ST PAUL'S SCHOOL
JUNIOR SCHOLARSHIP EXAMINATION

CHEMISTRY

NAME _____

MAY 2013

SECTION C – CHEMISTRY

1. A mistake at a chemical company means that two white solids have both been mixed up and placed into the same container.

   The two white solids were known to be magnesium carbonate and potassium nitrate.

   The manager of the company decided it was worthwhile to separate the two white solids that had been mixed up and discovered a table of information relating to the solubility of some of the chemicals made by the company. The table is shown below:

Substance	***Solubility in water at room temperature***
sodium chloride	*soluble*
barium sulfate	*insoluble*
potassium nitrate	*soluble*
lithium phosphate	*soluble*
magnesium carbonate	*insoluble*
sodium sulfate	*soluble*

   a) *Explain fully* how the two white solids could be recovered based upon their solubility in water. *You should make reference to key scientific terms and techniques in your answer to gain full credit.*

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   …… [4]

To confirm the identity of the two white solids, once they had been separated, some reactions were carried out and these, together with the observations of the reactions, are shown in the table below:

	Solid 1	**Solid 2**
Reaction 1: Addition of hydrochloric acid	No reaction.	Fizzing is observed and a clear colourless solution is formed.
Reaction 2: Prolonged heating in a roaring Bunsen flame	The solid first melts, then bubbling is seen and a glowing splint is relit. A white solid remained in the tube upon cooling.	The solid is seen to be agitated in the test tube as a gas is released. The colourless gas turned limewater cloudy. A white solid remained in the tube upon cooling.

b) *Identify* **Solid 2**.

…… [1]

c) Complete the word equation below for the reaction of **Solid 2** with hydrochloric acid. Note that there are *three* separate products in this reaction.

Solid 2 + hydrochloric acid → ……..... +

……..…… + …… [2]

d) When **Solid 1** is heated in **Reaction 2** there are two products – one product is a compound and the other is an element. Identify the element formed in this reaction.

…… [1]

e) When **Solid 2** is heated in **Reaction 2** there are again two products – this time both products are compounds. Identify the two compounds formed in this reaction by completing the word equation below.

Solid 2 + heat → ……..…… +

…… [2]

f) Suggest a possible identity for the white solid that remained after **Solid 1** had been heated.

…… [1]

TURN OVER

2. When the colourless gas ammonia dissolves into water it forms ‘ammonia solution’. A saturated solution of ammonia in water is moderately alkaline.

A pupil reads in an online science blog that ammonia has a much lower boiling point than water and so evaporates from the ‘ammonia solution’ more quickly than water does. The blog says that a bottle of ‘ammonia solution’ in the laboratory with its stopper left off will, in time, become a bottle of pure water. Two pupils decide to investigate this statement.

Pupil A puts 80 cm^3 of distilled water into a 100 cm^3 beaker and working in a fume cupboard he then bubbles ammonia gas into it. He uses a ‘test paper’ to work out when no more ammonia gas will dissolve.

a) Suggest why **Pupil A** did the experiment in a fume cupboard.

……

…… [1]

b) From the list of options below circle the type of ‘test paper’ that **Pupil A** should use:

Blue Litmus Red Litmus Litmus Universal Indicator

Cobalt (II) chloride Starch Iodide

[1]

c) Using the ‘test paper’, how did **Pupil A** know when he had a fully saturated ‘ammonia solution’ to start the experiment?

……

…… [1]

When Pupil A had a saturated ‘ammonia solution’ he took his first reading using a pH meter and started a stop clock. He then measured the pH of the solution every second day for eight days. His results are shown in the table below:

TIME	START	DAY 2	DAY 4	DAY 6	DAY 8
pH Value	12	10	9	8	7

d) Calculate the *average rate of decrease* in pH value from the start of the experiment to the reading taken on **Day 6**. Give your answer to **two decimal places** and **show your working.** The unit has been provided for you.

……pH per day [1]

e) Predict the pH reading on **Day 10.** *Explain your answer.*

pH value on Day 10 = ……....

Explanation:

……

…… [2]

Pupil B works at exactly the same time as **Pupil A** and in the same fume cupboard but decides on a different method using an electronic mass balance that is accurate to the nearest 0.5g.

He finds the mass of an empty 100 cm^3 beaker to be 120.0g. He then puts 80 cm^3 of distilled water into the beaker and reweighs it at 200.0g.

He then leaves the beaker and water on the balance in the fume cupboard and bubbles ammonia gas into the water until he has a saturated 'ammonia solution'

f) How will **Pupil B** know when he has a saturated 'ammonia solution' without using any test papers?

…… [1]

When **Pupil B** had achieved a saturated 'ammonia solution' he noted down the reading on the balance and started the stop clock at the same time as **Pupil A**. He then took a mass reading at the same time on every second day. **Pupil B's** results are shown in the table below:

TIME	**START**	**DAY 2**	**DAY 4**	**DAY 6**	**DAY 8**
Mass / g	**230.0**	**221.5**	**213.0**	**204.5**	**196.0**

g) Using the data in the table, calculate the ***percentage by mass*** of ammonia in **Pupil B's** saturated 'ammonia solution'. **Show your working.**

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…… [1]

h) **Pupil B** wrote in his note book that he thinks 8.5g of ammonia have evaporated from the solution in the first two days. Why is this **<u>not</u>** a reasonable deduction?

…… [1]

TURN OVER

i) Predict the mass reading on **Day 10** to **one decimal place**. *Explain your answer.*

Mass reading on Day 10 = ……

Explanation:

……

…… [2]

j) Assuming that **Pupil B** continued reading off the balance for a whole year, predict the likely mass reading on the balance at the end of one year. *Explain your answer.*

Mass reading after one year = ……

Explanation:

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…… [2]

k) 'Ammonia solution' can be neutralised by adding acids which then produce 'ammonium salts'. For example, neutralisation with nitric acid produces the salt, ammonium nitrate. Name the salt produced when ammonia solution is reacted with sulphuric acid.

…… [1]

END OF CHEMISTRY

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