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SAHETI SCHOOL

CHEMISTRY PRELIM 2022

PHYSICAL SCIENCE

GRADE 12

PAPER 2 : CHEMISTRY

EXAMINER : C ORCHISON

DATE : 21 JULY 2022

MODERATORS : J NAIDU

HOURS : 3 HOURS

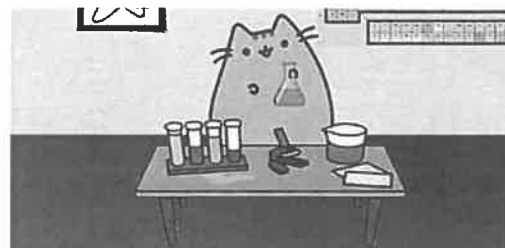
M. RAMUTHAGA-MUSAMPA

MARKS : 200

NAME : Orch memo

INSTRUCTIONS AND INFORMATION

1. This question paper consists of 28 pages with 8 questions.
2. A data sheet is provided.
3. Answer all questions on this paper and show all working out.
4. Extra space is provided at the end of the paper should you require it.
5. Use the mark allocation as guide to the maximum time you should spend on a question.
6. Use bullet points for all explanations.
7. Round all answers to 2 decimal places and include the correct SI unit.
8. Answers should be expressed in decimal format and not left as fractions.
9. Don't be diene during this paper.. that's asking for alkynes of trouble.



Pusheen the cat making some chemistry.

That cat is not wearing safety goggles, he hasn't even bothered to clean up that spilled solvent, and he is holding that Erlenmeyer flask way too close to his face.

Pusheen the Cat, more like Pusheen the limits of lab safety

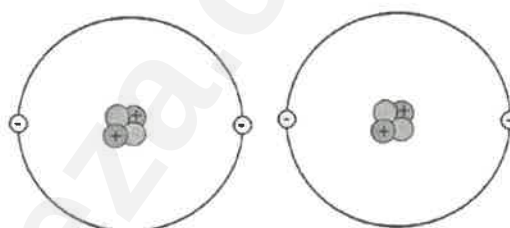
QUESTION 1

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.

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

No one:

Michael Jackson:



1.1 Which of the following does not have London forces as the dominant intermolecular force?

A CH₄

B Br₂

C CO₂

☒ D PH₃

1.2 Which of the following correctly describes the changes in concentrations of the ions present in solution after 100 cm³ of a 1 mol.dm⁻³ BaI₂ solution is mixed with 100 cm³ of a 2 mol.dm⁻³ KI solution?

	[K ⁺]	[Ba ²⁺]	[I ⁻]
A	Stays the same	Stays the same	Decreases
☒ B	Decreases	Decreases	Stays the same
D	Decreases	Increases	Decreases
C	Increases	Stays the same	Increases

before:
 $KI : n = CV$
 $= (2)(0.1)$
 $= 0.2$
 $BaI_2 : n = (1)(0.1)$
 $= 0.1$
 $\therefore [I^-] = 0.2$

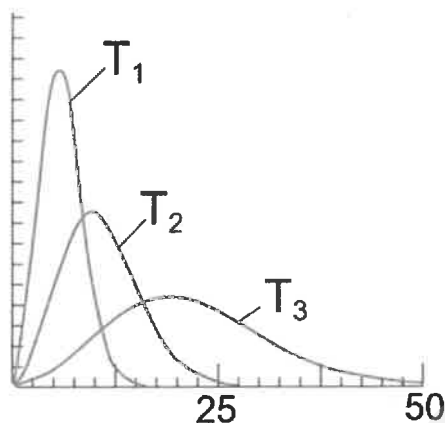
after: $c = n/v$

$$[Ba^{2+}] = 0.1/0.2 = 0.5 \therefore \downarrow$$

$$[K^+] = 0.2/0.2 = 0.1 \therefore \downarrow$$

$$[I^-] = (0.2 + 0.2)/0.2 = 0.2 \therefore \text{same}$$

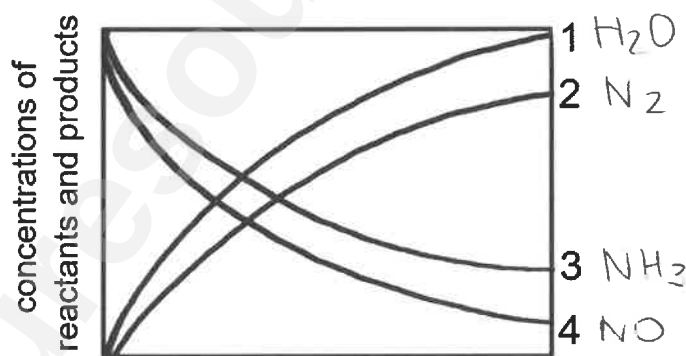
- 1.3 Consider the following Maxwell-Boltzmann distribution curve and the statements which follow:



- I – T_3 corresponds to the reaction taking place at the highest temperature ✓
 II – if the activation energy for the reaction is 25 J, only the reaction taking place at T_3 will take place ✗
 III – the reaction at temperature T_1 contains the greatest number of molecules ✓

Which of the statements are **incorrect**?

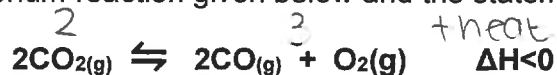
- A I and II (B) II and III C I only D III only
- 1.4 The graph below depicts the change in concentrations of four substances as a reaction proceeds. At the start, an equal number of moles of the reactants, NH_3 and NO , were mixed together.



Choose the option which correctly identifies the substances based on the relative ratios shown in the graph :

	1	2	3	4
A	NH_3	NO	N_2	H_2O
B	H_2O	NO	N_2	NH_3
C	NH_3	N_2	NO	H_2O
(D)	H_2O	N_2	NH_3	NO

- 1.5 Consider the equilibrium reaction given below and the statements that follow:



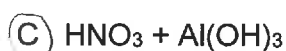
I – a decrease in pressure results in a decrease in the concentration of CO_2 ✓

II – an increase in temperature results in a decrease in the concentration of O_2 ✓

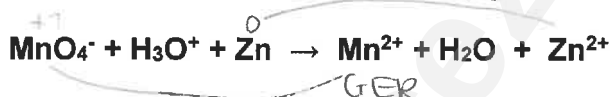
III – an increase in the concentration of carbon dioxide results in an increase K_c ✗

Which of the statements are correct?

