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2022 CHEMISTRY PRELIMINARY EXAMINATION

MULTIPLE CHOICE QUESTIONS

MEMO

[20 marks]

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

QUESTION 2.

[13 marks]

- 2.1 Calculate the number of moles of hydrochloric acid initially added to the ammonium oxide in STEP A. (3)

$$n = cV \checkmark (\text{method}) = 2 \times 0,1 = 0,2 \checkmark \text{mol (accuracy; no penalty for no SI unit)}$$

- 2.2 Calculate the number of moles of excess hydrochloric acid neutralised by the NaOH in STEP B. Answer to 3 decimal places. (3)

$$n(\text{NaOH}) = cV = 0,6 \times 0,04 \checkmark (\text{method}) = 0,024 \text{ mol}$$

$$n(\text{NaOH}):n(\text{HCl}) = 1:1 \checkmark (\text{method})$$

$$\text{Therefore, } n(\text{HCl}) = 0,024 \checkmark \text{mol (accuracy; no penalty for no SI unit)}$$

- 2.3 Use your answers to 2.1 and 2.2 to calculate how many moles of HCl reacted with the $(\text{NH}_4)_2\text{O}$ in STEP A. Answer to 3 decimal places. (2)

$$n(\text{HCl}) = 0,2 - 0,024 \checkmark (\text{method}) = 0,176 \checkmark \text{mol}$$

- 2.4 Hence calculate the percentage purity of the original $(\text{NH}_4)_2\text{O}$ sample. Assume that none of the impurities in the $(\text{NH}_4)_2\text{O}$ reacted with the acid. (5)

$$n((\text{NH}_4)_2\text{O}):n(\text{HCl}) = 1:2 \checkmark (\text{method; accuracy})$$

$$\text{Therefore } n((\text{NH}_4)_2\text{O}) \text{ that reacted} = \frac{1}{2} \times 0,176 \checkmark = 0,088 \text{ mol}$$

$$\text{Mass of } (\text{NH}_4)_2\text{O} \text{ in } 5 \text{ g} = nM \checkmark (\text{method}) = 0,088 \times 52 \checkmark = 4,576 \text{ g}$$

$$\% \text{ Purity} = \frac{4,576}{5} \times 100\% = 91,52\% \checkmark (\text{accuracy})$$

$$\text{OR Moles used initially} = \frac{5}{52} = 0,096$$

$$\% \text{ Purity} = \frac{\text{moles used}}{\text{moles initially}} = \frac{0,088}{0,096} \times 100\% = 91,67\% \checkmark \text{ (accuracy)}$$

QUESTION 3.**[27 marks]**

- 3.1 The table below gives information about the boiling points of various substances which contain a halogen atom.

Substance	F ₂	Br ₂	HF	HBr	HCl	CH ₃ F	CH ₃ Br
Boiling point (°C)	-188	59	20	-66	-85	-78	4

- 3.1.1 Explain why fluorine requires more energy to boil than bromine does. (4)

- Both F₂ and Br₂ molecules are non-polar molecules ✓
- with London (dispersion) forces between them. ✓
- Br₂ molecules have many more electrons in them than F₂ molecules, therefore more London forces can form between their molecules (OR there can be a greater imbalance in electron distribution in Br₂ molecules.) ✓
- Therefore the intermolecular forces in bromine are stronger than those in fluorine. More E is required to overcome these forces therefore higher BP ✓

- 3.1.2 Explain why the boiling points of hydrogen bromide (HBr), hydrogen chloride (HCl), and hydrogen fluoride (HF) differ. (5)

- Both HBr and HCl have dipole-dipole van der Waals forces between them. ✓
- HF has hydrogen bonds between its molecules. ✓
- Hydrogen bonds are stronger than dipole-dipole forces. ✓
- HBr has more electrons than HCl in its molecules, so the London dispersion forces between HBr molecules are stronger than those between HCl molecules. ✓
- Therefore HF requires the greatest amount of energy to overcome its intermolecular forces; HBr requires more energy than HCl for its molecules to separate from each other. ✓

- 3.1.3 The boiling points of CH₃F and CH₃Br differ by about 80°C.

