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**PHYSICAL SCIENCE
PRELIM – PAPER 2 – CHEMISTRY
JULY 2018**

**MARKS: 200
EXAMINER: C. ORCHISON**

**TIME: 3 HOURS
MODERATOR: S. MANICUM**

INSTRUCTIONS AND INFORMATION

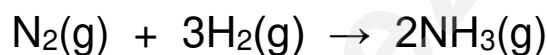
1. This question paper consists 15 pages with 9 questions
2. A data sheet is provided
3. Answer the multiple choice and the indicated questions on the answer sheet.
4. Write your name and teacher's name in the appropriate spaces on the ANSWER BOOK.
5. You may use a non-programmable calculator and appropriate mathematical instruments.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Use mark allocation as a guide to the maximum time you should spend on a question.
8. May the m x a be with you ☺

QUESTION 1

- 1.1 In which of the options have the intermolecular forces of the substances all been correctly identified?

	Carbon dioxide	Ammonia	Helium
A	Dipole-dipole	Hydrogen bonding	London forces
B	London forces	Dipole-dipole	Hydrogen bonding
C	London forces	Hydrogen bonding	London forces
D	Dipole-dipole	London forces	London forces

- 1.2 If 11,2 dm³ of nitrogen reacts with excess hydrogen, how many particles of ammonia will be formed according to the equation given:



- A $3,01 \times 10^{23}$ B $6,02 \times 10^{23}$ C $1,20 \times 10^{24}$ D $1,81 \times 10^{24}$

- 1.3 Luka describes a reaction as having an activation energy for the forward reaction of 60kJ and an activation energy for the reverse reaction of 100kJ.

Which of the following is then correct?

I – the reaction is exothermic

II – the enthalpy of the reaction is 40kJ

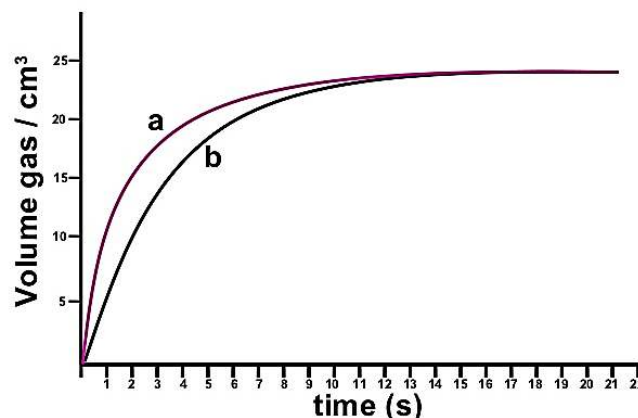
III – the activated complex has a value of 160kJ

- A I and III B II only C I only D II and III

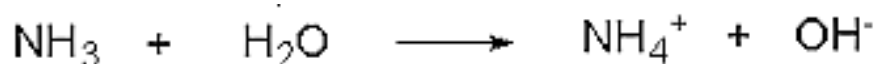
- 1.4 Luka reacts pieces of zinc metal with sulphuric acid and plots graph **a** based on the time it takes for the reaction to go to completion.

Which of the changes he makes would **not** give rise to the curve marked **b**?

- A adding a catalyst
B decreasing the surface area of the zinc
C adding water to the solution
D increasing the pressure on the container

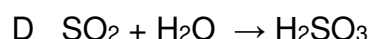
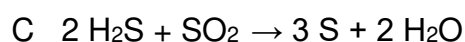
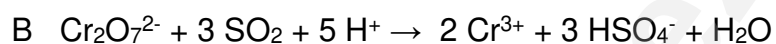
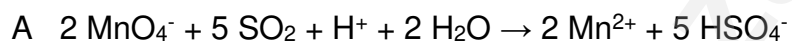


- 1.5 In which of the following options have the conjugate acid base pairs been correctly identified?

