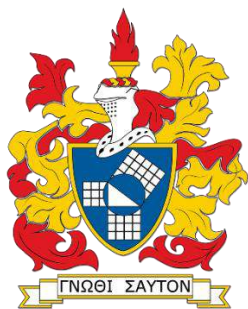




eduresourceza.com

CHEMISTRY PRELIM 2022



SAHETI SCHOOL

PHYSICAL SCIENCE

GRADE 12

PAPER 2 : CHEMISTRY

EXAMINER : C ORCHISON

DATE : 20 JULY 2022

MODERATORS : J NAIDU

HOURS : 3 HOURS

M. RAMUTHAGA-MUSAMPA

MARKS : 200

NAME : _____

INSTRUCTIONS AND INFORMATION

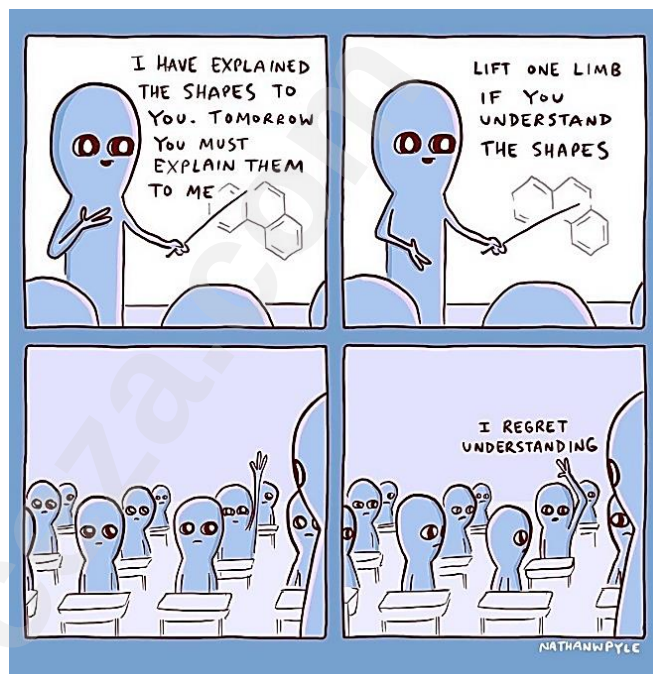
1. This question paper consists of 34 pages with 9 questions.
2. A separate data sheet is provided.
3. Answer all questions on this paper and show all working out.
4. Extra space is provided at the end of the paper should you require it.
5. Use the mark allocation as guide to the maximum time you should 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. What do you call $6,02 \times 10^{23}$ avocados? A guaca-mole



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



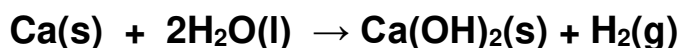
1.1 Data relating to substances P, Q and R is tabulated below:

	P	Q	R
Melting point (°C)	160	650	1420
Electrical conductivity in liquid phase	none	high	high
Electrical conductivity in solid phase	none	high	none

Using the data in the table, which option gives the type of substances P, Q and R are most likely to be?

	P	Q	R
A	ionic	molecular	metal
B	metal	ionic	molecular
C	molecular	ionic	metal
D	molecular	metal	ionic

- 1.2 An 80 g piece of impure calcium metal reacts with excess water according to the equation

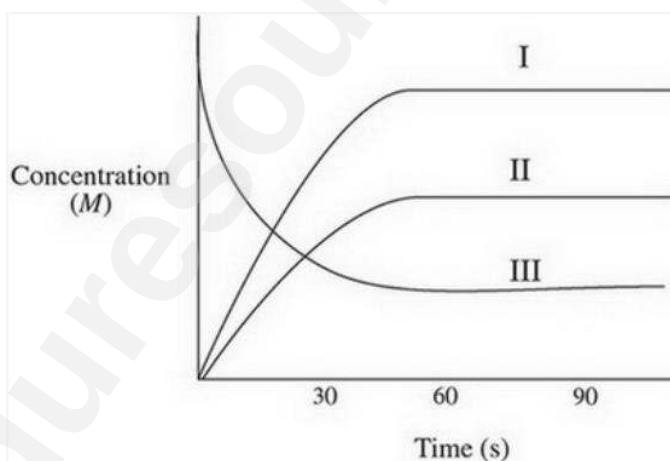


At the end of the reaction 0,5 moles of water remained unreacted and 1,5 moles of hydrogen gas was collected.

What was the percentage purity of the calcium sample and the amount of water originally added to the calcium?

	Percentage purity of Ca(s)	Amount of water initially added (mol)
A	75	3
B	50	2,5
C	25	3
D	75	2,5

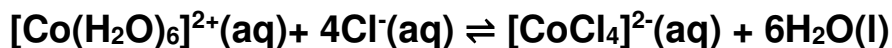
- 1.3 The graph below shows the changes in concentration over time for each of the species in the given reaction:



Which of the following options matches the numbered lines to the correct gases?

	I	II	III
A	NO ₂	O ₂	NO
B	NO	O ₂	NO ₂
C	O ₂	NO	NO ₂
D	NO ₂	NO	O ₂

1.4 Consider the following aqueous equilibrium reaction and the statements that follow:



pink

blue

I – the addition of hydrochloric acid results in a blue solution

II – the addition of water increases the concentration of water and therefore the solution turns pink

III – the addition of silver(I)nitrate resulting in the formation of silver(I)chloride turns the solution blue

Which of the statements are **incorrect**?

A I and II

B II and III

C I and III

D all are correct

1.5 Which of the following equilibrium expressions correctly represents the hydrolysis of the CN^{-} ion?

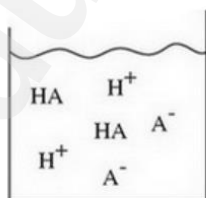
A $K_c = \frac{[\text{HCN}][\text{OH}^{-}]}{[\text{CN}^{-}]}$

B $K_c = \frac{[\text{CN}^{-}][\text{OH}^{-}]}{[\text{HCN}]}$

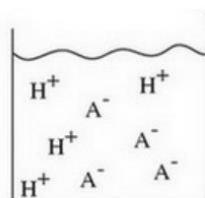
C $K_c = \frac{[\text{HCN}]}{[\text{CN}^{-}][\text{OH}^{-}]}$

D $K_c = \frac{[\text{HCN}][\text{H}_3\text{O}^{+}]}{[\text{CN}^{-}]}$

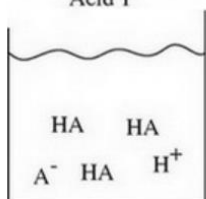
1.6 In which of the following acids would the pH be the highest?