Name the type of intermolecular force that is responsible for the substance named in (a) having the higher boiling point.

Dipole-dipole ✓ forces

(2)

- 3.2 The melting point of potassium sulfate (K₂SO₄) is 197°C, and that of calcium sulfate is 1 460°C.

3.2.1 Name the intramolecular force in potassium sulfate. (2)

Ionic bond✓✓

3.2.2 Explain the vast difference in melting points of these two substances. (3)

- Ca^{2+} ions have twice the (electrostatic) attraction (force) on sulfate ions than K^+ ions.✓
- The ionic bonds between cations and anions in the calcium sulfate lattice are twice as strong as each bond between K^+ and SO_4^{2-} ions.✓
- It takes more energy to break these bonds. ✓

3.2.3 Write the balanced equation for potassium sulfate dissolving in water. (2)



(water or H_2O can be written on the arrow)

(arrow in one direction only)

(phase symbols can be left out)

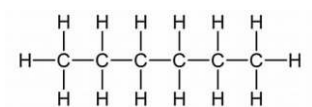
3.2.4 Predict which substance is more soluble in water at room temperature: calcium sulfate or potassium sulfate. (2)

Potassium sulfate (K_2SO_4) ✓✓

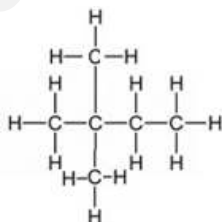
3.3 Hexane and 2,2-dimethylbutane are isomers.

3.3.1 Draw the structural formulae for each of these substances. (3)

Hexane



2,2-dimethylbutane



- Correct number of C-atoms in main chains✓✓
- Both methyl branches on C-2 in -butane✓

3.3.2 Which of hexane and 2,2-dimethylbutane has the stronger intermolecular forces? (1)

hexane

3.3.3 Explain your answer to 3.3.2. (3)

- Hexane has the longer chain therefore greater surface area than its isomer.
- There are more points of contact in the longer chain.✓
- Therefore a greater number of London dispersion forces between molecules of hexane ✓ makes these the stronger IMF.
- 2,2-dimethylbutane is a smaller (more compact) molecule ✓so it has less (weaker) London forces between its molecules.✓

QUESTION 4.

[20 marks]

- 4.1 40 cm of magnesium ribbon is rubbed gently with fine sandpaper until all the black residue is removed from its surface, and the ribbon shines. Four 10 cm lengths of magnesium ribbon are cut.

Magnesium reacts with hydrochloric acid as shown in the following equation:



- 4.1.1 Explain what is meant by *the rate of a reaction*. (2)

The reaction rate is the change in concentration per unit time of either a reactant or product. ✓✓

- 4.1.2 Is this reaction exothermic or is it endothermic? (1)

exothermic ✓

- 4.1.3 Why was it necessary to rub the magnesium ribbon with sandpaper to make it shine? (1)

To expose the same (clean) surface area of ribbon in each experiment ✓ and thus ensure a fair test.

[NB. No marks to clean the metal – unless it is clearly related to the idea of a fair test. Also no marks for just – to make it a fair test – the answer must say how it ensures this.]

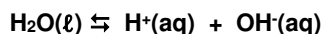
- 4.1.4 With reference to the collision theory of reactions, describe how an increase in temperature increases the rate of this reaction. (4)

- *An increase in temperature increases the average kinetic energy of the particles. ✓*
- *Faster particles collide more frequently ✓*
- *More particles with more kinetic energy therefore more with greater E_a . ✓*
- *This leads to an increase in the frequency of successful collisions ✓ which therefore increases the rate of the reaction.*

- 4.1.5 Suggest **two** other methods, besides increasing the temperature or adding a suitable catalyst, by which the rate of this reaction can be increased. (2)

- 1) *Increase the concentration of the acid. ✓*
- 2) *Increase the surface area of the magnesium ribbon OR use powdered magnesium OR cut the 10 cm strips into the same number of smaller pieces. ✓*

4.2 Water can self-ionise, as shown by the following equation:



Temperature (°C)	pH
0	7,12
10	7,06
20	7,02
25	7,00
30	6,99
40	6,98

The reaction equilibrium and the pH of water are both affected by changes in temperature. The data in the following table show how changing the temperature affects the pH of pure water.