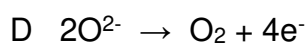
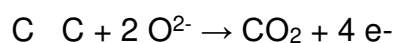
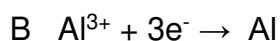
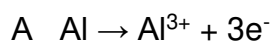
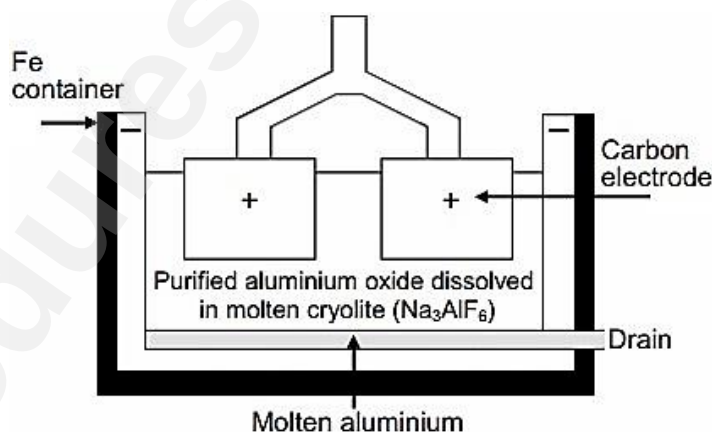


	NH_3	H_2O	NH_4^+	OH^-
A	Base	Acid	Base	Acid
B	Acid	Base	Acid	Base
C	Acid	Acid	Base	Base
D	Base	Acid	Acid	Base

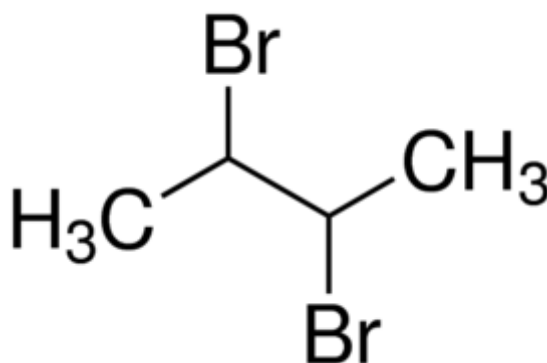
- 1.6 In which of the following reactions does SO_2 act as an oxidizing agent?



- 1.7 Which of the equations given below is the correct cathode reaction for this cell?

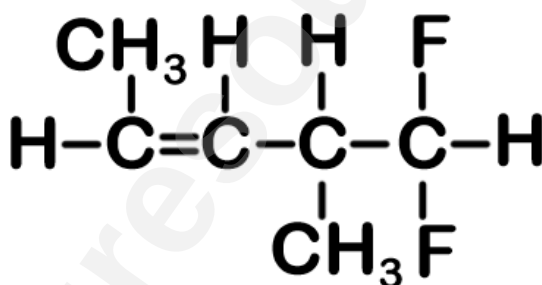


1.8 When performing the test for saturation the following compound is produced:



It can therefore be concluded that ...

- A the initial compound was saturated and an addition reaction took place
 - B the initial compound was unsaturated and an addition reaction took place
 - C the initial compound was saturated and a substitution reaction took place
 - D the initial compound was unsaturated and a substitution reaction took place
- 1.9 Which is the correct general formula for the series to which ethyne belongs?
A C_nH_n B C_nH_{2n} C C_nH_{2n-2} D C_nH_{2n+2}
- 1.10 What is the correct IUPAC name for the molecule shown below?

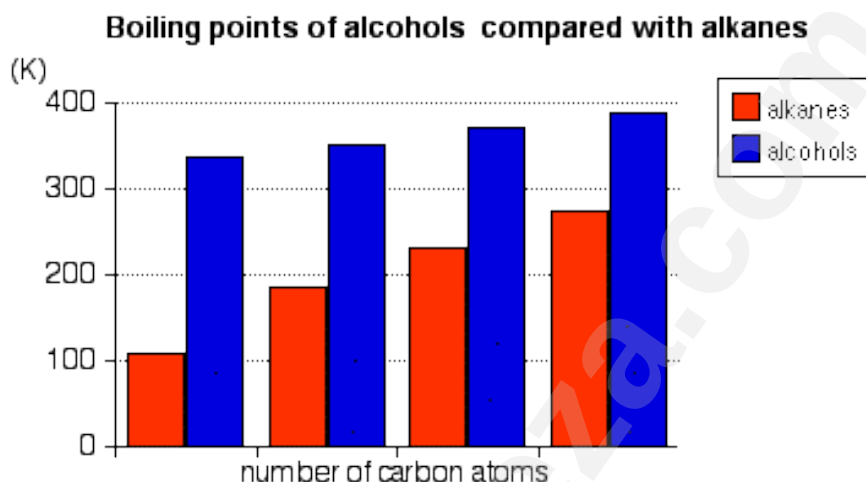


- A 4,4-difluoro-1,3-dimethylbut-1-ene
- B 1,1-difluoro-2,4-dimethylbut-1-ene
- C 1,1-difluoro-2-methylpent-3-ene
- D 5,5-difluoro-4-methylpent-2-ene