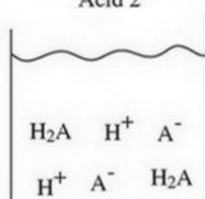
Acid 1



Acid 2



Acid 3



Acid 4

A acid 1

B acid 2

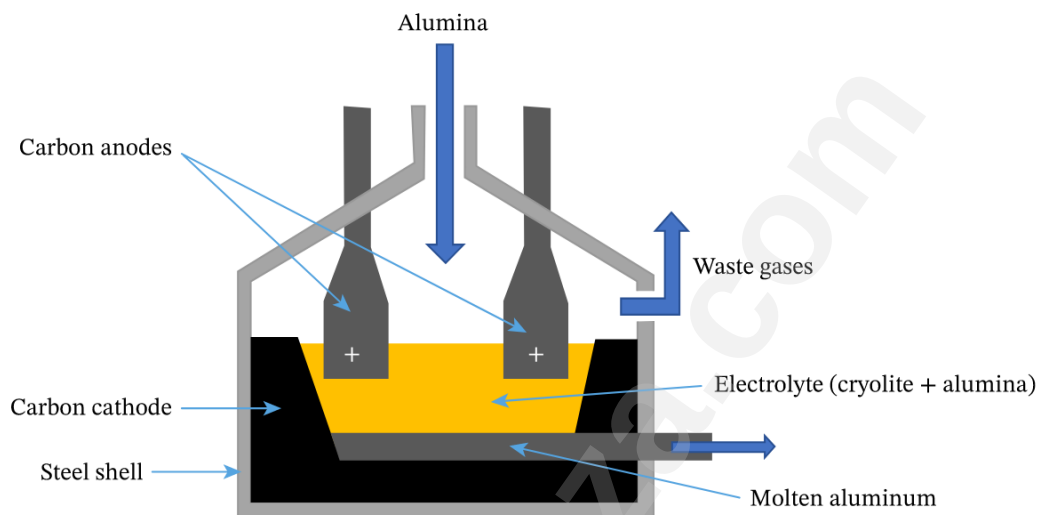
C acid 3

D acid 4

1.7 Which of the following is **not** able to act as a reducing agent?

- A Br^- B Fe^{2+} C Mg D MnO_4^-

1.8 The diagram below is a schematic representation of the Hall-Heroult process.



Which correctly gives the reaction taking place at the anode?

- A $\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^-$ B $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$
 C $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$ D $\text{O}_2 + 4\text{e}^- \rightarrow 2\text{O}^{2-}$

1.9 Which of the following reactions does **not** represent cracking?

- A $\text{C}_5\text{H}_{10} \rightarrow \text{ethene} + \text{propane}$
 B $\text{C}_6\text{H}_{14} \rightarrow \text{prop-1-ene} + \text{propane}$
 C $\text{C}_{10}\text{H}_{22} \rightarrow \text{but-1-ene} + \text{hexane}$
 D $\text{C}_7\text{H}_{16} \rightarrow \text{pentane} + \text{ethene}$

1.10 Which of the following is the sum of the coefficients for the balanced complete combustion of propane?

- A 10 B 13 C 9 D 15

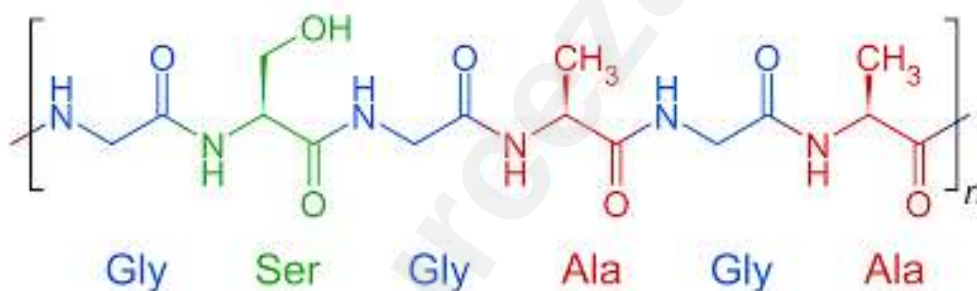
20 MARKS

QUESTION 2

It's 2012... Welcome to grade 1 ! You are making your big school debut the same year as Andrew Garfield graced us with The Amazing Spider-Man.

In this version of events, Peter Parker makes his webbing out of old watches and Oscorp's bio-cable pellets which contain silk from the same genetically engineered spiders that bit him.

Spider silk primarily consists of proteins that possess large quantities of amino acids like glycine (Gly) or alanine (Ala) as shown below:



2.1 Define *intramolecular bond*. (1)

2.2 Explain why the bonds found in spider silk are classified as being polar covalent. (2)

2.3 Identify the bond with the greatest polarity in the protein molecule. (1)

- 2.4 Peter says that spider silk has hydrogen bonding intermolecular forces but Aunt May says that it has dipole-dipole intermolecular forces. Are either of them correct? Explain your answer fully by making reference to the relevant parts of the protein molecule. (3)

Green Goblin is tired of Spider-Man interfering with his diabolical plans, so he wants to be able to dissolve the silk webbing. He has the option of using carbon disulphide (CS_2) or ethanol to do this.

- 2.5 Draw the Lewis diagram of carbon disulphide and explain the polarity of the bonds. (3)

- 2.6 Would you recommend that Green Goblin uses carbon disulphide to dissolve the webbing? Explain your answer fully. (3)

- 2.7 Which of the two solvents, ethanol or carbon disulphide, would evaporate quicker?
Explain by referring to the relative strengths of their intermolecular forces. (3)



16 MARKS

QUESTION 3

2005.. the year that gave us most of you.. woo hoo..
and Star Wars Episode III: Revenge of the Sith..
two excellent reasons to celebrate! 😊

While you were crying to be fed, Anakin was crying
as the river of lava on Mustafar ensured that he
would be dependent on his iconic black life-support
suit for the rest of his days.