4.2.1 State Le Chatelier's Principle. (2)

When an external stress (change in pressure, temperature, 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. ✓✓

4.2.2 Show how the tabulated data and Le Chatelier's Principle can be used to deduce whether the self-ionisation of water is exothermic or endothermic. Calculations are not required. (4)

- The pH of pure water decreases as temperature increases. ✓
- This tells us that the concentration of H^+ ions increases when temperature increases. ✓
- Therefore, the forward reaction is favoured as temperature increases. ✓
- Applying Le Chatelier's Principle, forward (self-ionisation reaction) reaction is endothermic. ✓

4.2.3 Calculate the concentration of $\text{H}^+(\text{aq})$ ions in pure water at 100°C given that $K_w = 5,25 \times 10^{-15}$ at 100°C . (2)

$$K_w = [\text{H}^+][\text{OH}^-] = 5,25 \times 10^{-15} \checkmark$$

$$\text{But } [\text{H}^+] = [\text{OH}^-]$$

$$\text{Therefore, } [\text{H}^+][\text{H}^+] = 5,25 \times 10^{-15}$$

$$[\text{H}^+] = 7,25 \times 10^{-8} \text{ mol}\cdot\text{dm}^{-3} \checkmark$$

4.2.4 The pH of pure water at 100°C is 6,14. Is pure water acidic at 100°C ? Briefly justify your answer. (2)

No. $[\text{H}^+] = [\text{OH}^-]$ ✓ therefore in pure water all the H^+ ions are neutralised by OH^- ions. ✓

QUESTION 5.

[20 marks]

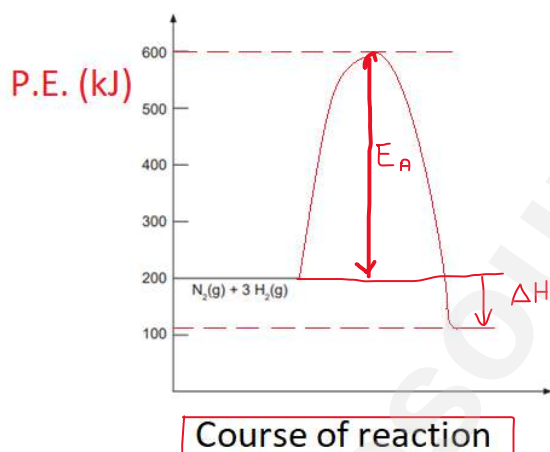
- 5.1 Ammonia is manufactured by the Haber process. The reaction is shown by the equation that follows:

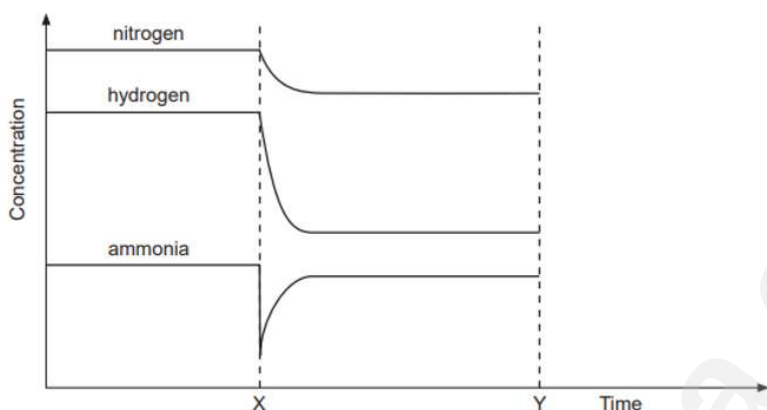


At 400°C, the equilibrium constant of this reaction is equal to $1,60 \times 10^{-2}$.
The activation energy of the forward reaction is $4,00 \times 10^2 \text{ kJ}\cdot\text{mol}^{-1}$.