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QUESTION 2

Harry and Jason, who absolutely love the section on intermolecular forces, obviously, gather some data on the boiling points of the alkanes and the alcohols for straight chain compounds of increasing lengths and plot this in the graph shown below:



- 2.1 Identify the intramolecular forces present in a molecule of ethane. (2)
- 2.2 Explain why the number of carbon atoms in the chain increases the boiling points of the alkanes. (3)
- 2.3 Identify the specific intermolecular forces present in ethanol. (1)
- 2.4 Why are the boiling points of the alcohols higher than that of the alkanes? (1)
- 2.5 Draw the Lewis structure of methane and explain why the molecule is considered to be non-polar. (3)
- 2.6 Name the intermolecular forces present in methane gas. (1)
- 2.7 Harry says that both methane and methanol would be soluble in water, but Jason disagrees. Who is correct? Explain your answer. (2)

Select the substance from the list below which best matches the description given:

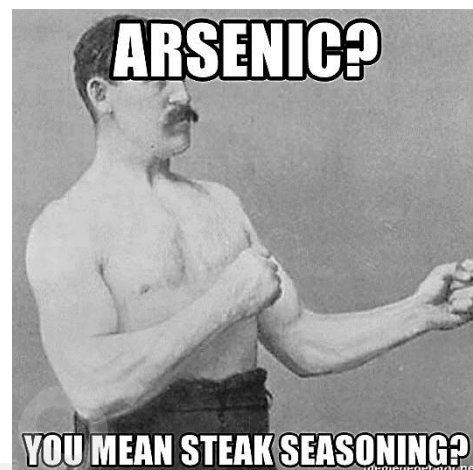
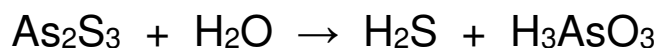
H_2Se (g) graphite (s) NH_4Cl (aq) HF H_2 (g)

- 2.8 has dipole-dipole intermolecular forces (1)
- 2.9 is a giant covalent macromolecule (1)
- 2.10 has the lowest boiling point (1)
- 2.11 has ion-dipole intermolecular forces (1)

QUESTION 3

Denis and Dimitris are hatching diabolically evil plans in the lab by investigating arsenic poisoning, as one does.

Consider the following reaction for the preparation of arsenious acid from arsenic trisulphide.

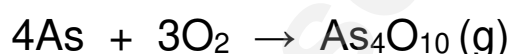


- 3.1 Balance the given equation. (3)
- 3.2 What mass of arsenious acid is needed to give a 75kg man a daily dose of 150mg/kg/day? (1)
- 3.3 Calculate the mass of arsenic trisulphide Denis would have to measure out in order to produce the mass of the acid calculated above. (6)
- 3.4 What would the concentration of their arsenious acid solution be if this mass is casually dissolved in a 400ml bottle of water? (3)

Not satisfied with only poisoning the drinking water they also think about air-born toxins.

There is clearly no end to their madness.

They refer to the balanced equation given below:



- 3.5 Dimitris says that if 50g of arsenic reacts with 20dm³ of oxygen the limiting reagent would be the arsenic. Calculate whether he is right or not. (6)
- 3.6 Calculate the mass of the left over reactant. (3)

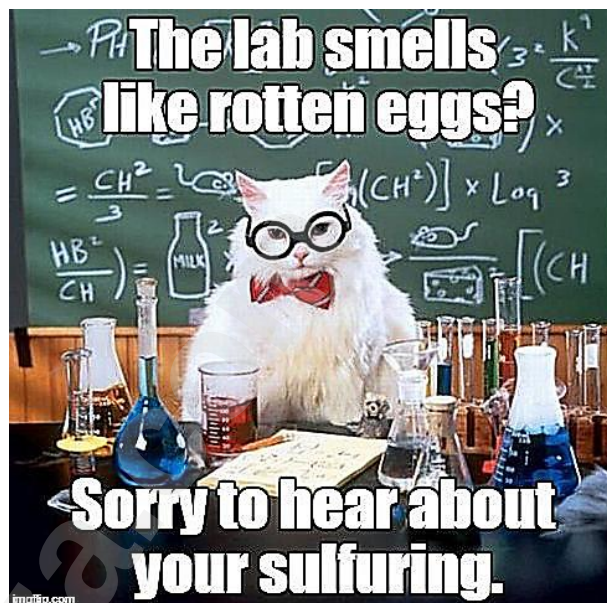
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QUESTION 4

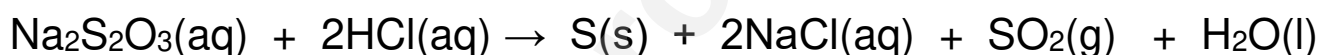
Maria and Ilias are more responsible chemists and so they decide to focus on safe ways to investigate the factors that influence the rates of reactions.

