Q1. Magnesium carbonate, $MgCO_3$, can occur as the anhydrous compound, or as hydrates with 2, 3 or 5 molecules of water of crystallisation. All types of magnesium carbonate can be decomposed to form magnesium oxide, an important starting material for many processes. This decomposition reaction can be used to identify the type of magnesium carbonate present in a mineral.

A chemist was asked to identify the type of magnesium carbonate present in a mineral imported from France. The chemist weighed a clean dry crucible, and transferred 0.25 g of the magnesium carbonate mineral to the crucible. The crucible was then heated for a few minutes. The crucible was then allowed to cool, and the crucible and its contents were reweighed. This process was repeated until the crucible and its contents had reached constant mass. The mass of the crucible and its contents was then recorded.

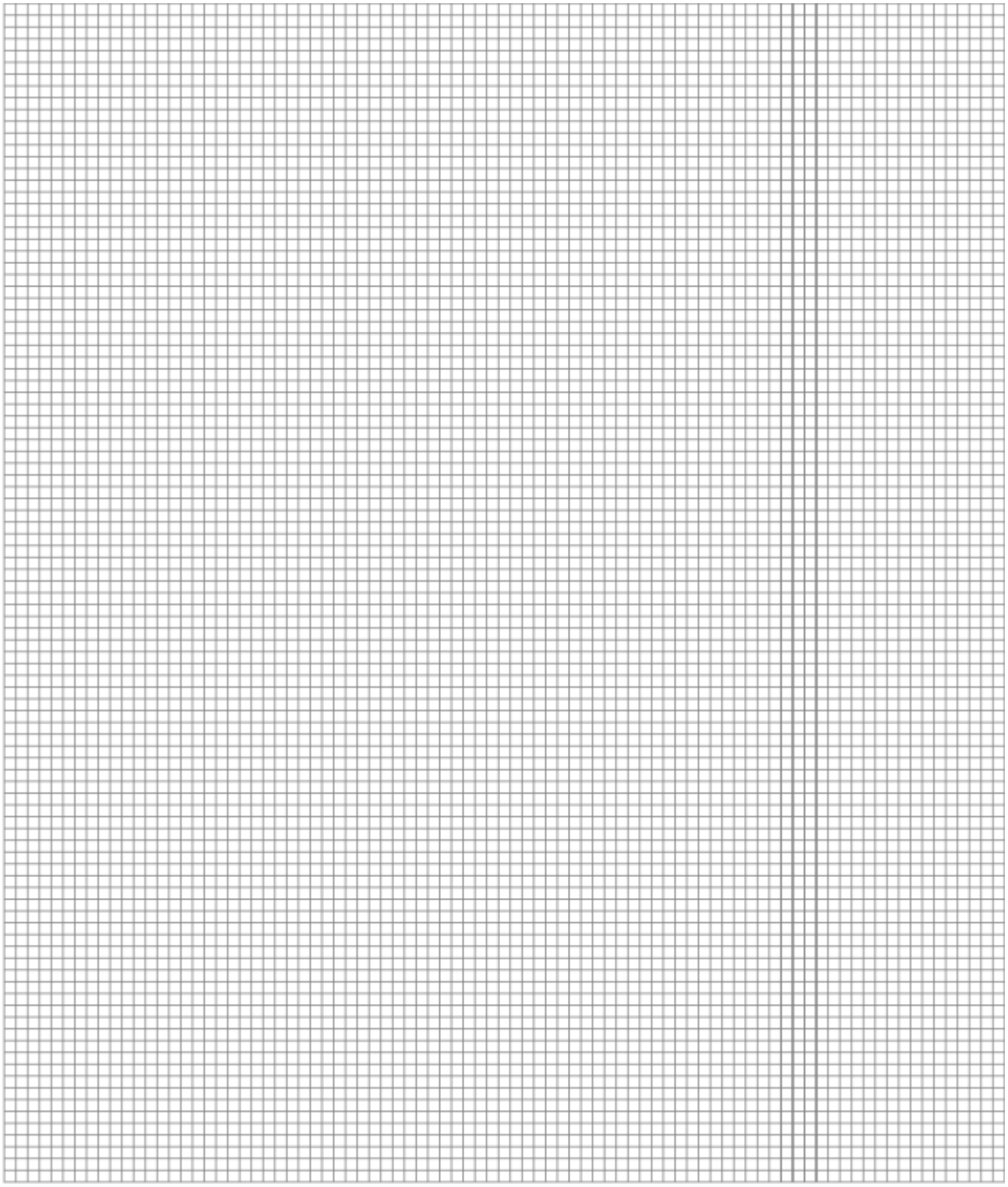
The experiment was repeated using different masses of the magnesium carbonate mineral.

