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**HILTON COLLEGE
GRADE 12 TRIAL EXAMINATIONS
SEPTEMBER 2022**

**TOTAL
MARKS**

11/11/2019

PHYSICAL SCIENCES: PAPER II

EXAMINATION NUMBER

[illegible]

Examiner: Mr. KP Ntshontsho
Moderator: Mr. N Robert

Time: 3 hours
200 Marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 35 pages as well as a green DATA SHEET of 3 pages (i–iii). Please make sure that your question paper is complete.
2. Read the questions carefully.
3. Answer all the questions.
4. Unless instructed otherwise, you do NOT have to give state symbols (phase indicators) when asked to write a balanced chemical equation.
5. Use the data and formulae whenever necessary.
6. Show all the necessary steps in calculations.
7. Where appropriate, take your answers to two decimal places.
8. It is in your interest to write legibly and to present your work neatly.
9. Three blank pages (page 33 - 35) are included at the end of the question paper. If you run out of space for a question, use these pages. Clearly indicate the question number of your answer, should you use this extra space.

FOR OFFICE USE ONLY: MARKER TO ENTER MARKS

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ANSWERS FOR MULTIPLE CHOICE QUESTIONS

Question Number	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10
Answer										

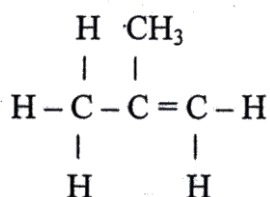
QUESTION 1: MULTIPLE CHOICE

Four options are provided as possible answers to the following questions. Each question has only **ONE** correct answer. **Write** only the letter (**A – D**) of the correct answer in **the table at the bottom of page 1**.

1.1 Which one of the following is the general formula for alkynes?

- A C_nH_{2n+2}
- B C_nH_{2n-2}
- C C_nH_{2n}
- D C_nH_{2n-1}

1.2



The correct systematic name for the above compound is...

- A but-1-ene
- B but-2-ene
- C methylpropane
- D methylpropene

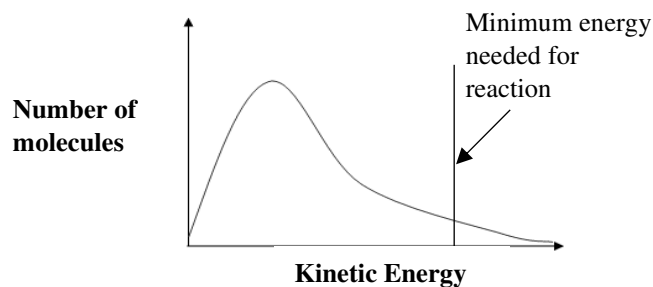
1.3 In the electrochemical cell, $\text{Al}_{(s)}|\text{Al}^{3+}_{(aq)}||\text{Fe}^{2+}_{(aq)}|\text{Fe}_{(s)}$, the oxidising agent is

- A Al
- B Al^{3+}
- C Fe^{2+}
- D Fe

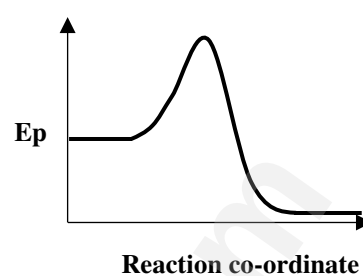
1.4 Which of the reactions represented below will NOT occur spontaneously under standard conditions?

- A $\text{Fe} + 2\text{H}^+ \rightarrow \text{Fe}^{2+} + \text{H}_2$
- B $2\text{Ag} + \text{I}_2 \rightarrow 2\text{AgI}$
- C $2\text{Na} + 2\text{H}_2\text{O} \rightarrow \text{H}_2 + 2\text{NaOH}$
- D $2\text{Sn} + \text{O}_2 + \text{H}_2\text{O} \rightarrow 2\text{Sn}^{2+} + 4\text{OH}^-$

- 1.5 The kinetic energy distribution curve of the reactant particles in a reaction mixture is shown in **Graph 1**. The potential energy profile for the reaction pathway without the presence of a catalyst is shown in **Graph 2**.