This is an extract of their write-up:

“Sodium thiosulphate reacts with dilute acid to produce sulphur dioxide, sulphur and water. Sulphur dioxide is a soluble gas and dissolves completely in aqueous solution. The sulphur formed however is insoluble and exists in the mixture as a white or pale yellow precipitate or a colloid that gives a milky appearance and makes the solution opaque.”



The balanced equation is given below:



They obtained the following results:

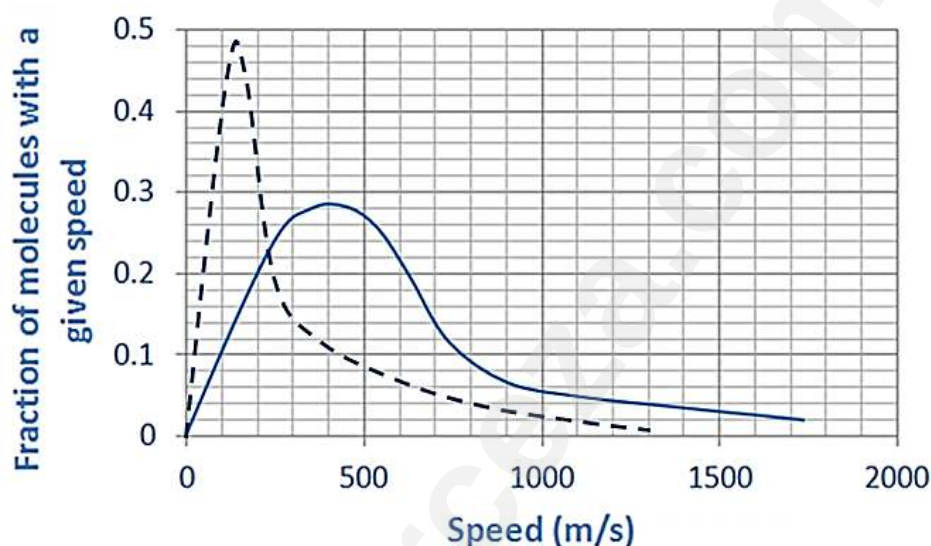
Sample Data and Results

Beaker	Volume of $\text{Na}_2\text{S}_2\text{O}_3$ (mL)	Volume of H_2O (mL)	$[\text{Na}_2\text{S}_2\text{O}_3]$, M	Reaction time (sec)
1	50	0	0.15	22.5
2	40	10	0.12	27.3
3	30	20	0.090	35.1
4	20	30	0.060	60.0
5	10	40	0.030	159.1

- 4.1 What is meant by *rate of reaction*? (1)
- 4.2 In order to determine when the reaction has gone to completion, the opacity of the precipitate is measured. Maria says that a change in mass would not be a suitable method of measuring the rate of this reaction. Explain why she is correct. (1)
- 4.3 Aside from changing the concentration of the sodium thiosulphate, Ilias knows that there are two other factors contributing to the rate of the reaction that could be investigated. What would those two factors be? (2)

- 4.4 Explain in terms of collision theory why concentration affects the rate of the reaction. (2)
- 4.5 Plot the data gathered on a suitable graph. (7)

The graph below is a Maxwell-Boltzmann distribution curve for this same reaction at two different temperatures.



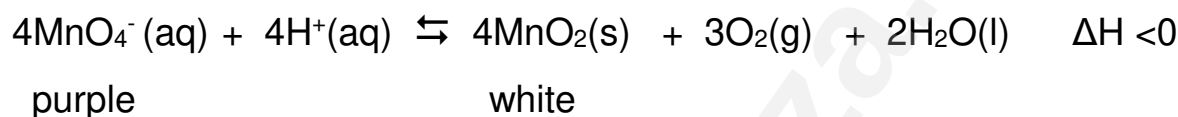
- 4.6 Explain why the x-axis being given as speed instead of energy is an acceptable variable. (1)
- 4.7 Which line, dotted or solid, represent the reaction taking place at a higher temperature? (1)
- 4.8 If the activation energy for the forward reaction is given as 150kJ and the activation energy for the reverse reaction is given as 200 kJ, draw and fully label the energy profile graph for this reaction. (5)

