Mark schemes

Q1.

(a) Electron is removed from 1(s) (rather than 2(s))

Mark independently

Lower in energy (than 2s)/Less/No shielding/closer to the nucleus

Stronger attraction between nucleus and outer electron

3

(b) Similarity: produce hydrogen/produce gas/produce white solids/produce Mg^{2+} compounds/produce a base

Difference: magnesium oxide formed with steam and magnesium hydroxide formed with (cold) water

2

(c) Oxidation state of Ca increases, so Ca is oxidised
OR
Oxidation state of Ca from 0 to +2, so Ca is oxidised

*If no marks awarded, then correct oxidation states of Ca **and** H before **and** after the reaction scores 1 mark*

Oxidation state of H decreases, so H is reduced
OR
Oxidation state of H from +1 to 0, so H is reduced

2

[7]

Q2.

This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.	
Level 3 5-6	All stages are covered and the explanation of each stage is generally correct and virtually complete. Answer is well structured with no repetition or irrelevant points. Accurate and clear expression of ideas with no errors in use of technical terms.
Level 2 3-4	All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete. Answer shows some attempt at structure. Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points. Answer shows some attempt at structure. Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points. Some minor errors in use of technical terms.
Level 1 1-2	Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies, OR only one stage is covered but the explanation is generally correct and virtually complete. Answer includes isolated statements but these are not presented in a logical order or show some confusion. Answer may contain valid points which are not clearly linked to an argument structure. Errors in the use of technical terms.
Level 0 0	Insufficient correct chemistry to gain a mark.

In order to score 6 marks all 4 compounds must be identified in some way

Stage 1: Suggested tests **(3 + virtually 'complete', 1 + 'covered')**

1a: add NaOH
1b: add NaOH (and warm) then hold damp red litmus at mouth of tube (if sequential tests performed NaOH can be scored from 1a)
1c: add nitric acid/hydrochloric acid
1d: add acidified $BaCl_2$ / acidified $Ba(NO_3)_2$
(if sequential tests performed acidified can be scored from 1c)

Stage 2: Observations linked to correct solution and test **(3 + virtually 'complete', 1 + 'covered')**

2a: Mg^{2+} / $Mg(NO_3)_2$ will give a white ppt with NaOH
2b: red litmus (at mouth of the tube) will turn blue for NH_4^+ / NH_4NO_3 with NaOH (do not award if red litmus is placed in the solution)
2c: CO_3^{2-} / Na_2CO_3 will effervesce with acid/gas formed turns limewater cloudy
2d: SO_4^{2-} / K_2SO_4 will give a white ppt with $BaCl_2$
2e: the final tube will be the remaining solution (if only three tests have been done).

Stage 3: Equations **(3 + virtually 'complete', 1 + 'covered')**

3a: $Mg^{2+} + 2\ OH^- \rightarrow Mg(OH)_2$

3b: $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$

3c: $CO_3^{2-} + 2\ H^+ \rightarrow CO_2 + H_2O$

3d: $SO_4^{2-} + Ba^{2+} \rightarrow BaSO_4$

(Ignore state symbols; allow multiples)

[6]

Q3.

(a) (To make sure that) as much as possible/maximum amount (of solid) dissolves
OR
(To ensure that) the solution/it is saturated

Do not accept reacted

Ignore references to right/correct concentration

1

(b) otherwise, the titre would be larger
OR
would need a larger volume of acid/HCl
OR
because undissolved strontium hydroxide will react (with the acid/HCl).

Allow (solid) could block pipette

Ignore references to changes in concentration and pH

1

(c) To prevent reaction with carbon dioxide (in the air)

Allow so flask can inverted/shaken (to ensure homogeneous mixture)

OR
To prevent evaporation (of water/from solution)

Ignore contamination

1

(d) Answer **C**

1

(e) **M1** $Sr(OH)_2 + 2\ HCl \rightarrow SrCl_2 + 2\ H_2O$

M1 Equation

M2 32.43 (cm^3)

M2 Allow 32.425

M3 n HCl in mean titre = $3.24(3) \times 10^{-3}$ mol

M3 Allow 0.1 x M2 ÷ 1000

M4 n $Sr(OH)_2$ in 25 cm^3 = 1.62×10^{-3} mol

M4 Allow M3 ÷ 2

M5 n $Sr(OH)_2$ in 100 cm^3 of solution = 6.48×10^{-3} mol

M5 Allow M4 × 4

M6 mass = (6.48×10^{-3} mol x 121.6) = 0.788 (g per 100 cm^3 solution)

M6 Allow = M5 × 121.6
M6 Allow 0.79

Allow M5 and M6 in either order

6

[10]

Q4.