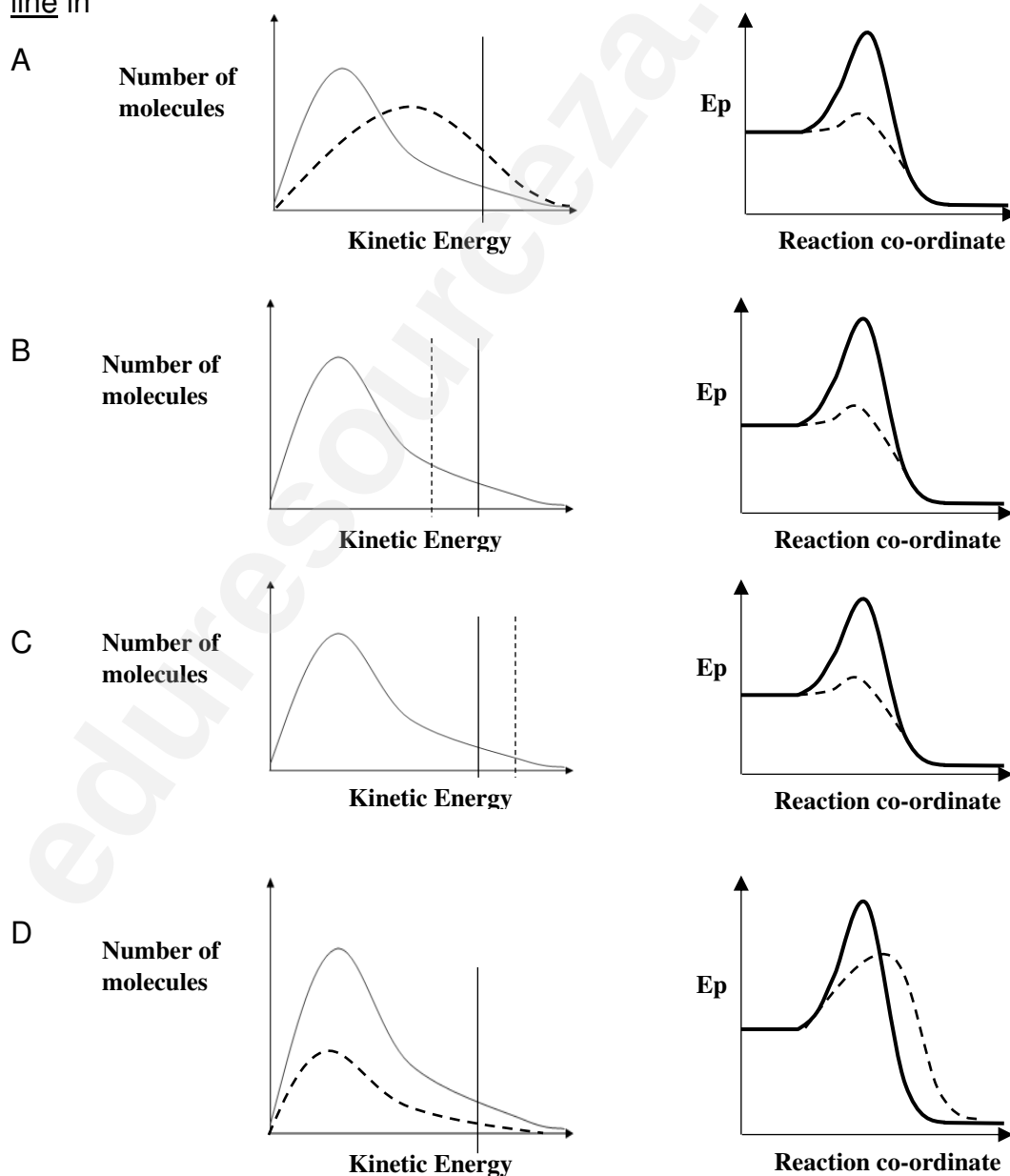


Graph 1



Graph 2

If the reaction is repeated **at the same temperature** but **in the presence of a catalyst**, the effect on Graphs 1 and 2 is most accurately shown by the dotted line in



- 1.6 The equilibrium reaction for the manufacture of XY_3 is given by the following chemical equation:



Which one of the following conditions will produce a **low yield** of $XY_{3(g)}$?

	Pressure	Temperature
A	low	low
B	high	high
C	low	high
D	high	low

- 1.7 A sodium hydroxide solution of concentration $0,1 \text{ mol.dm}^{-3}$ is added dropwise to a ethanoic acid solution of concentration $0,1 \text{ mol.dm}^{-3}$. Which ONE of the following substances will **increase** in concentration as sodium hydroxide is added dropwise?

- A H_3O^+
- B OH^-
- C CH_3COOH
- D H_2O

- 1.8 10 g of magnesium react with 10 g of HCl to produce a $MgCl_2$ salt and H_2 gas.

The balanced equation for this reaction is:

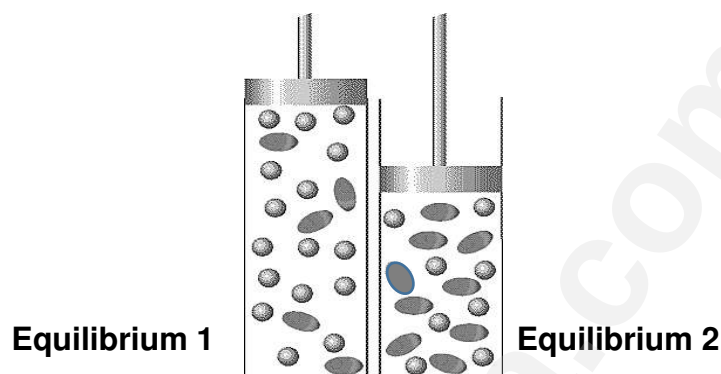


The mass of magnesium chloride produced (in grams) is:

- A 13.01 g.
- B 39,58 g.
- C 26,03 g.
- D 0.27 g.