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QUESTION 5

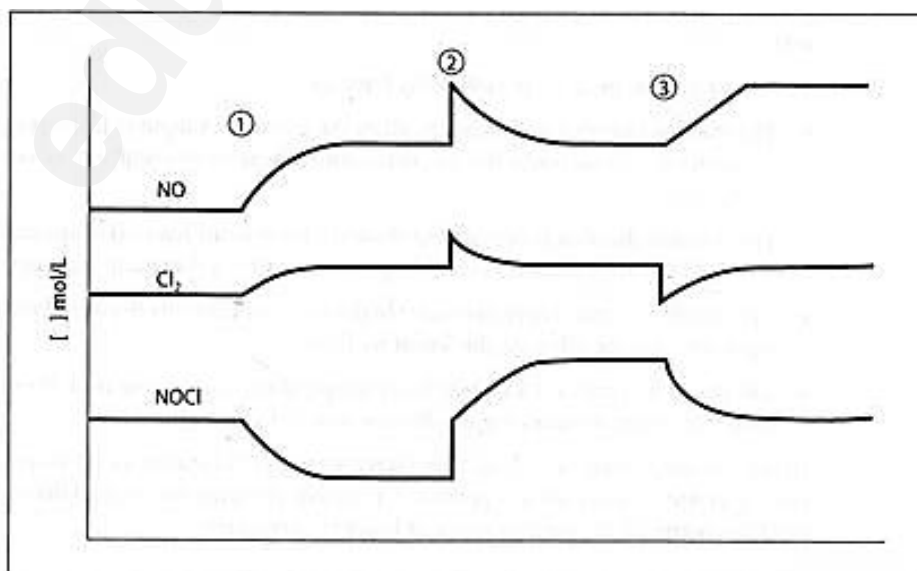
Gerry and William are working peacefully together on an equilibrium demonst ration. Orch is tired of the usual pink and blue solutions, so they decide to use a purple one instead. (#notaboutthatpinklife)

Their following reaction takes place in aqueous solution and reaches equilibrium at 450K as shown below:



- 5.1 What is meant by *chemical equilibrium*? (1)
- 5.2 State le Chatelier's principle. (2)
- 5.3 Explain what effect increasing the temperature would have on this equilibrium. (3)
- 5.4 If Gerry adds dilute hydrochloric acid is added to the solution, fully explain what he would observe. (4)
- 5.5 Write the expression for the equilibrium constant for this reaction at 450K. (2)
- 5.6 What effect would increasing the pressure have on the equilibrium constant? (1)

The graph below shows three different stresses on the reaction given:



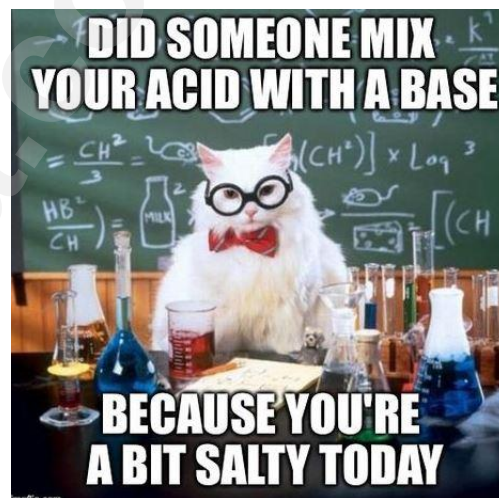
- 5.7 If the change that occurred at time marked 1 corresponds to when William cooled the reaction vessel, explain whether the forward reaction is exothermic or endothermic. (3)
- 5.8 Explain fully the change that took place at time marked 2. (3)
- 5.9 Would the value of the equilibrium constant between intervals 1 and 2 be the same as between 2 and 3? Explain your answer. (2)

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QUESTION 6

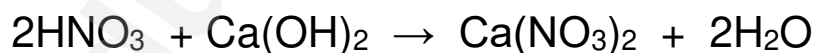
Kat and Kimon are more inspired by titrations, and so they mix up a standard solution of calcium hydroxide by adding 10 g of solute to make up a concentration of 2 mol.dm^{-3} .