The main component of lava is silicon dioxide and it can be produced by the following two steps:

- I - sodium silicate (Na_2SiO_3) reacts with hydrochloric acid and water to form silicon hydroxide and sodium chloride
- II - the silicon hydroxide produced in step I is broken down into silicon dioxide and steam

3.1 Write the balanced equation for the reaction in **step I**. (4)

90 g of Na_2SiO_3 reacts with 500 cm^3 of a $1,5 \text{ mol.dm}^{-3}$ solution of hydrochloric acid.

3.2 Determine the limiting reagent in this reaction. (7)

3.3 Write the balanced chemical equation for **step II**. (2)

- 3.4 At the end of **step II**, 20 g of silicon dioxide was produced. Calculate the percentage yield of this process. (4)

- 3.5 Hence, calculate the volume of steam produced in this process if it is carried out at STP. (4)

21 MARKS



When everyone talked about 'May The 4th be with you' but no one talking about 'Revenge of the 5th.'



QUESTION 4

2023.. you've made it to matric ! 😊 It's a year you will look back on and enjoy the wonderful memories you will have stored up.. things like your last sport and cultural fixtures, matric dance, stay-awake and the many hours you spent at the movies or binging Netflix instead of doing homework or studying. (#procrastinationiskey)

One of the biggest theatrical releases of 2023 so far has been Avatar: The Way of Water.

AVATAR: THE WAY OF WATER Set To Earn Less Than AVATAR And Unlikely To Be 2022's Biggest Movie

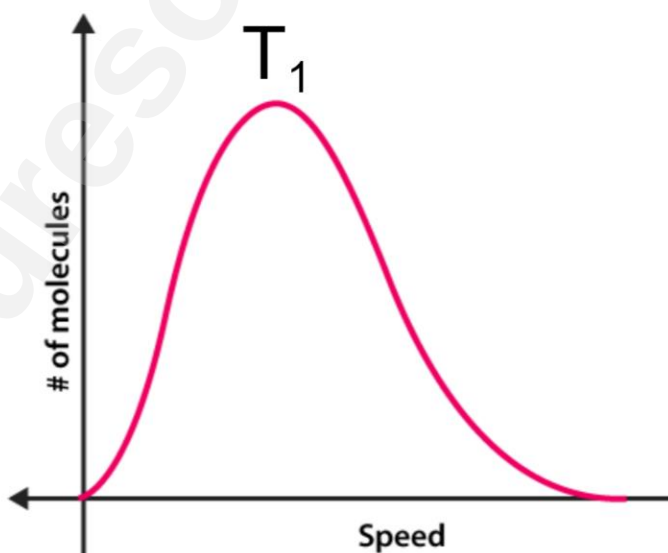


Jake Sully is living on the planet Pandora. The atmosphere is a mixture of nitrogen, oxygen, carbon dioxide, xenon, methane and ammonia and therefore humans need to wear Exo-Packs when outside their buildings or vehicles. Not only are the gases toxic by themselves, but methane and ammonia react in the presence of oxygen over a platinum catalyst to form hydrogen cyanide gas according to the equation given below:



Jake's scientist friend Max Patel is investigating the above reaction to see if he can slow it down.

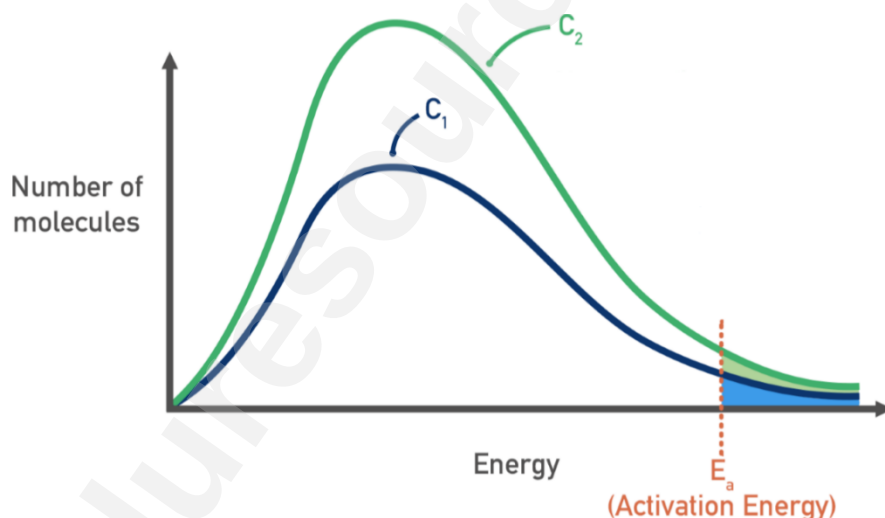
Consider the Maxwell-Boltzmann curve he has drawn below for the reaction at temperature T_1 :



4.1 Why is 'speed' a suitable label for the x-axis? (1)

- 4.2 Max repeats the experiment at a lower temperature. Sketch the shape of the graph this reaction would produce on the axes above. Clearly label this as T_2 . (2)
- 4.3 Fully explain, by referring to collision theory, what effect a lower temperature would have on the rate of the reaction. (4)

Max also produces the graph below, showing two different concentrations of reactants.

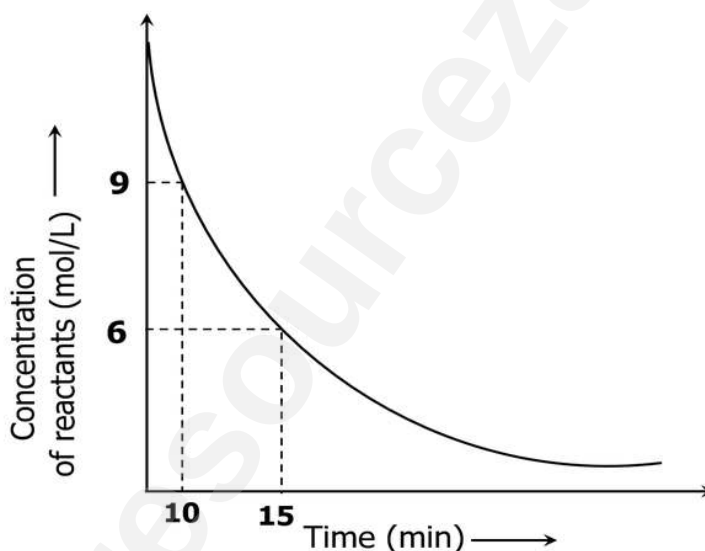


Jake looks at it and reasons that an increase in pressure must have resulted in the increased concentration shown by curve C_2 .