- 1.9 A gas X (shown as  in the diagram) is placed into a closed container. After a short while, some of gas X reacts to form gas Y (shown as  in the diagram). Eventually, equilibrium between the two gases is reached (shown as **Equilibrium 1** in the diagram).

The volume of the container is decreased by pushing in the plunger as shown in the diagram. After a short while, the system reaches **Equilibrium 2**.



The reaction equation for the equilibrium between X and Y is:

- | | | | |
|---|---------------------------|---|-------------------------------|
| A | $X \rightleftharpoons Y$ | B | $X \rightleftharpoons 2Y$ |
| C | $2X \rightleftharpoons Y$ | D | $X + Y \rightleftharpoons XY$ |

- 1.10 While attempting to standardise an acid, two students each did five titrations. Their burette readings (from zero) are shown in the table below.

	Volume NaOH (cm ³) at end point				
Student A	24,93	24,75	25,02	25,16	24,98
Student B	25,02	25,53	24,16	23,75	24,63

If the expected volume was 25,00 cm³, which of the following statements is true?

- A Student A's results are more accurate and more precise than student B's results.
- B Student B's results are more accurate and more precise than student A's results.
- C Student A's results are more accurate but less precise than student B's results.
- D Student B's results are more accurate but less precise than student A's results.

[20]

QUESTION 2:

2.1 Define an *intermolecular force*.

(2)

2.2 Consider the following list of compounds:

Calcium carbonate (CaCO_3), Methane (CH_4), Hydrogen sulphide (H_2S)

Water (H_2O) and Ethane (C_2H_6)

2.2.1 Name the type of **intermolecular** force found in ethane.

(2)

2.2.2 Name the specific type of **intra**molecular bond found in calcium carbonate.

(2)

2.2.3 What type of **intra**molecular bond is found in H_2S ? Justify your answer with a calculation.

(3)

2.2.4 Which compound will have the highest melting point? Give a reason for your answer.

(2)

2.3 The table below shows the boiling points of methane and a selection of fluoromethanes.

Compound	Formula	Boiling point (°C)
Methane	CH ₄	−161
Fluoromethane	CH ₃ F	−78
Difluoromethane	CH ₂ F ₂	−52
Trifluoromethane	CHF ₃	−82
Tetrafluoromethane	CF ₄	−128

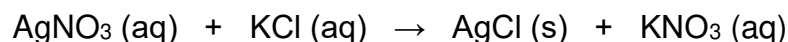
Explain why the boiling point of CH_3F is higher than that of CF_4 .

(4)

[15]

QUESTION 3:

- 3.1 Silver nitrate (AgNO_3) reacts with potassium chloride (KCl) in aqueous solution, to form a white solid (AgCl) according to the following equation:



Lucinda investigated the relationship between the mass of AgNO_3 dissolved in 200cm^3 of a solution of KCl, and the mass of AgCl that was formed in the reaction which occurred.

The following table contains her results for this investigation.

Experiment no.	Volume of KCl solution (cm^3)	Mass AgNO_3 added (g)	Mass of AgCl formed (g)
1	200	10	8
2	200	20	16
3	200	30	24
4	200	40	32
5	200	50	40
6	200	60	48
7	200	70	52
8	200	80	52
9	200	90	52
10	200	100	52

- 3.1.1 What is the relationship between the mass of AgNO_3 added and the mass of AgCl formed in experiments 1 – 6?

_____ (2)

- 3.1.2 Which substance is the limiting reagent in

(a) Experiments 1 – 6? _____ (1)

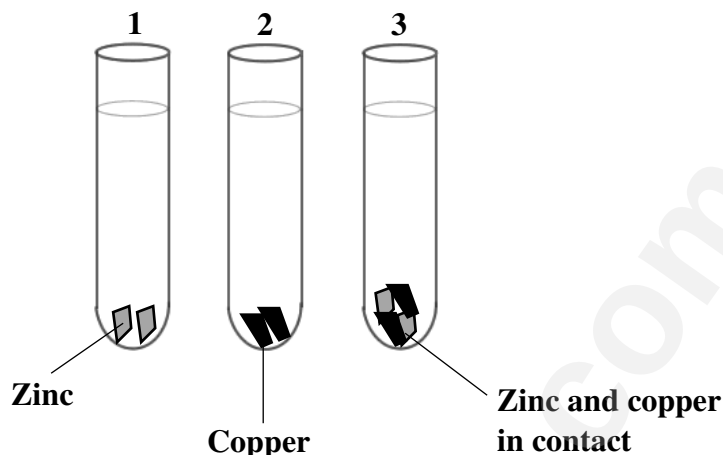
(b) Experiments 7 – 10? _____ (1)

3.1.3 Use (pertinent) information from the table to calculate the concentration of the KCl solution.

[illegible]

(4)

- 3.2 The diagrams below show 0,5 g of zinc and 0,5 g of copper reacting with dilute hydrochloric acid in test tubes 1 and 2. In test tube 3, the copper and zinc are in contact with each other.



In **test tube 1**, the reaction proceeds and hydrogen gas is given off.

In **test tube 2**, no reaction occurs.