- 6.1 Calcium hydroxide is a base, what does that mean in terms of Bronsted-Lowry theory? (1)
- 6.2 Calculate the volume of water Kimon needs to add to the solute in order to make up the 2 mol.dm^{-3} solution. (5)
- 6.3 What is the concentration of hydroxide ions in the solution? (1)
- 6.4 Using your answer above, calculate the concentration of hydronium ions in solution. (3)



25 cm^3 of the standard solution prepared above is then titrated with nitric acid and it is found that 30 cm^3 of the acid is neutralized by 25 cm^3 of the base.

Kat correctly gives the balanced chemical equation as follows:



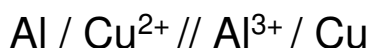
- 6.5 What is meant by a *strong acid*? (1)
- 6.6 Show the ionization of nitric acid and indicate conjugate acid and base pairs. (2)
- 6.7 Calculate the concentration of the nitric acid. (6)
- 6.8 Use hydrolysis to explain the pH of the end solution. (2)
- 6.9 The K_a value for nitric acid at 298 K is $28,2$. If the concentration of an initial solution of nitric acid is given as $0,8 \text{ mol.dm}^{-3}$, calculate the concentration of the nitrate ions in solution once equilibrium has been established in a 1 dm^3 container. (4)

QUESTION 7

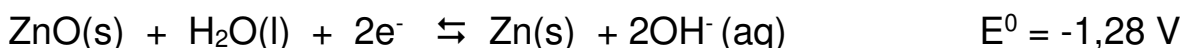
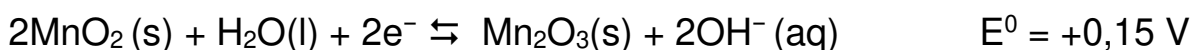
When life gives them lemons, Alexis and Dale make lemon batteries... and then shock people.. what? Who said that? To do this they investigate electrochemical cells.

- 7.1 What energy conversion takes place in a galvanic cell? (1)

Consider the following galvanic cell:



- 7.2 They have deliberately written an incorrect cell notation for their Al-Cu galvanic cell. Rewrite the full cell notation correctly. (3)
- 7.3 What standard conditions would be applicable to this cell? (2)
- 7.4 Write the equation for the reaction taking place at the anode. (2)
- 7.5 Give the formulae for suitable electrolytes for the anode and cathode respectively. (2)
- 7.6 Define reduction. (1)
- 7.7 Dale says that if this cell is connected to a bulb that needed 2 V to function, the bulb would light up. Is he correct? Justify your answer with a calculation. (4)
- 7.8 In order to complete the circuit, a salt bridge is needed. Explain how the electrolyte in the salt bridge functions in order to maintain electrical neutrality at the anode? (2)
- 7.9 Alexis decides that using a salt bridge with a wider diameter could change how their cell functions. What effect would this have on:
- 7.9.1 the current produced
- 7.9.2 the emf of the cell (2)
- 7.10 The cell is allowed to run for 1,5 hours and produces a current of 30 mA. Calculate the change in the mass of aluminium if the electrode initially had a mass of 50 g. (7)
- 7.11 Secondary cells are rechargeable cells and a popular choice is the zinc-alkaline cell. Below are the two half reactions for this cell:



Use the given half-reactions to write the oxidation, reduction and overall equation for the reaction when the cell is **recharging**. (4)