- 5.1.1 Use the following axes to sketch an energy profile diagram for the forward reaction in the Haber process. Label the:

- axes ✓ (x-axis may have no title- **accept this**)
- products ✓ (below reactants - $\pm 92 \text{ kJ}$ below 300 kJ)
- activation energy ✓ (at 600 kJ and arrow showing 400 kJ)
- heat of the reaction ✓ ($\pm 92 \text{ kJ}$ below 300 kJ) (4)



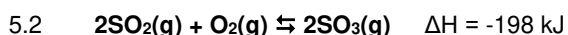


5.1.2 Some hydrogen, nitrogen and ammonia were sealed in a reaction vessel and their concentrations were monitored for a period, as shown in the following graph:

- i) A change was made in the reaction system at time $t = X$. Identify this change and use collision theory to explain the shapes of the curves in the region X – Y. (5)

- Ammonia concentration was decreased (ammonia was dissolved in water – removed from the system) ✓
- There are relatively more molecules of hydrogen and nitrogen in the container, and these have higher concentration than ammonia (3)
- Therefore, more of the successful collisions occur between hydrogen and nitrogen producing ammonia. This causes the concentration of ammonia to rise as shown by the upward curve of the graph immediately after time X. ✓
- This also causes the concentrations of nitrogen and hydrogen to immediately start decreasing. ✓
- Since 3 moles of hydrogen gas combine with one mole of nitrogen, the hydrogen curve drops three times as much as the nitrogen gas. ✓
- As the amount of ammonia increases the rate of its decomposition increases until the rate of the forward reaction is equal to the rate of the reverse reaction again, and all the concentrations remain constant. ✓

- ii) The temperature of the reaction system was increased at time $t = Y$. Show on the graph how this affected the concentrations of hydrogen, nitrogen and ammonia as the system returned to equilibrium. (3)



This process is carried out at a temperature of 450°C and at a pressure of 0f 150 kPa, in the presence of the catalyst, vanadium pentoxide (V_2O_5).

5.2.1 Briefly describe the function(s) of the catalyst, and its effect on the rate of the reactions. (3)

- The catalyst increases the rate of the reactions (equally).✓
- The catalyst provides an alternative pathway for the reactions to take place✓ at lower activation energy.✓

[NB: The catalyst DOES NOT lower the activation energy – the E_A is lowered by the alternative reaction mechanism provided by the surface of the catalyst.] DO NOT accept “the catalyst lowers the activation energy.”

5.2.2 Comment on the choice of the reaction conditions (temperature and pressure), given that the aim is to produce the greatest yield in the shortest time, taking economic constraints into consideration. (5)

Possible answer

- 150 kPa is a low pressure (just 1,5 times atmospheric pressure). Since three moles of reactant molecules produce 2 moles of product molecules, high pressure favours the forward reaction (production of $\text{SO}_3(\text{g})$).✓ Using too high a pressure industrially would be more costly ✓as construction and maintenance of high-pressure vessels is expensive, ✓(or there would be safety concerns in using high pressures) therefore lower pressures are used.
- The forward reaction is exothermic therefore the production of SO_3 is favoured at lower temperatures. ✓ The higher temperature increases the rates of both reactions, and thus shortens the time taken to produce $\text{SO}_3(\text{g})$.✓ This reduces labour costs as more $\text{SO}_3(\text{g})$ is produced per unit time. ✓

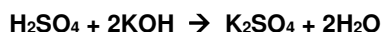
MARK SCHEME:

- ✓ Comment on low pressure – and optimum conditions require higher pressure
- ✓ Sound reason for using lower pressure
- ✓ Comment on high temperature – and optimum conditions require lower temperature
- ✓ Sound reason for using lower temperature
- ✓ Overall economy – lower cost of pressure vessel, greater safety in operating the plant, less time to produce SO_3 therefore lower labour cost.