- (A) I and II B I and III C II and III D I, II and III
- 1.6 Which of the following acid reactions will not produce a gas as one of the products?



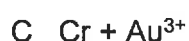
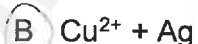
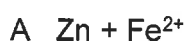
- 1.7 Consider the following redox reaction:



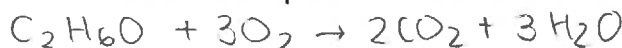
In which of the following are the oxidizing and reducing agents correctly identified?

	Oxidizing agent	Reducing agent
A	Zn	MnO_4^-
B	H_3O^+	Zn
(C)	MnO_4^-	Zn
D	H_3O^+	MnO_4^-

- 1.8 Which of the following reactions could occur in an electrolytic cell? non-spontaneous



- 1.9 What is the sum of the coefficients for the balanced equation for the reaction of ethanol in excess oxygen?



(A) 9

B 6

C 5

D 8

- 1.10 A compound has the formula $\text{C}_6\text{H}_{12}\text{O}_2$. Which of the following could **not** be the IUPAC name of the compound?

A butyl ethanoate

C hexanoic acid

B hexane-2,4-diol

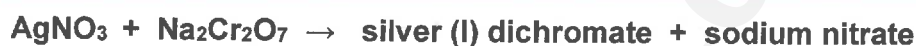
(D) methyl hexanoate

QUESTION 2



Inspired by the Zondo commission's quest to bring corruption and fraud to light, the creators of Among Us devise a new task which involves rooting out 'sussy' imposters aboard the ship using stoichiometry.

300 g of a ruby red powder are found on the floor near a vent. Tests confirm that it is silver (I) dichromate. Each of the crewmates (and the sneaky imposter) are required to carry a vial containing 200 g of sodium dichromate as it is a useful corrosion inhibitor. In order to confirm who was at the vent, each sample of sodium dichromate is reacted with a solution of silver (I) nitrate as shown below:



- 2.1 Rewrite the reaction as a balanced chemical equation. (3)



- 2.2 Calculate the number of moles of silver (I) dichromate found at the scene. (3)

$$\begin{aligned} n &= m/M_r \\ &= 300/432 \\ &= 0,69 \text{ mol} \end{aligned}$$

- 2.3 60 g of dichromate found in the vial belonging to the red suspect. Based on the amount of sodium dichromate that has been used from her vial, and the fact that the reaction is only able to achieve an 80% yield, prove by calculation that the red suspect could not have been at the vent. (5)

ratio 1:1

$$0,69 \text{ mol} \dots \text{but } 80\% = 0,55 \text{ mol}$$

$$m = n \times M_r$$

$$= (0,55)(262)$$

$$= 144,10 \text{ g needed}$$

$$\text{But } 200 - 60 = 140 \text{ g}$$

$\therefore$ not enough

2.4 Define molar volume of a gas.

(1)

volume of gas that one mol of gas
occupies at STP ✓

2.5 While in the vent, the imposter mixed 200 cm³ of a 2 mol.dm⁻³ hydrochloric acid solution with 110 g of sodium sulphite, because they knew that this reaction produces poisonous sulphur dioxide gas according to the equation given below:



Calculate the volume of gas that this reaction produces at STP.

(6)

	HCl:		Na ₂ SO ₃ :
	$n = CV$		$n = m/M_r$
	$= (2)(0,2)$		$= 110/126$
	$= 0,4 \text{ mol (a)}$ ✓		$= 0,87 \text{ mol (b)}$ ✓
	1 :	2 :	1 : 2 :
✓ a)	0,2 :	0,4 :	0,2 : 0,4 :
b)	0,87 :	1,74 :	0,87 : 1,74 :
	∴ $V = n \times V_m$		
	$= (0,2)(22,4)$		
	$= 4,48 \text{ dm}^3$ ✓		

Types of Headaches

Migraine



Hypertension



Stress

when red is
not the imposter

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QUESTION 3

The day of the final call-backs is here and Gabriella and Taylor are trying to come up with the perfect chemical reaction to carry out during their academic decathlon. They need to cause an evacuation of the school in order to foil Sharpay's plan and let Troy audition!



They start by investigating the reaction between barium hydroxide and ammonium thiocyanate because they know that one of the products formed is ammonia gas. They think that if they seal the reaction container, the pressure of the gas will build-up and cause an explosion releasing the toxic gas.

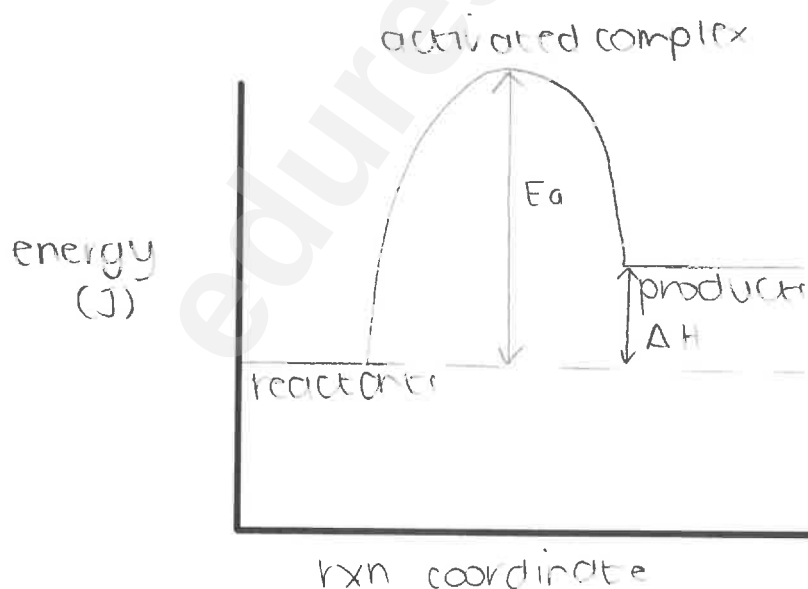
- 3.1 Rewrite and balance the equation below: (extra lines in case you need them) (3)

Barium hydroxide + $\text{NH}_4\text{SCN}_{(s)} \rightarrow$ barium thiocyanate + ammonia + water



-1 per mistake

- 3.2 The reaction vessel they are using becomes noticeably cooler as the reaction proceeds. Sketch and fully label the energy profile graph that corresponds to this reaction. (4)



