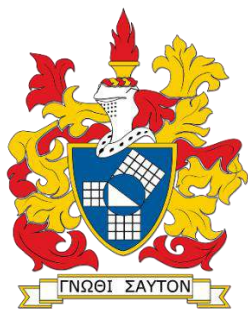




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MARCH BLOCK TEST 2022



SAHETI SCHOOL

PHYSICAL SCIENCE

GRADE 12

PAPER 2 : CHEMISTRY

EXAMINER : C ORCHISON

DATE : 08 APRIL 2022

MODERATORS : M RAMUTHAGA-MUSAMPA

HOURS : 3 HOURS

J. NAIDU

MARKS : 200

NAME : _____

INSTRUCTIONS AND INFORMATION

1. This question paper consists of 30 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. You may use a non-programmable calculator and appropriate mathematical instruments.
6. Use the mark allocation as guide to the maximum time you should spend on a question.
7. Use bullet points for all explanations.
8. Round all answers to 2 decimal places and include the correct SI unit.
9. The optimist sees the glass half full, and the pessimist sees the glass half empty...
but the chemist knows that its always completely full 😊

Chemists in
1925



I'm going to pipette
 H_2SO_4 using my mouth

Chemists now



Help, 0.00001M
acetic acid fell
on my glove

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

WHICH OF THE FOLLOWING FAMOUS PEOPLE DO NOT HAVE A SCIENCE DEGREE ?

- A COLE SPROUSE (JUGHEAD IN RIVERDALE)
- B POPE FRANCIS JORGE BERGOGLIO
- C NATALIE PORTMAN (PADME IN STARWARS)
- D ROWAN ATKINSON (MR BEAN)

BONUS QUESTION FOR A CHOCOLATE:

WARNING



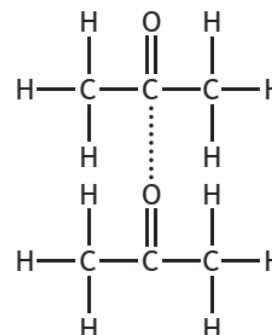
I DO MY OWN SCIENCE

- 1.1 Consider the molecule shown alongside, and the intermolecular forces listed below:

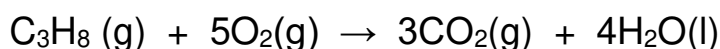
- I – London forces
- II – dipole-dipole forces
- III – hydrogen bonding

Which of the intermolecular forces are present in the molecule?

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



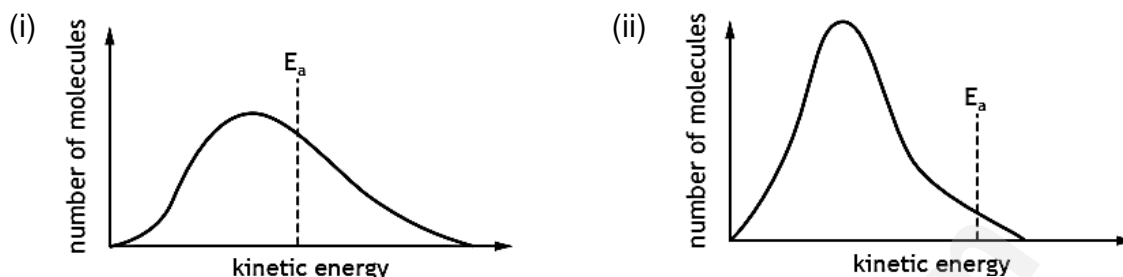
- 1.2 1 mol of propane gas burns in 6 mol of oxygen gas as shown in the reaction below:



At the end of the reaction, the **total** moles of gas at STP would be:

- A 3 mol B 4 mol C 7 mol D 8 mol

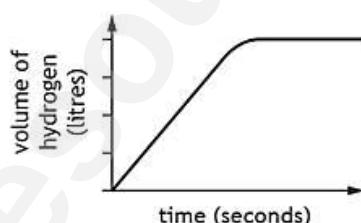
- 1.3 Consider the two Maxwell-Boltzmann distribution curves shown below for the same reaction under different conditions :



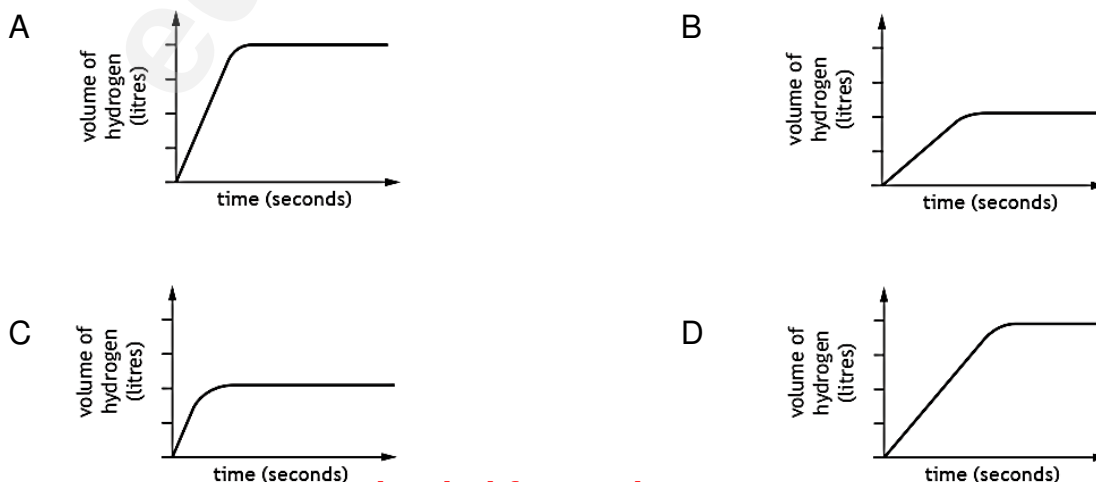
Which of the following correctly gives the changes made to reaction conditions (i) to produce graph (ii) ?