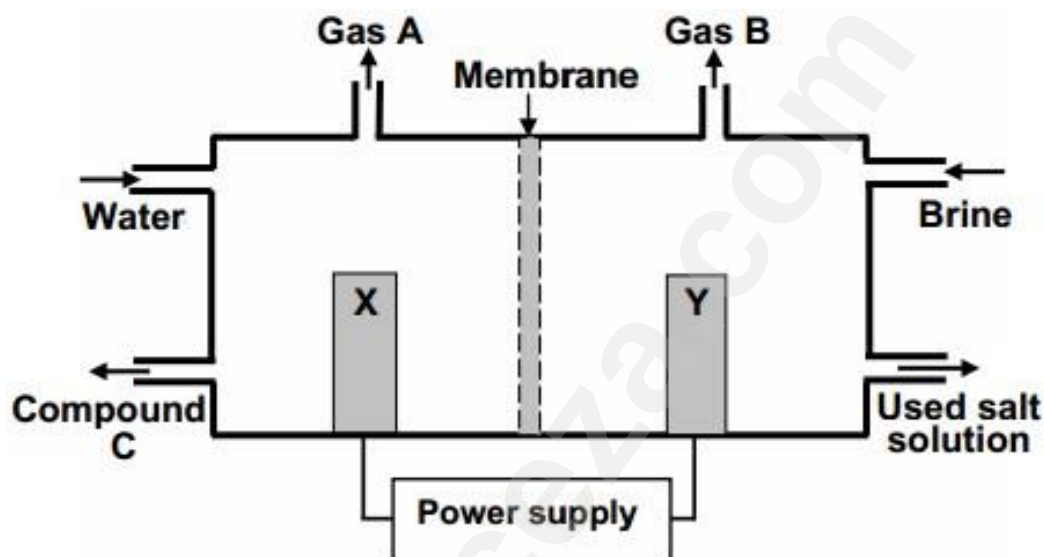
WHEN LIFE GIVES YOU LEMONS

make lemonades!

QUESTION 8

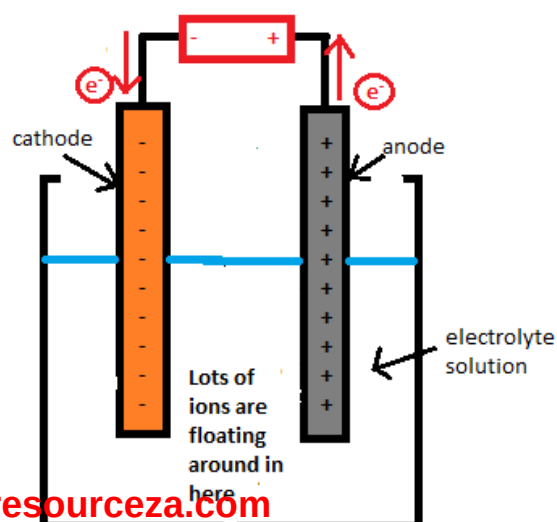
Stef and Kyle are revising some theory regarding industrial applications of electrolysis, because we all know how much Kyle totally loves learning definitions and theory off by heart.

Stef draws the simplified sketch below showing the membrane cell used in the manufacture of chlorine gas.



- 8.1 What is the chemical formula for brine? (1)
- 8.2 Which is the anode, X or Y? Explain your answer. (1)
- 8.3 Give the names of gas B and compound C. (2)
- 8.4 Why would Stef say that this cell is classified as an electrolytic cell? (1)
- 8.5 Give the equation for the reaction taking place at electrode X. (2)
- 8.6 Write the overall cell reaction. (2)
- 8.7 What is the function of the polymer membrane in this cell? (1)
- 8.8 Explain one advantage the mercury cell has over the membrane cell in terms of the cathode intermediate step. Refer to a suitable equation as part of your answer. (2)

Kyle would rather electroplate the bumper of his car with chrome than do theory. He gives Stef this very helpful diagram to explain what needs to be done:



- 8.9 To which electrode should he connect the bumper? (1)
- 8.10 In the electrolyte solution, there are evidently “a lot of ions floating around”. Give the formulae of two ions these could possibly be. (2)
- 8.11 What voltage would be required in order for the electroplating to take place? (1)
- 8.12 Write the equation for the reaction taking place at the anode. (2)

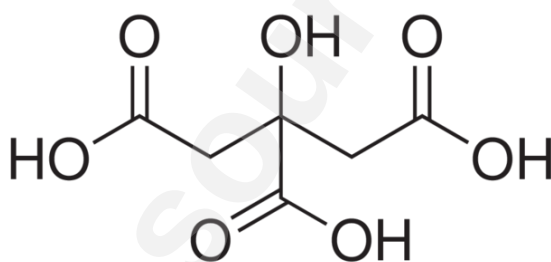
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QUESTION 9

Tyag and Justus aren't feeling challenged enough by the organic chemistry syllabus, so they look up citric acid to see how much they really know.

