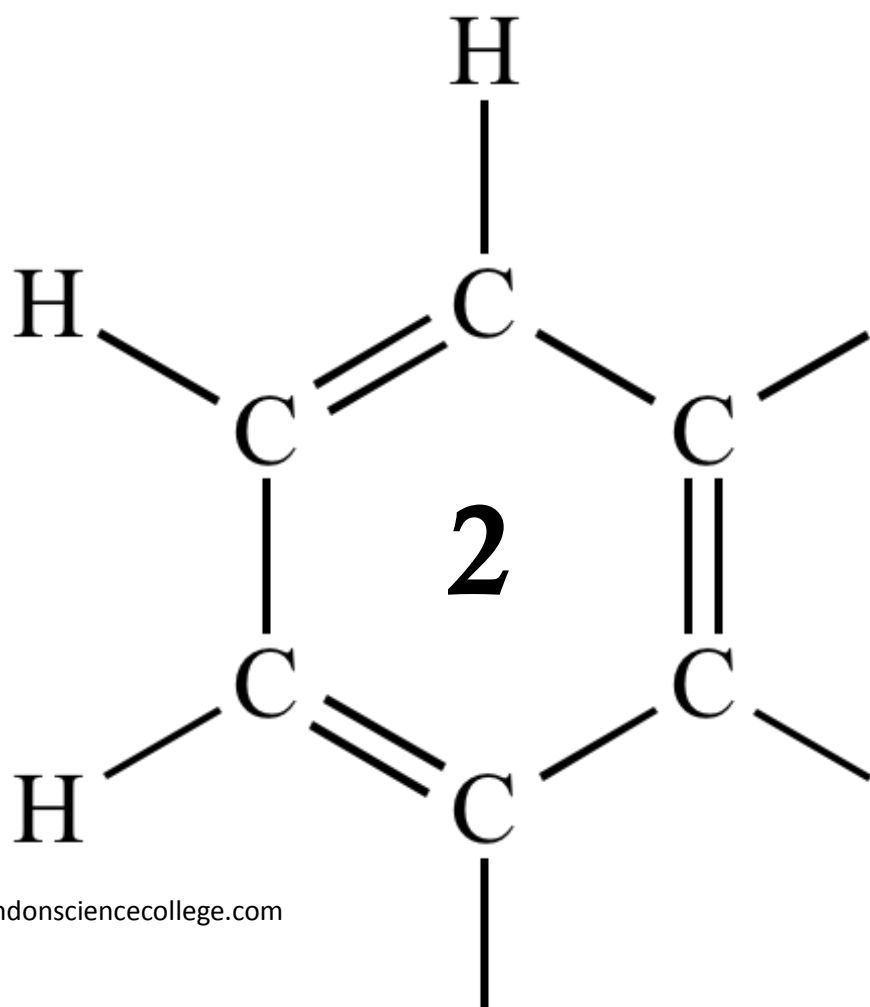


AQA AS CHEMISTRY
AMOUNT OF SUBSTANCE



1

A sample of pure $\text{Mg}(\text{NO}_3)_2$ was decomposed by heating as shown in the equation below.



- (a) A 3.74×10^{-2} g sample of $\text{Mg}(\text{NO}_3)_2$ was completely decomposed by heating.

Calculate the total volume, in cm^3 , of gas produced at $60.0\text{ }^\circ\text{C}$ and 100 kPa .

Give your answer to the appropriate number of significant figures.

The gas constant $R = 8.31\text{ J K}^{-1}\text{ mol}^{-1}$.

Total volume of gas = cm^3

(5)

- (b) The mass of MgO obtained in this experiment is slightly less than that expected from the mass of $\text{Mg}(\text{NO}_3)_2$ used.

Suggest **one** practical reason for this.

.....
.....
.....

(1)

(Total 6 marks)

2

Which of these pieces of apparatus has the lowest percentage uncertainty in the measurement shown?

A Volume of 25 cm^3 measured with a burette with an uncertainty of $\pm 0.1\text{ cm}^3$.

