

Eton College King's Scholarship Examination 2013

SCIENCE (SECTION 2 - DATA ANALYSIS)

(30 minutes)

Candidate Number: _____

*Write your candidate number, **not your name**, in the space provided above.*

Read the information and answer the questions in the spaces and on the graph paper provided as appropriate.

You are expected to answer all the questions.

In questions involving calculations, all your working must be shown.

[Additional materials required: graph paper]

For examiners' use only.

Total [40]	
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1. For years scientists have heated substances and observed any changes. In the 17th, 18th and 19th centuries there was much debate about some of the changes observed. More recently a teacher tried his own experiments which involved weighing substances both before and after heating them. His procedure was as follows:

Step 1 – Find the mass of a heat-proof tray.

Step 2 – Place substance to be heated on the tray and find the total mass.

Step 3 – Place the tray on a tripod and heat the tray from below for 2 minutes with a roaring blue Bunsen flame.

Step 4 – Place the tray on the balance and find the new mass.

Step 5 – Repeat steps 3 and 4.

Here is a table of results for a variety of substances:

Mass of tray = 45.0 g

Substance to be heated	Mass of tray + substance before heating /g	Mass of tray + substance after 2 minutes /g	Mass of tray + substance after 4 minutes /g
Wood shavings	52.0	49.3	47.1
Charcoal	47.0	46.0	45.2
Wax	48.0	45.0	45.0
Magnesium	47.0	48.5	48.5
Iron	50.0	51.0	52.0
Sulphur	47.0	46.0	45.0
Copper oxide	48.0	48.0	48.0

- a) Which substances gained mass when heated? [1]

- b) i) For which substance or substances can you be most confident that any reaction has finished? Explain your selection. [2]

[Turn over]

ii) What could you do to increase your confidence for those substances about which some doubt remained? [1]

c) i) What would you observe when the magnesium is heated in air? [2]

ii) What name is given to the substance formed when magnesium is heated? [1]

iii) What type of chemical reaction is this? [1]

iv) The product formed when magnesium is heated is added to a beaker of water and stirred. Explain what effect, if any, you would predict there to be on the pH. [2]

d) i) Some substances lost mass when heated. What explanation can you give for this? [2]

[Turn over]

ii) Calculate the percentage loss in mass of the wood shavings and the charcoal after 4 minutes. [2]

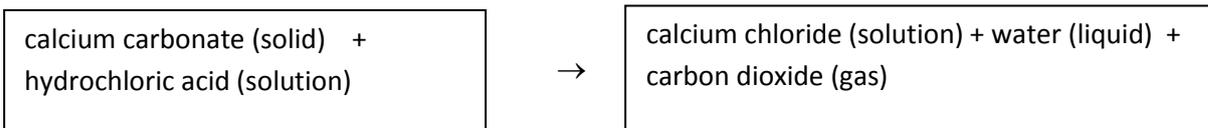
iii) Assuming that both reactions had finished after 4 minutes, what explanation can you provide for the difference in percentage loss in mass calculated in (ii) above? [2]

iv) What was the percentage mass loss of sulphur and wax when they were heated? [1]

v) What does this tell you about these two substances? [1]

[Turn over]

2. The teacher mentioned that mass appears to be lost when some other types of chemical reaction occur. One such reaction is:



The class came up with the theory that the mass would be lost at a constant rate until this reaction had finished.

- a) Draw a labelled diagram to show a possible set up for apparatus that would allow this reaction to occur and describe how you would use it to provide sufficient data to test the theory. [4]

[Turn over]

In the table below are some readings that the teacher recorded when he did the experiment.

Time (minutes)	Mass Loss (g)
0.0	0.00
1.0	0.36
2.0	0.58
4.5	0.94
6.5	1.10
9.0	1.18
10.0	1.30
13.0	1.36
14.0	1.36

b) Use the numbers in the table and the graph paper provided to plot a graph of mass loss against time (with time on the x -axis). Draw a best fit curve through your results and circle any points that you think should not be included in your best fit curve. [4]

c) Use your graph to calculate an initial rate of reaction. [3]

d) Does your graph support the class's theory or not? How can you tell? [2]

e) Despite some solid still being visible, after 14 minutes the reaction had finished.

i) How could you see the reaction had finished if you were watching the experiment? [1]

ii) Suggest why there was still some solid left in the reaction vessel? [1]

iii) Describe how the pH of the reaction mixture changed over the 14 minutes of the reaction. [2]

f) The teacher repeated the experiment above but used an equal quantity of sodium carbonate instead of calcium carbonate (making sure that this was the ONLY CHANGE). Decide whether the reaction would have gone more slowly, more quickly, at the same rate or that you couldn't predict what rate it would be. Explain your answer. [3]

g) The teacher tells the students that mass cannot be lost or gained in a reaction. Why does the reaction only seem to have lost mass? [2]

[END OF PAPER]