



eduresourceza.com



WOODRIDGE COLLEGE

14 SEPTEMBER 2020

3 HOURS

PHYSICAL SCIENCES: PAPER II

EXAMINER: Dr C Logie

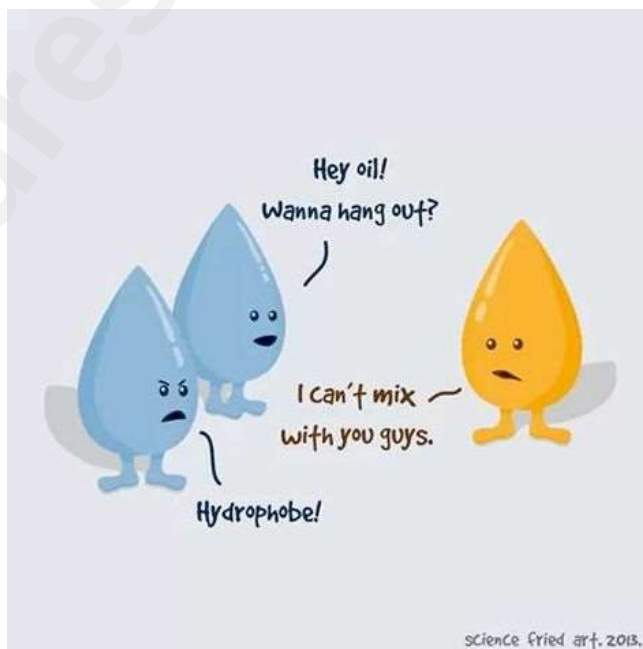
TOTAL = 200 marks

MODERATOR: Mr P Maartens

GRADE 12

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY:

1. This question paper consists of 15 pages with 7 questions, an answer sheet (page 15) and a data sheet of three pages. Please check that your question paper is complete.
 2. Detach the answer sheet and attach it to the rest of your answers.
 3. Answer ALL the questions.
 4. Number your answers exactly as they appear in the question paper.
 5. It is in your own interest to write legibly and to present your work neatly.
 6. Show all the formulas and equations you use.
 7. Show all calculations and round off answers to 2 decimal places.
 8. All answers should have the correct units.
 9. A non-programmable scientific calculator may be used.
-



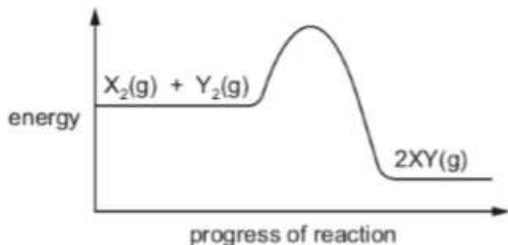
QUESTION 1 – Multiple Choice

Downloaded from eduresourceza.com

(Adapted from Marist Brothers Linmeyer Prelim 2019, St Anne's Trial 2019 & St John's DSG Trials 2019)

Answer these questions on the ANSWER SHEET provided. Make a cross(X) on the letter of the response which you consider to be the most correct.

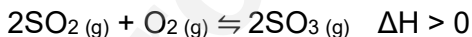
1.1 The energy level diagram for the reaction between X_2 and Y_2 to form XY gas is shown.



Which statement is correct?

- A. Energy is released when X_2 and Y_2 bonds are broken
 - B. Energy is needed to form XY bonds
 - C. The net energy change for the reaction is negative
 - D. The reaction is endothermic.
- (2)

1.2 Sulfur trioxide is made by reacting sulfur dioxide with oxygen. The reaction is reversible.



Which combination of temperature and pressure gives the highest equilibrium yield of sulfur trioxide.