For each experiment the chemist recorded the original mass of the mineral and the mass of magnesium oxide left after heating to constant mass. The chemist's results are shown in the table below.

Experiment	1	2	3	4	5	6
Mass of mineral / g	1.60	1.17	0.74	1.31	1.80	1.34
Mass of magnesium oxide / g	0.54	0.39	0.24	0.44	0.61	0.49

(a) Plot a graph of the mass of the mineral (x-axis) against the mass of magnesium oxide on the grid below.

Draw a straight line of best fit on your graph.



(4)

(b) Use the graph to determine the mass of the mineral which would have formed 0.50 g of magnesium oxide.

Mass of the mineral .....

(1)

(c) Calculate the amount, in moles, of MgO present in 0.50 g of magnesium oxide.

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(1)

(d) Use your answers from part (b) and from part (c) to calculate the M_r of the magnesium carbonate present in the mineral.

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(1)

(e) Use your answer from part (d) to confirm that this mineral is $MgCO_3.2H_2O$

(If you could not complete the calculation in part (d), you should assume that the experimental M_r value is 122.0 This is not the correct answer.)

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(1)

(f) Explain why it was **not** necessary to use a more precise balance in this experiment.

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(1)

(g) Consider your graph and comment on the results obtained by the chemist. Identify any anomalous results.

Comment .....

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Anomalous results .....

.....

(2)

(h) Explain why it was necessary for the chemist to heat the crucible and its contents to constant mass.

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(1)

(i) Suggest **one** reason in each case why

(i) small amounts of the mineral, such as 0.10 g, should **not** be used in this experiment.

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(1)

(ii) large amounts of the mineral, such as 50 g, should **not** be used in this experiment.

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(1)

(j) Analysis of a different hydrated magnesium carbonate showed that it contained 39.05% by mass of water. Determine the formula of this hydrated magnesium carbonate.

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(2)

(k) Magnesium oxide is produced by the thermal decomposition of magnesium

carbonate and by the thermal decomposition of magnesium hydroxide. The equations for the reactions taking place are shown below.

Reaction 1	$MgCO_3$	→	$MgO + CO_2$
Reaction 2	$Mg(OH)_2$	→	$MgO + H_2O$

Show that Reaction 2 has the greater atom economy for the production of magnesium oxide.

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(2)

(l) Apart from cost, suggest **one** advantage of using magnesium hydroxide rather than magnesium carbonate to reduce acidity in the stomach.

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(1)
(Total 19 marks)

Q2. The relative molecular mass (M_r) of benzene-1,4-dicarboxylic acid is

A 164

B 166

C 168

C 170

(Total 1 mark)

Q3. (a) State the relative charge and relative mass of a proton, of a neutron and of an electron.
In terms of particles, explain the relationship between two isotopes of the same element.
Explain why these isotopes have identical chemical properties.

(7)

(b) Define the term *relative atomic mass*. An element exists as a mixture of three isotopes.

Explain, in detail, how the relative atomic mass of this element can be calculated from data obtained from the mass spectrum of the element.

(7)

(Total 14 marks)