

Q1.Some antacid tablets contain sodium hydrogencarbonate, sucrose and citric acid.

- (a) Analysis of a pure sample of citric acid showed that it contained 37.50% of carbon and 4.17% of hydrogen by mass, the remainder being oxygen. Use these data to show that the empirical formula of the acid is $C_6H_8O_7$.

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(3)

- (b) When the antacid tablet is added to water, sodium hydrogencarbonate and citric acid react together to form a gas. Identify this gas.

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(1)

- (c) A weighed portion of this antacid was added to water. The gas formed was collected and its volume measured.

- (i) Draw a diagram to show how this experiment could have been carried out to collect and measure the volume of the gas.

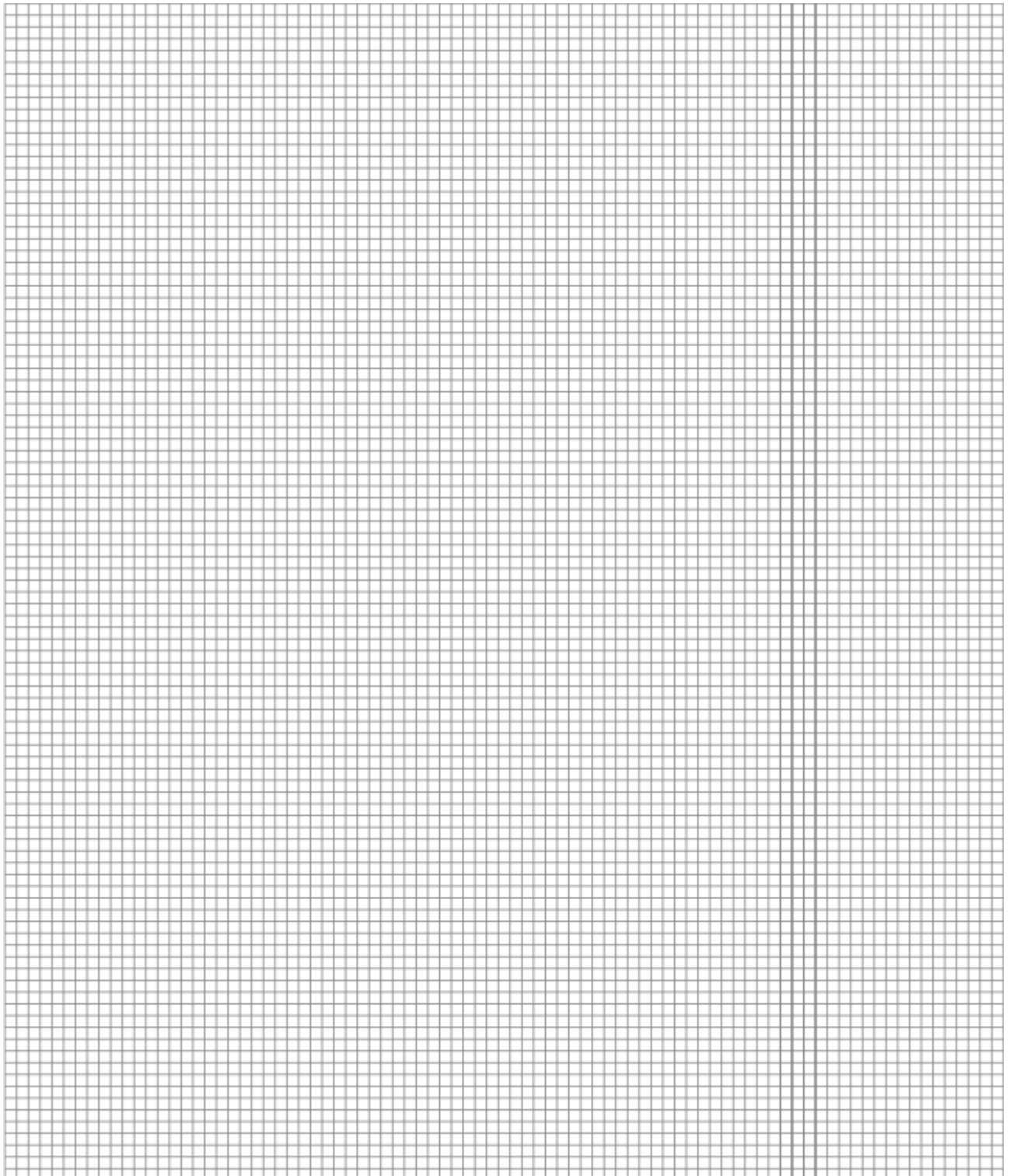
- (ii) The experiment was repeated with further weighed portions of the same antacid.

The results are shown below.

Experiment	1	2	3	4	5
Mass of antacid / g	2.60	1.17	0.88	2.31	1.80

Volume of gas collected / cm ³	168	86	57	149	116
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- 1 On the graph paper below, plot a graph of mass of antacid (x -axis) against volume of gas collected.



(3)

2 Draw a line of best fit on the graph, ignoring any anomalous points.

(1)

3 Use the graph to determine the volume of gas which would have been collected using 2.00 g of antacid.

Volume of gas collected

(1)

(d) Suggest **one** reason why the presence of sodium hydrogencarbonate in the stomach may cause a person to suffer some extra discomfort for a short time.

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(1)

(e) Explain why the value for the M_r of citric acid does not need to be an exact value to deduce the molecular formula of citric acid from its empirical formula.

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(2)

(f) Apart from misreading the gas volume, suggest **two** reasons why the volumes of gas collected may be lower than the volumes of gas produced.

Reason 1

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Reason 2

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(2)

(g) Explain why it is important to record the temperature and pressure when measuring the volume of a gas.

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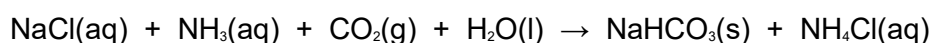
(1)

- (h) Suggest why, in an analysis of an antacid, it is important to test samples from more than one bottle of the antacid.

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(1)

- (i) In the industrial production of sodium hydrogencarbonate, ammonia and carbon dioxide are bubbled through a saturated solution of sodium chloride. The equation for this reaction, and some solubility data, are shown below.



Compound	Solubility in water at 20 °C / g dm ⁻³
sodium chloride	360
sodium hydrogencarbonate	96
ammonium chloride	370

- (i) Suggest **one** reason why sodium hydrogencarbonate precipitates from the reaction mixture at this temperature.

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(1)

- (ii) Explain how this reaction could be used to remove carbon dioxide from the gases formed when fossil fuels are burned.

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(1)

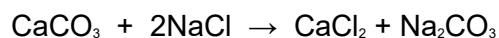
- (j) The thermal decomposition of sodium hydrogencarbonate produces sodium

carbonate. The other products are water and carbon dioxide. Write an equation for this thermal decomposition.

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(1)

- (k) Sodium carbonate is produced on an industrial scale by a multi-step process. The equation which summarises the reactions taking place is shown below.



Calculate the percentage atom economy for the production of sodium carbonate by this reaction.

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(1)

(Total 20 marks)