IB · HL · Chemistry

🕐 60 mins   ❓ 3 questions

Practice Paper 1B

Total Marks   **/35**

1 (a) A student investigated the effect of temperature on the rate of hydrogen peroxide (H_2O_2) decomposition using manganese(IV) oxide (MnO_2) as a catalyst. The volume of oxygen gas produced in the first 20 seconds was measured at five different temperatures.

$$2H_2O_2 \text{ (aq)} \rightarrow 2H_2O \text{ (l)} + O_2 \text{ (g)}$$
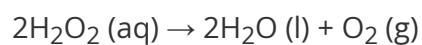
Temperature / °C	Volume of O_2 produced / cm^3
20	6.2
30	10.7
40	15.6
50	22.3
60	23.1
70	23.3
80	23.2

(i) Describe the trend shown in the data.

[1]

(ii) Use particle theory to explain the effect of increasing temperature on the rate of reaction.

[2]

....

....

(b) (i) Calculate the average rate of reaction at 50 $^{\circ}$C in cm^3 s^{-1}.

[1]

(ii) Calculate the percentage increase in rate when the temperature is raised from 40 $^{\circ}$C to 50 $^{\circ}$C.

[2]

(3 marks)

(c) Explain why there is only a small increase in rate between 50 $^{\circ}$C and 60 $^{\circ}$C.

(2 marks)

(d) The student repeats the experiment without MnO_2.

(i) Sketch a second curve on the grid below to show how the reaction rate would differ without a catalyst. Label the curve.
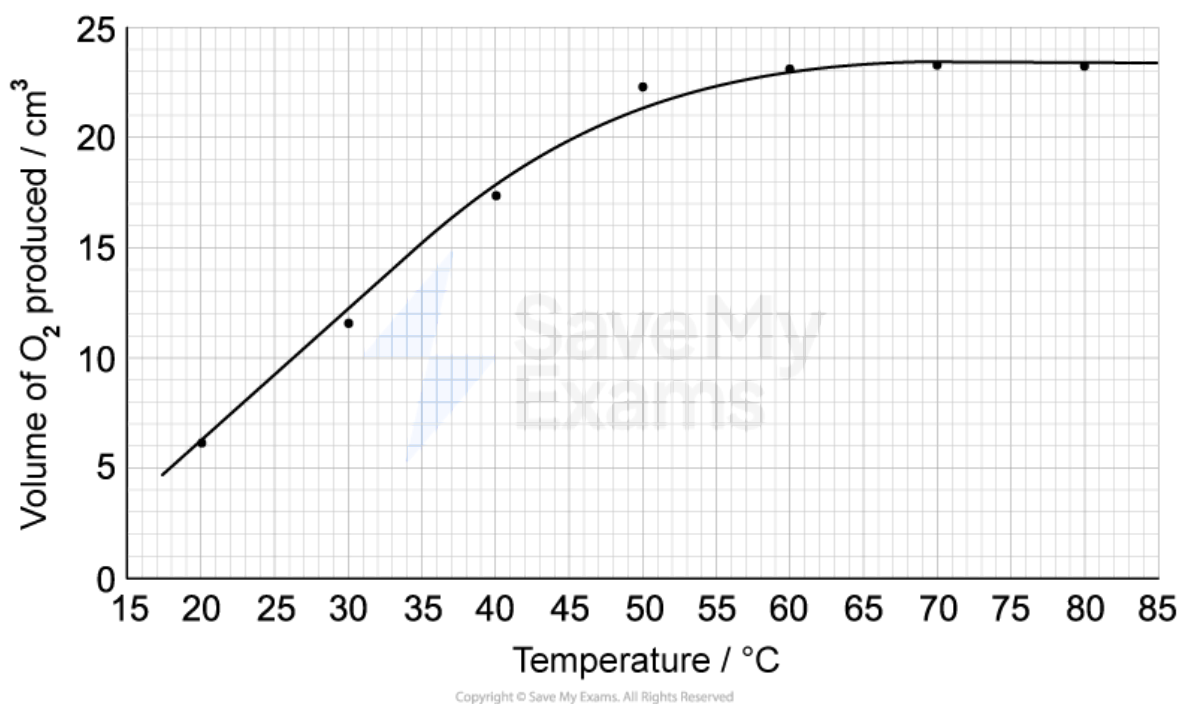
[1]

(ii) Explain why the catalyst affects the rate.