- 4.4 Explain why an increase in the pressure of the gases would lead to an increase in their concentration. (1)

- 4.5 Is Jake correct that curve C₂ is the result of an increase in pressure? Explain your answer fully. (2)

Jake's wife Neytiri joins in the discussion and presents the graph below:



- 4.6 Define a *catalyst*. (1)

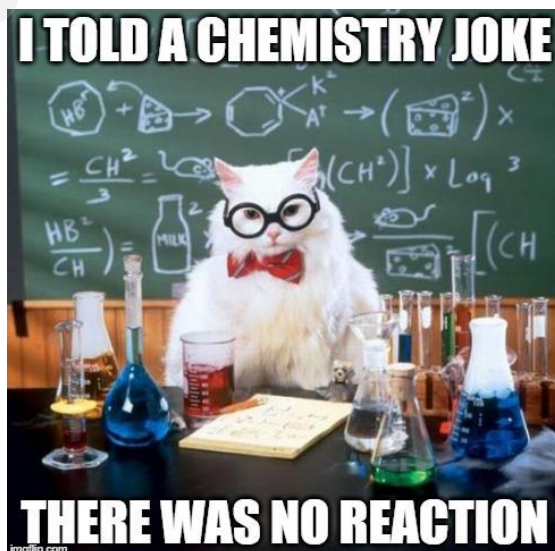
- 4.7 Show the effect of a catalyst on the concentration graph above. (1)

4.8 Define *reaction rate*. (1)

4.9 Calculate the average rate of reaction between 10 and 15 seconds. Include the correct units in your answer. (2)

4.10 Which of the other factors able to affect the rate of the reaction would **not** affect the rate of this specific reaction? Explain your answer fully. (2)

17 MARKS



QUESTION 5

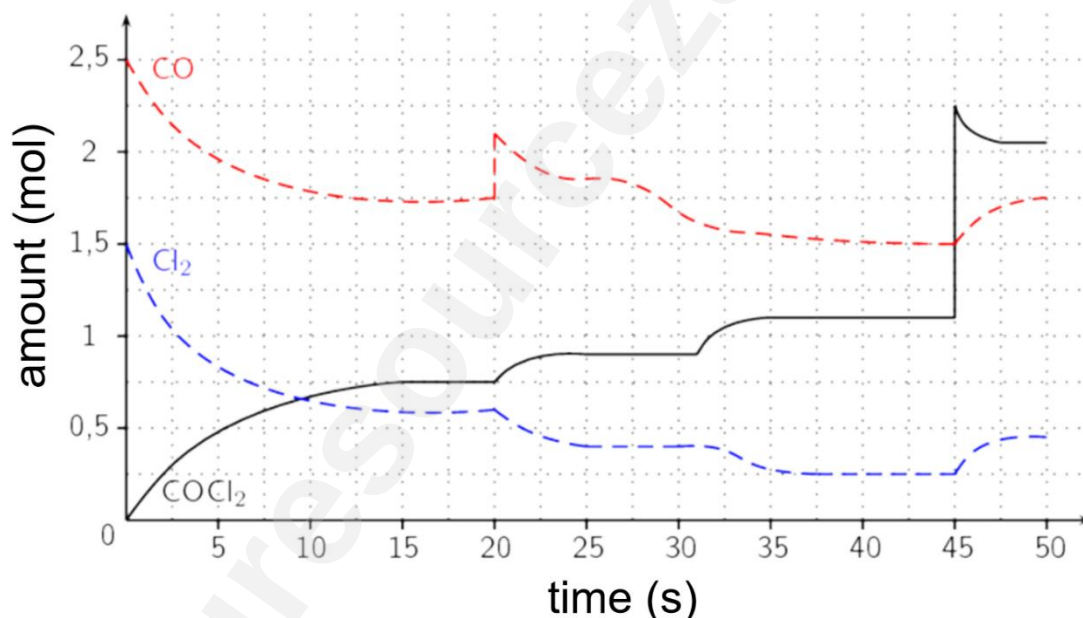
It's 2018 and you are living your best lives as grade 7's. You are the kings and queens who rule the playgrounds of primary school, you meet up at Bedford Centre to walk around aimlessly for hours (as cool kids apparently did), and then watch Black Panther in NuMetro's VIP seats.

WHEN THE TEACHER USES YOUR ASSIGNMENT AS AN EXAMPLE OF HOW TO DO IT RIGHT.



Shuri, master engineer and lead scientist of Wakanda, knows that Thanos is a real threat and so she is doing research on various poisonous gases in order to be prepared.

The first gas she focuses on is the equilibrium of phosgene (COCl_2) in a 500 cm^3 reaction vessel, and she graphs how the moles of gas change in response to various stresses.



- 5.1 Write the balanced chemical equation for this endothermic gaseous equilibrium and indicate the enthalpy change. (3)

- 5.2 Compare the rates of the forward and reverse reactions at 5 seconds. (1)

5.3 Calculate the value of the equilibrium constant at 18 seconds. (5)

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. A faint, diagonal watermark reading "jeza.com" is visible in the lower right quadrant of the page.

5.4 State *Le Chatelier's principle*. (1)

5.5 Hence, fully explain the change to the system at 20 seconds. (3)

- 5.6 How would the value of the equilibrium constant at 27 seconds compare to the value calculated in 5.3 above ? Explain your answer fully. (2)

The second toxic gas Shuri investigates is nitrogen dioxide.



Shuri places brown NO₂ gas in a syringe and pushes the plunger in, decreasing the volume. The gas immediately goes darker brown but then turns colourless.