-1 per mistake



They measure the change in the concentration of the barium hydroxide solution as the reaction proceeds and tabulate their results as shown :

when the whole class fails a test

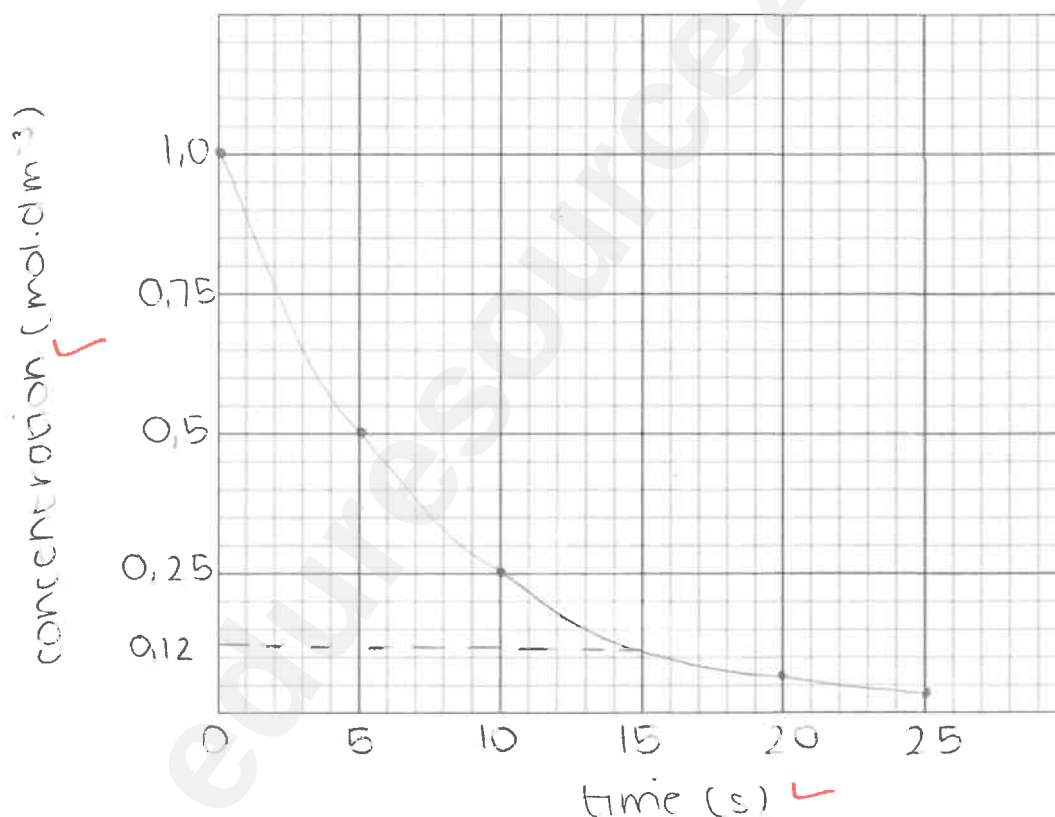
Concentration ($\text{mol}\cdot\text{dm}^{-3}$)	Time (s)
1	0
0,5	5
0,25	10
0,06	20
0,03	25



3.3 Plot their results on the graph paper provided below

(6)

Change in concentration of
 $\text{Ba}(\text{OH})_2$ vs time ✓



LOBF ✓
plotting ✓
scale ✓

3.4 Use your graph to determine the concentration of the barium hydroxide at 20 seconds. (1)

$\pm 0,12 \text{ mol}\cdot\text{dm}^{-3} = 15 \text{ s}$ ✓

Gabriella says that the rate of the reaction is decreasing as the reaction proceeds because reactant particles are being used up. Taylor thinks the reason the reaction is slowing down is because of the fact that the reaction is cooling itself as it goes to completion.

- 3.5 Explain whether Gabriella is correct or not by making reference to and stating what is meant by collision theory. (4)

- collision theory: molecules need correct orientation and sufficient energy in order for successful collisions to occur ✓
- fewer particles available for collision means less fruitful collisions per unit time ✓
- ∴ she is correct ✓

- 3.6 Is there any merit to what Taylor is saying? Explain your answer. (2)

- yes ✓
- as temp decreases, particles have less E_k ∴ less fruitful collisions as they are moving slower ✓

- 3.7 Define *rate of reaction*. (1)

the change in concentration per unit time of either a reactant or a product ✓

- 3.8 In order to increase the initial rate of the reaction and head towards their glorious explosion quicker, they could repeat the experiment but make two changes to their original conditions. State ONE of these two changes. (1)

- increase $[Ba(OH)_2]$ ✓
- increase surface area of NH_4SCN ✓

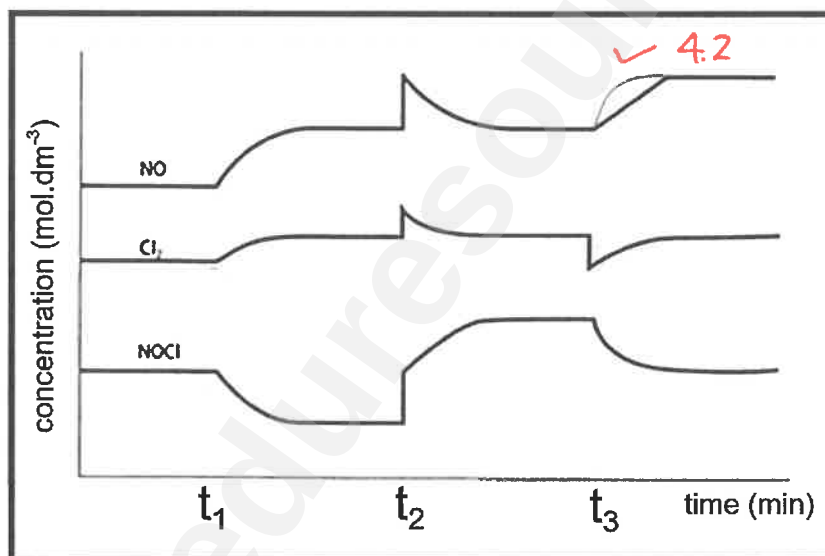
- 3.9 As the reaction proceeds, they notice that there is no pressure being built up. By identifying and making reference to the intermolecular forces between water and ammonia respectively, explain fully why this is the case. (4)

- water has hydrogen bonding IMF ✓
 - ammonia has hydrogen bonding IMF ✓
 - ∴ ammonia dissolves in water ✓
 due to same strength of IMF ✓

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QUESTION 4

The scheming Jafar is frustrated at not being able to get his hands on the magic lamp and so he decides to pollute the city's air in retaliation. He initially adds NOCl(g) to a sealed container and allows the reaction to reach equilibrium. He then responsibly graphs his findings, as nefarious villains are known to do.