In **test tube 3**, a vigorous reaction occurs (more rapid than in test tube 1) and hydrogen gas is given off. When the reaction is complete, the copper is removed, dried and massed. It has a mass of 0,5 g.

- 3.2.1 What is the role of the copper in the third reaction (test tube 3)? Explain your answer.

 _____ (2)

- 3.2.2 In reactions 1 and 3, the same mass of zinc is used. Name two other factors which should be kept constant if the effect of copper on the reaction rate is to be determined by comparing these two reactions.

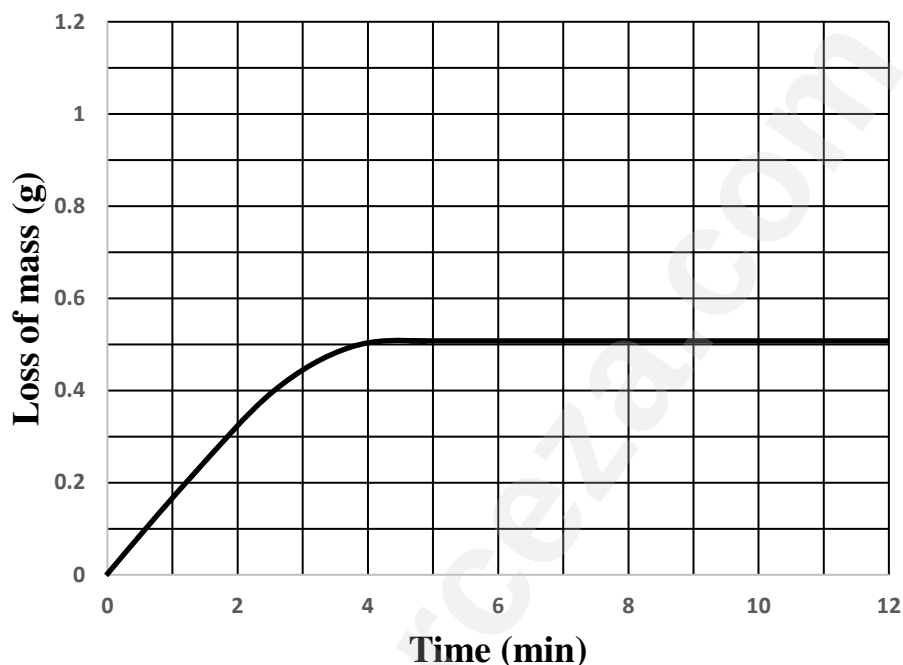
 _____ (2)

- 3.2.3 Suggest why dilute hydrochloric acid is used in reactions 1 and 3, rather than concentrated hydrochloric acid.

 _____ (2)

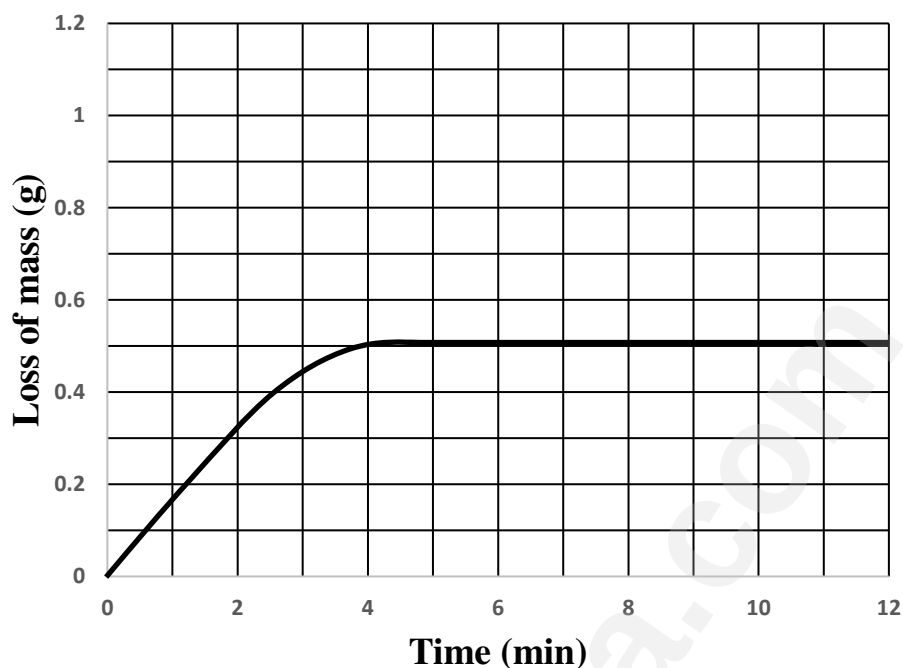
- 3.3 The reaction between zinc and hydrochloric acid, with and without the presence of a catalyst, is studied in more detail in a series of reactions. The reactions are carried out in an open beaker and the **loss of mass** of the reaction mixture was recorded as the reactions proceeded.