- 5.7 Why does the colour of the gas first darken for a few seconds? (1)

- 5.8 Explain fully in terms of Le Chatelier's principle why the gas turns colourless. (3)

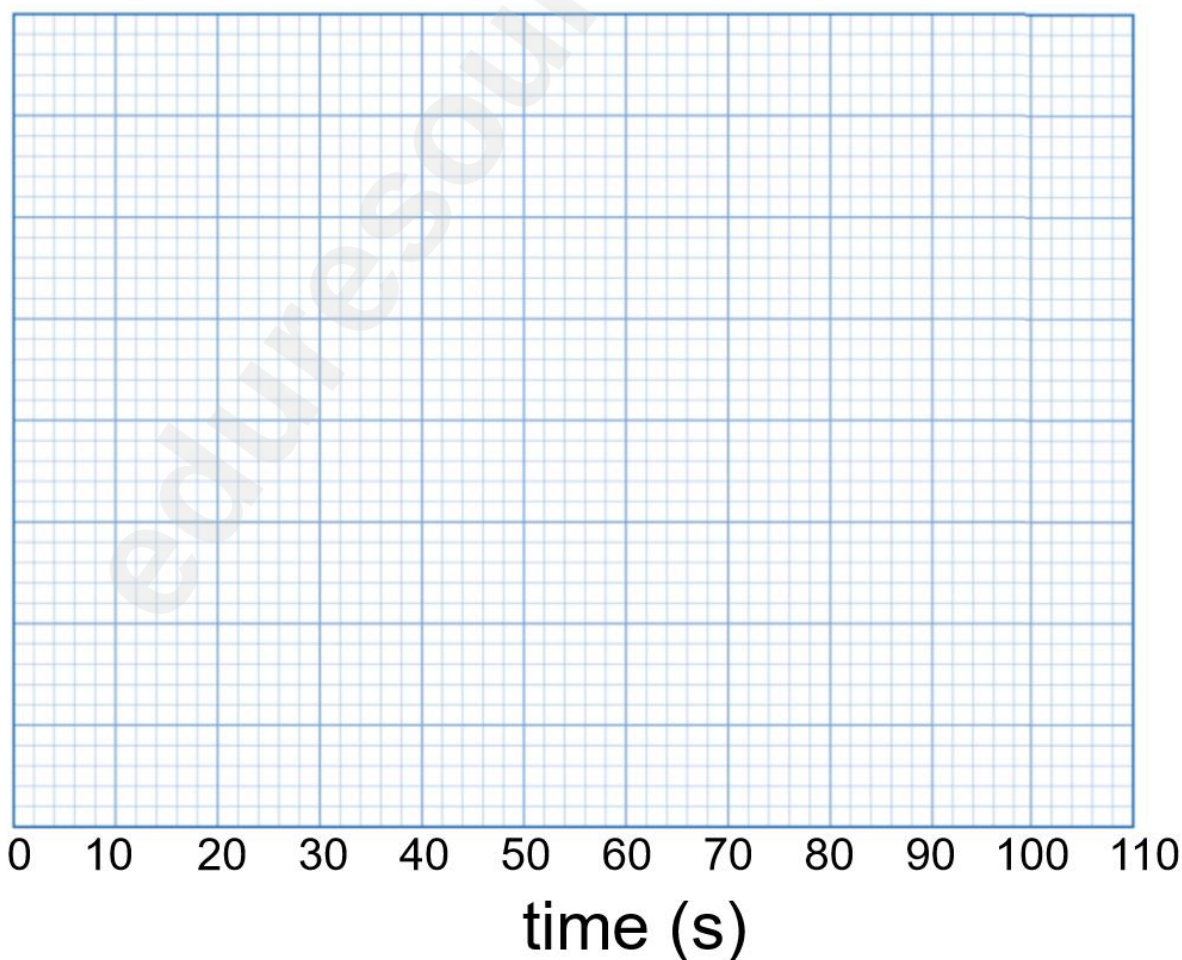
Shuri then performs another experiment, starting with N_2O_4 in the reaction vessel, and tabulates the changes in concentration over a period of 80 seconds as given below:



Time (s)	$[\text{NO}_2]$ ($\text{mol}\cdot\text{dm}^{-3}$)	$[\text{N}_2\text{O}_4]$ ($\text{mol}\cdot\text{dm}^{-3}$)
0	0,000	0,100
10	0,038	0,083
20	0,060	0,070
40	0,100	0,059
50	0,110	0,045
60	0,120	0,040
80	0,120	0,040

5.9 Plot these results on the axes below, clearly indicating each gas.

(7)



At 85 seconds T'Challa ask Shuri to decrease the temperature of the reaction vessel.

5.10 Show this change and the system's response on the axes above if equilibrium is re-established at 100 seconds. (3)

5.11 Using dotted lines, show the effect that adding a catalyst at the start of the reaction would have on the system between 0 and 20 seconds only. (1)

30 MARKS

QUESTION 6

While you are singing alone to "Sucker" and nervously making your way across the hall to your grade 8 science class, you are stared down by the scary matrices of 2019.

Nick Jonas who was diagnosed with Type 1 diabetes when he was 13 and is now is a diabetes ambassador.

Diabetic ketoacidosis (DKA) is a life-threatening problem which occurs when the body starts breaking down fat at a rate that is much too fast which causes the blood to become acidic. The most important pH buffer system in the blood involves carbonic acid.

6.1 Define a *Bronsted-Lowry* acid. (1)

6.2 Explain why carbonic acid is considered to be a weak acid. (1)

Kevin and Joe are wanting to determine the concentration of a sample of carbonic acid that Nick gives them. Kevin mixes up a standard solution containing 120 g of potassium hydroxide in 4 litres of distilled water. He titrates 30 cm³ of this solution against the carbonic acid solution and finds that 50 cm³ of the acid is required for neutralization.

6.3 Write a balanced chemical equation for the reaction of carbonic acid and potassium hydroxide. (3)

6.4 Define *standard solution*. (1)

6.5 Calculate the concentration of the standard solution. (3)

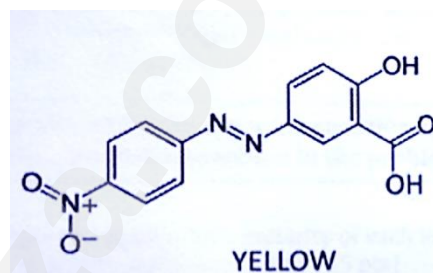
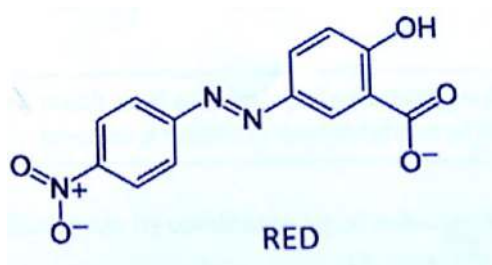
6.6 Define *equivalence point*. (1)

6.7 Hence, determine the concentration of the carbonic acid solution. (5)

Joe finds the table below showing pH ranges for indicators:

acid-base indicator table			
indicator	pH range	color for weak acid	color for conjugate base
methyl orange	4-6	orange	yellow
bromophenol blue	6-7	yellow	blue
thymol blue	8-9	yellow	blue
phenolphthalein	9-10	colorless	pink
alizarin yellow	10-12	yellow	red

He also finds the following diagrams for the alizarin yellow indicator equilibrium, showing what the different structures looks like when it is red and when it is yellow:



- 6.8 Using both the table and the equilibrium structures above, state and explain what colour this indicator would turn in the carbonic acid solution. (3)

Frankie (yes.. there is another brother known as the “bonus Jonas”) would like to investigate monoprotic lactic acid, $\text{HC}_3\text{H}_5\text{O}_3$, with a K_a value of $8,3 \times 10^{-4}$.