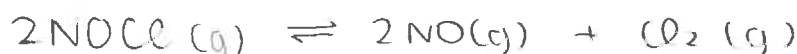


Jafar



Jaclose

- 4.1 Write a balanced chemical equation for the homogenous equilibrium if the forward reaction produces chlorine gas. (2)



eq ✓
bal ✓

- 4.2 On the graph, correct the mistake Jafar has made between time t_3 and when equilibrium is re-established. (1)

4.3 State Le Chatelier's Principle.

(1)

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 ✓

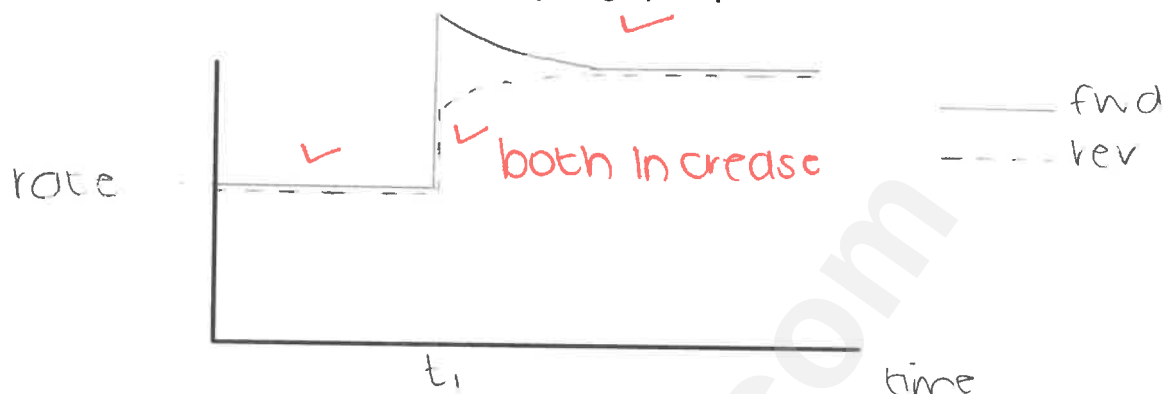
4.4 Jafar knows that the enthalpy for this reaction is $+77,16 \text{ kJ mol}^{-1}$. At time t_1 he changes the **temperature** of the reaction vessel. Explain fully whether he increased or decreased the temperature. (3)

- graph shows forward reaction favoured ✓
- temp increase favours the endothermic reaction ✓
- $\therefore$ he increased the temperature ✓

4.5 Jafar then decreases the **volume** of the reaction vessel in order to change the concentration of NO(g) in the vessel, and says this corresponds to time t_2 . Explain fully by referring to the graph and Le Chatelier's principle whether the **decrease of volume** does in fact correspond to time t_2 . (5)

- a decrease in volume = increase in pressure ✓
- that would favour the reverse reaction ✓
- graph is showing the reverse reaction is being favoured ✓
- all concs of gases increased at t_2 ✓
 $\therefore$ it does correspond ✓

(3)



$$\text{Cu}^{2+}_{(\text{aq})} + 4\text{NH}_3_{(\text{aq})} \rightleftharpoons [\text{Cu}(\text{NH}_3)_4]^{2+}_{(\text{aq})}$$

light blue dark blue

(3)

$$\therefore [\text{NH}_3] \downarrow$$

- water decreases the concentration of all ions ✓

∴ reverse rxn favoured to increase concs

dark blue ✓

4.9 What is the name given to the phenomenon which causes this shift? (1)

common-ion effect ✓

4.10 Explain how the solid copper(II)sulphate crystals are able to dissolve in water. (3)

- CuSO_4 is ionic and water is polar ✓
- δ^+ hydrogens of water surround SO_4^{2-} ions ✓
- and δ^- oxygens of water molecule surround Cu^{2+}
- cumulative pull separates the ions ✓

4.11 Write the expression for the equilibrium constant for the original equilibrium reaction. (2)

$$K_c = \frac{[\text{Cu}(\text{NH}_3)_4^{2+}]}{[\text{Cu}^{2+}][\text{NH}_3]^4} \quad \checkmark$$

4.12 Genie adds 500 cm^3 solution containing 0,01 mol of Cu^{2+} ions to 500 cm^3 of a 2 mol. dm^3 solution of ammonia. If the equilibrium constant for this reaction at 25°C is 5×10^{13} , write the expression to show how you would calculate the concentration of the $[\text{Cu}(\text{NH}_3)_4]^{2+}$ ions at equilibrium. Do not solve the equation. (5)



start	0,01	1	0 ✓
rxn	x	$4x$	x ✓
end	$0,01 - x$	$1 - 4x$	x ✓
conc	$(v=1)$		

$$\text{NH}_3: n = cv$$

$$\therefore 5 \times 10^{13} = \frac{x}{(0,01 - x)(1 - 4x)^4} \quad \checkmark \quad = (2 \times 0,5) \quad \checkmark$$

$$= 1 \text{ mol} \quad \checkmark$$

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QUESTION 5

In one of the episodes of "We bare bears", Chloe is required to redo a chemistry test that involves acids and bases under the watchful eye of her professor and supported, of course, by Grizzly, Panda, and Ice Bear.