QUESTION 6.

[34 marks]

- 6.1 In a titration, a 20 cm³ potassium hydroxide solution was neutralized by 15 cm³ of dilute sulfuric acid with a concentration of 0,1 mol·dm⁻³.



- 6.1.1 Which indicator will be most suitable for this titration? (2)

Choose from:

Indicator	PH range
phenolphthalein	8.2 - 10
methyl orange	3.1 - 4.4
bromothymol blue ✓✓	6 - 7.6

- 6.1.2 Explain your choice of indicator in 6.1.1. (2)

Strong base reacting with strong acid ✓
pH at equivalence point = 7 ✓

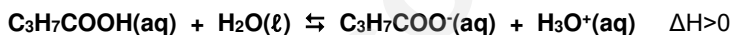
- 6.1.3 Calculate the concentration of the potassium hydroxide solution. (5)

$$\frac{n_{\text{acid}}}{n_{\text{base}}} = \frac{1}{2} \quad \text{OR} \quad n_{\text{acid}} = \frac{1}{2} n_{\text{base}} \quad \text{OR} \quad n_{\text{base}} = 2 \times n_{\text{acid}}$$

$$C_{\text{base}} V_{\text{base}} = 2 \times C_{\text{acid}} V_{\text{acid}} \quad \text{OR equivalent statement}$$

$$C_{\text{base}} = \frac{2 \times (0,1)(0,015)}{0,020} = 0,15 \text{ mol·dm}^{-3} \quad \checkmark$$

- 6.2 Butanoic acid undergoes the following hydrolysis reaction:



- 6.2.1 Define hydrolysis. (2)

A reaction of an ion (from a salt) with water ✓✓

- 6.2.2 Name the H₃O⁺ ion. (2)

Hydronium OR oxonium OR hydroxonium ✓✓

- 6.2.3 The butanoic acid concentration at 25°C was determined as 0,26 mol·dm⁻³. The value of K_a at 25°C is 1,5 × 10⁻⁵. Calculate the concentration of H₃O⁺ ions. (4)

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{C}_4\text{H}_9\text{COO}^-]}{[\text{C}_4\text{H}_9\text{COOH}]} = 1,5 \times 10^{-5} \quad \checkmark$$

$$\frac{[\text{H}_3\text{O}^+][\text{C}_4\text{H}_9\text{COO}^-]}{(0,26)^2} = 1,5 \times 10^{-5} \quad \text{but } [\text{H}_3\text{O}^+] = [\text{C}_4\text{H}_9\text{COO}^-] \quad \checkmark$$

$$[\text{H}_3\text{O}^+]^2 = (1,5 \times 10^{-5})(0,26) \quad \checkmark$$

$$[\text{H}_3\text{O}^+] = 1,97 \times 10^{-3} \text{ mol·dm}^{-3} \quad \checkmark$$

- 6.2.4 What is the effect on the value of K_a for this acid, if its temperature is raised to 60°C ? Explain your answer. (4)

Since the forward reaction is endothermic, ✓ an increase in temperature favours the ionisation of the acid. ✓

With an increase in the concentration of H_3O^+ and $\text{C}_4\text{H}_9\text{COO}^-$ ions ✓ the value of K_a increases. ✓

- 6.3 1,23 g of powdered sodium carbonate are reacted with 25 cm^3 nitric acid with a concentration of $0,58\text{ mol}\cdot\text{dm}^{-3}$. The balanced reaction equation is shown below:



- 6.3.1 Determine, by calculation, which reactant is the limiting reagent in this reaction. (5)

$$\text{Na}_2\text{CO}_3: n = \frac{m}{M} = \frac{1,23}{106} \checkmark = 0,0116\text{ mol}$$

$$\text{HNO}_3: n = cV = (0,58)(0,025) \checkmark = 0,0145\text{ mol}$$

$$\text{Na}_2\text{CO}_3: \text{HNO}_3 = 1:2 \checkmark$$

Number of mol HNO_3 required to react with 1,23 g Na_2CO_3 is 0,0232 mol. ✓

OR equivalent calculation.