- 6.9 What does ‘monoprotic’ mean? (1)

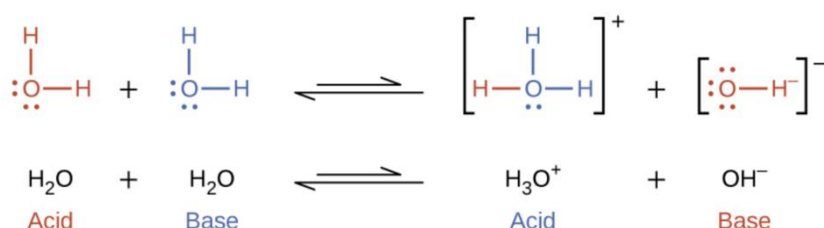
- 6.10 Show the ionization of lactic acid and indicate the conjugate acid-base pairs. (2)

- 6.11 If the initial concentration of the lactic acid solution is 2 mol.dm^{-3} , determine the expression to calculate the concentration of hydronium ions present at equilibrium in the 1 dm^3 bottle. Do not solve for the concentration of the ions. (4)

Kevin decides he would rather work with strong acids and so heads to the storeroom to collect the bottle containing $1,5 \text{ mol.dm}^{-3}$ sulphuric acid. He also fills a beaker with distilled water. He likes the cold so he cools both the water in the beaker and the acid to a chilly 10°C . Kevin presents his brothers with the following information:



T ($^\circ\text{C}$)	$K_w (\text{mol}^2 \text{ dm}^{-6})$
0	0.114×10^{-14}
10	0.293×10^{-14}
20	0.681×10^{-14}
25	1.008×10^{-14}
30	1.471×10^{-14}
40	2.916×10^{-14}
50	5.476×10^{-14}
100	51.3×10^{-14}



- 6.12 Nick says that because the water is colder than room temperature, it would have a lower pH than normal. Explain fully why he is incorrect by making reference to the information Kevin has presented. (3)

- 6.13 Calculate the concentration of hydroxide ions in the acid solution at 10°C if the sulphuric acid ionizes completely. (3)

32 MARKS

QUESTION 7

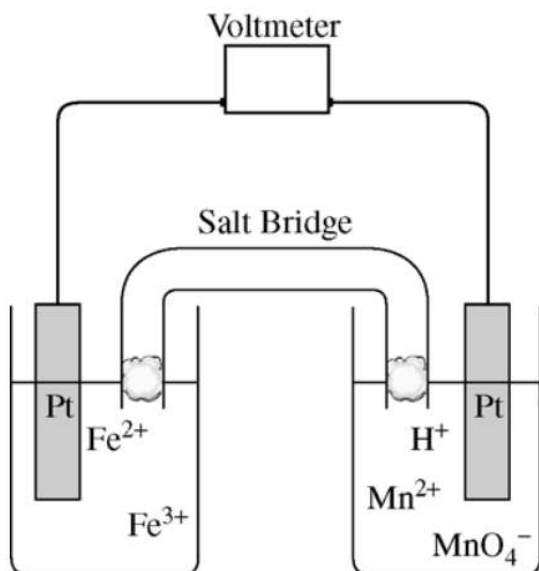


Eskom is aware that the power is on. They are currently working on the problem.

In a December 1998 report, analysts and leaders in Eskom and in the South African government predicted that Eskom would run out of electrical power reserves by 2007 unless action was taken to prevent it. Failure to heed this timeous warning saw South Africa introducing load shedding for the first time, exactly as predicted, in 2007 when you were 2 years old and watching Dora the Explorer.

Dora wants to figure out how to make a battery so that she can still have light during loadshedding, so she sets up the following galvanic cell and provides a table showing the colours of the ions in solution.





Ion:	Colour:
Fe^{2+}	Orange-red
Fe^{3+}	Yellow-green
MnO_4^-	Purple
Mn^{2+}	Colourless

7.1 State the energy conversion taking place in a galvanic cell. (1)

7.2 Write the oxidation half-reaction for this cell. (1)

7.3 Define *oxidizing agent*. (1)

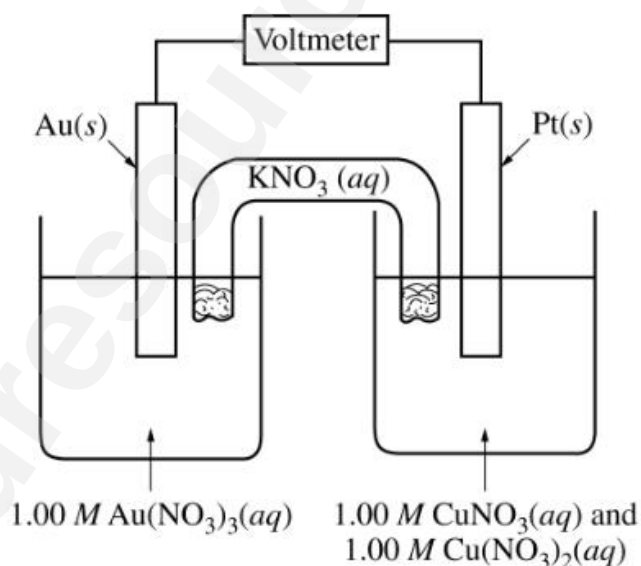
7.4 Identify the oxidizing agent in Dora's cell. (1)

7.5 Boots says that as the reaction proceeds, the solution in the cathode compartment will turn darker purple. Fully explain whether you agree with Boots or not. (3)