Consider the graph below. **The solid line shows the result of Reaction 1 in which zinc pieces were reacted with excess dilute hydrochloric acid.**



- 3.3.1 Use information from the graph to determine the average rate of formation of hydrogen in the first 4 minutes of reaction 1 (in mol.s^{-1}). Write your answer in scientific notation, correct to 2 decimal places.

[illegible]



3.3.2 On the graph drawn above, sketch **curves** which could be expected for each of the following experiments, and label them as indicated.

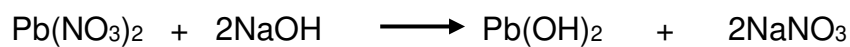
- Reaction 2 is carried out with the same reactants as reaction 1, but at a lower temperature. Label this curve **P**. (2)
- Reaction 3 is carried out with twice the mass of zinc, which was in powdered form. Label this curve **Q**. (2)
- Reaction 4 is carried out with the same mass of zinc pieces as in reaction 1 and an excess of a **more concentrated** HCl solution than in reaction 1. Label this curve **R**. (2)

3.3.3 Refer to the collision theory to explain the curve drawn in question 3.3.2 (c) above. (Hint: **bullet points**)

(3)

3.4 In a separate experiment, 198,6 g of lead (II) nitrate reacts with 4,5 dm³ of 0,2 mol·dm⁻³ solution of sodium hydroxide.

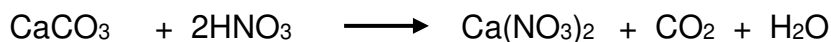
The balanced equation for this reaction is:



Determine the limiting reagent in this reaction.

Source: [source24.com](https://www.source24.com)

3.5 In another experiment, 10 g of crushed sea shells is added into excess nitric acid. The following equation represents the reaction that occurs between the acid and the calcium carbonate found in the shells.



A maximum volume of 1,90 dm³ of CO₂ gas was produced at STP. Assume that calcium carbonate is the only substance that reacts with the acid in this experiment.

3.5.1 Calculate the number of moles of the gas produced.

[illegible]

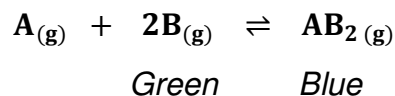
3.5.2 Calculate the percentage **purity** of the seashells.

(4)

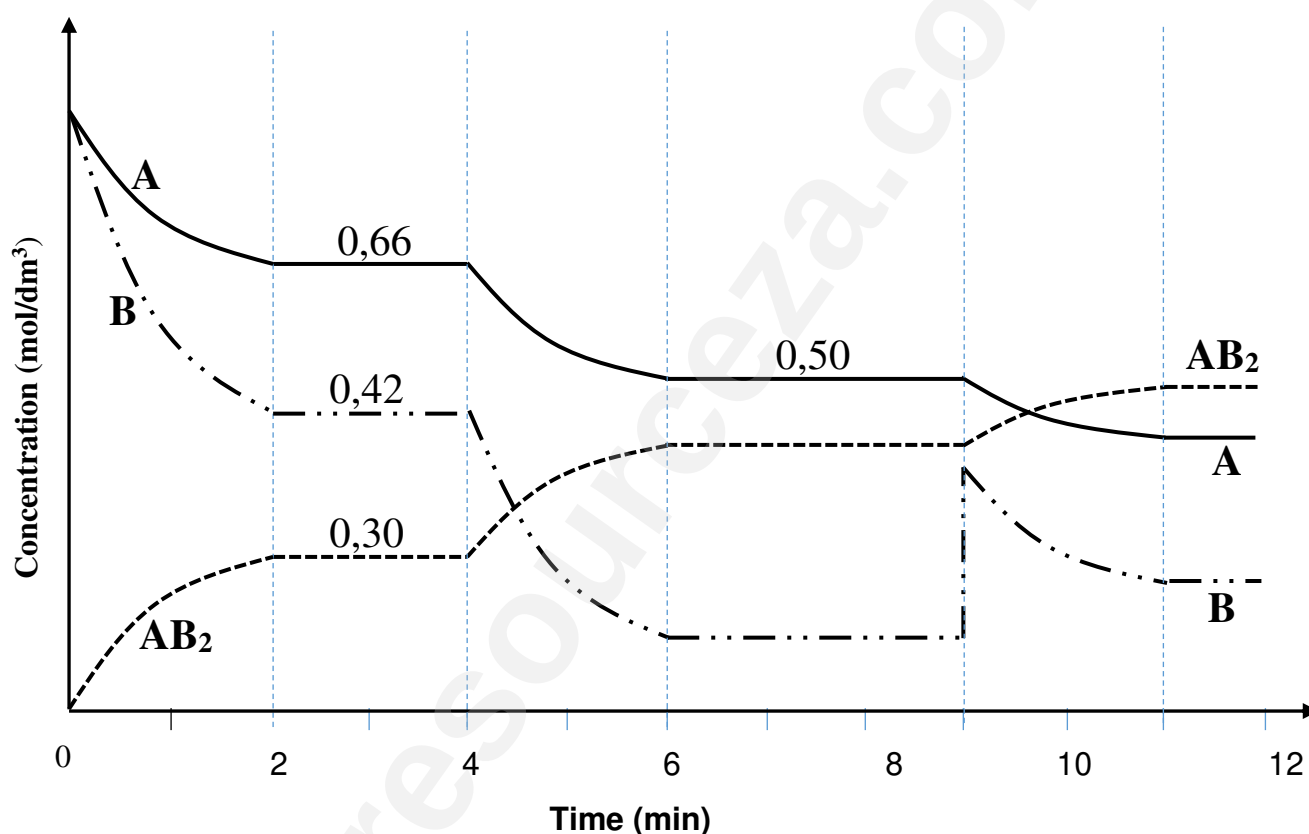
[39]

QUESTION 4:

Gases A (colourless) and B (green in colour) are placed in a sealed container and they react reversibly to form gas AB₂ (blue in colour).