	Temperature ($^{\circ}C$)	Pressure (atm)
A.	200	10
B.	200	200
C.	600	10
D.	600	200

(2)

1.3 Which of the following compounds has a polar covalent bond?

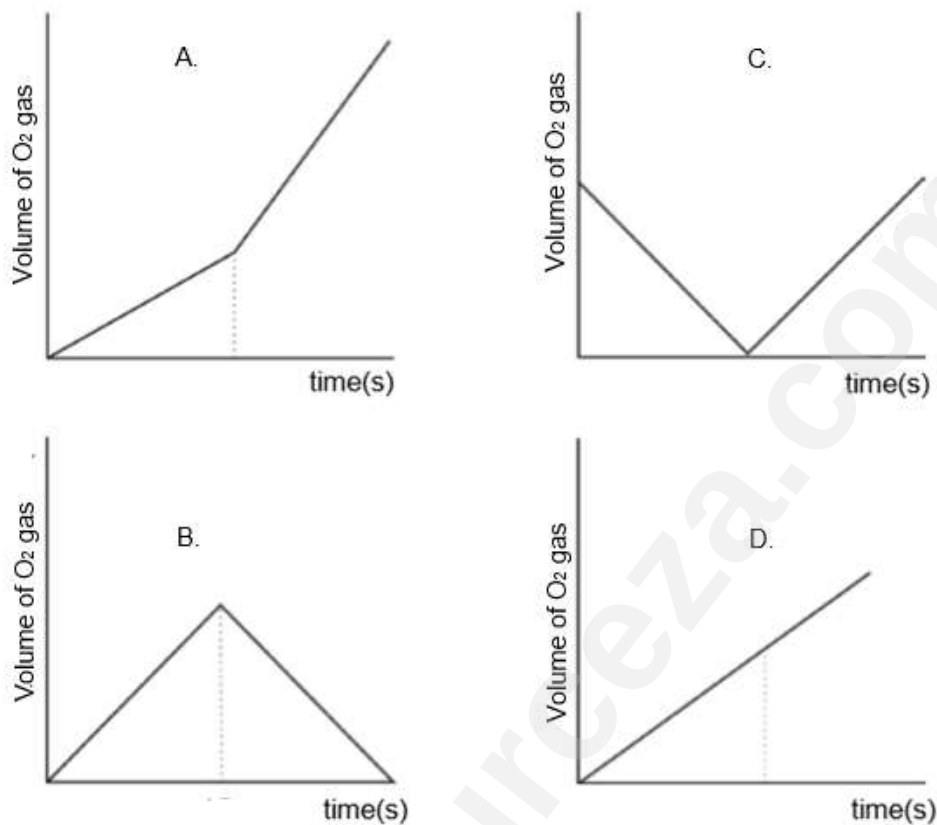
- A. Carbon dioxide
 - B. Sodium chloride
 - C. PH_3
 - D. Chlorine
- (2)

1.4 Consider the reaction:



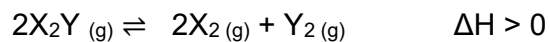
- A. The product is an isomer of chloropropane.
B. The reaction is a substitution reaction.
C. The reaction is slow and needs UV light.
D. The product is an ester. (2)
- 1.5 Diluted HCl is gradually added to a flask of distilled water, keeping the temperature constant. How does this affect the value of the dissociation constant (K_w) of water?
- A. It increases and then decreases
B. It increases but eventually reaches a maximum
C. It decreases but eventually reaches zero
D. It does not change no matter what volume of HCl is added (2)
- 1.6 Ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$ is dissolved in water at 25°C . Which of the statements gives the best description of the solution?
- A. $[\text{OH}^-] = 10^{-7} \text{ mol}\cdot\text{dm}^{-3}$
B. $[\text{OH}^-] = [\text{H}_3\text{O}^+]$
C. the pH of the solution is less than 7
D. $[\text{OH}^-] > [\text{H}_3\text{O}^+]$ (2)
- 1.7 The name of K_2SO_3 is
- A. Potassium sulfate
B. Dipotassium sulfite
C. Dipotassium sulfate
D. Potassium sulfite (2)
- 1.8 Which one of the following statements is true for a reaction in a state of dynamic chemical equilibrium?
- A. The limiting reagent has been used up.
B. The forward and reverse reactions have stopped.
C. The rates of the forward and reverse reactions are equal.
D. The concentration of products equals the concentration of reactants. (2)

- 1.9 When hydrogen peroxide decomposes, oxygen gas is produced as one of the products. The volume of oxygen gas released is measured every second. Shortly after the reaction started, a catalyst is added to the reaction. Which one of the following graphs is an accurate representation of the course of the reaction?