(a) **M1** (giant) lattice of (Mg^{2+}) cations / (giant) lattice of (Mg) atoms

Incorrect structure type loses M1

M2 (Electrostatic) attractions between cations / Mg^{2+} ions / nuclei **and** delocalised electrons

2

(b) **M1** Trend: increases

M2 Reason: the number of electron energy levels increases

Allow: the number of electron shells increases

Ignore increase in shielding

2

(c) $Mg(s) + H_2O(g) \rightarrow MgO(s) + H_2(g)$

State symbols essential

Bright/white flame/light

White/grey ash/powder (allow smoke)

Do not allow ppt

Ignore black solid

Ignore fumes.

3

(d) **M1** $BaSO_4$

M2 X-rays (of internal organs) / barium meal

2

(e) **M1** Abundance of ^{87}Sr = X

and Abundance of ^{86}Sr = 1 - 0.83 - X

= 0.17 - X

Allow M1 for

*Abundance of ^{87}Sr = X and Abundance of ^{86}Sr = Y **if** also states that X + Y = 17*

M2 87.73 = (88 × 0.83) + (87 × X) + (86 × (0.17 - X))

87.73 = (88 × 0.83) + (87 × X) + (86 × Y)

87.73 = 73.04 + 87X + 14.62 - 86X

87.73 = 87.66 + X

M3 ^{87}Sr = 0.07 = 7 %

M4 Abundance of ^{86}Sr = 1 - 0.83 - 0.07 = 0.1 = 10 %

M4 = 17 - M3

4

(f) **M1** Amount of HCl added = 0.200 × 0.040 = 0.00800 mol

M2 Amount of NaOH = 0.100 × 0.02925 = 0.002925 mol

(Amount of HCl = 0.002925 mol)

M3 Amount of HCl reacted with $Mg(OH)_2$ = 0.00800 - 0.002925 = 0.005075 mol

M3 = M1 - M2

M4 Amount of $Mg(OH)_2$ = 0.005075 ÷ 2 = 0.0025375 mol

M4 = M3 ÷ 2

M5 Mass of $Mg(OH)_2$ = 58.3 × 0.0025375 = 0.148 g

M5 = M4 × 58.3

M6 % by mass = $\frac{0.148}{0.200}$ × 100 = 74.0 %

M6 = $\frac{M5}{0.200}$ × *100*

Do not allow M6 if >100%

6

[19]

Q5.

(a) the outer electron is in a higher (energy) level / there is an increase in shielding / the atoms get larger / more shells

Mark independently

1

There is a weaker attraction between the nucleus and the outer electron.

1

(b) $Mg^{2+}(g) \rightarrow Mg^{3+}(g) + e^-$

$Mg^{2+}(g) + e^- \rightarrow Mg^{3+}(g) + 2\ e^-$

1

(c) The electron is removed from 2p sub-shell / 2nd energy level / lower energy level / sub-shell that is closer to the nucleus

1

(Electron being removed is) less shielded (than 3s)

1

[5]

Q6.

(a) Identity of gas: Carbon dioxide / CO_2

1

Test: When gas bubbled through limewater, a white ppt formed

When gas bubbled through limewater, it turns milky/cloudy

M2 dependent on M1

1

(b) Effervescence (with Na_2CO_3), so contains H^+ ions /
Effervescence (with Na_2CO_3), so is acidic

The result from Test 1 shows the presence of H^+ / acidic

1

White ppt (with $AgNO_3$), so contains chloride ions

The result from Test 2 shows the presence of chloride ions.

1

Allow balanced equation for each test that links to each observation

(c) (Warm with some) NaOH,

1

Damp red litmus at the mouth of the tube turns blue

Do not allow red litmus dipped in solution

1

Add (acidified) $BaCl_2$ / $Ba(NO_3)_2$

If reagent incorrect, cannot score observation mark

1

White ppt formed

If reagent incomplete, mark on

1

Use of $Ba(OH)_2$ can score M1 and M3

(d) The second mass is smaller / the mass after step 4 is smaller than the mass after step 2

1

AgCl dissolves in dilute ammonia / some ppt dissolves as AgCl is soluble in dilute ammonia

The ppt formed by chloride ions dissolves in dilute ammonia.

1

[10]