B Volume of 25 cm^3 measured with a measuring cylinder with an uncertainty of $\pm 0.5\text{ cm}^3$.

C Mass of 0.150 g measured with a balance with an uncertainty of $\pm 0.001\text{ g}$.

D Temperature change of $23.2\text{ }^\circ\text{C}$ measured with a thermometer with an uncertainty of $\pm 0.1\text{ }^\circ\text{C}$.

(Total 1 mark)

3

A student is provided with a 5.00 cm^3 sample of $1.00 \times 10^{-2} \text{ mol dm}^{-3}$ hydrochloric acid. The student is asked to devise a method to prepare a hydrochloric acid solution with a concentration of $5.00 \times 10^{-4} \text{ mol dm}^{-3}$ by diluting the sample with water.

Which of these is the correct volume of water that should be added?

A 45.0 cm^3

B 95.0 cm^3

C 100 cm^3

D 995 cm^3

(Total 1 mark)

4

Which of the following contains the most chloride ions?

A 10 cm^3 of $3.30 \times 10^{-2} \text{ mol dm}^{-3}$ aluminium chloride solution

B 20 cm^3 of $5.00 \times 10^{-2} \text{ mol dm}^{-3}$ calcium chloride solution

C 30 cm^3 of $3.30 \times 10^{-2} \text{ mol dm}^{-3}$ hydrochloric acid

D 40 cm^3 of $2.50 \times 10^{-2} \text{ mol dm}^{-3}$ sodium chloride solution

(Total 1 mark)

5

Compound **J**, known as leaf alcohol, has the structural formula $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_2\text{OH}$ and is produced in small quantities by many green plants. The *E* isomer of **J** is responsible for the smell of freshly cut grass.

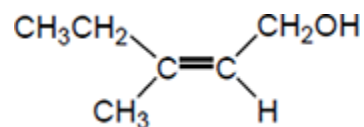
(a) Give the structure of the *E* isomer of **J**.

(1)

- (b) Give the **skeletal formula** of the organic product formed when **J** is dehydrated using concentrated sulfuric acid.

(1)

- (c) Another structural isomer of **J** is shown below.



Explain how the Cahn-Ingold-Prelog (CIP) priority rules can be used to deduce the full IUPAC name of this compound.

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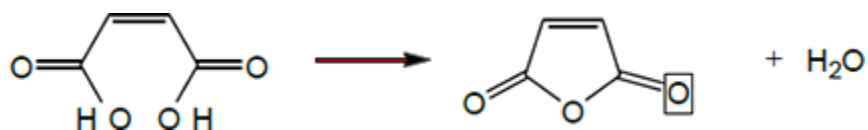
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(6)

(d) The effect of gentle heat on maleic acid is shown below.



A student predicted that the yield of this reaction would be greater than 80%.

In an experiment, 10.0 g of maleic acid were heated and 6.53 g of organic product were obtained.

Is the student correct? Justify your answer with a calculation using these data.

.....
.....
.....

(2)
(Total 10 marks)

6

Glucose can decompose in the presence of microorganisms to form a range of products. One of these is a carboxylic acid ($M_r = 88.0$) containing 40.9% carbon and 4.5% hydrogen by mass.

(a) Deduce the empirical and molecular formulas of the carboxylic acid formed.

Empirical formula = Molecular formula =

(4)

(b) Ethanol is formed by the fermentation of glucose.
A student carried out this fermentation reaction in a beaker using an aqueous solution of glucose at a temperature of 25 °C in the presence of yeast.

Write an equation for the reaction occurring during fermentation.

.....

(1)

(c) In industry, this fermentation reaction is carried out at 35 °C rather than 25 °C.

Suggest **one** advantage and **one** disadvantage for industry of carrying out the fermentation at this higher temperature.

Advantage

.....

Disadvantage

.....

(2)

(d) The method used by the student in part (b) would result in the ethanol being contaminated by ethanoic acid.

How does this contamination occur?

.....

.....

(1)

(e) Give **two** differences between the infrared spectrum of a carboxylic acid and that of an alcohol other than in their fingerprint regions.