	Mass of reactant	Temperature	Catalyst
A	Same	Increased	Added
B	Doubled	Same	Added
C	Doubled	Same	No catalyst
D	Same	Decreased	Added

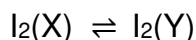
- 1.4 Zinc lumps are added to 100 cm^3 of a $2 \text{ mol} \cdot \text{dm}^{-3}$ hydrochloric acid solution and the graph below shows the volume of hydrogen gas produced by the reaction:



Which of the graphs below would correspond to the reaction between excess zinc powder and 50 cm^3 of a $2 \text{ mol} \cdot \text{dm}^{-3}$ solution of hydrochloric acid?



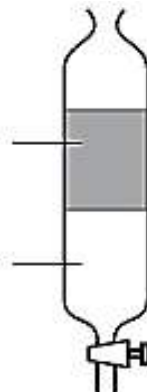
- 1.5 Iodine is added to two immiscible solvents, X and Y, as shown in the diagram. The mixture is shaken and the following equilibrium is established:



An additional 10 cm³ of solvent X is added, and the mixture is once again shaken and allowed to reach equilibrium. Which of the following statements is true?

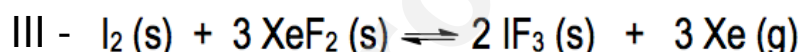
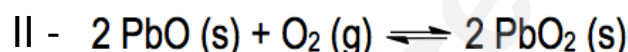
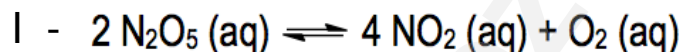
I₂ in 50 cm³ of solvent X

I₂ in 50 cm³ of solvent Y



- A the concentration of I₂ in solvent Y decreases
- B the concentration of I₂ in solvent Y increases
- C the equilibrium constant increases
- D the equilibrium constant decreases

- 1.6 In which of the following reactions will an increase in pressure favour the reverse reaction?

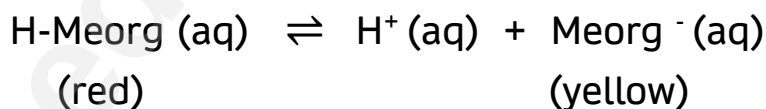


- A I only
- B II only
- C III only
- D I and III

- 1.7 Adding which of the following substances will **not** increase the pH of an acidic solution?

- A NaNO₃
- B HNO₃
- C H₂O
- D Li₂SO₄

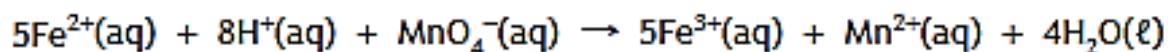
- 1.8 The equation for the indicator methyl-orange (H-Meorg) is given below:



What colour is the indicator in a solution of potassium chloride?

- A red
- B yellow
- C orange
- D pink

1.9 Consider the following redox reaction:

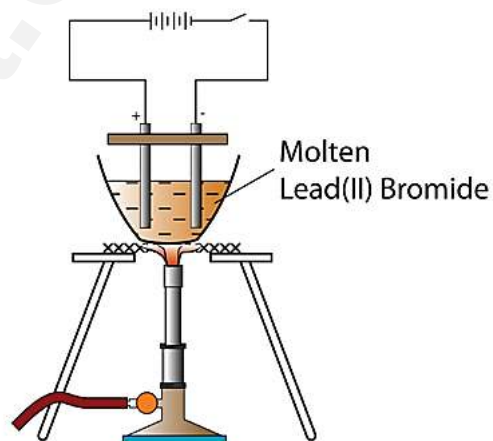


Which of the following statements are true?

- A manganese ions are oxidized
- B hydrogen ions are the reducing agent
- C iron undergoes reduction
- D permanganate ions are reduced

1.10 Which of the options below correctly identifies the species that undergo reduction and oxidation in the electrolysis of lead (II) bromide?

	Oxidation	Reduction
A	Pb^{2+}	Br^{-}
B	Br_2	Pb^{2+}
C	Br^{-}	H_2O
D	Br^{-}	Pb^{2+}



20 MARKS

QUESTION 2

Batman sends word to Superman that Lex Luthor, nemesis and general bad guy, is rumoured to have stolen and stashed a number of dangerous substances in a lair under his mansion !

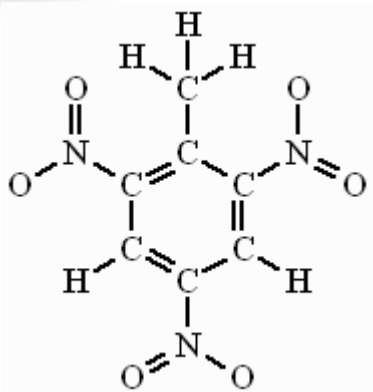
Superman uses his x-ray vision to have a look inside the vault and discovers the following:



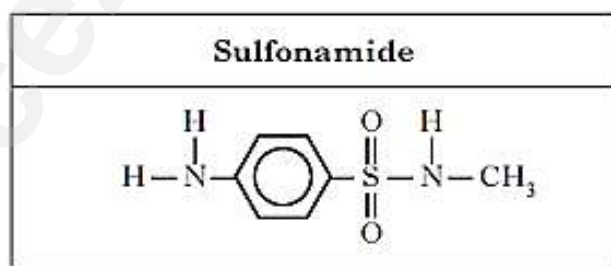
X - RAY VISION



CH₃OH - fuel source
S₂Cl₂ - toxic gas prep.
SiO₂ - microelectronics
Br₂ - insecticides
PbI₂ - carcinogen
sulphonamide
TNT - explosives