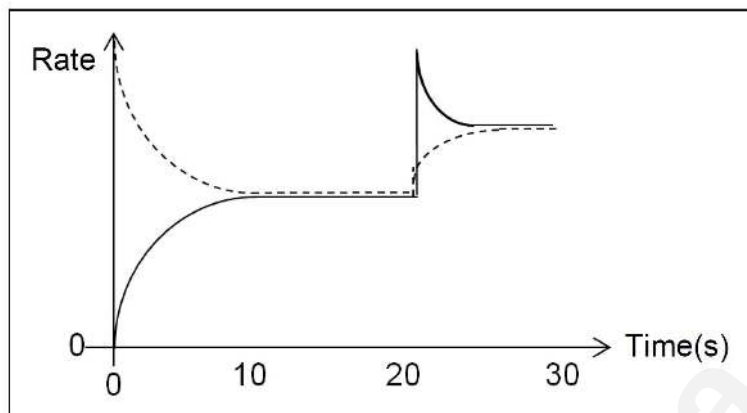


(2)

1.10 Gas X_2Y is introduced into a container, which is then sealed. The gas decomposes and the reaction reaches equilibrium. The balanced chemical equation of the reaction is:



At $t = 20$ s, a change is made to the reaction in equilibrium. The graph below shows the change in the rates of the forward and reverse reactions with time.



Which one of the following gives the change made at $t = 20$ s?

- A. Increase in temperature
- B. Increase in pressure
- C. Decrease in temperature
- D. Decrease in pressure

(2)
[20]

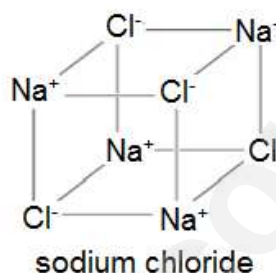
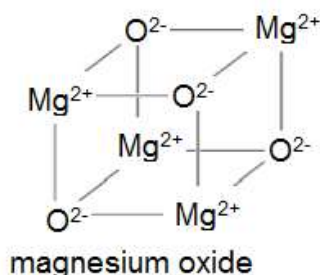
QUESTION 2 – Chemical Bonding

Downloaded from eduresourceza.com

(Adapted from St Anne's Trial 2019)

2.1 When chlorine gas is bubbled into a hot sodium hydroxide solution it reacts to produce a mixture of sodium chlorate, sodium chloride and water. This is an example of a chemical change. Represent this chemical change using a balanced chemical equation. (4)

2.2 The structures below show two different ionic lattices (not to scale):



2.2.1 Define an *ionic bond*. (2)

2.2.2 Under which circumstances are these compounds able to conduct electricity? Explain briefly. (3)

2.3 Consider the methanol molecule which has molecular formula CH₄O.

2.3.1 Define *electronegativity*. (2)

2.3.2 Between which two atoms will the most polar bond be found in the methanol molecule? (1)

2.3.3 Draw two methanol molecules, showing how they are held together in the liquid phase. Label the intermolecular force present. (3)

2.3.4 Give reasons for your choice of intermolecular force present between methanol molecules in question 2.3.3. (3)

2.4 Consider the boiling points of the hydrogen halides below:

	Boiling point (°C)
HCl	- 85
HBr	-66
HI	-34

2.4.1 Name the specific forces which need to be overcome in order for these halides to evaporate? (2)

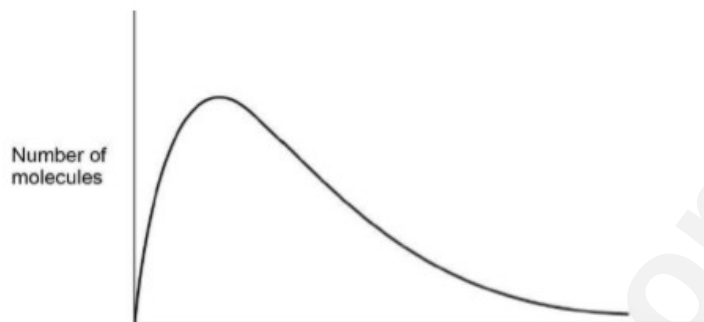
2.4.2 Explain clearly why HI has a higher boiling point than HBr and HCl. (3)

[23]

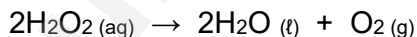
QUESTION 3 – Energy Changes and Rates of Reaction

(adapted from St Mary's DSG Trials 2019)

- 3.1 The graph below shows the Maxwell-Boltzmann distribution of molecular energies in a sample of gases at a fixed concentration.