She is given the following two equations, and her professor says that both of these equations represent the ionization of acids



5.1 Define a *Bronsted-Lowry acid*.

(1)

a proton donor ✓

5.2 Why do acids undergo ionization rather than dissociation ?

(2)

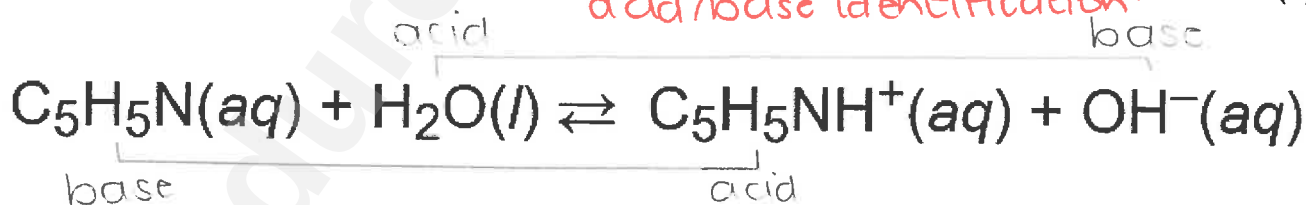
- acids are covalent ✓

- they need to react with water to form ions ✓

5.3 Show the conjugate acid-base pairs for the first reaction which has been reproduced below:

(2)

correct pairs ✓
 acid/base identification ✓



5.4 Is her professor correct that both equations show ionization? YES/NO

(1)

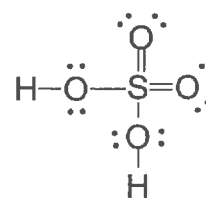
no ✓

5.5 Define a *strong acid*.

(1)

an acid that ionizes completely in aqueous solution ✓

- 5.6 Sulphuric acid is an oily liquid and the Lewis structure of the molecule is shown alongside. Chloe is asked to explain why this substance has a higher viscosity (resistance to flow) than water by making reference to the intermolecular forces present within the two substances respectively. How should she answer this? (4)



- both H_2O and H_2SO_4 have hydrogen bonding IMF ✓

- H_2SO_4 also has dipole-dipole IMF ✓

- $\therefore H_2SO_4$ has stronger IMF ✓

Chloe is required to perform a titration using sulphuric acid and an impure sample of lithium hydroxide. She mixes up a standard solution by adding 90 g of sulphuric acid to 500 cm³ of water. The mass of the impure lithium hydroxide she uses is 5 g. The unbalanced equation is given below:



- 5.7 Calculate the concentration of the standard solution. (5)

$$n = m/M_r \quad \text{eq } \checkmark$$

$$c = n/v$$

$$= 90/98 \quad \checkmark$$

$$= 992/0,5 \quad \checkmark$$

$$= 0,92 \text{ mol} \quad \checkmark$$

$$= 1,84 \text{ mol} \cdot \text{dm}^{-3} \quad \checkmark$$

- 5.8 Calculate the hydroxide concentration in the standard solution at 25°C. (3)

$$K_w = [H_3O^+][OH^-] \quad \checkmark$$

$$1 \times 10^{-14} = (1,84 \times 2)[OH^-] \quad \checkmark$$

$$\therefore [OH^-] = 2,75 \times 10^{-15} \text{ mol} \cdot \text{dm}^{-3} \quad \checkmark$$

The titration reaches the equivalence point after 45 cm³ of the standard solution of acid ^{is added} to a 100 cm³ solution containing all 5 g of lithium hydroxide which Chloe has mixed in the conical flask used for the titration.



5.9 Define equivalence point.

(1)

the point where an acid and base have reacted so neither is in excess ✓

5.10 Why would it make no difference to the equivalence point of the titration whether Chloe had dissolved the lithium hydroxide in 100 cm³ of water or 200 cm³ of water in the conical flask?

(1)

it does not affect the number of moles of LiOH ✓

5.11 Determine the percentage purity of the lithium hydroxide sample that Chloe used.

(8)



$$c = 1,84 \text{ mol} \cdot \text{dm}^{-3} \quad (V = 100 \text{ cm}^3)$$

$$V = 45 \text{ cm}^3 \quad (5 \text{ g})$$

$$n = CV$$

$$= (1,84)(45 \times 10^{-3}) \quad \checkmark$$

eq ✓

$$= 8,28 \times 10^{-2} \text{ mol} \quad \checkmark$$

$$1 : 2$$

$$m = n \times M_r = (0,17)(24)$$

$$8,28 \times 10^{-2} : 0,17 \quad \checkmark$$

$$= 4,08 \text{ g} \quad \checkmark$$

$$\% \text{ purity} = \frac{\text{pure}}{\text{impure}} \times 100 \quad \checkmark$$

$$= (4,08/5) \times 100 \quad \checkmark$$

$$= 81,6\% \quad \checkmark$$

The tables below shows the K_a values for several acids and the colours of select indicators:

Acid	K_a
Hydroiodic acid (HI)	3.16×10^9
Hydrobromic acid (HBr)	1.0×10^9
Hydrochloric acid (HCl)	1.0×10^6
Sulfuric acid (H_2SO_4)	1.0×10^3
Hydronium ion (H_3O^+)	55
Nitric acid (HNO_3)	28.2
Trifluoroacetic acid (CF_3COOH)	5.62×10^{-1}
Oxalic acid ($HOOC-COOH$)	5.37×10^{-2}
Acetic acid (CH_3COOH)	1.75×10^{-5}

Name of indicator	Color at lower pH	pH range	End-point	Color at higher pH
methyl violet	yellow	0.0 - 1.6	0.8	blue
thymol blue	red	1.2 - 2.8	2.8	yellow
methyl orange	red	3.2 - 4.4	3.7	yellow
bromophenol blue	yellow	2.8 - 4.6	4.0	blue
bromocresol green	yellow	3.8 - 5.4	4.7	blue
methyl red	red	4.2 - 6.3	5.1	yellow
bromothymol blue	yellow	6.0 - 7.6	7.0	blue
thymol blue	yellow	8.0 - 9.6	8.1	blue
phenolphthalein	colorless	8.2 - 10.0	9.3	pink/violet