TNT - trinitrotoluene



2.1 Identify which of the substances contain non-polar covalent bonds. (1)

2.2 Draw the Lewis diagram for the S₂Cl₂ molecule. (3)

2.3 Define *intermolecular force*. (1)

2.4 Superman wants to dissolve TNT in water. Explain by making reference to the relevant intermolecular forces if this will be successful or not. (3)

2.5 Lex knows that lead (II) iodide is not only toxic but can also conduct current when aqueous. He believes this is because it contains a metal which contributes delocalized electrons. Is Lex correct? Explain your answer fully. (2)

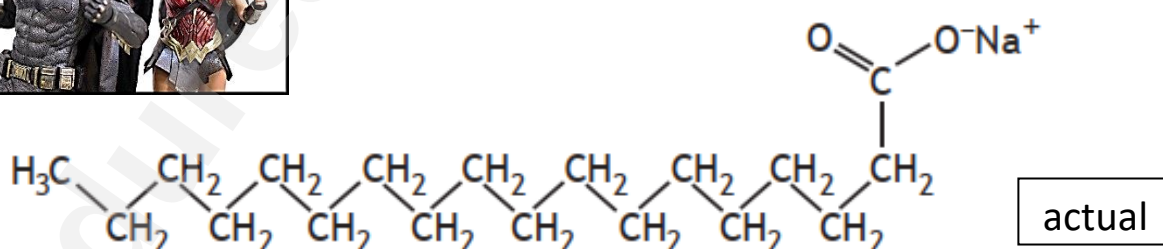
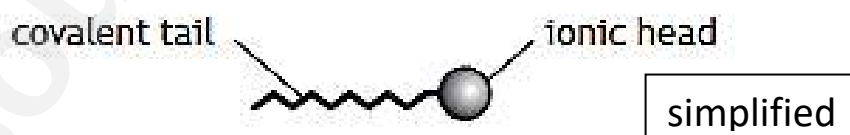
2.6 Name the predominant intermolecular force present in sulphonamide. (1)

- 2.7 Trinitrotoluene has a melting point of 80,35 °C and silicon dioxide has a melting point of 1710 °C. Explain this difference in melting point fully by referring to all relevant intra- and intermolecular forces. (4)



Superman pops in at Wayne Manor because he notices that there is a nasty oil stain on his cape, and he knows that Alfred will help with removing it.

Batman shows him the structure of a detergent molecule, showing a non-polar tail and an ionic head.



- 2.8 In the diagram below, using the simplified diagram of the detergent molecule, show how they will embed into the oil stain on his suit to surround the molecule and dissolve it. (2)



- 2.9 Would the detergent molecules behave the same if the stain had been red wine, which contains water and ethanol? Explain your answer fully. (3)

20 MARKS

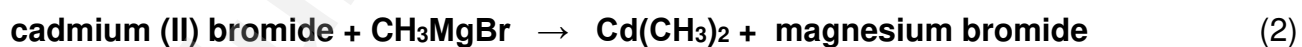
QUESTION 3

Kevin Crumb, who is suffering from dissociative identity disorder, has 23 vastly different alter egos. The elderly Patrica tries to keep another terrifying personality "The Beast" subdued. The Beast is familiar with the deadly toxin, dimethylcadmium.

when you don't need a squad bc you are the squad



- 3.1 Write and balance the chemical equation for the production of dimethylcadmium given below:



- 3.2 Define *concentration*. (1)

- 3.3 The Beast reacts 100 g of cadmium(II)bromide with 250 cm³ of a 1,5 mol.dm⁻³ solution of CH₃MgBr. Determine by calculation which is the limiting reagent. (6)

- 3.4 Define *percentage yield*. (1)

- 3.5 Calculate the mass of dimethylcadmium produced if the percentage yield is 83%. (5)

QUESTION 4

Phineas and Ferb are hiding from Candace and investigating the reaction between peroxodisulphate (VI) ions and iodide ions. This produces iodine which they have read can be used to improve their brain functions.



This is the information they find on the process:

Peroxodisulphate (VI) ions and iodide ions react together in aqueous solution to form sulphate(VI) ions and iodine.



This reaction is catalysed by a number of transition metal ions including Fe^{2+} and Fe^{3+} .

If a small amount of Fe^{2+} ions are added to the reaction mixture, the reaction proceeds as follows:



4.1 Define *catalyst*.

(1)