- 3.1.1 On the ANSWER SHEET provided, give a suitable label for the horizontal axis. (1)
- 3.1.2 Define *concentration*. (2)
- 3.1.3 On the ANSWER SHEET provided, sketch a distribution of molecular energies for this sample of gases at a higher concentration. (2)
- 3.1.4 These gases react on heating. Explain why an increase in temperature increases the rate at which these gases react. (3)
- 3.2 Hydrogen peroxide solution decomposes slowly to form water and oxygen. The reaction is much faster in the presence of a manganese (IV) oxide catalyst.

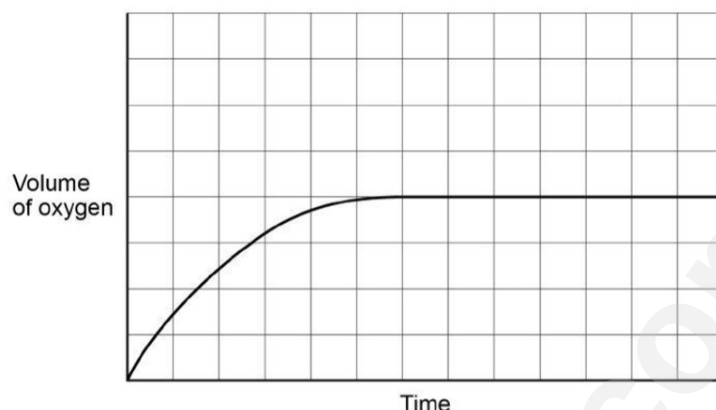


Three experiments, shown in the table below, were carried out to investigate how the volume of oxygen produced varied over time under different conditions. The same mass of catalyst was used in each experiment.

Experiment	Concentration of H_2O_2 ($\text{mol}\cdot\text{dm}^{-3}$)	Volume of H_2O_2 (cm^3)	Temperature ($^{\circ}\text{C}$)	Catalyst
1	1	50	20	Lumps
2	1	50	20	Powder
3	0.5	50	20	Lumps

The graph below shows how the volume of oxygen collected varied with time in Experiment 1.

A plot of the volume of oxygen collected vs time for the decomposition of H_2O_2



3.2.1 Define the term *catalyst*. (2)

3.2.2 Draw two lines on the graph on the ANSWER SHEET provided to show how the volume of oxygen collected varied with time in Experiments 2 and 3. Label each line with the experiment number. (4)

3.3 An industrial process makes an acid. The table below shows the percentage yield of the acid made at different temperatures and pressures.

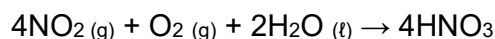
Pressure in atmospheres	Percentage yield at 200°C	Percentage yield at 400°C	Percentage yield at 600°C
100	80%	22%	8%
200	92%	40%	14%
300	95%	56%	18%
400	96%	67%	22%

3.3.1 Define *yield*. (2)

3.3.2 How does increasing the temperature change the percentage yield? (1)

3.3.3 A temperature of 400°C , a pressure of 200 atmospheres and a catalyst is actually used to make the acid. These conditions do not give the highest percentage yield. Suggest why these conditions are chosen. (4)

3.3.4 The final equation in the Ostwald process for the formation of nitric acid is given below.



Using the conditions in Question 3.3.3, if 504 g of HNO_3 was produced and having a yield of 40%, what mass of NO_2 was used? (7)

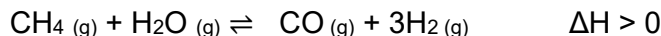
[28]

QUESTION 4 – Chemical Equilibrium

Downloaded from eduresourceza.com

(adapted from Hilton Trials 2019)

- 4.1 The industrial preparation of hydrogen gas is represented by the equation below.



The reaction reaches equilibrium at 1 000°C in a closed container.

