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TRIAL EXAMINATIONS - 2022
PHYSICAL SCIENCES P2

Time: 3 hours
Examiner : K. Storm

Marks : 200
Moderator : C. Maritz

NAME: Memo - Final

The use of IEB/ IEB teacher's questions, in whole or in part, is gratefully acknowledged.

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 31 pages and a Chemistry Data Sheet. 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 examination. Remember to write your name in the space provided above.
4. Use the data and formulae 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. THREE blank pages (pages 29 to 31) are included at the end of the paper. If you run out of space for a question, use these pages. Clearly indicate the question number of your answer should you use this extra space.

QUESTION 1 MULTIPLE CHOICE

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

1.1 Which one of the bonds between the atoms below has the highest polarity?

- A H – C
- B H – Cl
- C H – O
- D H – N

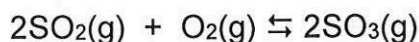
1.2 Which chemical equation represents an endothermic reaction?

- A $\text{NH}_4\text{NO}_3(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{NH}_4^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \quad \Delta H > 0$
- B $2\text{Mg}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{MgO}(\text{s}) \quad \Delta H < 0$
- C $\text{Zn}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{ZnCl}_2(\text{aq}) + \text{H}_2(\text{g}) + \text{heat}$
- D $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g}) \quad \Delta H = -131 \text{ kJ.mol}^{-1}$

1.3 Which one of the reactions below will produce the salt sodium ethanoate?

- A $\text{HCl(s)} + \text{CH}_3\text{COOH(aq)} \rightarrow$
- B $\text{CH}_3\text{COOH(aq)} + \text{H}_2\text{O(l)} \rightarrow$
- C $\text{CH}_3\text{COOH(aq)} + \text{NaOH(aq)} \rightarrow$
- D $\text{H}_2\text{CO}_3\text{(aq)} + \text{NaOH(aq)} \rightarrow$

1.4 In an experiment, 0,1 mol of $\text{SO}_2\text{(g)}$ and 0,1 mol of $\text{O}_2\text{(g)}$ are added to an empty 1 dm^3 flask which is then sealed. The resulting reaction reaches equilibrium as shown in the following balanced chemical equation:



Which one of the following is NOT TRUE at equilibrium?

- A $[\text{SO}_2] = [\text{O}_2] = [\text{SO}_3]$
- B $[\text{O}_2] > [\text{SO}_2]$
- C $[\text{SO}_2] = [\text{SO}_3]$
- D $[\text{SO}_2] < [\text{O}_2]$

1.5 An electrochemical cell consists of a standard hydrogen electrode and a $\text{Cu}^{2+}\text{(aq)}/\text{Cu(s)}$ electrode which uses copper (II) sulphate solution. Which one of the following does not affect the emf of the cell?

- A The volume of the copper (II) sulphate solution.
- B The temperature.
- C The pressure of the hydrogen.
- D The concentration of the copper (II) sulphate solution.

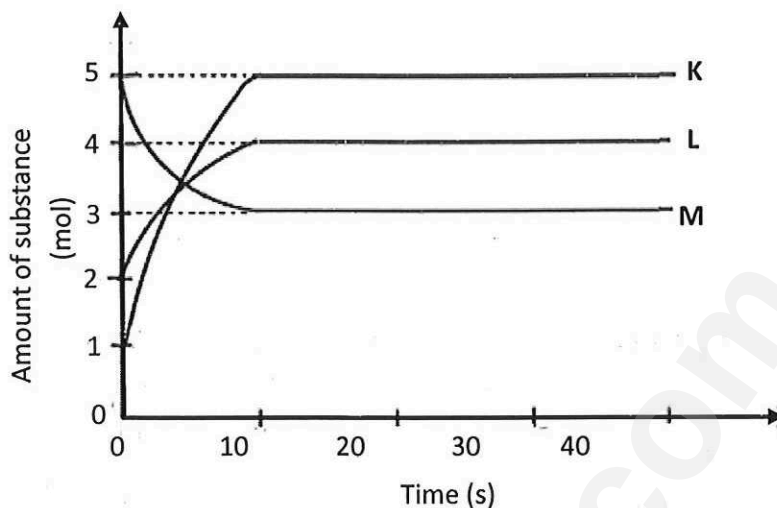
1.6 Three substances, X, Y and Z_2 are mixed. The reaction which occurs takes place in two steps as follows:



Which one of the substances acts as a catalyst?

- A X
- B Y
- C XZ_2
- D Z_2

- 1.7 The graph below shows the relationship between the amount of substance and time in a chemical reaction involving substances K, L and M.



The chemical reaction represented above could be:

- A $3M \rightarrow 4K + 5L$
- B $5M \rightarrow 2K + L$
- C $M \rightarrow 2K + L$
- D $M \rightarrow K + 2L$

- 1.8 The half-reactions below take place in an electrochemical cell.



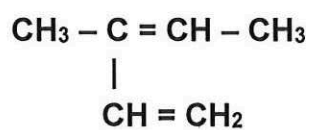
Which one of the statements below is true for this cell when it delivers current?

- A The mass of the Cs electrode increases.
- B Pt^{2+} undergoes oxidation more easily than Cs.
- C Pt^{2+} undergoes reduction more easily than Cs^+ .
- D Electrons will flow from the Pt electrode to the Cs electrode in the external circuit.

- 1.9 Why is it necessary to dissolve aluminium oxide in molten cryolite during the extraction of aluminium?

- A The cryolite reduces the melting point of the aluminium oxide.
- B The cryolite acts as a catalyst for the production of aluminium
- C The cryolite reacts with aluminium oxide to form aluminium.
- D Aluminium oxide can only conduct electricity when mixed with cryolite.