The graph below shows the concentration of each species in the sealed container as time passes. At t = 3 minutes, the concentrations of the three gases were determined and are indicated on the graph.



4.1 What occurs in the system at t = 2 minutes?

_____ (1)

4.2 Define the term *dynamic chemical equilibrium*.

 _____ (2)

- 4.3 The temperature of the system was increased at $t = 4$ minutes. Is the forward reaction exothermic or endothermic? Explain your answer with reference to Le Chatelier's principle. (**Hint: bullet points**)

(4)

- 4.4 After the change made at 4 minutes, state the change in the equilibrium constant when equilibrium is re-established at 6 minutes. Write INCREASES, DECREASES or UNCHANGED. Explain your answer. (**Hint: bullet points**)

(3)

- 4.5 Write an expression for the equilibrium constant of this reaction.

(2)

4.6 On analysis of the mixture at $t = 6$ minutes, it is found that the concentration of A is $0,5 \text{ mol.dm}^{-3}$. Calculate the value of the equilibrium constant at $t = 6$ minutes.

Sourceza.com

(5)

4.7 What change was made to the system at $t = 9$ minutes?

_____ (1)

4.8 After the change made at 9 minutes, state the change in the equilibrium constant when equilibrium is re-established at 12 minutes. Write INCREASES, DECREASES or UNCHANGED. Explain your answer.

(2)

- 4.9 A colour change is seen at $t = 9,5$ minutes. State the colour change which occurred.

(2)

- 4.10 On **space provided below**, sketch labelled graphs for the **rate of the forward reaction** and the **rate of the reverse reaction** versus time for $t = 0$ to $t = 8$ minutes. Use a solid line (—) for the forward reaction and a dotted line (---) for the reverse reaction. Values are not required on the **y-axis**. (5)



[27]

QUESTION 5:

5.1 Phosphoric acid (H_3PO_4) is a weak, polyprotic acid.

5.1.1 Define an acid.

_____ (2)

5.1.2 Define a **weak** acid?

(2)

5.1.3 Give a reason why phosphoric acid is referred to as a **polyprotic** acid.

(1)

5.2 A student needs to determine the concentration of a phosphoric acid solution. She decides to titrate the phosphoric acid against a standard potassium hydroxide solution. The balanced chemical equation is given below:



5.2.1 What is meant by a *standard solution*?

(2)

5.2.2 Calculate the mass of KOH needed to make up 300 cm³ of a 0,2 mol.dm⁻³ KOH solution.

(4)

5.2.3 Which one of the indicators listed below should be used in this titration? Briefly explain your answer.

Name of indicator	pH range of indicator
Methyl orange	3,1 – 4,4
Bromothymol blue	6,0 – 7,6
phenolphthalein	8,4 – 10,0

(3)

5.2.4 During the titration she found that 15 cm³ of the 0,2 mol.dm⁻³ KOH solution neutralises 20 cm³ of the phosphoric acid solution. Calculate the concentration of the phosphoric acid solution.

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5.3.1 Define *hydrolysis of a salt*?

(2)