- 4.1.1 State *Le Chatelier's Principle*. (2)
- 4.1.2 How will an increase in pressure at 1 000°C (by decreasing the volume) affect the yield of hydrogen gas? Write down only INCREASES, DECREASES OR NO EFFECT. Explain the answer. (3)
- 4.1.3 The hydrogen gas is removed as it is formed. Use *Le Chatelier's Principle* to explain how this influences the yield. (3)
- 4.2 Carbon dioxide reacts with carbon in a closed system to produce carbon monoxide, CO(g), according to the following balanced equation:
- $$\text{CO}_2(\text{g}) + \text{C}(\text{s}) \rightleftharpoons 2\text{CO}(\text{g}) \quad \Delta H > 0$$
- 4.2.1 Initially an unknown amount of carbon dioxide is exposed to hot carbon at 800 °C in a sealed 2 dm³ container. The equilibrium constant, K_c , for the reaction at this temperature is 14. At equilibrium it is found that 168.00 g of carbon monoxide is present.
- 4.2.1.1 How will the equilibrium concentration of the product compare to that of the reactants? Choose from LARGER THAN, SMALLER THAN or EQUAL TO. Give a reason for the answer. (No calculation is required.) (2)
- 4.2.1.2 Calculate the initial amount (in moles) of CO₂ present. (9)
- 4.2.2 State how EACH of the following will affect the yield of CO(g) at equilibrium. Choose from INCREASES, DECREASES or REMAINS THE SAME.
- 4.2.2.1 More carbon is added at constant temperature. (1)
- 4.2.2.2 The pressure is increased. (1)
- 4.2.2.3 The temperature is increased. (1)

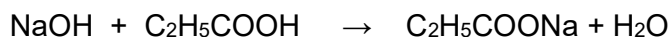
[22]

QUESTION 5 – Acids and Bases

Downloaded from eduresourceza.com

(Adapted from St John's DSG Trial 2019)

- 5.1 Propanoic acid ($\text{C}_2\text{H}_5\text{COOH}$) reacts with sodium hydroxide during a titration according to the following equation:



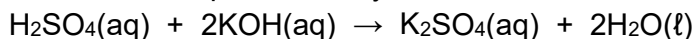
The following table of indicator colours might be useful in the questions that follow.

Indicator	More acidic colour	More basic colour	pH range of colour change
Bromothymol blue	Yellow	Blue	6.0 – 7.7
Phenolphthalein	Colourless	Pink	8.3 – 10.0
Methyl orange	Red	Yellow	3.2 – 4.4

- 5.1.1 Classify propanoic acid as a monoprotic or polyprotic acid. (1)
- 5.1.2 Which indicator should be used for the above titration? Give a reason for your choice. (2)
- 5.1.3 Define the term *hydrolysis of a salt*. (2)
- 5.1.4 Which ion of the salt formed in the above reaction will undergo hydrolysis? (1)
- 5.1.5 Write an equation for the hydrolysis of this ion. (2)
- 5.2 The table below shows the ionisation constants for two acids.

Name	Formula	K_a
Nitrous acid	HNO_2	4.5×10^{-4}
Nitric acid	HNO_3	?

- 5.2.1 Define a *strong acid*. (2)
- 5.2.2 Will the ionisation constant for nitric acid be GREATER THAN, LESS THAN or EQUAL to that of nitrous acid? Give a reason for your choice. (2)
- 5.2.3 Which of these acids (if any) will have a higher electric conductivity? Briefly explain. (assume that the concentration of both of acids is the same) (2)
- 5.2.4 Write a balanced chemical equation for the reaction of nitric acid with calcium carbonate. Ignore phase indicators. (3)
- 5.3 A standard solution of sulfuric acid, H_2SO_4 (concentration $0.4 \text{ mol} \cdot \text{dm}^{-3}$) was titrated against a potassium hydroxide, KOH , solution of unknown concentration. Bromothymol blue was used as an indicator for the titration. The balanced chemical equation for the reaction between sulfuric acid and potassium hydroxide is shown below:



- 5.3.1 Calculate the concentration of the hydroxide ions in the standard solution of sulfuric acid at 25°C . (4)
- 5.3.2 20 mL of sulfuric acid exactly neutralises 30 mL of potassium hydroxide. Calculate concentration of the potassium hydroxide solution. (5)