5.13 Which indicator should Chloe have used for her titration? (1)

bromothymol blue ✓

5.14 If Chloe had used acetic acid instead of sulphuric acid, use a hydrolysis equation to justify why she would have had to use phenolphthalein as her indicator instead. (4)

acetic acid is a weak acid ✓



- hydrolysis produces OH^- ions ✓

- $\therefore$ basic ✓

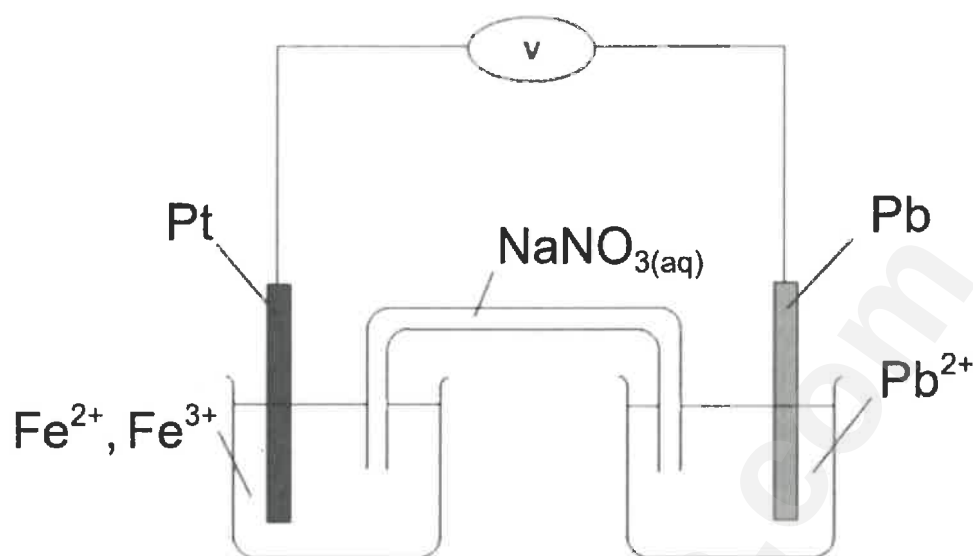
34 MARKS

QUESTION 6

Before the introduction of the child-friendly laugh cannisters which were used as power sources in the world of Monsters Inc, there was a brief and undocumented period in which Mike and Sully tried using galvanic cells as an alternative source to scream-energy.



They set up the following galvanic cell with the salt bridge containing a solution of sodium nitrate.



6.1 What is the energy conversion that takes place in a galvanic cell? (1)

chemical $\rightarrow$ electrical ✓

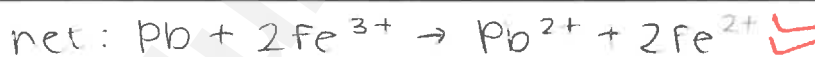
6.2 Define *cathode*. (1)

the electrode where reduction takes place ✓

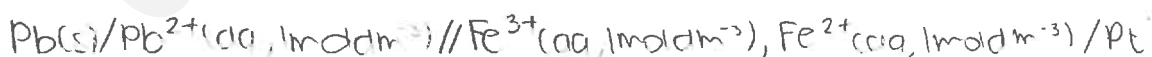
6.3 Write the relevant equation for the reaction taking place at the cathode. (1)(3)



6.4 Write the net ionic equation for this cell. (4)(3)



6.5 Write the symbolic cell notation for this cell under standard conditions. (4)(3)



@ 25°C

-1 per mistake

- 6.6 Calculate the emf Sully and Mike are able to produce using this cell under standard conditions. (3)

$$E^{\ominus}_{\text{cell}} = E^{\ominus}_{\text{cathode}} - E^{\ominus}_{\text{anode}} \quad \checkmark$$

$$= +0,77 - (-0,13) \quad \checkmark$$

$$= +0,9V \quad \checkmark$$

Roz, who is watching as usual, notices that the cell was allowed to run for 3 hours and produced a current of 200 mA.

The table below gives the colours of the ions present in the cell:

Pb^{2+}	Fe^{2+}	Fe^{3+}
Colourless	Green	Orange



- 6.7 State and explain the colour changes that Roz would observe as the cell runs. (2)

- at the cathode the solution turns more green $\checkmark$

- Fe^{3+} ions are reduced to Fe^{2+} $\checkmark$

- 6.8 Fully explain the movement of the sodium ions during the operation of the cell. (2)

- Na^+ ions move towards the cathode $\checkmark$

- there is a decrease in positive charge as Fe^{3+} are reduced to Fe^{2+} $\checkmark$

6.9 Calculate the decrease in the mass of the anode in this time.

(6)

$$Q = It$$

$$= (200 \times 10^{-3}) (3 \times 60 \times 60)$$

$$= 2160 \text{ C}$$

$$\#e^- = Q/q_e^- = 2160 / 1,6 \times 10^{-19}$$

$$= 1,35 \times 10^{22} e^-$$

$$n_{e^-} = \#e^- / N_A = 1,35 \times 10^{22} / 6,02 \times 10^{23}$$

$$= 2,24 \times 10^{-2} \text{ mol}$$



$$1,12 \times 10^{-2} : 2,24 \times 10^{-2}$$

$$\therefore m = n \times M_r$$

$$= (1,12 \times 10^{-2}) (207)$$

$$= 2,32 \text{ g}$$

6.10 Give two changes that Mike and Sully could make to their cell in order to produce a greater current.

(2)

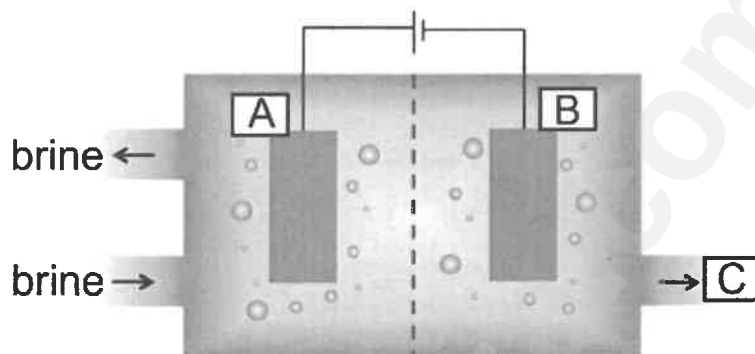
- greater surface area of electrodes

- shorter / wider salt bridge

26 MARKS

QUESTION 7

The Monke Men have decided that instead of making videos showing off their football skills, they should focus on educational videos teaching chemical industries instead. They start with the chlor-alkali industry and select one of the three types of cells used in the manufacture of chlorine as shown below:



7.1 What is *brine*? (1)

saturated salt solution ✓

7.2 Identify the product shown as C. (1)

NaOH / sodium hydroxide ✓

7.3 Explain to the Monke Men why sodium ions are not reduced in this cell. (1)

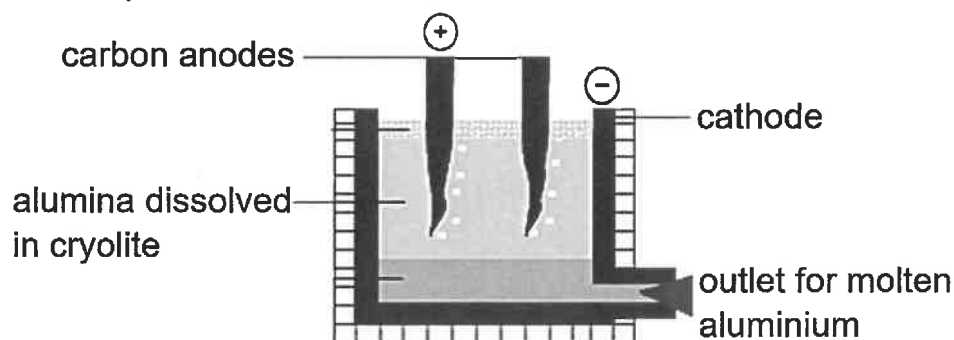
Na metal is too reactive to form in aqueous solution ✓

7.4 Give two reasons why this type of cell is preferable to the diaphragm cell. (2)

- no toxic asbestos ✓

- purer product ✓

They then turn to the recovery of aluminium from bauxite.



7.5 Write the equation for the reaction taking place at the cathode. (1)



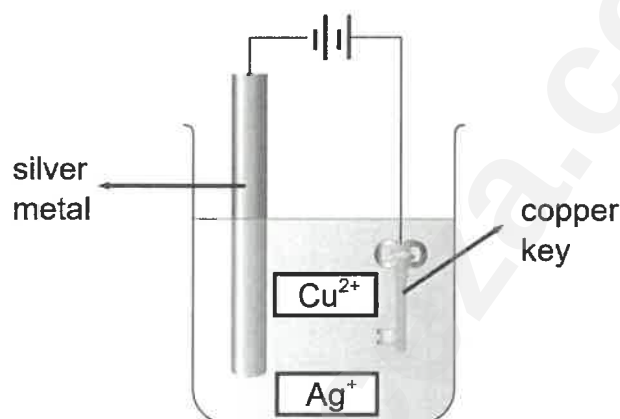
7.6 Explain to the Monke Men why the anodes are eroded as the cell operates. (2)

- $\text{O}_2(\text{g})$ produced at anodes $\checkmark$

- $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$ as a secondary reaction $\checkmark$

C eroded $\checkmark$

They are then given a diagram relating to the process by which a copper key is silver plated.



7.7 They notice two mistakes that have been made in setting up this cell. Identify and explain what these mistakes are. (4)

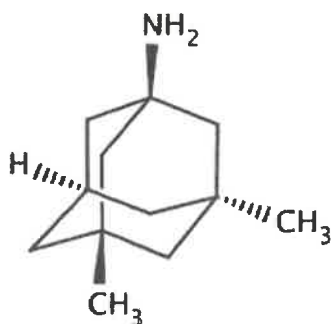
- key needs to be attached to the negative cathode $\checkmark$ so Ag^+ can be reduced and plate Ag metal onto the key $\checkmark$

- Cu^{2+} should not be in solution $\checkmark$
 key should not be oxidized $\checkmark$

12 MARKS

QUESTION 8

12 year old Miguel's great-grandmother Mama Coco suffers from dementia. While Miguel is in the Land of the Dead, he asks Héctor for help investigating medicines that could help her.



Héctor tells him that doctors prescribe Memantine to slow the progression of moderate-to-severe Alzheimer's disease. The structure of Memantine is shown alongside.

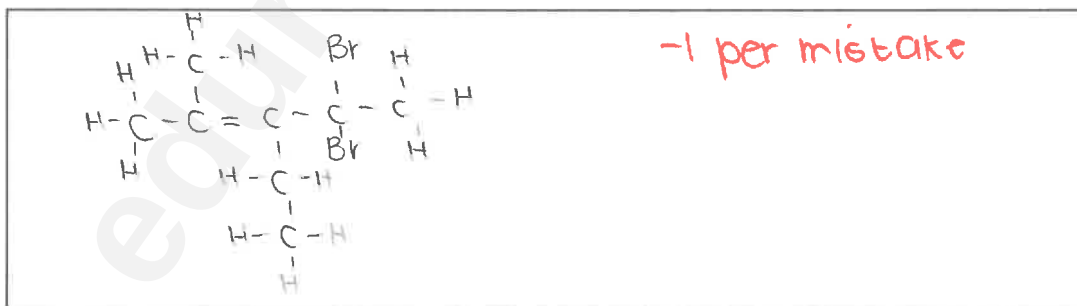
Héctor goes through the basics of organic chemistry with Miguel so that he has an understanding of the medicine. He presents Miguel with the following molecules:



- (i) $\text{CH}_3\text{C}(\text{CH}_3)\text{C}(\text{C}_2\text{H}_5)\text{CBr}_2\text{CH}_3$
- (ii) $\text{C}_3\text{H}_8\text{O}$
- (iii) $\text{CH}_3\text{CH}_2\text{COOH}$

8.1 Draw the full structural formula for compound (i).

(3)



8.2 Could compound (i) be classified as a hydrocarbon? Explain your answer.

(2)

- no ✓

- doesn't only contain carbons and hydrogen ✓

8.3 Give the IUPAC name for compound (i). (3)

4,4-dibromo-3-ethyl-2-methyl-pent-2-ene

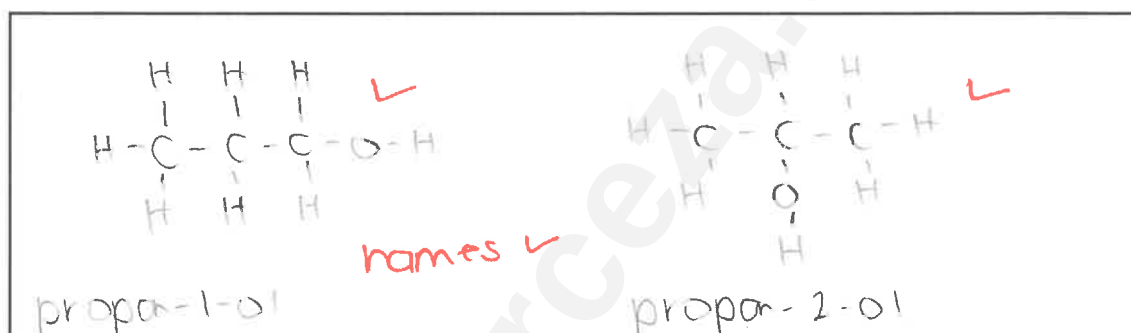
8.3 Identify the homologous series to which compound (ii) belongs. (1)

alcohols

8.4 Define an isomer. (1)

compounds having same molecular formula
but different structural formulae

8.5 Draw and name two positional isomers of compound (ii). (3)



8.6 Name the functional group present in compound (iii). (1)

carboxyl

8.7 Both compound (ii) and compound (iii) contain 3 carbon atoms, yet Héctor says that they have different boiling points. Help Miguel fully explain which would have the higher boiling point and why. (4)