- 7.6 Would Dora be able to light up her 1,5 V LED bulb using this cell under standard conditions ? Justify your answer by calculation. (4)

- 7.7 Boots suggests increasing the concentration of Fe^{3+} ions in solution to increase the emf. Fully explain whether his suggested method will have the desired effect or not. (2)

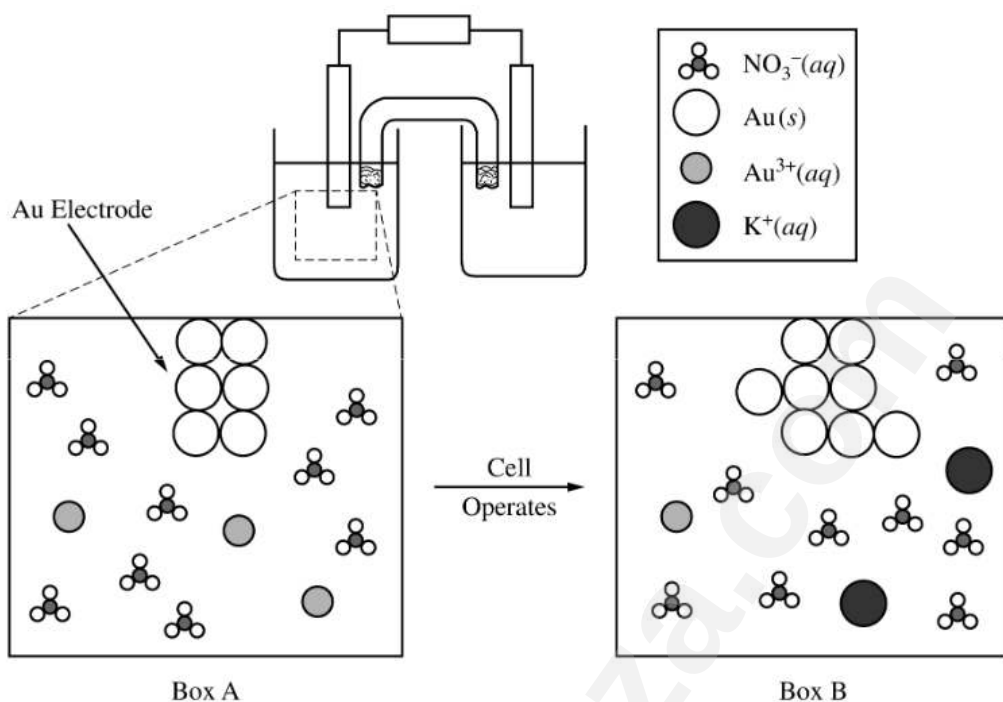
Dora sets up another cell, as shown below and includes the standard reduction potentials:



Half-reaction	E° (V)
$\text{Cu}^{2+}(\text{aq}) + e^- \rightarrow \text{Cu}^+(\text{aq})$	0.16
$\text{Au}^{3+}(\text{aq}) + 3 e^- \rightarrow \text{Au(s)}$	1.50

- 7.8 Write the cell notation for this cell under standard conditions. (3)

An expanded view of the gold half-cell before the reaction takes place is shown in box A.



- 7.9 Fully explain whether box B correctly represents an expanded view of the same half cell after the reaction has proceeded for some time. (3)

- 7.10 Explain the effect it would have on the direction of electron flow if the gold electrode was replaced with a copper electrode and corresponding electrolyte. (2)

QUESTION 8

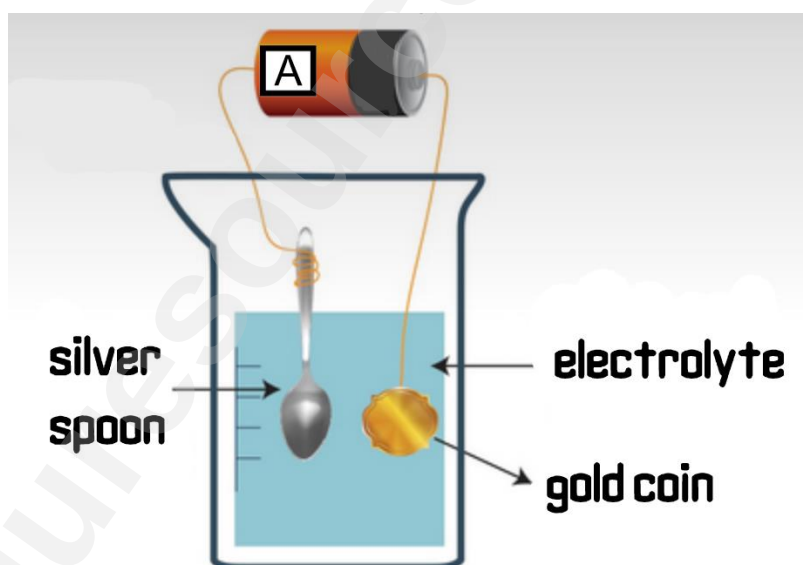
The year is 2010, so you are now 5 years old. While you are navigating the playgrounds in grade R, the country is going wild over South Africa hosting the FIFA World Cup.



The solid gold trophy used to be kept by the winning team until the final draw of the next tournament, but now the winners of the tournament instead receive a gold-plated bronze replica.



Zakumi, the mascot for the World Cup, decides to experiment with electroplating and tests it out on a silver spoon.



- 8.1 In order for the spoon to be electroplated, should A be the positive or negative terminal of the cell? (1)
- 8.2 Write the equation for the half-reaction taking place at the anode. (1)

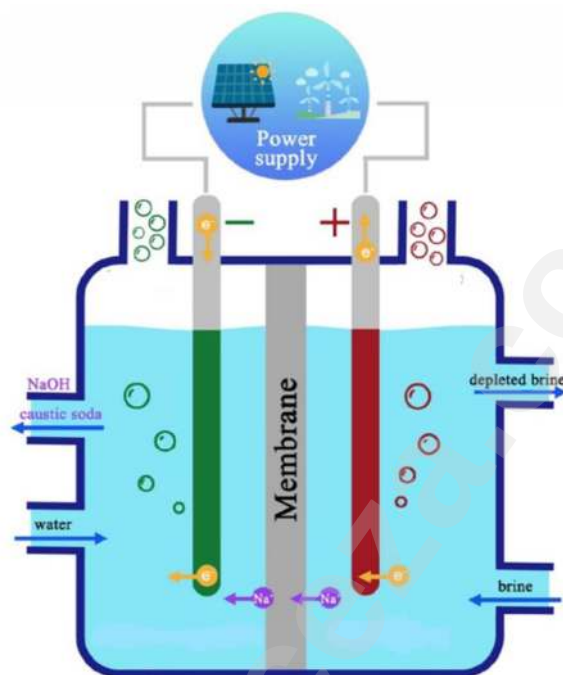
sourceza.com

8.4 Must the impure gold be attached to the anode or the cathode in this process? (1)

If silver was one of the impurities in the gold, explain what would happen to it during the refining process.