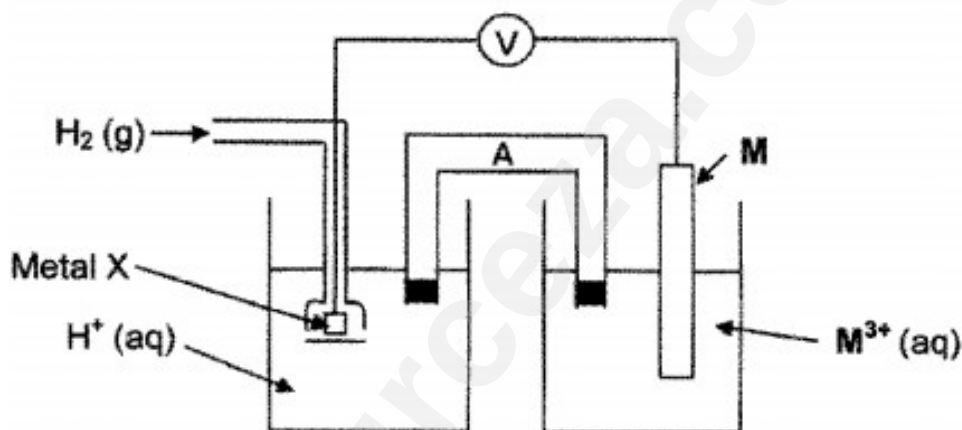
[26]

QUESTION 6 – Electrochemistry

Downloaded from eduresourceza.com

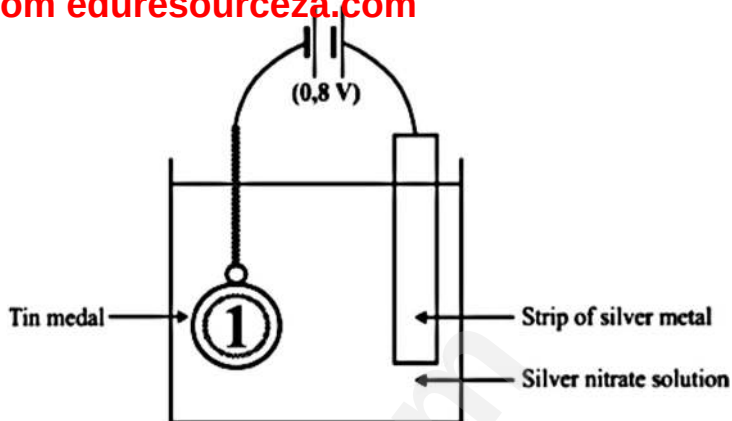
(Adapted from St John's DSG Trials 2019 & Marist Brothers Prelim 2019)

- 6.1 The standard cell potential produced by a galvanic cell consisting of a cobalt electrode in contact with a solution of $\text{Co}^{2+}(\text{aq})$ and an aluminium electrode in contact with a solution of $\text{Al}^{3+}(\text{aq})$, is 1,38 V.
- 6.1.1 Define *reduction*. (2)
- 6.1.2 Write down the reduction half-reaction for the above cell. (2)
- 6.1.3 Identify the oxidizing agent. (1)
- 6.1.4 Write down the cell notation of this cell. Include the standard conditions. (5)
- 6.2 An unknown metal, M, is connected to a hydrogen standard half-cell as indicated below. The metal, M, is placed in a solution of its salt, $\text{M}^{3+}(\text{aq})$.