1.10 Which is the correct IUPAC name for the following organic compound?

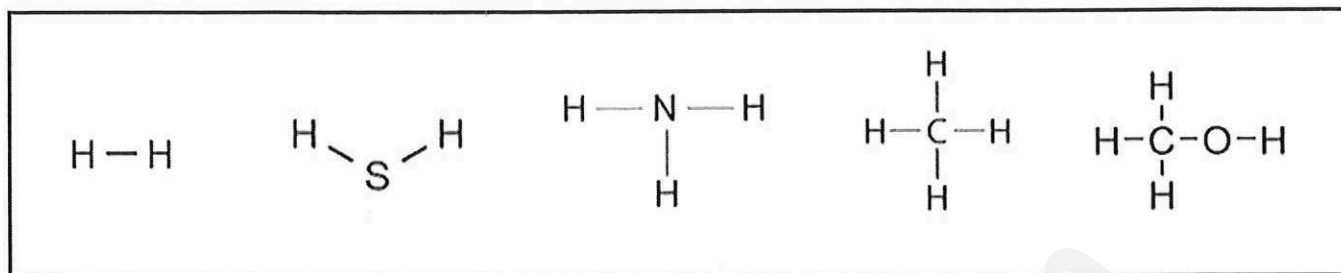


- A 3-methylpenta-2,4-diene
- B 3-methylpenta-1,3-diene
- C 2-ethylbut-2-ene
- D hex-1,3-diene

[10 x 2 = 20]

QUESTION 2

2.1 Given the following substances, answer the questions that follow.



2.1.1 Name the substance which will have the lowest boiling point? (1)

Hydrogen ✓

2.1.2 Which intermolecular forces are responsible for the low boiling point in question 2.1.1? (1)

London Forces ✓

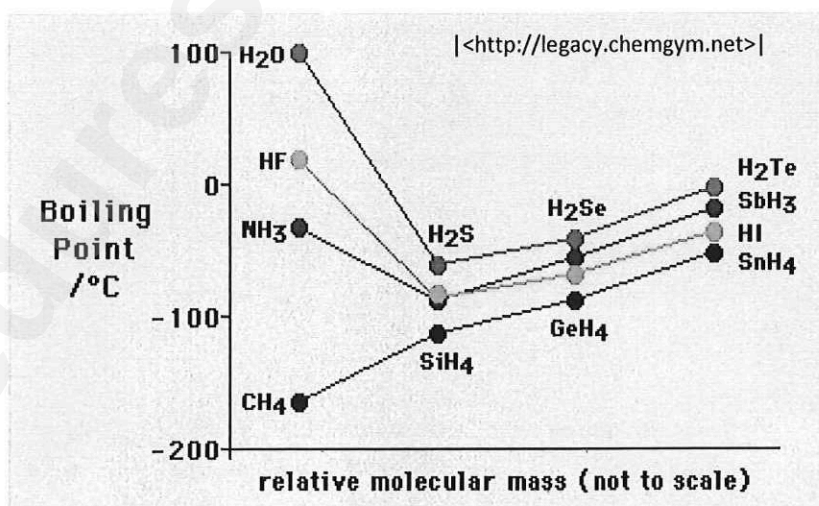
2.1.3 Classify the specific type of bond between the hydrogen and carbon atoms in methane. (2)

polar covalent ✓

2.1.4 Which substance/s form non-polar molecules? (2)

hydrogen and methane ✓

2.2 The graph below shows the boiling points of the hydrides of the elements in groups 14, 15, 16 and 17. Water (H_2O), hydrogen fluoride (HF) and ammonia (NH_3) do not follow the trend of the other hydrides.



2.2.1 Name the intermolecular forces present between the molecules of water (H_2O), hydrogen fluoride (HF) and ammonia (NH_3) (1)

Hydrogen bonds ✓

- 2.2.2 What 3 properties of the oxygen, fluorine and nitrogen atoms allow these compounds to exhibit these specific intermolecular forces? (3)

Small atoms ✓

high electronegativity ✓

at least one lone pair of electrons ✓

- 2.2.3 Explain why HF has a higher boiling point than the other hydrides of the group 17 elements. (3)

HF has hydrogen bonds while the other hydrides have dipole-dipole forces between their molecules. Hydrogen bonds are stronger than dipole-dipole forces and therefore more energy is needed to overcome them and hence HF has a higher boiling point.

- 2.3 Study the substances below and select one which meets the criteria of each statement. You can use any of the substances more than once. (5)

Mg

C

KCl

CH₄

Ar

- 2.3.1 It has a sea of delocalised electrons surrounding positive kernels.

Mg ✓

- 2.3.2 It has London forces between its atoms.

Ar ✓

- 2.3.3 It dissociates into ions in water.

KCl ✓

- 2.3.4 It has a solid allotrope comprised of an atomic lattice of covalently bonded atoms.

C ✓

- 2.3.5 It conducts electricity when melted into a liquid, but cannot conduct as a solid.

KCl ✓

QUESTION 3

The chemical compound methyl isocyanate (MIC) is used in the production of pesticides. The molecular formula of MIC is CH_3NCO . MIC reacts with water as shown in the balanced chemical equation. An iron catalyst is used in the reaction.