4.2 Explain how the given equations confirm that Fe^{2+} is considered to be catalyst.

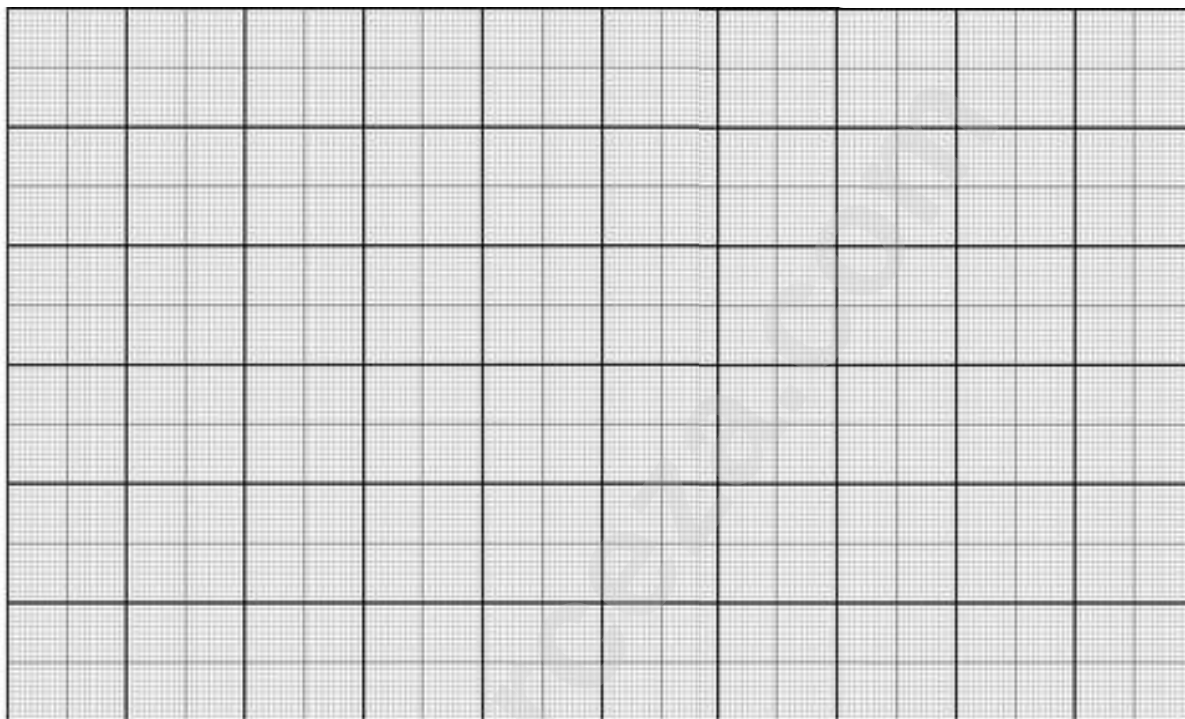
(1)

They change the concentration of iodide ions to see the effect this will have on the rate of the reaction and tabulate the gathered data:

Experiment	Concentration of $\text{I}^-(\text{aq})$ (mol l^{-1})	Concentration of $\text{S}_2\text{O}_8^{2-}(\text{aq})$ (mol l^{-1})	Time (s)
1	0.04	0.05	241
2	0.06	0.05	180
3	0.08	0.05	125
4	0.1	0.05	103

4.3 Plot a suitable graph of these results on the axes provided below:

(7)



4.4 Define *rate of reaction*.

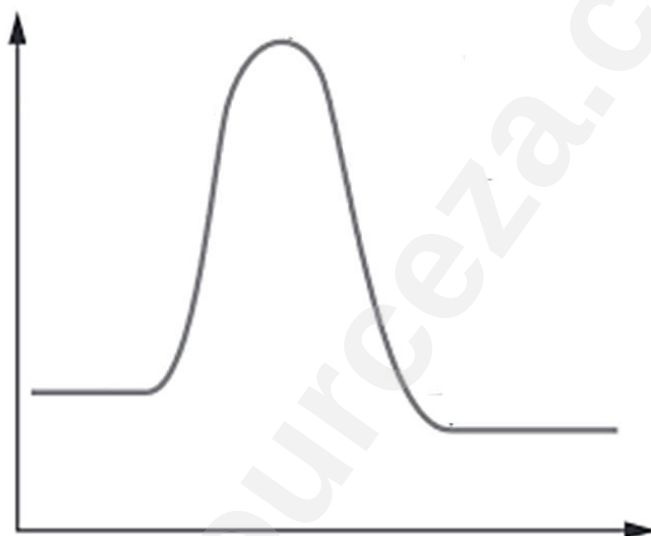
(1)

4.5 Explain how the change in concentration affected the rate of the reaction by referring to collision theory.

(4)

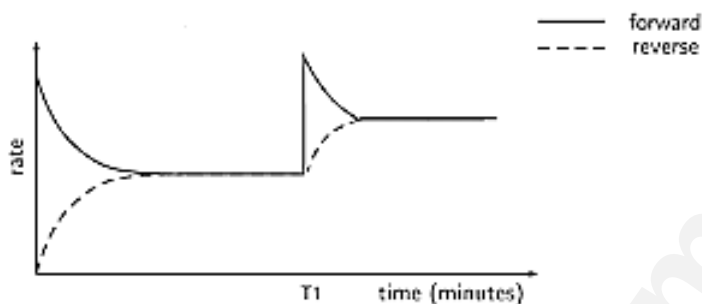
4.6 Define *exothermic reaction*. (1)

4.7 The reaction is exothermic, and Phineas sketches the energy profile graph below. Fully label the graph, and include the effect of the Fe^{2+} ions on the reaction. (5)



4.7 Ferb says that increasing the temperature of the reaction will decrease the rate of the forward reaction and increase the rate of the reverse reaction since the reaction is exothermic. Is he correct? Explain your answer. (2)

- 4.8 Would the graph below correctly show the effect of an increase in concentration of the peroxodisulphate (VI) ions if this change happened at time T_1 ? Explain your answer. (2)



24 MARKS

QUESTION 5

Detective L is on a mission to apprehend Light Yagami, who is in possession of the “Death Note”, a mysterious book which grants the user the ability to kill anyone whose name is written in it. Detective L wonders if he is able to reverse the effects of the book by using bleach to erase the ink on the pages.