- propanol: has hydrogen bonding IMF (ii)
- propanoic acid has hydrogen bonding IMF (iii)
and dipole-dipole IMF
∴ propanoic acid has stronger IMF
∴ (iii) has a higher boiling point

Héctor is able to produce methyl propanoate by using either molecules (ii) or (iii) and another compound..

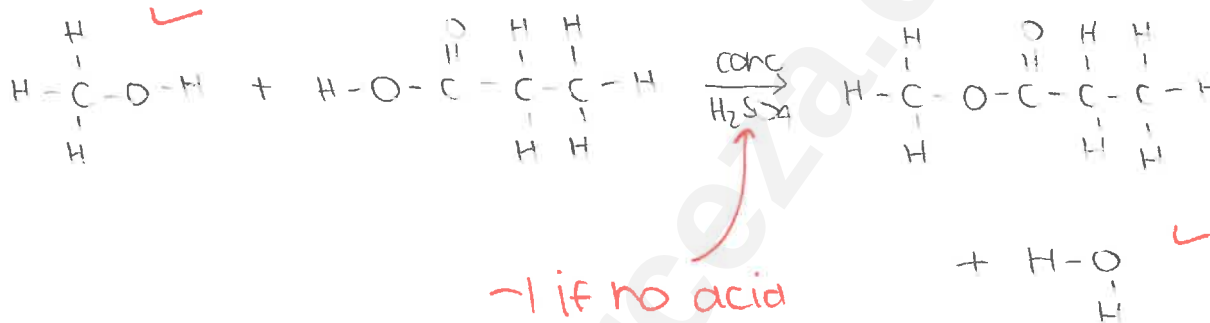
8.8 Identify which molecule this would be. (1)

(iii) ✓

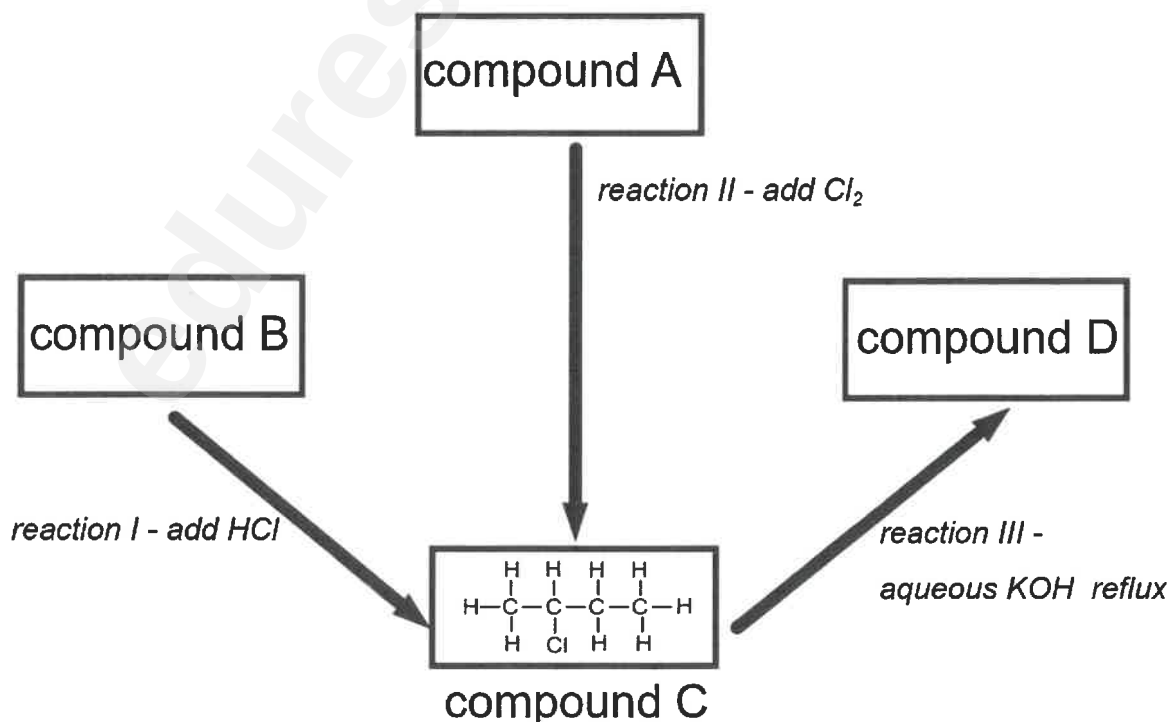
8.9 What catalyst is required for this reaction to take place? (1)

concentrated sulphuric acid ✓

8.10 Using **structural formulae**, show the formation of methyl propanoate. (4)



Miguel studies the flow chart below which shows compounds in the blocks and the arrows representing chemical reactions, which have some of the specific conditions indicated.



8.11 Give the IUPAC name for compound B. (1)

but-2-ene ✓

8.12 What is the **specific** name for reaction I. (1)

hydrohalogenation ✓

8.13 What is the **general** name for reaction II? (1)

substitution ✓

8.14 Reaction I and II both produce the same compound C. Explain the difference in the required reaction conditions and relative rates of the reactions. (3)

- I : addition reaction in which double bond is broken ✓

- II : substitution reaction takes place in the presence of light ✓

∴ reaction I is faster than reaction II ✓

8.15 Reaction III forms three products, one of which being organic compound D. Give the **condensed structural formula** for this organic molecule. (1)

$\text{CH}_2 = \text{CHCH}_2\text{CH}_3$ or $\text{CH}_3\text{CH} = \text{CHCH}_3$ ✓

8.16 Explain whether the Memantine molecule is saturated or unsaturated. (2)

- saturated ✓

- single bonds between carbon atoms ✓

34 MARKS