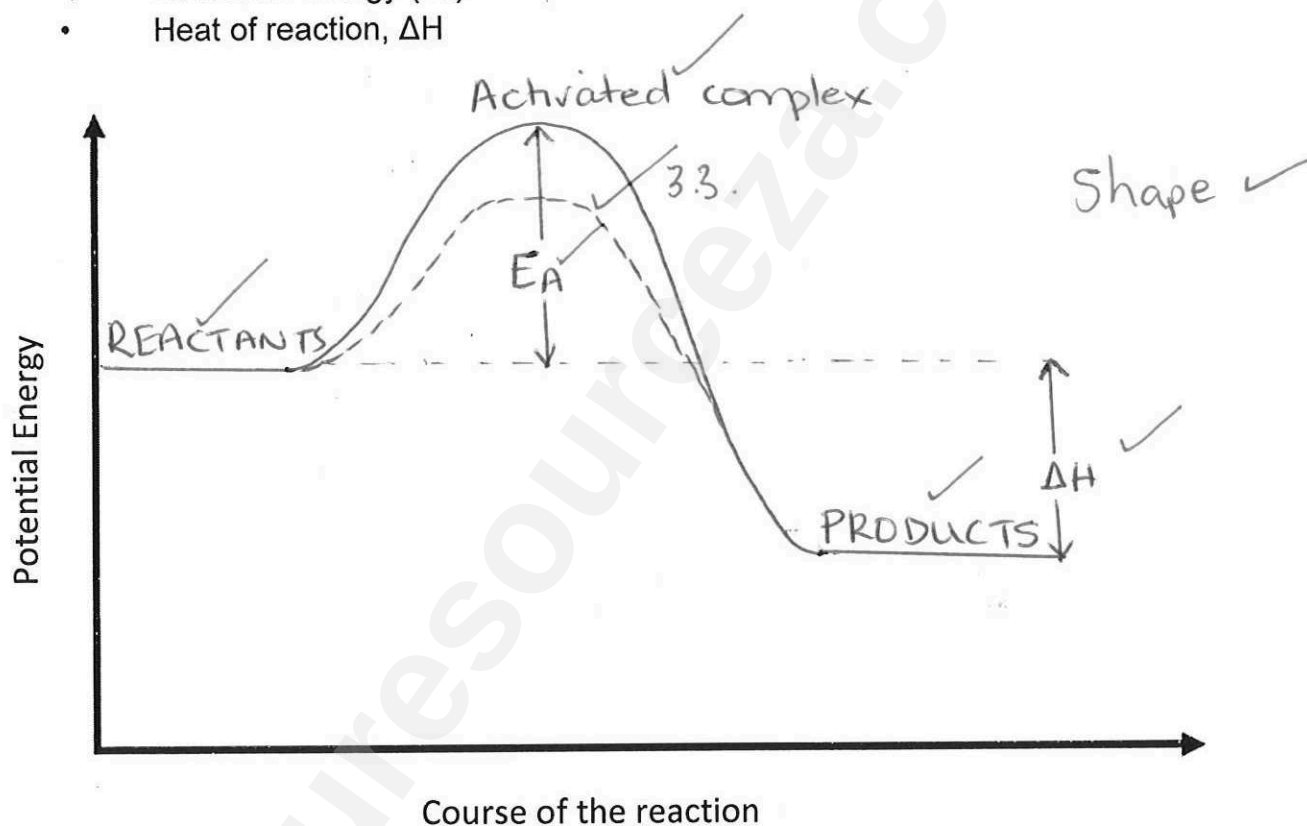


3.1 On the axes below draw a potential energy profile graph to represent the above reaction.

Label the following:

- Energy of the reactants
- Energy of the products
- Activated complex
- Activation energy (E_A)
- Heat of reaction, ΔH

(6)



3.2 Define *catalyst*.

(2)

A substance that increases the rate of a
reaction but remains unchanged at the
end of the reaction

3.3 Draw a dashed line (---) on your graph to show the effect of a catalyst.

(1)

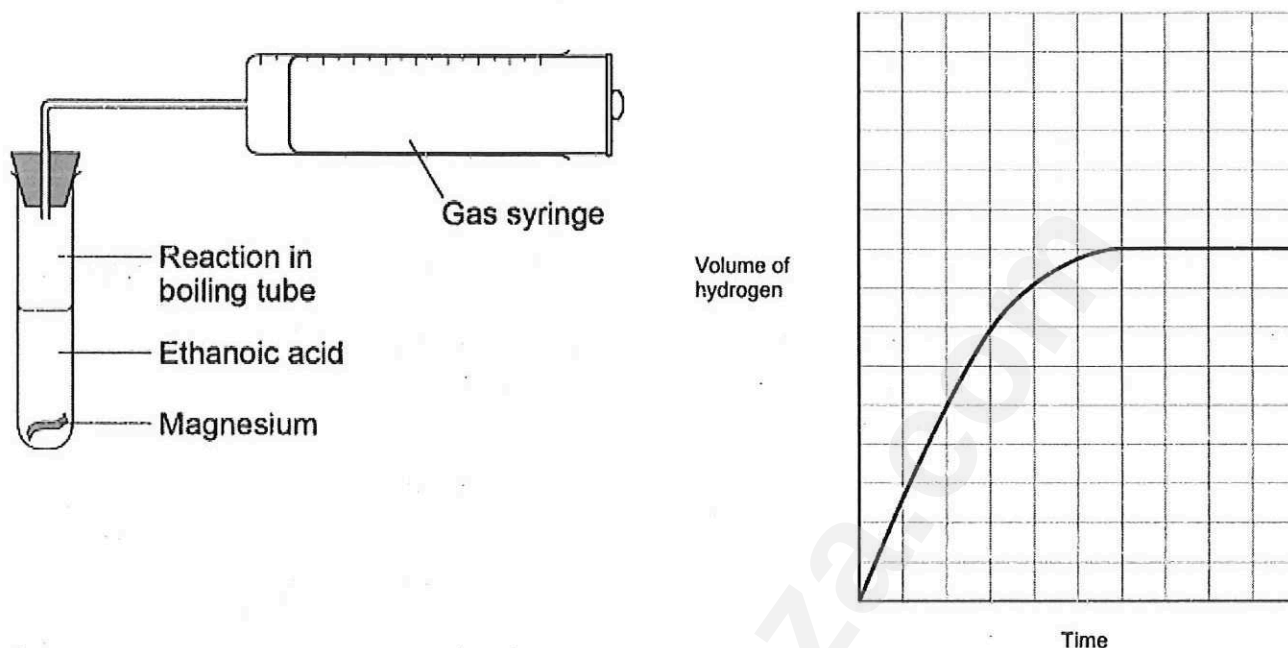
3.4 Explain, in terms of the collision theory, how a catalyst achieves its function. (3)

A catalyst lowers the activation energy needed for an effective collision. ✓
More particles now have the required activation energy. ✓
There are now more effective collisions per second. ✓
The reaction rate increases.

[12]

QUESTION 4

When an aqueous solution of ethanoic acid reacts with magnesium, the progress of the reaction can be followed using the equipment shown below to measure the volume of hydrogen produced.



The graph shows how the volume of hydrogen produced varies with time when 396 mg of magnesium is added to 30,0 cm³ of 0,600 mol.dm⁻³ ethanoic acid.

4.1 Explain why the gradient of the graph...

4.1.1 decreases with time

(2)

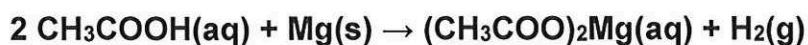
As the reactants are used up there will be fewer collisions per second and the rate of the reaction will decrease.

4.1.2 eventually becomes zero.

(2)

When the limiting reactant is used up the reaction will stop.

The equation for the reaction between ethanoic acid and magnesium is shown.