Me, trying to remember the name of the detective with an “L” symbol from Death Note



The equation below shows how bleach exists in equilibrium:

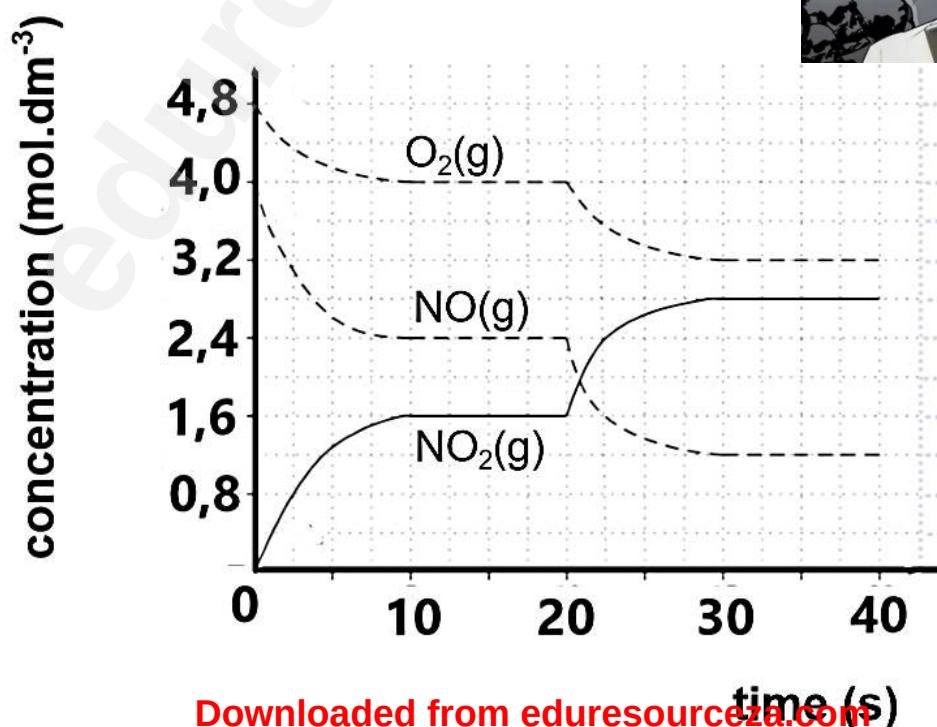


- 5.1 State *Le Chatelier's principle*. (1)

- 5.2 Detective L adds sulphuric acid to the container thinking it will add to the effectiveness of the bleach solution. Explain fully how this would affect the concentration of the bleach ions in (OCl^-) solution. (3)

- 5.3 Another of his elite Japanese task force suggests that increasing the pressure would increase the concentration of the bleach ions. Explain if he is correct or not. (3)

Light knows that although the usual cause of death is a heart-attack, nitrogen (IV) oxide poisoning would work just as well. He investigates the reaction shown below which takes place in a sealed 900 dm³ container.



5.4 Write the balanced equation for this reaction. (3)

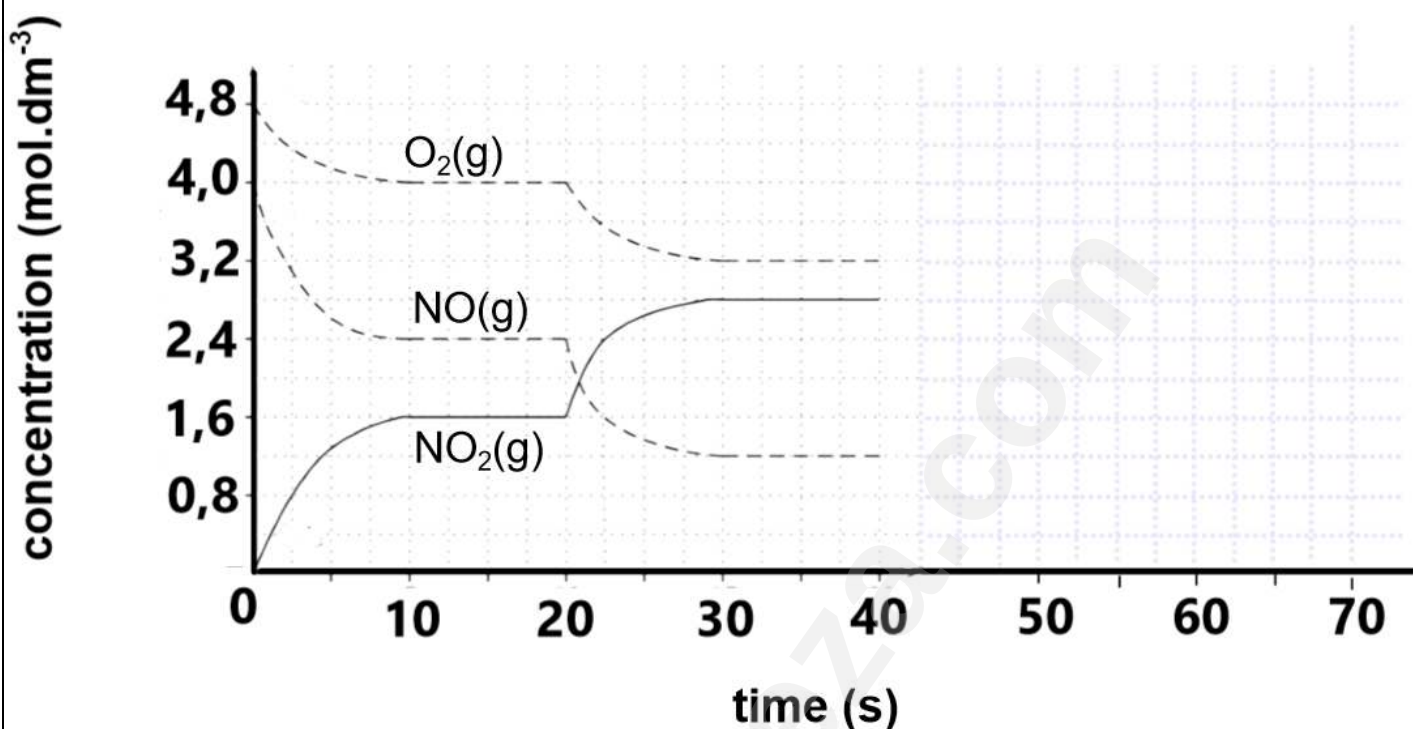
5.5 At 20 seconds, the temperature of the reaction vessel was **decreased**. Light suspects that the changes which took place to re-establish equilibrium indicate that the forward reaction is endothermic. Explain fully if he is correct or not. (3)