Zakumi was proud of the fact that our water purification system was of such a high standard that drinking straight from the tap was perfectly safe.

This is thanks to the NCP chlor-alkali plant in Kempton Park (viva East Rand !) where chlorine is produced. NCP makes use of the membrane cell as depicted below:



8.6 Which gas is produced at the positive electrode? (1)

8.7 Write the overall (net) chemical reaction for this cell. (1)

8.8 Explain fully why this cell is preferable over the diaphragm cell with respect to purity of product. (2)

8.9 Give the equation for the reaction that takes place at the cathode in the mercury cell. (1)

8.10 Give the name of the electrolyte that is found in all three cells. (1)

18 MARKS

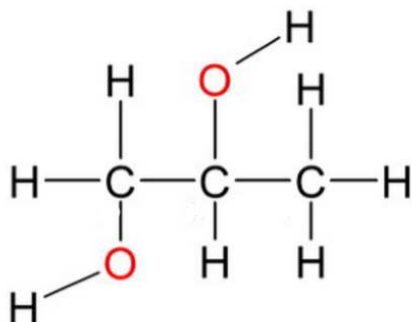
QUESTION 9

Who could ever forget the year that was 2020.. when you lost at least 4 layers of skin to hand sanitizers containing a minimum of 60% ethanol, and Sister Sarah could sense in her soul (from a distance of 12 km away) if someone wasn't wearing a mask.

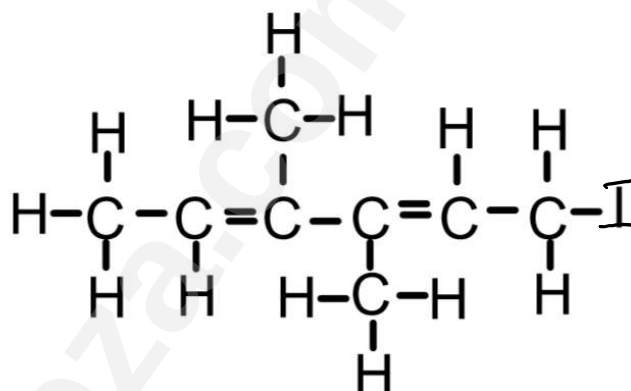
Sister Sarah gives you the following compounds:

Flexing in March 2019

Flexing in March 2020



compound 1



compound 2

9.1 Give the IUPAC names for both compounds. (5)

1: _____

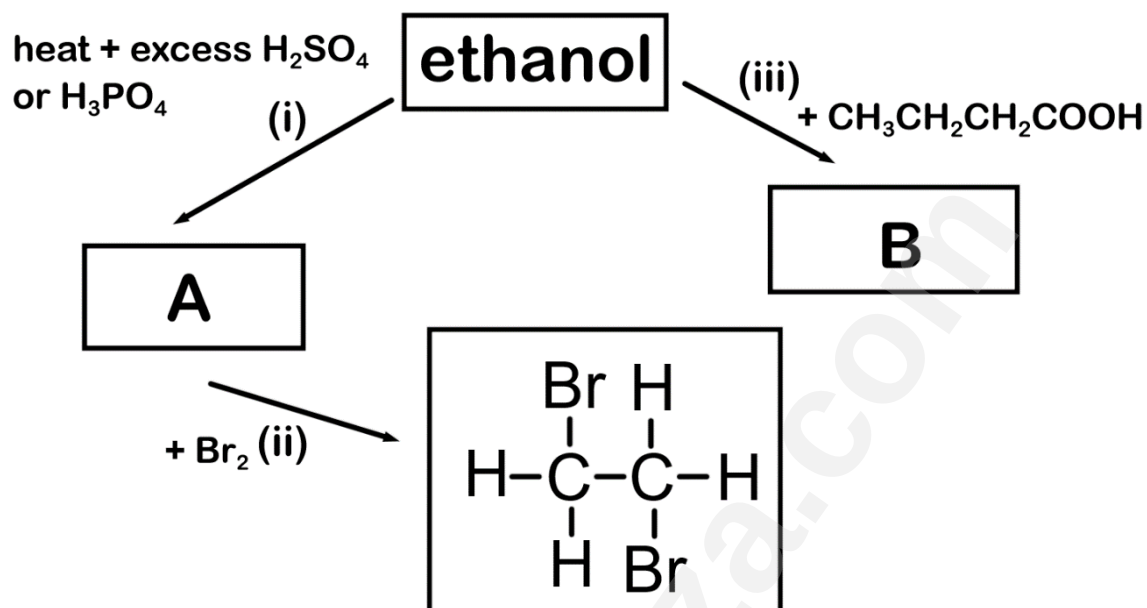
2: _____

9.2 Name the functional group of compound 1. (1)

9.3 Write the condensed structural formula for compound 2. (1)

9.4 Explain which of these compounds is/are saturated. (2)

Consider the flow diagram below where the letters represent organic compounds and the roman numerals in brackets represent reactions.



9.5 Name the homologous series compound A belongs to. (1)

9.6 Give the names of the specific reaction types for reactions (i) and (ii). (2)

(i) _____

(ii) _____

9.7 Use structural formulae to show the formation of compound B, given as reaction (iii), which takes place in the presence of concentrated sulphuric acid. (4)

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

9.9 Define *functional group*. (1)

Sister Sarah provides you with the following table:

Compound:	Boiling point (°C)
HCOOCH ₂ CH ₂ CH ₃	78,9
CH ₃ CH ₂ CH ₂ COOH	163,5

9.10 Explain fully why these two compounds are considered to be functional isomers. (3)

9.11 By making reference to their intermolecular forces, explain the difference in their boiling points. (4)

25 MARKS

eduresourceza.com