4.2 With the aid of calculations, show that the magnesium is in excess in this reaction. (6)

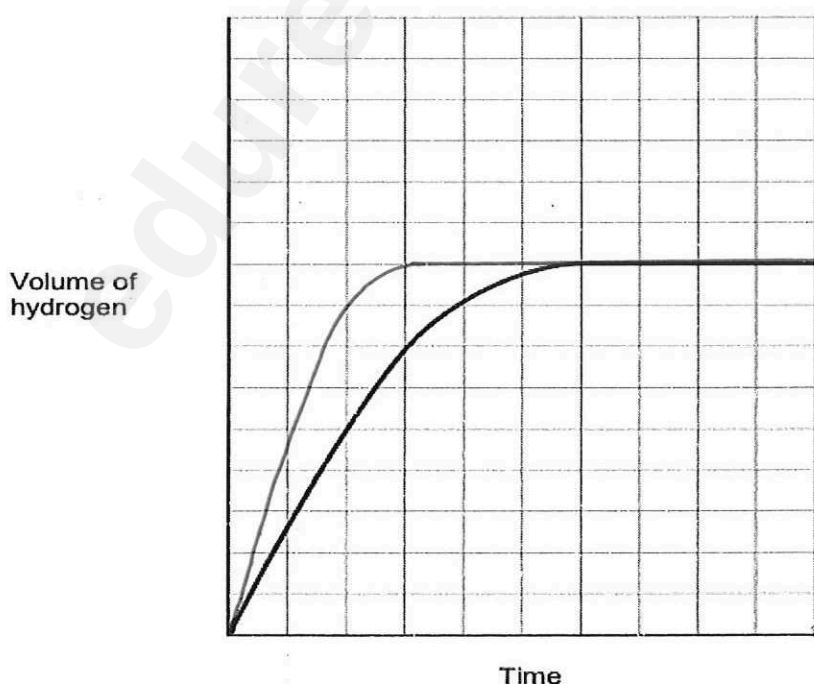
$$\begin{aligned} n(\text{Mg}) &= \frac{m}{M} \quad \checkmark \\ &= \frac{0,396}{24,3} \quad \checkmark \\ &= 0,016 \text{ mol} \quad \checkmark \end{aligned}$$

$$\begin{aligned} n(\text{CH}_3\text{COOH}) &= CV \quad \checkmark \\ &= 0,6 \times 0,03 \quad \checkmark \\ &= 0,018 \text{ mol} \quad \checkmark \end{aligned}$$

0,018 mol CH_3COOH reacts with 0,009 mol Mg
 $\therefore$ Mg is in excess

4.3 Sketch an **accurate, clearly labelled** line on the copy of this graph below to show how the volume of hydrogen produced varies with time when the reaction was repeated under the following condition.

1,5 times the mass of **powdered** magnesium was used, with all the other conditions kept the same. (2)



Steeper ✓
 Same ending vol. ✓

- 4.4 Sketch an accurate, clearly labeled, line on the copy of this graph below to show how the volume of hydrogen produced varies with time when the reaction was repeated under the following condition.

20 cm³ of 0,800 mol.dm⁻³ of ethanoic acid solution was used, with all other conditions the same. The magnesium was still in excess. (3)

$$n = c \times v$$

$$= 0,8 \times 0,02$$

$$= 0,016 \text{ mol} \quad \therefore \text{less limiting reagent}$$

$$\frac{0,016}{0,018} = \frac{8}{9}$$

Volume of
hydrogen



Time

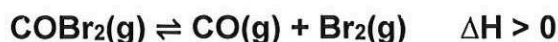
Steeper ✓

endpt $\frac{8}{9}$ ✓
(exact)
endpt lower ✓

[15]

QUESTION 5

Carbonyl bromide, COBr_2 , decomposes into carbon monoxide and bromine according to the following balanced equation



Initially $\text{COBr}_2(\text{g})$ is sealed in a 2 dm^3 container and heated to 73°C . The reaction is allowed to reach equilibrium at this temperature. The equilibrium constant for the reaction at this temperature is 0,19.

At equilibrium it is found that 1,12 g $\text{CO}(\text{g})$ is present in the container.

5.1 Explain what is meant by a *reversible reaction*. (2)

A reversible reaction is one in which products can be converted back into reactants ✓✓

5.2 Calculate the equilibrium concentration of the COBr_2 . Write your answer in scientific notation to 2 decimal places. (7)

$$n(\text{CO at equilibrium}) = \frac{m}{M} = \frac{1,12}{28} = 0,04 \text{ mol} \quad \checkmark$$

$$n(\text{Br}_2) = n(\text{CO}) \text{ at equilibrium} = 0,04 \text{ mol} \quad \checkmark$$

$$[\text{Br}_2] = [\text{CO}] = 0,04/2 = 0,02 \text{ mol} \cdot \text{dm}^{-3} \quad \checkmark$$

$$K_c = \frac{[\text{CO}][\text{Br}_2]}{[\text{COBr}_2]} \quad \checkmark$$

$$0,19 = \frac{0,02 \times 0,02}{[\text{COBr}_2]} \quad \checkmark_{\text{sub}}$$

$$[\text{COBr}_2] = 2,11 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3} \quad \checkmark$$

5.3 Calculate the percentage of $\text{COBr}_2(\text{g})$ that decomposed at 75°C .

(4)

At equilibrium $n(\text{COBr}_2) = c \times v$
 $= 2,11 \times 10^{-3} \times 2 \checkmark$
 $= 4,22 \times 10^{-3} \text{ mol} \checkmark$

Initial moles $\text{COBr}_2 = 4,22 \times 10^{-3} + 0,04$
 $= 0,044 \text{ mol} \checkmark$

% decomposition $= \frac{0,04}{0,044} \times 100 \checkmark$
 $= 90,46\%$

5.4 Which ONE of the following correctly describes the K_c value when equilibrium is reached at a higher temperature? Explain your answer.

(4)

$K_c < 0,19$	$K_c > 0,19$	$K_c = 0,19$
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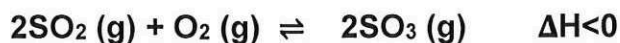
$K_c > 0,19 \checkmark$

Higher temperature favours the endothermic
reaction which is the forward reaction.
more products are made and K_c increases.