Nitric acid (HNO_3) is the limiting reagent. ✓

- 6.3.2 Determine the maximum volume of carbon dioxide which can be released at S.T.P. during this reaction. (4)

2 mol HNO_3 releases 1 mol of CO_2 ✓ [c.o.e. using the limiting reagent]

$$0,0145\text{ mol HNO}_3 \text{ releases } \frac{1}{2} \times 0,0145\text{ mol CO}_2 = 7,25 \times 10^{-3}\text{ mol} \checkmark$$

$$V \text{ at STP} = n \times 22,4 \checkmark = 7,25 \times 10^{-3} \times 22,4 = 0,16\text{ dm}^3 \checkmark$$

- 6.3.3 The % yield of this reaction is 76%.

- a) Calculate the volume of carbon dioxide released during this reaction. (2)

$$V = 0,76 \times 0,16 \checkmark = 0,12\text{ dm}^3 \checkmark$$

- b) Give **two** reasons which could account for the less than 100% yield of carbon dioxide. (2)

- Some CO_2 leaked out of (escaped from) the apparatus ✓
- Some CO_2 gas dissolved in the water. ✓
- Not measuring at standard temperatures. ✓
- Conc of nitric acid was not calculated correctly ✓

NB: The purity of the sodium carbonate will NOT affect the yield since it was in excess. NO MARK for this as a reason.

QUESTION 7.

[35 marks]

- 7.1 The cell notation of a standard galvanic (voltaic) cell containing an unknown metal electrode is shown below:



- 7.1.1 Give the energy conversion taking place in this galvanic cell. (2)

Chemical $\rightarrow$ electrical ✓✓

- 7.1.2 State **two** standard conditions that are applicable to the $\text{Pb}^{2+}(\text{aq}) \mid \text{Pb(s)}$ half cell. (2)

- Temperature = 25°C ✓
- Concentration of Pb^{2+} ions is 1 mol·dm⁻³ ✓ (initially)

- 7.1.3 Name the component of the cell which is represented by ||. (2)

Salt bridge ✓✓

- 7.1.4 The initial reading on a voltmeter connected across the electrodes of this standard galvanic cell is 1,53 V. Determine the identity of the unknown metal. (3)

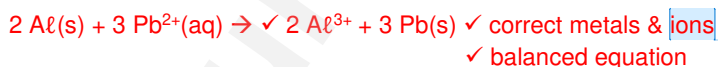
$$E^0_{\text{cell}} = E^0_{\text{cathode}} - E^0_{\text{anode}} \quad \text{OR equivalent} \checkmark$$

$$1,53 = -0,13 - E^0_{\text{anode}}$$

$$E^0_{\text{anode}} = -1,66 \text{ V} \checkmark$$

$$\text{X} = \text{Al (aluminium)} \checkmark$$

- 7.1.5 Write down the balanced ionic equation representing the chemical reaction occurring in the galvanic cell. Use the symbol of the unknown metal in the equation, in place of X. (3)



Commented [KT1]: Would you get COE here?

- 7.1.6 How will the initial voltmeter reading be affected if the concentration of the electrolyte in the $\text{X(s)} \mid \text{X}^{3+}(\text{aq})$ half-cell is increased?

- a) Write down INCREASES, DECREASES or REMAINS THE SAME. (1)

Decreases ✓

- b) Briefly explain your choice of answer to part (a). (2)

Increasing the concentration of Al^{3+} ions favours the reverse reaction.✓ (favouring reduction in the anode which is not possible).