5.6 Write the expression for the equilibrium constant for this reaction. (2)

5.7 Calculate the value of the equilibrium constant at $t = 15$ seconds. (3)

5.8 Explain whether this value would increase, decrease or remain the same if calculated at $t = 35$ seconds. (3)

5.9 At time $t = 40$ seconds, the volume of the reaction vessel was decreased and equilibrium was re-established at $t = 60$ seconds. Show this on the graph below. (4)



5.10 Light repeats the reaction in a different vessel and obtains the following results:

$$K_c = 1,067$$

mass of $O_2 = 6,12 \text{ g}$

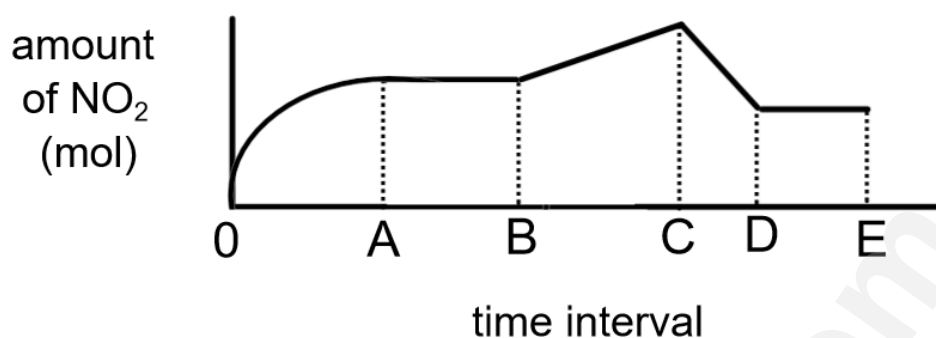
$$[\text{NO}] = 2,5 \text{ mol.dm}^{-3}$$

$$[\text{NO}_2] = 2 \text{ mol.dm}^{-3}$$

Calculate the volume of the container that Light used. (7)

[illegible]

5.11 Consider the graph below.



Which time intervals correspond to the following times on the original graph in 5.9 ?

5.11.1 $t = 0 - 10$ seconds _____ (1)

5.11.2 the addition of a catalyst _____ (1)

34 MARKS

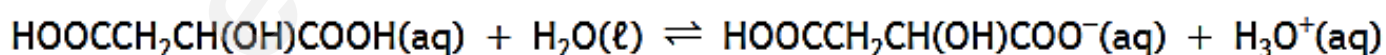
QUESTION 6

In a scandalous move The Prego Boyz have been sabotaged and their secret prego sauce has been tampered with ! Shock and horror ! Traces of malic acid, a weak acid found in jam, are discovered on a spoon lying near the sauce.



6.1 Define a *weak acid*. (1)

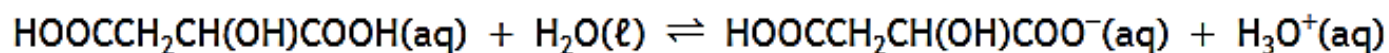
The diprotic acid dissociates in two steps, the first of which is shown below:



6.2 Explain why this statement is incorrect. (2)

6.3 Show the conjugate acid-base pairs on the equation given below.

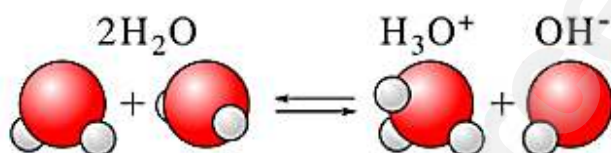
(3)



6.4 Why is the acid classified as being *diprotic* ?

(1)

6.5 The diagram below illustrates the auto-ionization of water and the table alongside it shows how the pH of the water changes as the temperature changes.



Temperature/ °C	pH
20	7.08
30	6.92
50	6.63

Use this information to fully explain whether the auto-ionization of water is an exo or endothermic reaction.

(4)

Pickles were also discovered in the sauce.. Scandal ! Calcium hydroxide solution is used for pickling, and a jar of it has been spilt on the counter. The concentration of the calcium hydroxide is $0,03 \text{ mol.dm}^{-3}$.

6.6 Write the dissociation reaction for calcium hydroxide in water. (3)

6.7 Calculate the concentration of hydronium ions in the calcium hydroxide solution at 25°C . (3)

Near to the scene of the jammy crime, they discover that their soda-machine has ALSO been a victim ! The soda machine uses carbonic acid to carbonate water. They need to refill the machine and find the original stock of carbonic acid, but are concerned that the percentage purity has decreased. They dissolve 2 g of the carbonic acid into distilled water and make the solution up to 100 cm^3 .

They then titrate 30 cm^3 of this with 10 cm^3 of sodium hydroxide. The concentration of the standard sodium hydroxide solution is $0,75 \text{ mol.dm}^{-3}$.