Use **Table A** on the Data Sheet.

Difference 1

.....

Difference 2

.....

(2)

(Total 10 marks)

7 CCl₄ is an effective fire extinguisher but it is no longer used because of its toxicity and its role in the depletion of the ozone layer. In the upper atmosphere, a bond in CCl₄ breaks and reactive species are formed.

(a) Identify the condition that causes a bond in CCl₄ to break in the upper atmosphere. Deduce an equation for the formation of the reactive species.

Condition

Equation

.....

(2)

- (b) One of the reactive species formed from CCl_4 acts as a catalyst in the decomposition of ozone.

Write **two** equations to show how this species acts as a catalyst.

Equation 1

.....

Equation 2

.....

(2)

- (c) A small amount of the freon CF_3Cl with a mass of 1.78×10^{-4} kg escaped from a refrigerator, into a room of volume 100 m^3 . Assuming that the freon is evenly distributed throughout the air in the room, calculate the number of freon molecules in a volume of 500 cm^3 .

Give your answer to the appropriate number of significant figures.

The Avogadro constant = $6.02 \times 10^{23} \text{ mol}^{-1}$.

Number of molecules =

(3)

(Total 7 marks)

8

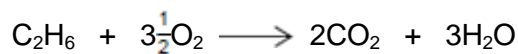
Which of these samples of gas contains the largest number of molecules?
The gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$.

- A** $5.0 \times 10^{-4} \text{ m}^3$ at $1.0 \times 10^6 \text{ Pa}$ and 300 K
- B** $4.0 \times 10^{-3} \text{ m}^3$ at $2.0 \times 10^5 \text{ Pa}$ and 400 K
- C** $3.0 \times 10^1 \text{ dm}^3$ at $3.0 \times 10^4 \text{ Pa}$ and 500 K
- D** $2.0 \times 10^2 \text{ dm}^3$ at $4.0 \times 10^3 \text{ Pa}$ and 600 K

(Total 1 mark)

9

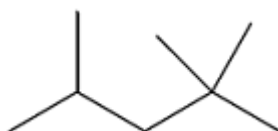
What is the total volume of gas remaining after 20 cm³ ethane are burned completely in 100 cm³ oxygen? All volumes are measured at the same pressure and the same temperature, which is above 100 °C.



- A 40 cm³
- B 100 cm³
- C 120 cm³
- D 130 cm³

(Total 1 mark)**10**

Isooctane (C₈H₁₈) is the common name for the branched-chain hydrocarbon that burns smoothly in car engines. The skeletal formula of isooctane is shown below.



- (a) Give the IUPAC name for isooctane.

.....

(1)

- (b) Deduce the number of peaks in the ¹³C NMR spectrum of isooctane.

5

6

7

8

(1)

- (c) Isooctane can be formed, together with propene and ethene, in a reaction in which one molecule of an alkane that contains 20 carbon atoms is cracked.

Using molecular formulas, write an equation for this reaction.

.....

(1)

- (d) How do the products of the reaction in part (c) show that the reaction is an example of thermal cracking?

.....

(1)

- (e) Deduce the number of monochloro isomers formed by isooctane.
Draw the structure of the monochloro isomer that exists as a pair of optical isomers.

Number of monochloro isomers

Structure

(2)

- (f) An isomer of isooctane reacts with chlorine to form only one monochloro compound.

Draw the **skeletal formula** of this monochloro compound.

(1)

- (g) A sample of a monochlorooctane is obtained from a comet. The chlorine in the monochlorooctane contains the isotopes ^{35}Cl and ^{37}Cl in the ratio 1.5 : 1.0
Calculate the M_r of this monochlorooctane.

$M_r = \dots\dots\dots$

(2)

- (h) Isooctane reacts with an excess of chlorine to form a mixture of chlorinated compounds. One of these compounds contains 24.6% carbon and 2.56% hydrogen by mass. Calculate the molecular formula of this compound.

Molecular formula =

(3)
(Total 12 marks)