This increases the cell potential of the Al/Al^{3+} half-cell OR as predicted by Le Chatelier's Principle.✓

7.1.7 The surface area of both electrodes is increased, while each of them continues to have the same surface area.

a) How does this affect the initial reading on the voltmeter? (1)

No change (It does not affect the reading; reading remains the same)✓

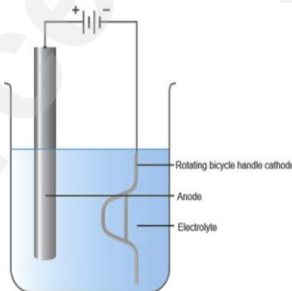
b) Briefly explain how increasing the surface area of the electrodes affects the operation of this cell. (2)

Greater surface area of the electrodes lowers the (internal) resistance of the cell.✓

The cell can supply a greater current.✓

7.2 Chromium plating is used to protect steel from corrosion and to improve the appearance of items, such as bath taps and bicycle handlebars. The diagram below shows a bicycle handlebar being plated with chromium.

0,02 mol of chromium are required to plate the bicycle handle. A current of 0,75 A is maintained during the process.



7.2.1 Why must the bicycle handle rotate during this process? (2)

To allow the handlebars to be evenly coated OR equivalent answer.✓✓

7.2.2 **Name** a substance which can be used as the electrolyte in this process. (1)

chromium nitrate (sulfate, chloride) ✓

7.2.3 a) Define the anode of this cell. (2)

The electrode at which oxidation takes place.✓✓

b) Name the material used for the anode of this cell. (2)

chromium ✓✓

7.2.4 Write down the half reaction that occurs at the bicycle handle. (2)



7.2.5 How many mol of electrons are required deposit 0,02 mol of chromium? (2)

$$n = 3 \times 0,02 \checkmark \text{ (method)} = 0,06 \checkmark \text{ mol (accuracy; ignore SI unit)}$$

7.2.6 Calculate the time needed to deposit this amount of charge. (4)

$$q = It \checkmark \text{ (method)} \quad q = 0,06 \times 6,02 \times 10^{23} \times 1,6 \times 10^{-19} \checkmark$$

$$= 5779,2 \text{ C}$$

$$5779,2 = 0,75 \times t \checkmark$$

$$t = 7705,6 \text{ s} \checkmark$$

OR

$$q = nF = 0,06 \times 96500 = 5790 \text{ C} \checkmark \checkmark$$

$$t = Q/t = 5790 / 0,75 = 7720 \text{ s} \checkmark \checkmark$$

7.2.7 This process uses a large amount of electricity. With reference to the charges on the ions, explain this statement. (2)

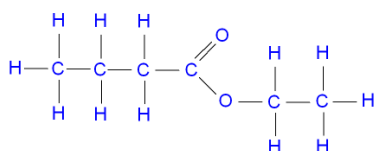
Each chromium ion requires 3 electrons to plate onto the steel. $\checkmark$

Either **a large current must be used**, OR the **current must run for a long time**, to provide the required amount of charge. $\checkmark$

QUESTION 8.

[14 marks]

The structure below shows an organic compound that is used to give a pineapple flavour in sweets.



- 8.1 Write down the IUPAC name for the organic compound above. (2)

ethyl butanoate ✓ (Two words else -1)

- 8.2 Define the term: *homologous series*. (2)

A series of similar compounds which have the same functional group and have the same general formula, ✓ in which each member differs from the previous one by a single CH_2 unit. ✓

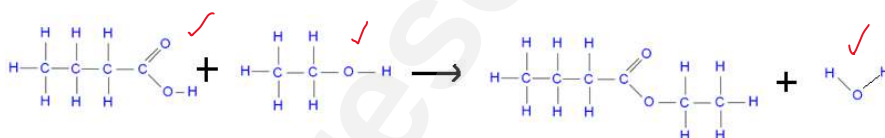
- 8.3 Name the homologous series to which this compound belongs. (2)

ester(s) ✓✓

- 8.4 Name the carboxylic acid used to make this compound. (1)

butanoic acid ✓

- 8.5 Write a balanced equation showing the preparation of this compound. Use STRUCTURAL FORMULAE in the equation. (3)



- 8.6 Write down the CONDENSED STRUCTURAL FORMULA of the functional isomer of this compound. (2)

$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$ OR $\text{CH}_3(\text{CH}_2)_4\text{COOH}$