6.8 Write a balanced chemical equation for this reaction. (4)

6.9 Define *standard solution*. (1)

6.10 Calculate the number of moles present in the sodium hydroxide solution. Give your answer in scientific notation (3)

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Indicator	Approximate pH Range for Color Change	Color Change
methyl orange	3.1–4.4	red to yellow
bromthymol blue	6.0–7.6	yellow to blue
phenolphthalein	8–9	colorless to pink
litmus	4.5–8.3	red to blue
bromcresol green	3.8–5.4	yellow to blue
thymol blue	8.0–9.6	yellow to blue

(1)

6.13 Define *hydrolysis*.

(1)

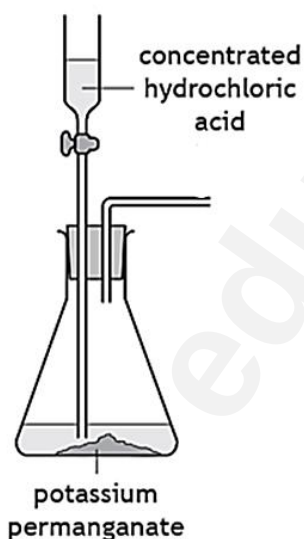
6.14 Use a hydrolysis **equation** to support your answer to 6.12 above.

(4)

40 MARKS

QUESTION 7

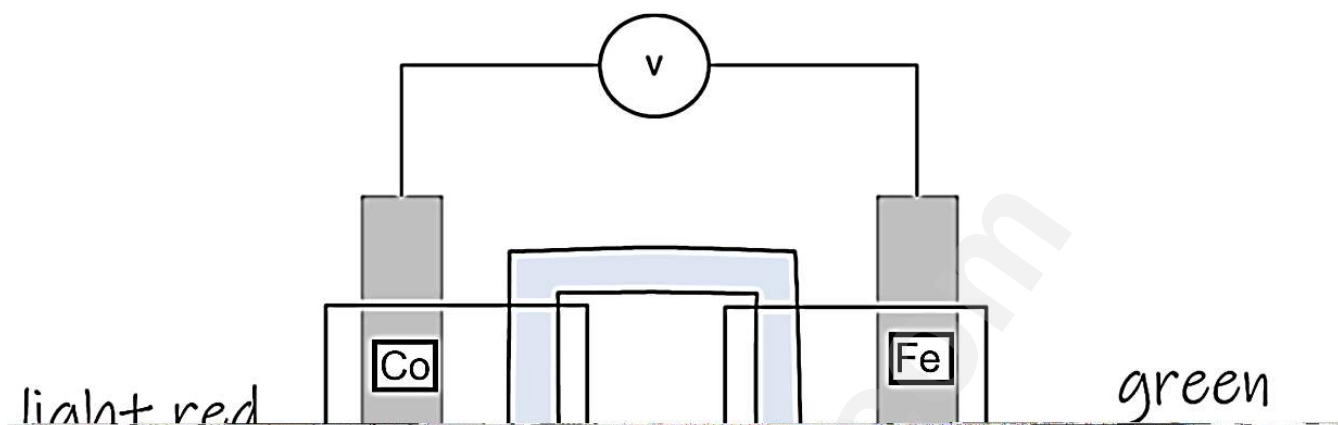
Eleven is having nightmares about being back in the Hawkins laboratory. She looks around and sees the following apparatus set up in order to produce chlorine gas to poison her made from the potassium permanganate used to treat her wounds:



7.1 Use your knowledge of the reduction table to predict whether this reaction will be spontaneous or require an energy source to take place.

(3)

In her nightmare, the lab is powered by Eskom, which means it has frequent outages and so the scientists are discussing using electrochemical cells as voltage sources. One such cell is shown below:



7.2 Define *anode*. (1)

7.3 Give the symbol for the cathode in this cell. (1)

7.4 Write the oxidation, reduction and net ionic reaction for this cell. (4)

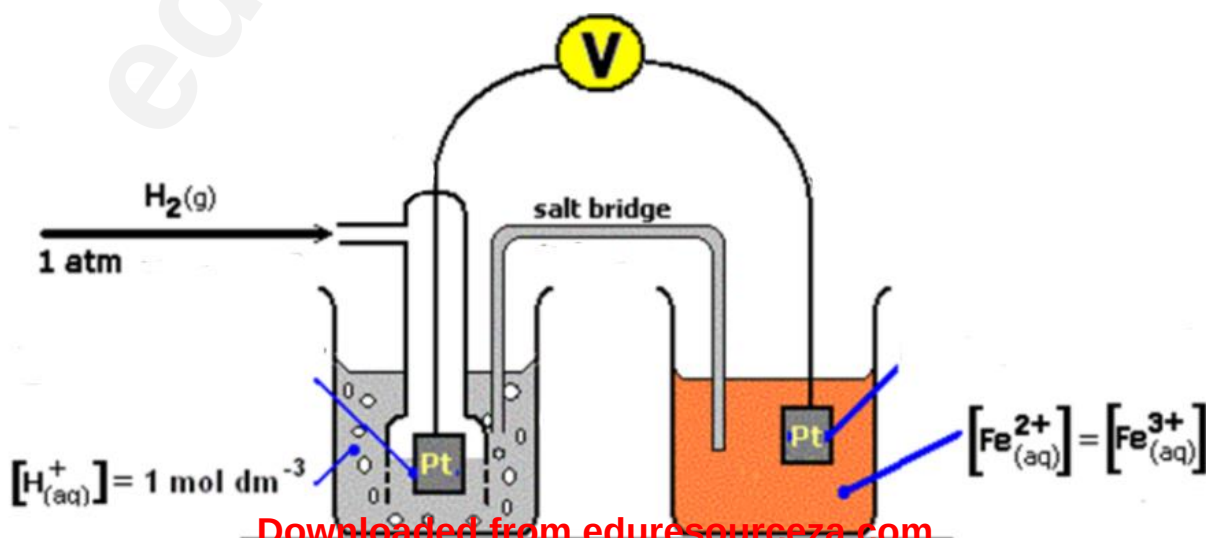
7.5 Describe and explain all changes that would be observed at the **cathode** half cell after a period of time. (4)

7.6 Calculate the emf this cell produces under standard conditions. (3)

7.7 Eleven overhears one of the scientists say that they are going to add cobalt (II) chloride crystals to the beaker on the left because that will increase the voltage of the cell. Are they correct? Explain your answer fully. (3)

7.8 Explain how the **cations** in the salt bridge move in order to maintain electrical neutrality in the relevant half cell. (2)

Eleven notices another cell as shown below, which contains Fe^{3+} and Fe^{2+} ions in the beaker on the right and an acidified solution in the beaker on the left.