[2]

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.... **(3 marks)**
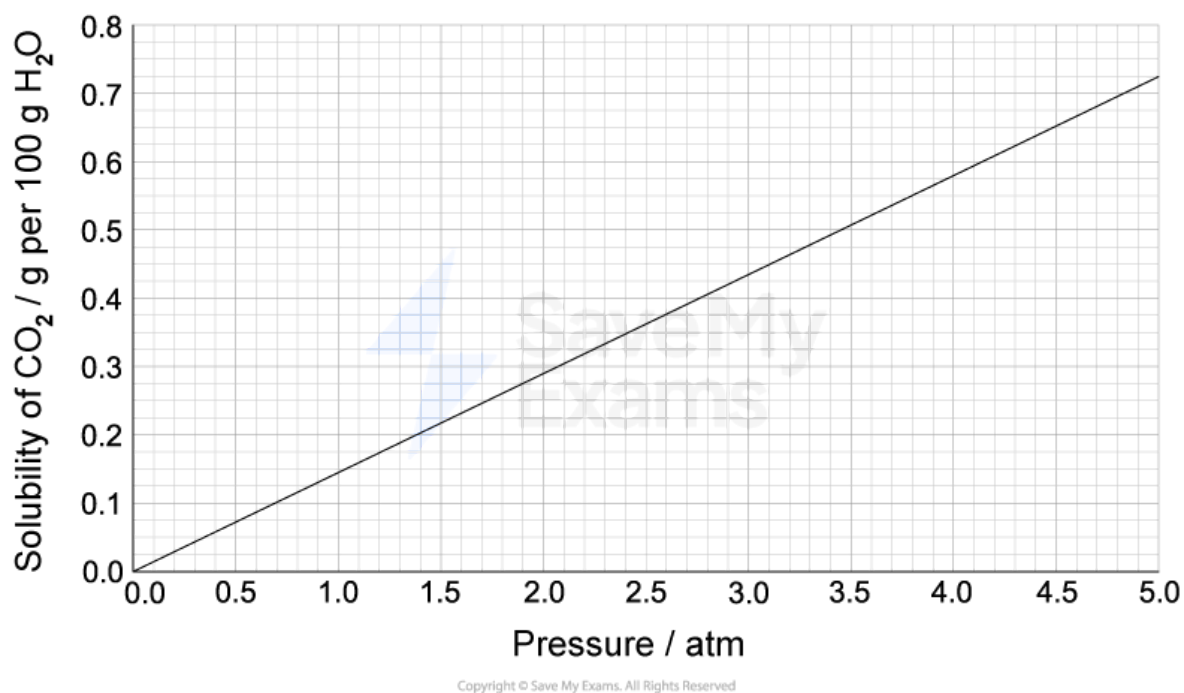
(e) Suggest one procedural improvement the student could make to increase accuracy in measuring the volume of gas produced.

.... **(1 mark)**

2 (a) The graph below shows how the solubility of carbon dioxide (CO_2) in water changes with pressure at a constant temperature of $25\,^{\circ}C$.

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(i) Describe the trend shown by the graph.

[1]

(ii) State the type of relationship shown between pressure and solubility.

[1]

....

.... **(2 marks)**

(b) Explain the trend using ideas about particle behaviour.

....

.... **(2 marks)**

(c) (i) Use the graph to determine the solubility of CO_2 at 2.5 atm.

[1]

(ii) Use the graph to determine the pressure needed for a solubility of 0.580 g per 100 g H_2O.

[1]

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(2 marks)

(d) Explain why the graph passes through the origin.

(1 mark)

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(e) (i) Explain why increasing the temperature would reduce the solubility of CO_2 in water.

[2]

(ii) Predict how the graph would look if temperature increased.

[1]

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(3 marks)

(f) Suggest one real-world situation that relies on the solubility of gases in liquids.

(1 mark)

....

(g) Explain why the dissolution of CO_2 in water is considered an exothermic process.

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(2 marks)

3 (a) A student investigates how different haloalkanes react with aqueous sodium hydroxide. Each halogenoalkane has the molecular formula C_4H_9Br, but a different structure:

Compound	Structural formula	Type of haloalkane
W	$CH_3CH_2CH_2CH_2Br$	Primary
X	$(CH_3)_2CHCH_2Br$	Primary (branched)
Y	$CH_3CHBrCH_3$	Secondary
Z	$(CH_3)_3CBr$	Tertiary

Equal volumes of NaOH (aq) are added to each compound in separate test tubes, and the mixture is warmed. The student records the time taken for a white precipitate (AgBr) to appear.

Compound	Time for precipitate to appear / s
W	95
X	80
Y	42
Z	11

Identify the compound that reacted the fastest and suggest the type of mechanism involved.

(1 mark)

(b) Explain why compound Z reacts faster than compound W, using ideas about carbocation stability and mechanism.

....

....
(2 marks)

(c) The student uses polar protic solvents in all trials.

Explain how this affects the likely substitution mechanism.

....

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(2 marks)

(d) Compound W is tested again using an aprotic solvent. The rate increases significantly. Suggest a reason for this observation.

....
(1 mark)

(e) Predict the major organic product formed when compound Z reacts with NaOH (aq). State the type of reaction.

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(2 marks)

(f) Suggest one experimental method, other than measuring rate, that could help distinguish between the S_N1 and S_N2 mechanisms.

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(2 marks)