[17]

QUESTION 6

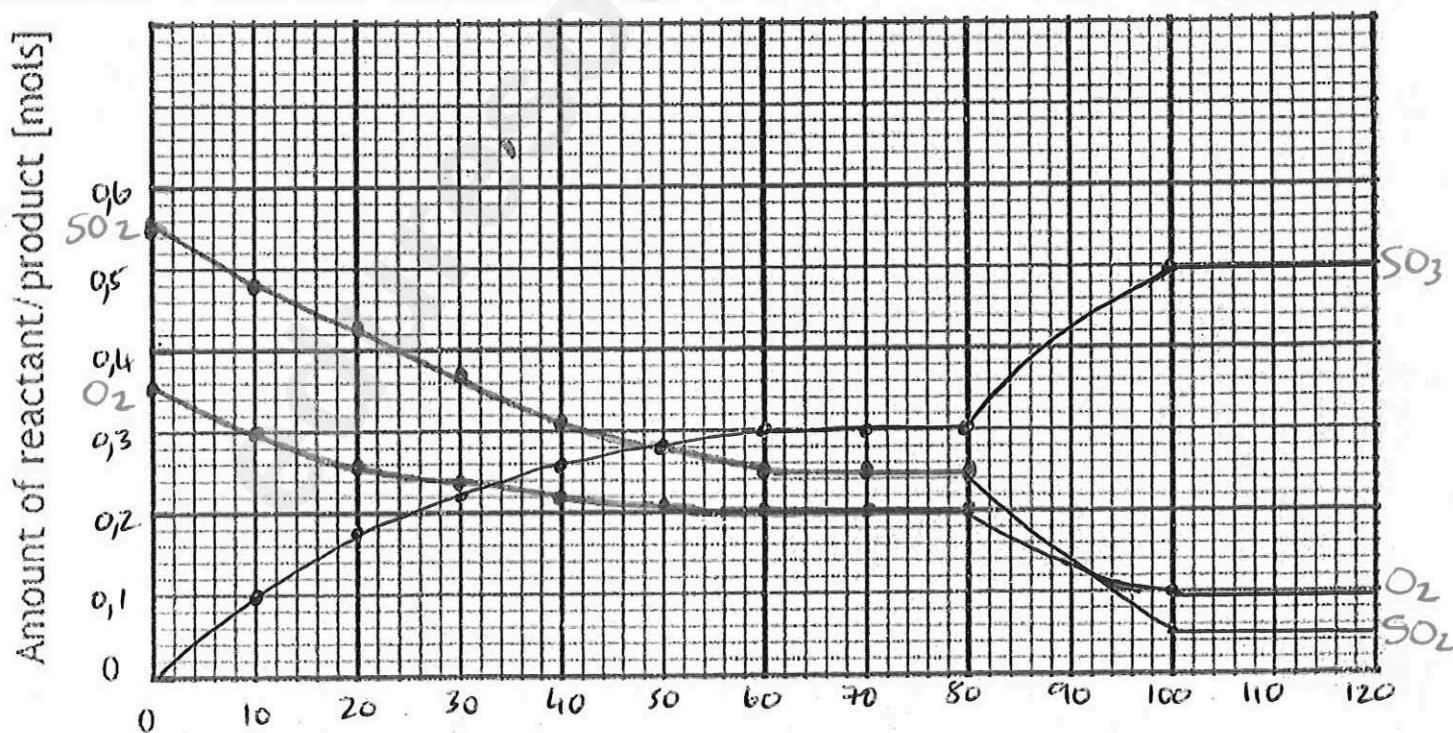
Sulphur dioxide reacts with oxygen to form sulphur trioxide according to the equation



Sensors inside the vessel allowed the recording of the amounts of reactants and products present as the reaction progressed. The table below gives the results that were recorded.

Time (s)	Amount of reactant and product (mol)		
	O ₂	SO ₂	SO ₃
0	0,35	0,55	0,00
10	0,30	0,48	0,10
20	0,26	0,43	0,18
30	0,24	0,37	0,22
40	0,22	0,31	0,26
50	0,21	0,28	0,28
60	0,20	0,25	0,30
70	0,20	0,25	0,30
80	0,20	0,25	0,30

You are provided below with a partially completed graph representing some of the data given in the table.



6.1 scale time axis ✓

6.2 SO₂/O₂ ✓

6.3 plot SO₃ curve ✓✓

Time

6.5

SO₃ up 2 units ✓

SO₂ down 2 units ✓

O₂ down 1 unit ✓

Ratio after 100 s constant ✓

- 6.1 Fill in a suitable scale for the time axis. (1)
- 6.2 Label the lines on the graph as SO_2 and O_2 . (1)
- 6.3 Using the data from the table, plot the amount of product (sulphur trioxide) versus time on the same, above set of axes. Include a line of best fit. (Show all plotted points clearly). (3)
- 6.4 State Le Châtelier's principle. (2)

When an external stress (change in pressure, temp or concentration) is applied to a system in dynamic chemical equilibrium, the equilibrium point will change in such a way as to counteract the stress. ✓✓

When $t = 80$ s, the sealed container is cooled, causing a rapid decrease in temperature. Equilibrium is re-established after an additional 20 s and is maintained for a further 20 s.

- 6.5 Show the effect of a decrease in temperature on the amounts of SO_2 , O_2 and SO_3 for the time 80 s to 120 s by completing the lines on the graph on page 4 for this period. (4)

SO_3 increases 2 units ✓

SO_2 decreases 2 units ✓

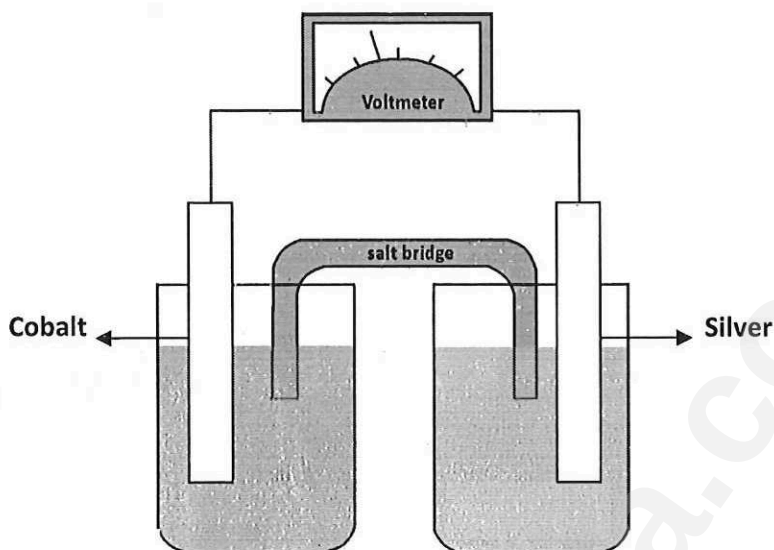
O_2 decreases 1 unit. ✓

Ratio after 100 s important and constant ✓

[11]

QUESTION 7

A galvanic cell is set up under standard conditions between silver (Ag) and cobalt (Co).