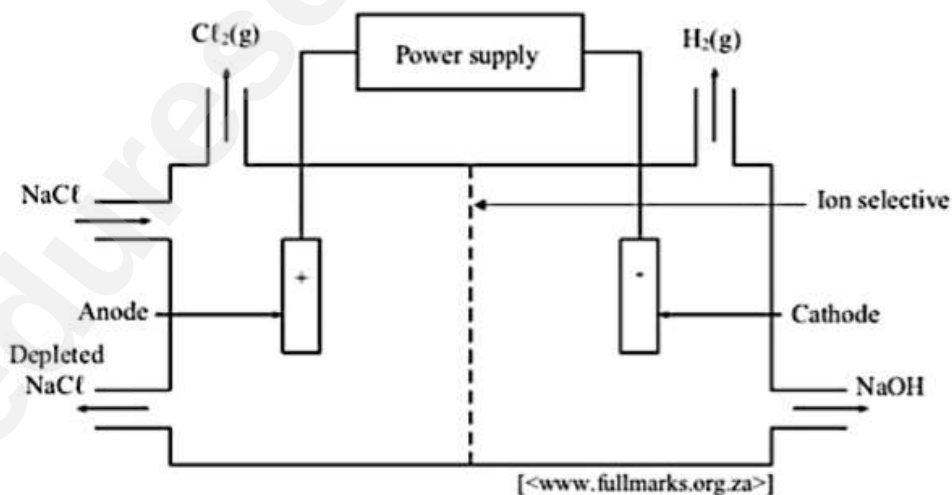


- 6.2.1 What is the purpose of the standard half-cell? (2)
- 6.2.2 Name the metal labelled X in the hydrogen half-cell. (1)
- 6.2.3 State two functions of the component labelled A. (2)
- 6.2.4 The reading on the voltmeter is -0.74 V. Identify the unknown metal, M. (2)
- 6.2.5 Is M the anode or the cathode? (1)
- 6.2.6 Write down the overall ionic cell reaction for the above galvanic cell. (2)
- 6.2.7 How will the reading on the voltmeter change with an increase in the concentration of the M^{3+} ion? Write only INCREASE, DECREASE or HAVE NO EFFECT. Give a reason for your Answer. (2)

- 6.3 Aidan wants to electroplate his old tin medal with silver. He connects his medal to the negative terminal of a battery and he connects a strip of silver metal to the positive terminal of the battery. The electrodes are then immersed in a solution of silver nitrate (AgNO_3). A voltage of 0.80 V is maintained across the terminals of the battery. The diagram below represents the simple electrolytic cell that he used.



- 6.3.1 State the energy conversion that takes place in this cell. (2)
- 6.3.2 Write down a balanced chemical equation for the half-reaction taking place on the surface of the medal. (2)
- 6.3.3 The strip of silver metal contains traces of copper and gold impurities. With reference to the relative strengths of the reducing agents involved, clearly explain what happens to the copper and gold impurities in the silver strip. (4)
- 6.3.4 With reference to the relative strengths of the oxidising agents involved, explain why none of the copper impurities are transferred to the medal. (2)
- 6.3.5 It is found that, after passing a constant current through the cell for 30 minutes, the mass of silver deposited on the medal is 5.83 g. Calculate the strength of the constant current that was used. (7)
- 6.4 Chlorine gas is produced on a large scale in industry by the electrolysis of a saturated solution of sodium chloride. The diagram below shows a commonly used cell in the Chlor-alkali process.



- 6.4.1 Identify the type of cell shown in the diagram. (1)
- 6.4.2 Describe the starting electrolyte which is pumped into the anode compartment. (2)
- 6.4.3 Give one reason why it is necessary to separate the gas products at each of the electrodes. (1)

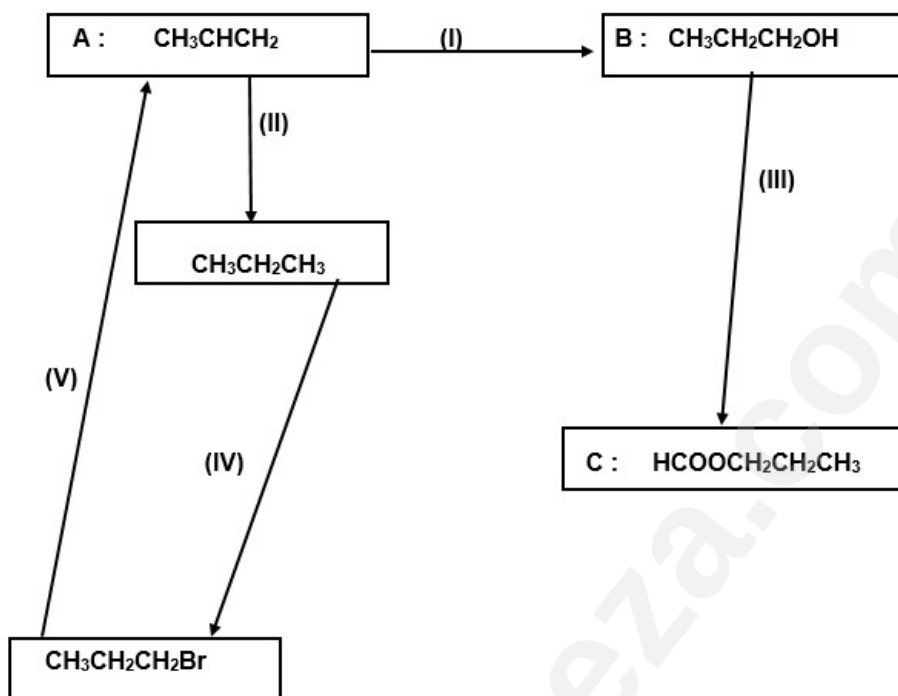
[43]

