graphs below would be the **rate graph** produced if some ICl was removed from the equilibrium system? Write down graph 1 or graph 2. (2)
- (Note: at equilibrium the forward and reverse reaction curves have been shown slightly split apart to make the reverse reaction easier to see.)



QUESTION 5 – START ON THE TOP OF A NEW PAGE 26 MARKS

- 5.1 A titration was carried out to find the relative molecular mass of a solid organic acid.

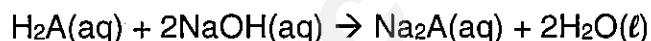
The formula of the acid can be written H_2A .

250cm^3 of a standard solution was made using 1,05 g of the acid dissolved in water.

- 5.1.1 Define *standard solution*. (2)
- 5.1.2 Name the piece of apparatus used for making a solution with a volume of exactly 250 cm^3 . (1)
- 5.1.3 Write down the balanced equation for the reaction that occurs when H_2A is placed into water. (3)
- 5.1.4 The acid is shown to have a K_a value of 10^{-4} . State whether the acid solution will be a good or a poor electrical conductor. Explain the chemistry behind your answer. (3)

$25,0\text{ cm}^3$ of the acid solution was pipetted into a conical flask and titrated with $0,100\text{ mol.dm}^{-3}$ sodium hydroxide solution. This titration was repeated three times.

The equation for the reaction is shown below.



The following results were recorded:

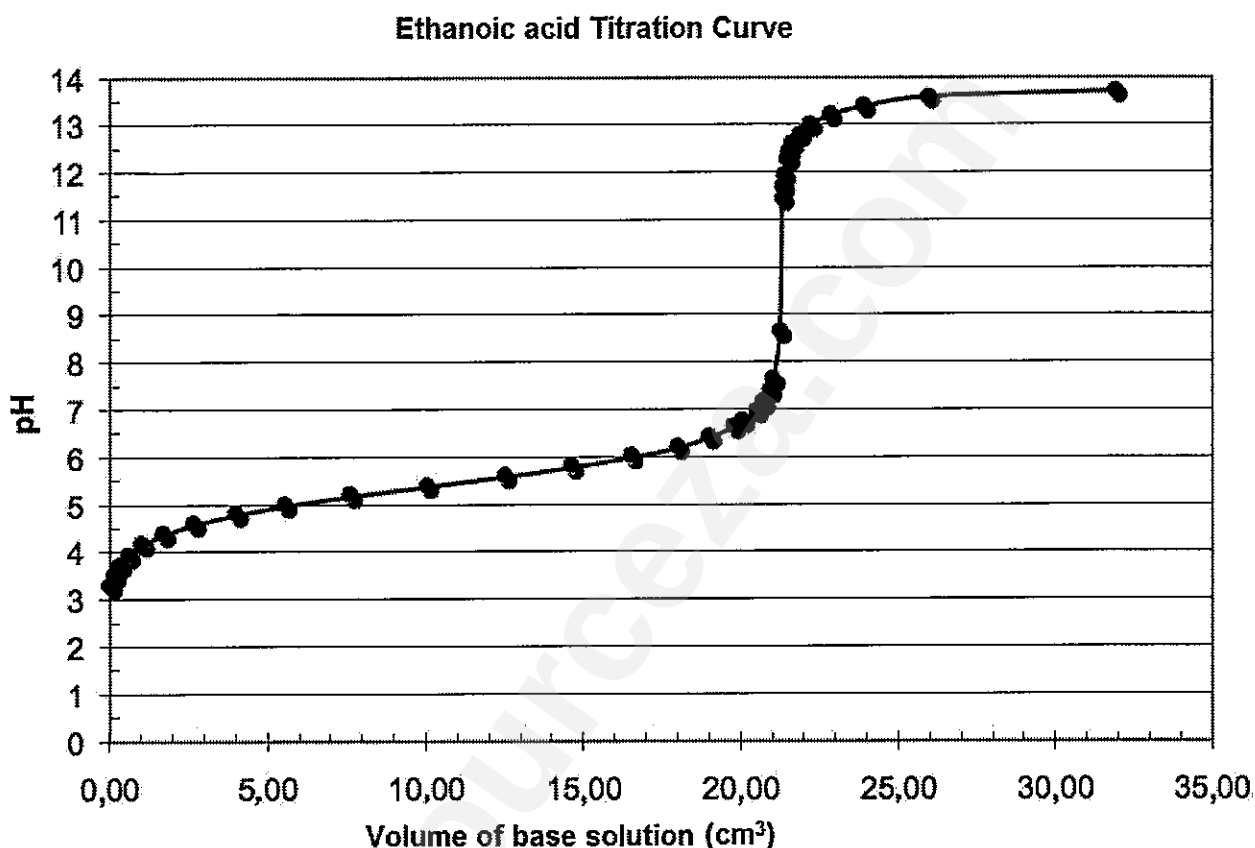
Titration number	1	2	3
Volume of $NaOH(aq)$ used (cm^3)	23,35	23,45	23,10

Consider the results in the table:

- 5.1.5 Define *molar mass*. (2)
- 5.1.6 Calculate the average volume of $NaOH(aq)$ used. (1)
- 5.1.7 Calculate the number of moles of H_2A in ^{each} the $25,0\text{ cm}^3$ pipette samples. (Ensure you maintain three significant figures in your answer) (4)
- 5.1.8 Hence show that the molar mass of H_2A is about 90 g.mol^{-1} . (2)

5.2 A titration was done using EITHER aqueous potassium hydroxide OR aqueous ammonium hydroxide with ethanoic acid (CH_3COOH).