7.1 Describe a galvanic cell in terms of the energy transfer that takes place within it. (1)

chemical to electrical ✓

7.2 Define oxidation. (1)

the loss of electrons ✓

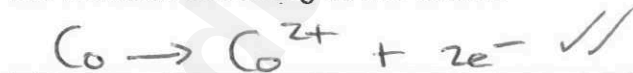
7.3 State the **specific** standard conditions that would be used for this cell between silver and cobalt. (2)

temp 25°C ✓

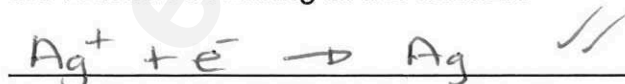
concentration of solutions 1 mol dm⁻³ ✓

7.4 Use your table of standard electrode potentials to give the equation for

7.4.1 the reaction occurring at the anode (2)



7.4.2 the reaction occurring at the cathode (2)



7.4.3 the nett cell reaction (2)



7.5 Give the symbol of the reducing agent in this cell. (1)

Co ✓

7.6 Calculate the emf of this cell under standard conditions.

(3)

$$\begin{aligned} E_{\text{cell}} &= E_{\text{cathode}} - E_{\text{anode}} \\ &= 0,8 - (-0,28) \\ &= 1,08 \text{ V} \end{aligned}$$

7.7 How will the emf of the cell be affected by the addition of extra Co^{2+} ions to the cobalt half-cell? Explain in terms of equilibrium principles.

(3)

stress: increase in $[\text{Co}^{2+}]$

response: reverse reaction is favoured. ✓

reason: the reverse reaction decreases $[\text{Co}^{2+}]$
and thus relieves the stress. ✓

observation: the emf will decrease. ✓

7.8 What will happen to the emf of this cell as the cell reaction approaches equilibrium.

(1)

it will approach zero ✓

7.9 Give two ways to increase the current that this cell can deliver without changing the emf. (2)

use electrodes with a larger surface area. ✓

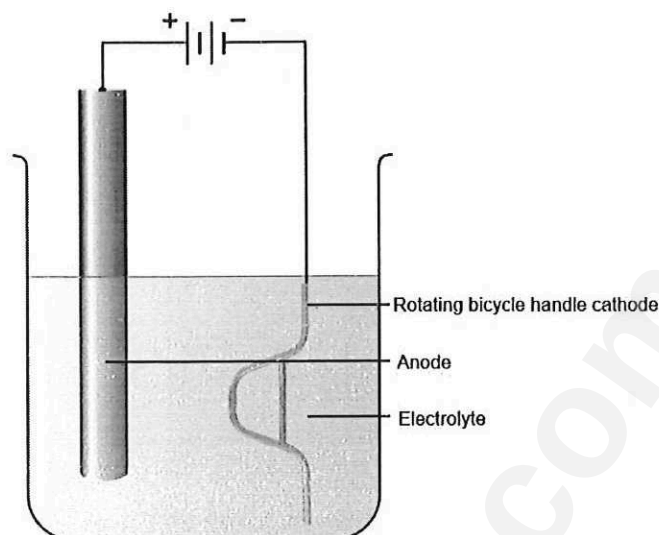
use a shorter/wider salt bridge ✓

or use a more conductive electrolyte in the salt bridge. ✓

[20]

QUESTION 8

Bicycle handlebars made from steel are protected from corrosion by plating them with chromium.



A deposit of 0,01 mol of chromium is needed to protect the handles. A current of 0,80 A is passed through a solution containing chromium ions (Cr^{3+}).

- 8.1 Give the chemical formula of a suitable salt that could be used for the electrolyte. (1)

$\text{Cr}(\text{NO}_3)_3$ ✓ or any other soluble Cr^{3+} salt

- 8.2 What substance should be used to make the anode? (1)

Chromium (Cr) ✓

- 8.3 Use the Table of Standard Electrode Potentials to write down the half reaction that occurs on the handlebars. (2)



- 8.4 How many moles of electrons are needed to deposit 0,01 mol of chromium? (1)

0,03 mol. ✓

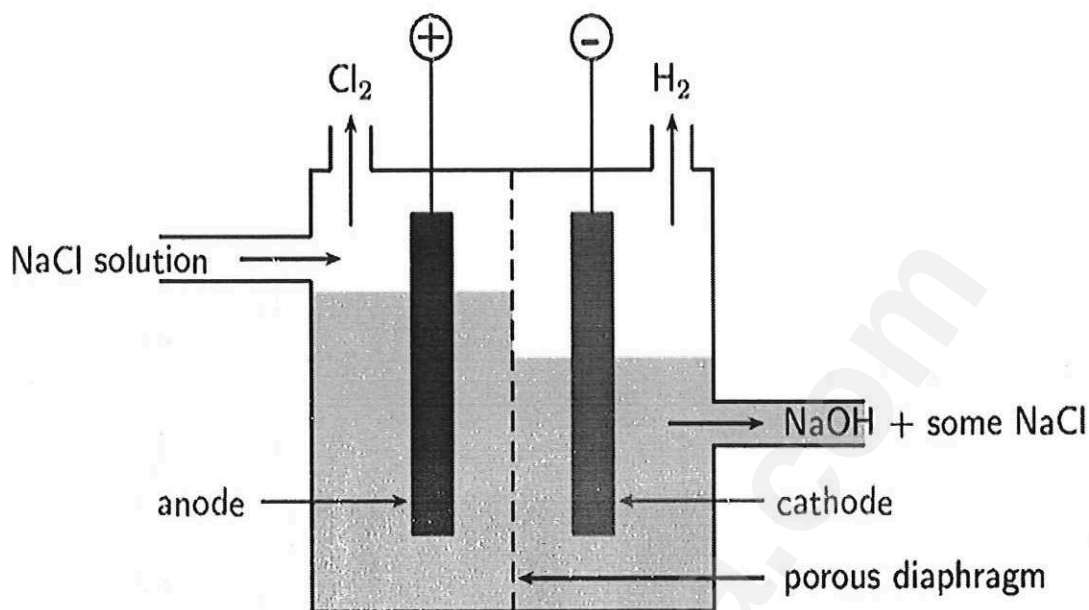
- 8.5 Calculate the time needed to deposit this 0,01 mol layer of chromium. (6)

$$\begin{aligned} q &= nF \quad \checkmark \\ &= 0,03 \times 96500 \quad \checkmark \\ &= 2895 \text{ C} \quad \checkmark \end{aligned}$$

$$t = \frac{q}{I} = \frac{2895}{0,8} = 3618,75 \text{ s.} \quad \checkmark$$

QUESTION 9

The following diagram illustrates the industrial production of chlorine by means of a diaphragm cell.