7.1 The boiling points of organic compounds A, B, C and D, are shown in the table below.

Organic compound	Boiling point (°C)	Condensed formula
A	119,3	CH ₃ CH ₂ CH ₂ CH(OH)CH ₃
B	99	CH ₃ CH ₂ OOCCH ₂ CH ₃
C	103	CH ₃ CH ₂ CH ₂ CH ₂ CHCH ₂
D	187	CH ₃ CH ₂ CH ₂ CH ₂ COOH

- 7.1.1 Define the term *homologous series*. (2)
- 7.1.2 Name the **homologous series** to which each of the following compounds belong.
- 7.1.2.1 B (1)
- 7.1.2.2 C (1)
- 7.1.3 Organic compound A is dehydrated during an acid catalysed reaction to form pent-1-ene. Write down the general formula of the homologous series of this product. (1)
- 7.1.4 Write down the IUPAC name for organic compound D. (2)
- 7.1.5 Will the boiling point of the next member in the homologues series of compound D be HIGHER THAN, LOWER THAN or EQUAL TO that of compound D? (1)
- 7.1.6 Fully explain the answer to Question 7.1.5. (4)
- 7.1.7 Organic compounds consist of different types of *isomers*.
- 7.1.7.1 Define: *structural isomer*. (2)
- 7.1.7.2 Draw ONE positional isomer for organic compound A. (2)
- 7.1.7.3 Write down the IUPAC name for the isomer drawn as the answer to Question 7.1.7.2. (2)
- 7.1.8 Write a balanced chemical equation using molecular formulas for the complete combustion of compound C. (5)

- 7.2 The flow-chart below represents some of the organic chemical reactions that originate with or involve the unsaturated compound **A**.



- 7.2.1 Define what is meant by the term “*unsaturated compound*”. (2)
7.2.2 Name the specific type of reaction represented by (I). (1)
7.2.3 **Name** compound B (2)
7.2.4 Name the functional group of compound C (1)
7.2.5 **Name** the substance needed to react with B to form C (1)
7.2.6 Describe the conditions required for reaction (III) (2)
7.2.7 Name and give the molecular formula of an isomer of compound C (3)
7.2.8 Name the general type of reaction represented by (IV) (1)
7.2.9 Describe the conditions required for reaction (V) (2)

[38]

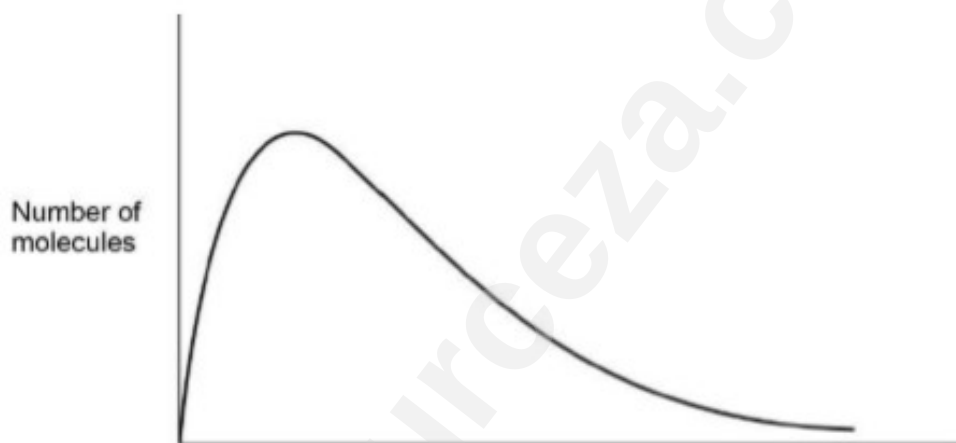
Total = 200 marks

Name: _____

Question 1 (Multiple Choice):

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

Questions 4.1.1 and 4.1.3:**Question 4.2.2:**A plot of the volume of oxygen collected vs time for the decomposition of H_2O_2 