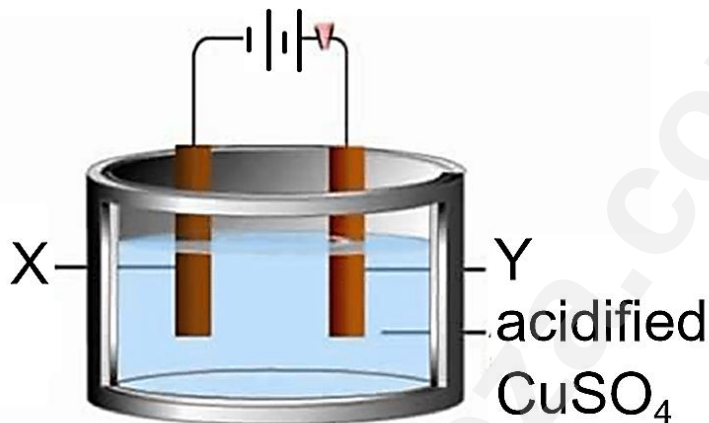


- 7.9 Explain the function of the platinum in the two half cells. (1)
- _____
- _____
- _____
- _____
- 7.10 Write the symbolic cell notation for this cell under standard conditions. (4)
- _____
- 7.11 Define *oxidizing agent*. (1)
- _____
- _____
- 7.12 Identify the oxidizing agent in this cell. (1)
- _____
- 7.13 What is the purpose of the hydrogen half cell with respect to the reduction table? (1)
- _____
- _____
- 7.14 Eleven notices that the scientists replace the salt bridge with one that is longer.
Circle the effect this will have on :
- 7.14.1 the emf of the cell? INCREASE / DECREASE / STAYS THE SAME (1)
- 7.14.2 the current of the cell? INCREASE / DECREASE / STAYS THE SAME (1)

31 MARKS

QUESTION 8

Burdine, the 'Reigning Queen of Fashion' has decided to launch a new gold-plated jewellery range to accessorize her pink pumps. She explains to Cloe and Sasha that you can extract gold from lumps of impure copper. Cloe and Sasha know that electrolysis is the key to retrieving the gold so they set up the following electrolytic cell:



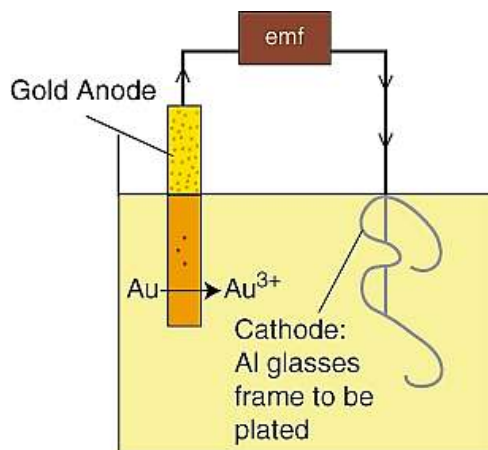
8.1 Which electrode is the pure copper formed at? X or Y ? (1)

8.2 Why is the solution acidified? (1)

8.3 What is this specific process called? (1)

8.4 The impure copper contains gold and nickel. Fully explain what happens to each of these metals during this process. (4)

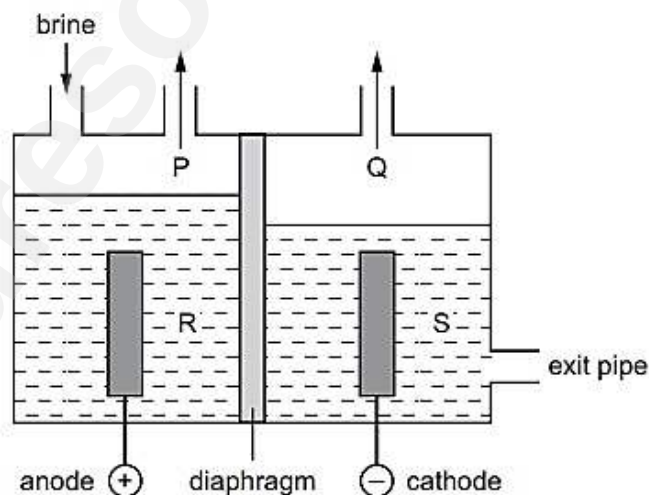
Once the Bratz girls have retrieved the gold they set about plating some retro aluminium glasses frames.



8.5 What voltage is required in order for this to take place under standard conditions? (1)

8.6 What is the net ionic reaction of this cell? (1)

Sasha is concerned that the music video she has in mind for the jewellery launch needs a sparkling pool so she pays a visit to the nearest Chlor-alkali plant to check that all is going smoothly. The diagram below shows one of the cells at the plant:



8.7 Is this the recommended cell type for the production of chlorine? Explain your answer. (2)

8.8 What is *brine* ? (1)

8.9 Write the equation for the ionic reaction taking place at the anode. (1)

8.10 What is the purpose of the diaphragm in this cell? (1)

8.11 Sasha is concerned that the sodium metal formed from the brine will be a problem. Is her concern warranted? Explain your answer. (2)

16 MARKS

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