✓ Total of 6 carbon atoms in main chain ✓ COOH functional group

- 8.7 Write down the name of one positional isomer of this compound. (2)

Any one of the following:

methyl pentanoate

propyl propanoate

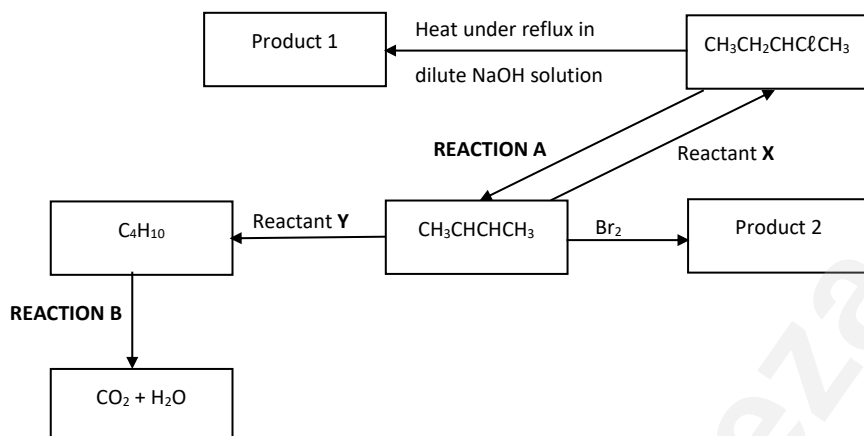
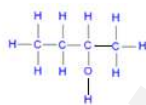
butyl ethanoate

pentyl methanoate

QUESTION 9.

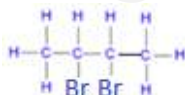
[19 marks]

A flow diagram of compounds and their reactions is shown below.

9.1 Give the specific names of reactions **A** and **B**:9.1.1 Reaction **A**: **dehydrohalogenation** ✓✓ (2)9.1.2 Reaction **B**: **(complete) combustion** ✓✓ (2)9.2 Give the chemical formulae of reactants **X** and **Y**.9.2.1. Reactant **X**: **HCl** ✓ (1)9.2.2. Reactant **Y**: **H2** ✓ (1)9.3 Give the IUPAC names and STRUCTURAL FORMULAE for products **1** and **2**.a) Product **1**:IUPAC name: **butan-2-ol** ✓ (1)Structural formula: (2)

✓ four carbon atoms in chain

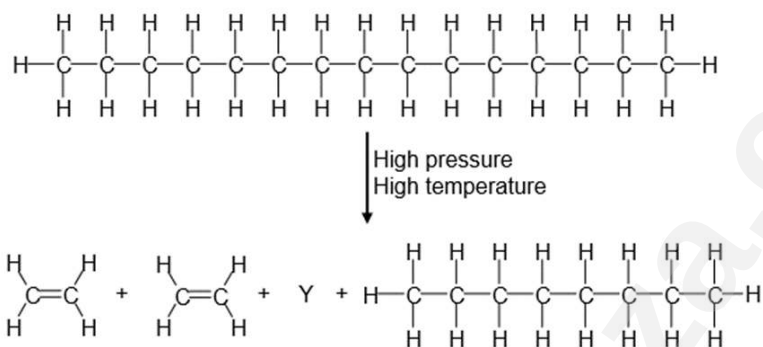
✓ -OH (hydroxyl) on carbon 2

b) Product **2**:IUPAC name: **2,3-dibromobutane** ✓ (1)Structural formula: (2)

✓ 4 carbon atoms in chain

✓ Bromine atoms on atoms 2 and 3

- 9.4 Cracking is the process of converting longer chain alkanes into smaller chains. The diagram below shows a possible outcome of cracking $C_{15}H_{32}$.



- 9.4.1 Name the type of cracking that is shown by the diagram above. (2)

Thermal ✓✓ (cracking)

- 9.4.2 Give the IUPAC name and STRUCTURAL FORMULA of product Y, shown in the diagram above.

IUPAC name: propene OR prop-1-ene OR 1-propene ✓ (1)

Structural formula: (2)