The pH of the ethanoic acid solution was recorded with a pH probe as the titration took place. The curve below was obtained.



The graph suggests that salt hydrolysis has occurred.

- 5.2.1 Define *hydrolysis of a salt*. (2)
- 5.2.2 Describe how the curve obtained indicates that salt hydrolysis has occurred. (2)
- 5.2.3 State whether the base used was aqueous potassium hydroxide OR aqueous ammonium hydroxide. (1)
- 5.2.4 Write the balanced chemical equation for the reaction between ethanoic acid and the base chosen in 5.2.3. (3)

QUESTION 6 – START ON THE TOP OF A NEW PAGE 28 MARKS

6.1 Marie and David 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

6.1.1 Define *reducing agent*. (2)

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

6.1.3 Marie states that another similar experiment needs to be performed in order to be able to place all four metals in order.

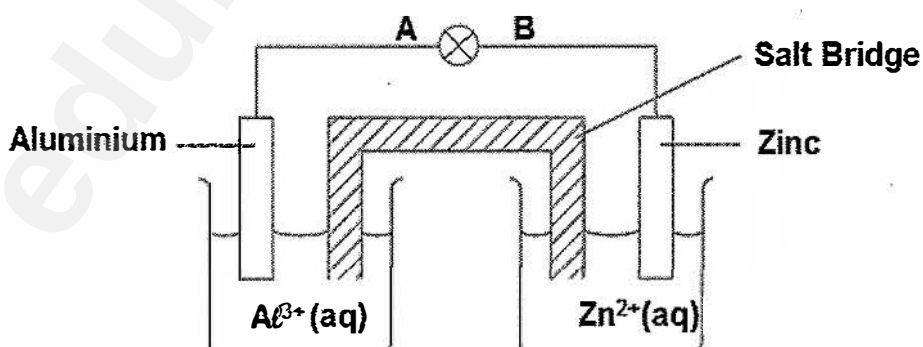
(a) Explain why Marie is correct. (1)

(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)

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

6.2 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.



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

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

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

6.2.4 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. Answer TO THE LEFT or TO THE RIGHT. (1)
- (c) Explain the chemistry behind your answer to 6.2.4 (b) in detail. (4)
- (d) Write down the direction that the electrons will flow through the light bulb. Write down only FROM A TO B or FROM B TO A. (1)

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} .

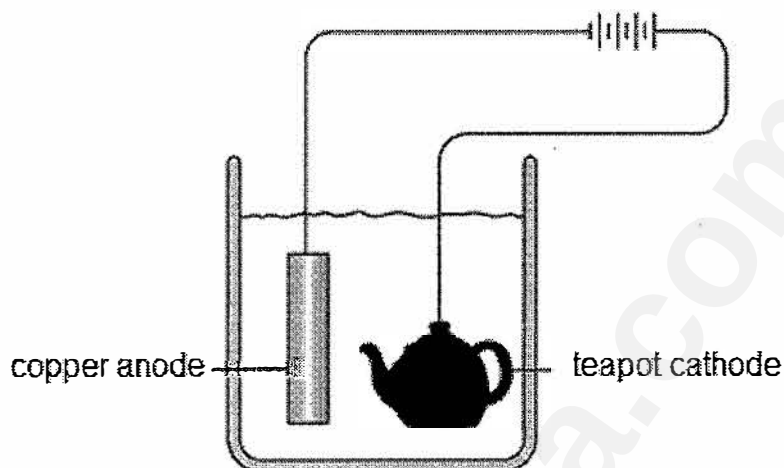
6.2.5 Complete the sentence :

The initial EMF of this new cell will be ..(6.2.5).. than the the initial EMF of the original cell.

Write down only GREATER THAN, THE SAME AS or LESS THAN for your answer. (2)

✓ **QUESTION 7 – START ON THE TOP OF A NEW PAGE 16 MARKS**

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



- 7.1 What is an *electrolyte*? (2)
- 7.2 Give the name of a solute Blessing could use to make a safe, suitable electrolyte for this process. (1)
- 7.3 Describe the error in the picture that Blessing was given. Explain the chemistry behind your answer. (3)
- Blessing corrects the error.
- 7.4 Calculate the mass of copper that Blessing wants to plate onto the teapot. (2)
- 7.5 Calculate the time it would take to plate the teapot as required if the process was 100% efficient. (5)
- 7.6 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 7.5? Assume all other conditions and variables are the same. Justify your answer. (3)

QUESTION 8 – START ON THE TOP OF A NEW PAGE 48 MARKS

8.1 The alkanes are a homologous series obtained from a mixture called crude oil.

8.1.1 State two characteristics, other than having the same general formula, of members of **any** homologous series. (2)