- 9.1 A DC power source is used. Why can alternating current not be used? (2)

Current must flow in one direction only as the polarity of the anode and cathode must remain constant.

- 9.2 Give the equation for the half-reaction that occurs at the anode. (2)



- 9.3.1 Give a definition for an **oxidizing agent**. (2)

A substance that is reduced and causes another substance to be oxidised.

- 9.3.2 Name the oxidizing agent in this cell. (1)

water

9.4 Explain why sodium ions (Na^+) do not get reduced at the cathode. (1)

Water is a stronger oxidising agent ^{than Na^+} and is reduced instead of Na^+

9.5 Give a difference between the membrane cell and the diaphragm cell. (1)

The diaphragm allows anions and cations to pass through but the membrane only allows cations to pass

9.6 Give a reason as to why the diaphragm cell is being phased out of industry and the membrane cell is now being used. (1)

The diaphragm is made from asbestos which is a health hazard.

[10]

QUESTION 10

Consider the four aqueous solutions in the table below.

A	0,1 mol.dm ⁻³ HNO ₃
B	0,1 mol.dm ⁻³ H ₂ SO ₄
C	0,1 mol.dm ⁻³ H ₃ PO ₄
D	0,1 mol.dm ⁻³ KOH

- 10.1 Describe how you would make 100 cm³ of solution B from a 0,15 mol.dm⁻³ solution of H₂SO₄. (4)

$$C_1 V_1 = C_2 V_2$$

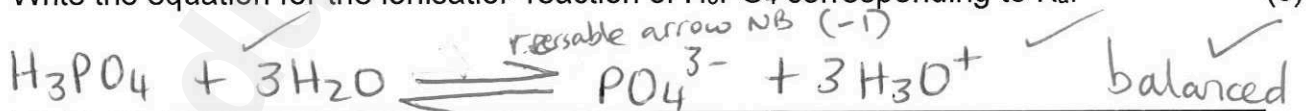
$$0,15 \times V_1 = 0,1 \times 0,1$$

$$V_1 = 0,067 \text{ dm}^3$$

Take 67 cm³ of the 0,15 mol.dm⁻³ solution and dilute it to a total volume of 100 cm³

- 10.2 K_a is known as the acid ionisation constant. For H₃PO₄, K_a = 7,1 x 10⁻³.

Write the equation for the ionisation reaction of H₃PO₄ corresponding to K_a.



- 10.3 Which of solutions A to D would have the highest pH? (1)

D

- 10.4 Place solutions A to C (NOT D) in order of electrical conductivity from lowest electrical conductivity to highest electrical conductivity. (2)

C, A, B

10.5 Explain your answer to Question 10.4.

(4)

H_3PO_4 is a weak acid and so produce very few ions in water. H_2SO_4 & HNO_3 are strong acids and so both ionise completely. BUT H_2SO_4 is diprotic and so produces $2\text{H}_3\text{O}^+$ for every H_2SO_4 molecule compared to HNO_3 which only produces $1\text{H}_3\text{O}^+$ ion for each HNO_3 molecule. H_2SO_4 will therefore have the highest conductivity

10.6.1 Solution D is at 25°C . Calculate the hydronium ion concentration in solution D. Assume that the KOH is fully dissociated.

(2)

$$[\text{OH}^-][\text{H}_3\text{O}^+] = 1 \times 10^{-14}$$

$$[\text{OH}^-] = [\text{KOH}] = 0,1 \text{ mol} \cdot \text{dm}^{-3}$$

$$[\text{H}_3\text{O}^+] = \frac{1 \times 10^{-14}}{0,1} = 1 \times 10^{-13} \text{ mol} \cdot \text{dm}^{-3}$$

10.6.2 Why is it necessary to specify that the temperature is 25°C ?

(1)

K_w is temperature dependent

[17]

QUESTION 11

16,65 g of impure bicarbonate of soda, which contains some NaHCO_3 together with inert impurities, is made up to 250 cm^3 in a volumetric flask.

$20,00 \text{ cm}^3$ of this solution is transferred to a conical flask and a few drops of methyl orange solution is added.

The solution is titrated with a solution of HCl of concentration $0,290 \text{ mol} \cdot \text{dm}^{-3}$ to an end point of $25,16 \text{ cm}^3$.

- 11.1 Name the item of glassware used to titrate the HCl solution into the conical flask. (1)

burette ✓

- 11.2 What is the function of the methyl orange solution? (2)

to indicate the endpoint of the titration by changing colour. ✓

- 11.3 Define the *equivalence point* of a titration. (2)

Equivalence point is the point where an acid and a base have reacted so that neither is in excess. ✓✓

- 11.4 The equation which represents the chemical reaction occurring during the titration is as follows:



- Calculate the percentage NaHCO_3 in the original sample of bicarbonate of soda. (7)

$$n(\text{HCl}) = c \times v = 0,29 \times 0,02516 = 7,29 \times 10^{-3} \text{ mol} \quad \checkmark$$

$$n(\text{NaHCO}_3) = 7,29 \times 10^{-3} \text{ mol}$$

$$c(\text{NaHCO}_3) = n/v = 7,2964 \times 10^{-3} / 0,02 = 0,365 \text{ mol} \cdot \text{dm}^{-3} \quad \checkmark$$

$$m(\text{NaHCO}_3) = c \times v \times M = 0,365 \times 0,25 \times 84 = 7,67 \text{ g} \quad \checkmark$$

$$\% \text{ purity} = 7,67 / 16,65 \times 100 = 46,04\% \quad \checkmark$$

[29]

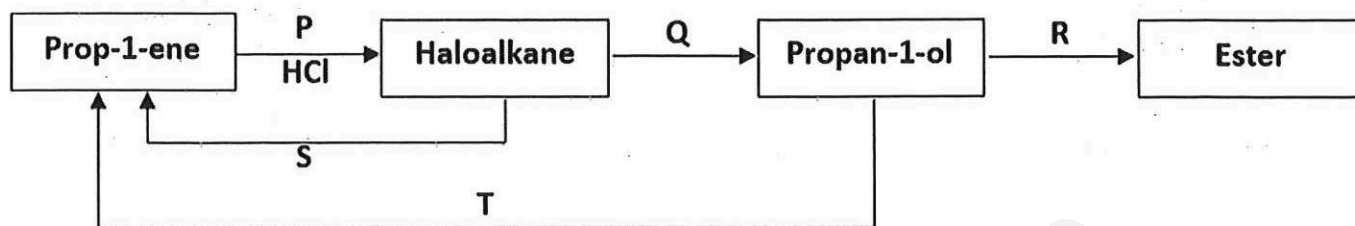
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QUESTION 12

Consider the flow diagram below which shows the preparation of an ester using prop-1-ene as a starting reagent. P, Q, R and S represent different organic reactions.