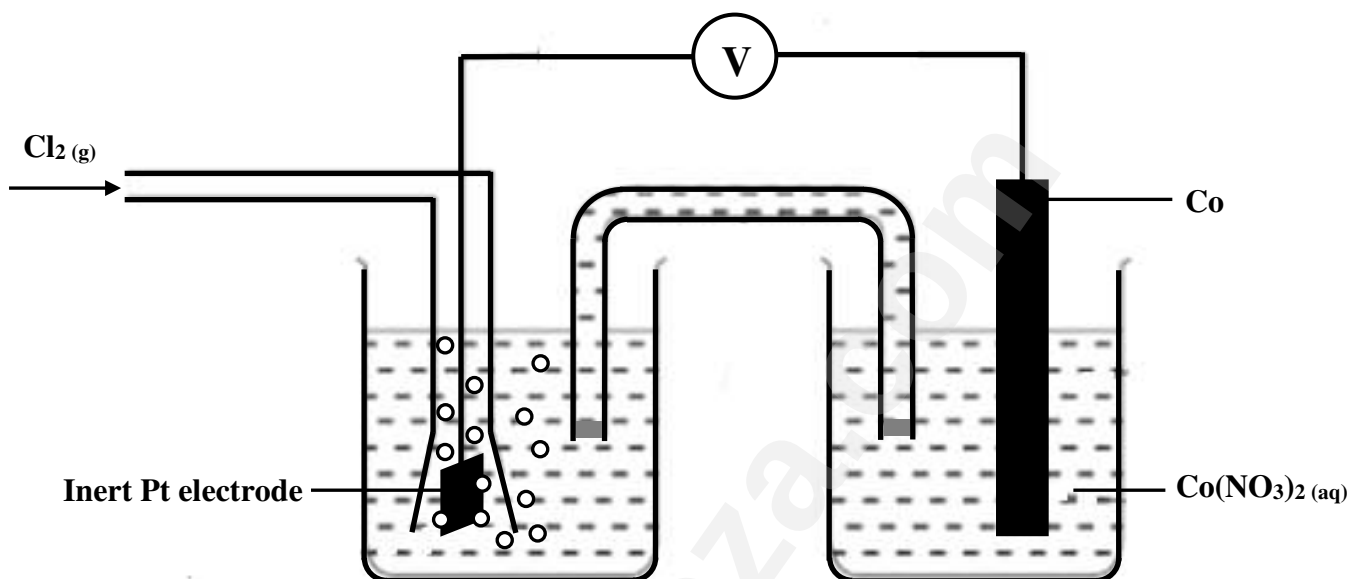
5.3.2 Explain how the hydrolysis of NH_4NO_3 in water results in the aqueous solution of this salt **not** being neutral. Include one or more equations with your answer.

(4)

[24]

QUESTION 6:

An electrochemical cell consisting of a cobalt half-cell, a salt bridge (potassium nitrate solution), and a chlorine half-cell, is set up under **standard conditions**.



6.1 State the energy conversion which takes place in this cell.

_____ (2)

6.2 What is the concentration of the electrolyte in the cobalt half-cell?

_____ (1)

6.3 A suitable electrolyte for the chlorine half-cell is HCl. Define an *electrolyte*.

_____ (2)

6.4 Write down the formula of the reducing agent.

_____ (2)

6.5 Write the half-reaction that occurs at the cathode.

_____ (2)

6.6 Write the **net ionic** equation for this electrochemical cell.

(3)

6.7 What is the direction of the electron flow in the external circuit?

(2)

6.8 Write down the cell notation for this electrochemical cell. Show all phases and standard conditions.

(3)

6.9 Calculate the emf of the cell.

(3)

- 6.10 After the cell has been assembled, a higher emf is required. A student suggests that this can be obtained by increasing the concentration of the cobalt (II) nitrate. Use equilibrium principles to determine whether this proposal is correct.

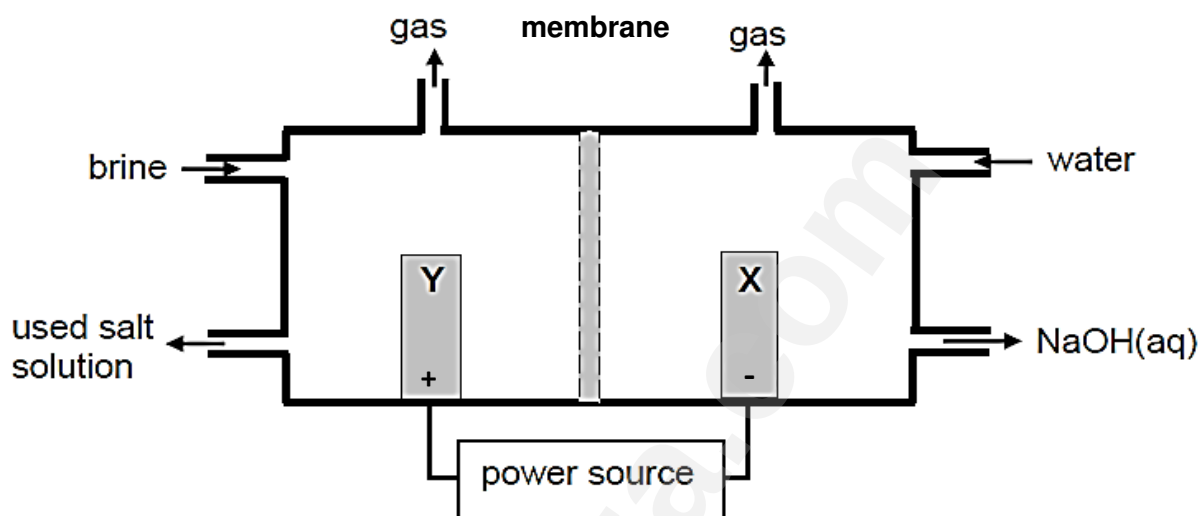
(3)

[23]

QUESTION 7:

The simplified diagram of a cell used in the chlor-alkali industry is shown below.

Brine (NaCl) and water are put in the cell as shown in the diagram below.



7.1 Define the term *oxidation*.

 _____ (2)

7.2 At which electrode, **X** or **Y**, is chlorine gas formed?

 _____ (1)

7.3 Write down the half reaction taking place at the cathode.

 _____ (2)

7.4 Write down the net ionic reaction for this cell.

 _____ (2)

- 7.5 Explain why sodium metal is NOT produced at the cathode in the membrane cell.