8.1.2 Describe the general chemical composition of all **alkanes**. (2)

8.1.3 The different alkanes in crude oil are separated from each other by a process called fractional distillation. Is this process a physical or a chemical process? (1)

8.1.4 Propane - C_3H_8 - is an alkane that is commonly used as a fuel.

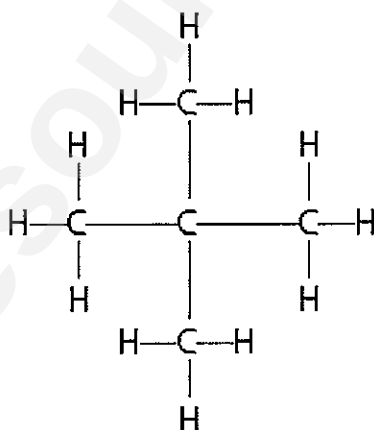
(a) Define heat of reaction. (2)

(b) Write down the balanced chemical equation for the complete combustion of propane. (3)

(c) Draw an energy profile diagram for the combustion reaction in 8.1.4 (b). Include **only** the labels for the following:

- x- and y-axes
- activation energy
- heat of reaction (5)

8.1.5 The structural (displayed) formula of a chain isomer of the alkane C_5H_{12} is shown below:



(a) Write down the IUPAC name of the above chain isomer. (3)

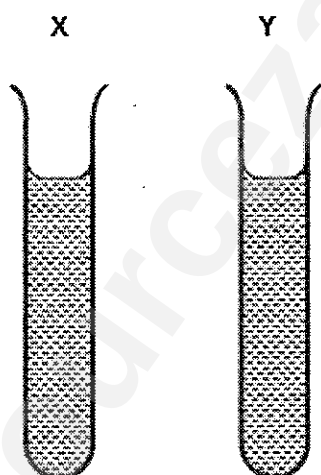
(b) Give the semi-structural (condensed structural) formula of a **different branched** isomer of C_5H_{12} . (2)

(c) The alkane C_5H_{12} can only have chain isomers. Name the other two **types** of structural isomers. (2)

8.1.6 Ethane (C_2H_6) is used as a starting material to manufacture plastics. It is first cracked to form ethene (C_2H_4) and another product - Q.

- Give two reasons why cracking is considered to be a chemical process. (2)
- Provide the chemical name of the product Q that also forms in this reaction. (2)
- Describe how bromine water can be used to distinguish between ethane and ethene. Be sure to mention any relevant conditions. (4)
- Ethene can undergo a hydration reaction under certain conditions. Write down the IUPAC name of the product of this reaction. (2)

8.2 Two liquid organic compounds, X and Y, both with the molecular formula $C_4H_8O_2$, are placed in separate test tubes.



Each substance undergoes various tests, and the results are recorded in the table below:

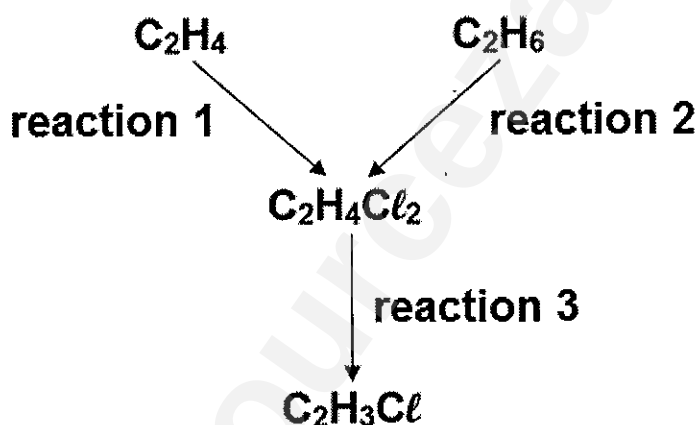
Test	Result with X	Result with Y
Boiling point	164 °C	77 °C
Solubility in water	Completely miscible (at 20 °C)	8,3 g per 100 cm ³ (at 20 °C)
Effect on litmus paper	Turns blue litmus red	No effect

The following **correct conclusion** is made after considering the results:

“Liquid X is a carboxylic acid and liquid Y is an ester”.

- 8.2.1 Write down the test result which, **on its own**, can be used to come to this correct conclusion. (1)
- 8.2.2 Select any **one** of the other tests in the table (i.e. not the test selected in 8.2.1) and explain in detail how the result of that test with X and with Y supports the conclusion that was made. (4)
- 8.2.3 Remembering that X and Y both have the chemical formula $C_4H_8O_2$, suggest the name of:
- (a) Compound X. (2)
- (b) Compound Y. (2)

8.3 Consider the reaction scheme given below:



- 8.3.1 Name the **type** of organic reaction represented by:
- (a) Reaction 1 (1)
- (b) Reaction 2 (1)
- 8.3.2 Suggest which reaction – 1 or 2 – is preferred in industry to make $C_2H_4Cl_2$. Provide one reason for your answer. (2)
- 8.3.3 Provide the balanced equation using structural formulae for reaction 3. You do not need to include any other reagents. (3)

END OF EXAMINATION ☺

eduresourceza.com