12.1 Prop-1-ene lends itself to many types of reactions due to its state of saturation.

12.1.1 Define the term **saturated molecule**.

(2)

a molecule that contains only single bonds between carbon atoms.

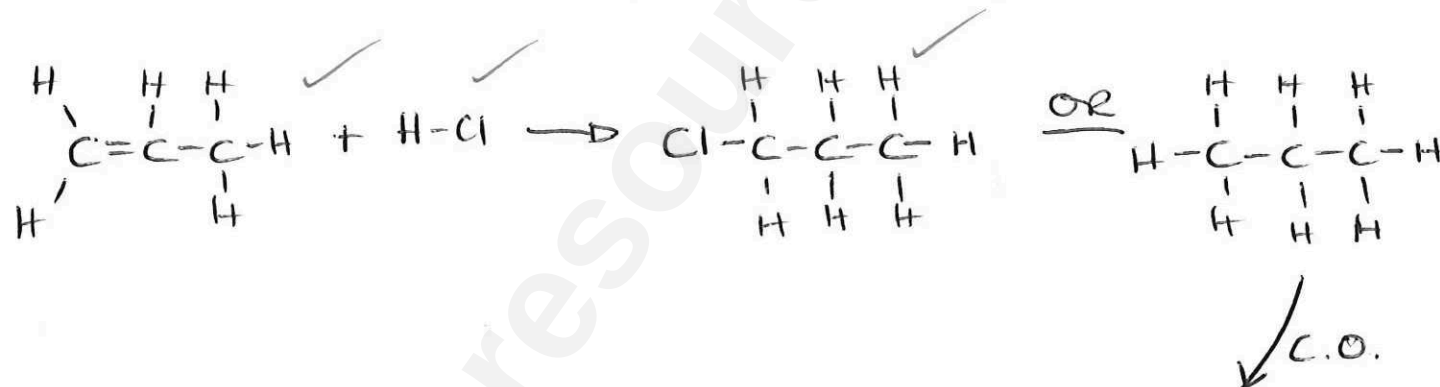
12.1.2 Give the type of addition reaction represented by P.

(1)

hydrohalogenation

12.1.3 Give the balanced equation for reaction P using structural formulae.

(3)



12.1.4 Give the IUPAC name of the haloalkane formed in reaction P.

(2)

1-chloropropane OR 2-chloropropane.

12.2 In both reactions Q and S, a haloalkane is reacted with potassium hydroxide.

12.2.1 In Reaction S, prop-1-ene is formed. Give the general formula for an alkene. (1)

C_nH_{2n}

12.2.2 What type of general reaction is represented by reaction Q?

(1)

Substitution

12.2.3 Give the chemical formulae for the 2 non-organic products in reaction S.

(2)

$\text{KCl} + \text{H}_2\text{O}$

12.3 In reaction T, propan-1-ol undergoes elimination to become prop-1-ene.

12.3.1 To which homologous series does propan-1-ol belong? (1)

alcohol ✓

12.3.2 Give the specific type of elimination reaction represented by T. (1)

dehydration ✓

12.3.3 Concentrated sulphuric acid is used as a catalyst in this reaction. What is its other function in this reaction? (1)

dehydrating agent ✓

12.3.4 Give a balanced chemical equation for this reaction using molecular formulae. (3)



12.4 In reaction R, propan-1-ol reacts with ethanoic acid to produce an ester.

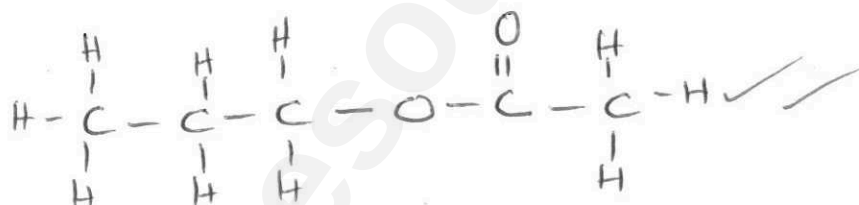
12.4.1 Name the reaction that takes place. (1)

esterification ✓

12.4.2 Give the formula for the catalyst needed. (1)

H_2SO_4 ✓

12.4.3 Draw the structural formula of the ester formed. (2)



12.4.4 Give the IUPAC name of the ester formed. (2)

propyl ethanoate ✓

12.4.5 Give the definition for **isomers**. (2)

Compounds with the same molecular formulae but different structural formulae ✓

12.4.6 Give the name of a functional isomer of the ester formed. (2)

pentanoic acid ✓

[28]

QUESTION 13

Consider the following compounds:

Name	Molar formula	Molar mass (g.mol^{-1})	Boiling point ($^{\circ}\text{C}$)
Pentane	C_5H_{12}	72,15	36
Methylbutane	C_5H_{12}	72,15	28
Dimethylpropane	C_5H_{12}	72,15	10
Pent-1-ene	C_5H_{10}	70,14	30
Hexane	C_6H_{14}	86,18	69
Pentan-1-ol	$\text{C}_5\text{H}_{12}\text{O}$	88,15	138

- 13.1 Pentane and pent-1-ene are both colourless liquids at room temperature. Describe a chemical test one could use to distinguish between the two liquids. (3)

Add bromine solution to each liquid & mix.
The pent-1-ene will rapidly decolourise the brown bromine solution whereas the pentane mixture will remain brown.

- 13.2 Explain the difference in boiling point between hexane and pentan-1-ol, despite them having similar molar masses. (4)

Hexane has London forces between its molecules.
Pentan-1-ol has Hydrogen bonds between its molecules. Hydrogen bonds are stronger and require more energy to overcome and therefore pentan-1-ol has a higher boiling point.

- 13.3 Draw the full structural formula of dimethylpropane. (2)