 _____(2)

- 7.6 A current of 4 000 A is passed through this chlor-alkali cell for 2,5 minutes. Calculate the mass of chlorine gas produced during this time.

 _____(4)

- 7.7 The purity of the sodium hydroxide produced in the chlor-alkali industry depends on the extent to which it is separated from the chlorine gas produced by this cell. Briefly describe how chlorine gas and sodium hydroxide are prevented from mixing in this cell.

 _____(2)

[15]

QUESTION 8:

8.1 The organic compound with the formula $C_2H_4O_2$ has more than one isomer.

8.1.1 Define the term *isomers*.

(2)

8.1.2 **Draw** the structural formulae of **two isomers** of $C_2H_4O_2$ and give the IUPAC name of each.

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(6)

8.1.3 Are the isomers drawn in question 8.1.2, structural isomers or functional isomers? Give a reason for your answer.

(2)

8.2 Ethyl propanoate is prepared by reacting an alcohol and an organic acid in the presence of a catalyst.

8.2.1 Name the homologous series to which ethyl propanoate belongs.

(1)

8.2.2 Name the alcohol and the organic acid used and clearly label which is which.

(2)

8.2.3 Draw the **condensed** structural formula of the organic acid used.

(2)

8.2.4 Write down the **name** or formula of the catalyst used.

(1)

8.3 A student prepares samples of **pent-2-ene** and **pentan-2-ol** in the laboratory, but manages to mix up the sample bottles before she has labelled them. Both compounds are colourless liquids. In order to identify each sample, she determines the boiling point of each under the same conditions. Her results are in the table below.

Sample no.	Boiling point (°C)
1	139
2	30

8.3.1 What is the independent variable in this experiment?

(2)

8.3.2 Which sample (1 or 2) is pentan-2-ol?

_____(1)

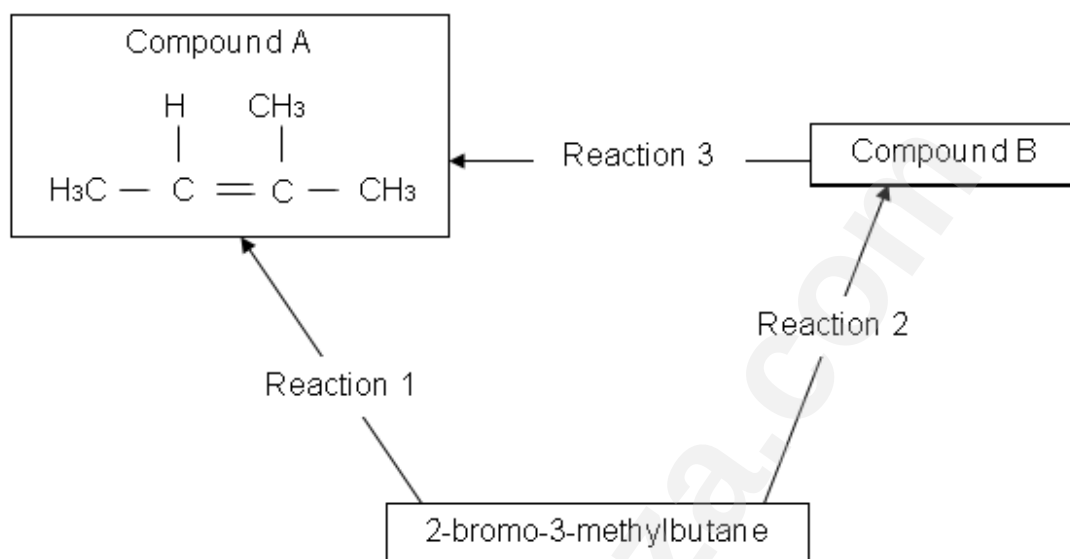
8.3.3 Explain your answer to question 8.3.2 by referring to the intermolecular forces present in each compound.

_____(3)

[22]

QUESTION 9:

The flow diagram below shows how two organic compounds, A and B, can be made from 2-bromo-3-methylbutane.



9.1 Name the homologous series to which 2-bromo-3-methylbutane belongs.

_____ (1)

9.2 Draw the structural formula of 2-bromo-3-methylbutane.



(3)

9.3 **Reaction 1** takes place in a concentrated solution of NaOH in an ethanol solvent to form compound A.

9.3.1 Name the type of reaction which takes place.

_____ (1)

9.3.2 State the other reaction condition required for this reaction.

 _____ (1)

9.3.3 Give the IUPAC name of compound A.

 _____ (2)

9.4 **Reaction 2** takes place in a warm aqueous alkali solution.

9.4.1 Name the type of substitution reaction which takes place.

 _____ (1)

9.4.2 Give the condensed structural formula of compound B.



(3)

9.5 Using molecular formulae, write a balanced equation for the combustion of compound A in excess oxygen.

 _____ (3)

[15]

THE END....

TOTAL = 200 MARKS

[illegible]

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