You are provided with the following;

BA1, which is a solution containing 20.0 g/dm^3 of unknown hydrated salt, $RCO_3.xH_2O$.

BA2, which is a 0.2 M hydrochloric acid.

You are required to determine the number of Moles of water of crystallization, x, in $RCO_3.xH_2O$ and the percentage of the anhydrous salt, RCO_3.
(1 mole of hydrated salt reacts with 2 moles of hydrochloric acid)

Procedure

Pipette 25.0 cm^3 (or 20.0 cm^3) of **BA1** into a clean conical flask using a clean pipette.
Add 2-3 drops of Methyl orange indicator and titrate it with **BA2** from the burette.

Repeat the procedure above until you obtain consistent results.

Record your results in the table below.

Results;
Volume of pipette used = 25.0 ✓ (cm^3) ½ (½mark)

	1	2	3
Final Burette reading (cm^3)	17.50 ✓	17.10 ✓	34.30 ✓
Initial Burette reading (cm^3)	0.00 ✓	0.00 ✓	17.20 ✓
Volume of **BA2** used (cm^3)	17.50 ✗	17.10 ✓	17.11 ✓

(7½ marks)

Titre values of **BA2** used to calculate the average volume.

17.10 and 17.10 ✓ ½ (cm^3) (½mark)

Average volume of **BA2** used.

±0.5 ✗ ±0.2 ✓ ±0.4 ✗ ±0.1 ✓ ±0.3 ✓ ✗

$\frac{17.10 + 17.10}{2} = 17.10$ ✓ ✗ 2½ (cm^3) (2½mark)

(a) Calculate;

(i) the number of moles of **BA2** that reacted. (03 marks)

1000cm^3 of solution contains 0.2 moles of BA_2 ✓
17.10cm^3 of solution contains $\frac{0.2 \times 17.10}{1000.0}$ moles of BA_2 ✓ 03
$= 0.00342$ moles of BA_2 ✓

Q 17.50 → 0.00176

0.0704 (284)

(ii) the concentration of the hydrated salt, $RCO_3.xH_2O$, in Moles per dm^3. (03 marks)

Since 2 moles of BA2 reacted with 1 mole of BA1 03

0.00342 moles of BA2 reacted with 1×0.00342 moles

$\frac{}{2} = 0.00171$ moles

$25cm^3$ of solution contain 0.00171 moles 784

$1000cm^3$ of solution contain $\frac{1000 \times 0.00171}{25}$ moles 784 0.0684M

(iii) the relative formula mass of the dehydrated salt, $RCO_3.xH_2O$. (03 marks)

0.0684 moles weighs 20g

1 mole weighs $\frac{20 \times 1}{0.0684}$ g 03

$\simeq 292.4$ g

Contain 20g of $RCO_3.xH_2O$

Contain $\frac{2 \times 25}{1000}$ g of $RCO_3.xH_2O$

$= 0.5g$

0.0171 moles weigh 0.5g

1 mole weighs $\frac{1 \times 0.5}{0.0171} = 292.4$

(b) Determine the;

(i) the value of x, in $RCO_3.xH_2O$. (02 marks)

[R = 46, O = 16, C = 12, H = 1]

$RCO_3.xH_2O = 292.4$ ½

$46 + 12 + 48 + 18x = 292.4$

$18x = 292.4 - 106$ 03

$x = 186.4 / 18$ ∴ $x \simeq 10$

(ii) the percentage of the anhydrous salt RCO_3. (03 marks)

Percentage of anhydrous salt $= \frac{106 \times 100}{286.4}$

$= 37.06\%$ $\simeq 37.0\%$ 02

2. You are provided with substance **Q** which contains **two** cations and a common anion. Carry out the following tests on **Q** to identify the cations and anion present. Identify any gas(es) evolved.

Record your observations and deductions in the table below. (23½ marks)

TEST	OBSERVATION	DEDUCTION
(a) To **one** spatula endful of Q in a clean test tube, add 4 cm^3 of distilled water and shake well. Filter and keep both the filtrate and residue. Divide the filtrate into **three** equal portions. (1 cm^3 each)	White powder / solid dissolves partially white residue Colourless filtrate Accept white crystalline solid mixture of white powder and crystals.	Zn^{2+}, Al^{3+}, Pb^{2+}, Mg^{2+}, NH_4^+, Ca^{2+} 04 Pb^{2+}, Mg^{2+}, Al^{3+}, Zn^{2+} + NH_4, Ca^{2+},

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(i) To the **first** portion add aqueous ammonia drop wise until in excess.	No observable colour change	NH_4^+, Ca^{2+} 07
(ii) To the **second** portion add aqueous sodium hydroxide drop wise until in excess and warm.	No precipitate, Colourless gas that turns moist red litmus paper blue	NH_3 (g) / NH_4^+ 2½
(iii) To the remaining portion of the filtrate, add 3 drops of Lead (II) nitrate solution followed by dilute nitric acid solution drop by drop until in excess.	white precipitate formed dissolves with effervescence of colourless gas that turns moist blue litmus paper red and lime water milky	$CO_{2(g)}$ / CO_3^{2-} 3½
(b) Add dilute Nitric acid to the residue until it dissolves. Divide the resultant solution into **four** equal portions.	Dissolves with effervescence of colourless gas that turns moist blue litmus paper red and lime water milky to form a colourless solution	$CO_{2(g)}$ / CO_3^{2-} 3½ Zn^{2+}, Al^{3+}, Pb^{2+}, Mg^{2+}, Ca^{2+}
(i) To the **first** portion add aqueous sodium hydroxide drop wise until in excess.	White precipitate dissolves forming a colourless solution	Zn^{2+}, Al^{3+}, Pb^{2+} 2½
(ii) To the **second** portion add aqueous ammonia solution drop wise until in excess.	White precipitate insoluble	Pb^{2+}, Al^{3+} 02
(iii) To the **third** portion add 3 drops of dilute hydrochloric acid solution. Warm the mixture, then allow to cool under water.	A white precipitate dissolves on warming and recrystallises on cooling	Pb^{2+} 02
(iv) Use the **fourth** portion to carry out a test of your own choice to confirm the cation in the residue. Add 3 drops of potassium iodide solution to the fourth portion	Yellow precipitate formed	PbI_2 / Pb^{2+} 2½

reject reappears

(e) Identify the ions in Q;

(i) Cations : NH_4^+ and Pb^{2+} (01 mark)

(ii) Anion CO_3^{2-} (½ mark)

END