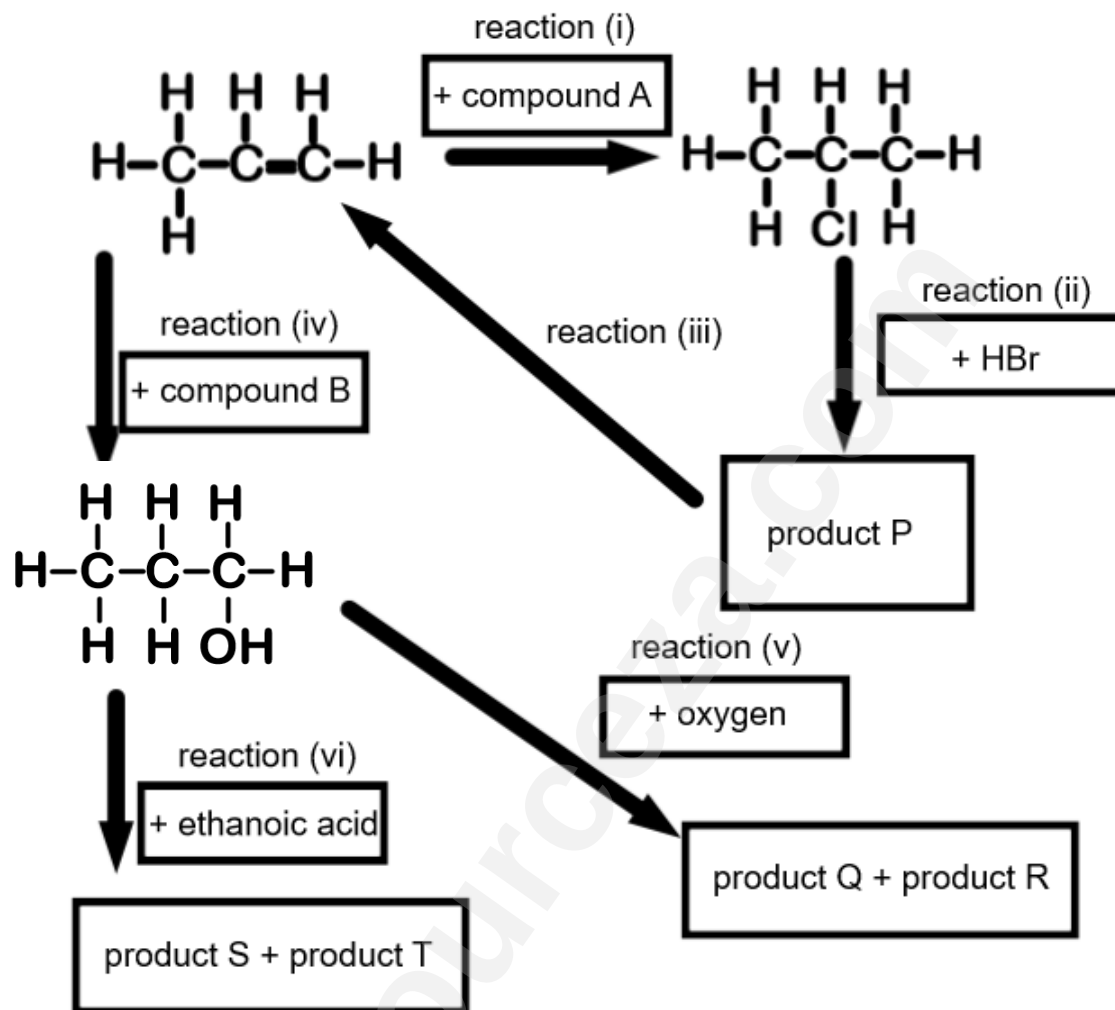
- 9.1 Explain what is meant by a *homologous series*. (1)

Use the molecule of citric acid shown below to answer the question 9.2 – 9.4 that follow:



- 9.2 Tyag says the molecule is unsaturated, Justus says it's saturated. Who is correct? (1)
- 9.3 Identify two different functional groups present in the molecule and name them. (2)
- 9.4 Would you expect this compound to have a high or low boiling point? Explain your answer. (2)

Use the flow chart below to answer questions 9.5 – 9.15



- 9.5 Give the chemical formula of compound A. (1)
- 9.6 What is the name of the homologous series to which the product of reaction (i) belongs? (1)
- 9.7 Give the condensed structural formula of product P and give its IUPAC name. (2)
- 9.8 Give the chemical formula of compound B. (1)
- 9.9 Using structural formulae, show reaction (iv) which forms products S and T. Name the organic product of this reaction. (4)
- 9.10 Give the classification of the reaction types (specific name if applicable) for the reactions numbered (i) to (vi) (6)
- 9.11 What is meant by *isomer*? (2)
- 9.12 Draw and name an isomer of the product of reaction (iv) (2)
- 9.13 Would reaction (i) or reaction (ii) be quicker? (1)
- 9.15 Under what conditions would reaction (vi) take place? (1)
- 9.16 Give the names of products Q and R. (1)

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