

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|--|------|
| 1(a)(i) | <p>Add hydrochloric acid / HCl(aq) / nitric acid / HNO₃(aq)</p> <p>ALLOW Just 'acid' only if a suitable acid is given in equation one Sulfuric acid / H₂SO₄((aq)) or HCl (1)</p> <p>IGNORE 'conc'</p> <p>Gas / carbon dioxide / CO₂ evolved turns lime water milky / cloudy / produces a white precipitate (1)</p> <p>MP2 is a stand alone mark but there must be some indication that a gas is being tested</p> | Just 'acid' OR heating the carbonate | 2 |

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| 1(a)(ii) | <p>ALL H₂CO₃(aq) for H₂O(l) + CO₂(g)</p> <p>BaCO₃(s) + 2HCl(aq) → BaCl₂(aq) + H₂O(l) + CO₂(g)</p> <p>OR</p> <p>BaCO₃(s) + 2HNO₃(aq) → Ba(NO₃)₂(aq) + H₂O(l) + CO₂(g)</p> <p>OR</p> <p>CO₃²⁻(s) + 2H⁺(aq) → H₂O(l) + CO₂(g)</p> <p>ALLOW BaCO₃(s) + H₂SO₄(aq) → BaSO₄(s/aq) + H₂O(l) + CO₂(g)</p> <p>OR</p> <p>BaCO₃(s) → BaO(s) + CO₂(g) (1)</p> <p>Ca(OH)₂(aq) + CO₂(g) → CaCO₃(s) + H₂O(l) (1)</p> <p>All state symbols in both equations correct (1)</p> <p>ALLOW State symbols mark if first equation not balanced but ALL species are correct. No TE on other equations</p> | | 3 |

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|-----------------|---|---|------|
| 1(b)(i) | <p>MP1 and MP2 Dip (clean) nichrome / platinum wire ALLOW loop / rod for wire OR Silica rod (1)</p> <p>in hydrochloric acid / HCl(aq) ALLOW any mention of HCl(aq) e.g. cleaning or mixing solid and acid HCl for HCl(aq) (1)</p> <p>ALLOW (for MP1 and MP2) (Wooden) splint (1) Soaked in distilled / deionised water (1)</p> <p>MP3 then dipped in solid and placed in (hot / roaring / blue-cone) (Bunsen) flame ALLOW On / over / under / above for 'in' (1)</p> <p>IGNORE inoculating / flame-test (wire)</p> | <p>Nickel / chrome / chromium</p> <p>spatula</p> <p>Other acids</p> <p>just 'water'</p> | 3 |

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| 1(b)(ii) | <p>A = Mg²⁺ (1) B = Ca²⁺ (1)</p> <p>Penalise omission of ²⁺ only once Correct ions with correct charge but the wrong way round scores 1 mark Correct ions with incorrect / no charge scores 1</p> <p>IGNORE Names / compounds</p> | | 2 |

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| 1(b) * (iii) | <p>Read the whole answer before awarding marks. If no mention of electrons only MP3 may be awarded.</p> <p>Electrons promoted to higher energy level (by thermal energy / heat from (Bunsen) flame) (1)</p> <p>(Promoted) electrons fall / drop / relax to lower energy level / orbital / shell / subshell OR Electrons return to ground state (1)</p> <p>Emitting radiation / light / photons (in the visible region) (1)</p> <p>IGNORE Colour</p> | <p>Just 'electrons promoted/ excited'</p> <p>Just 'energy lost'</p> <p>Just 'energy given out'</p> | 3 |

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| 1(b) (iv) | <p>Emitted radiation is not in the visible region (of the spectrum) ALLOW Emitted radiation is in IR / UV</p> | | 1 |

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| 1(c) | <p>As group is descended...</p> <p>First mark (metal ion size) (Metal) ion radius increases / has more (electron) shells (but charge remains the same) OR Charge density of metal ion decreases ALLOW (Metal) atomic radius increases / has more (electron) shells (1)</p> <p>Second mark (polarizing species) Polarizing (ALLOW distorting) power of cation / metal ion decreases (1)</p> <p>Third mark (polarized species) Polarization / distortion of (electron cloud of) carbonate ion /anion decreases</p> <p>ALLOW C—O / C=O for carbonate ion (1)</p> <p>(so carbonate more stable to heat)</p> <p>ALLOW reverse argument for ascent of the group.</p> | <p>Just "metal"</p> <p>Just 'ion'</p> <p>Just 'ion or bond'</p> | 3 |

Total for Question = 17 marks

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| 2 (a) | <p>The outer electrons are closer to the nucleus/smaller atomic radius/ less electron shells (in calcium) (1)</p> <p>Less shielding (in calcium) (1)</p> <p>OR</p> <p>Reverse argument for strontium</p> <p>Ignore reference to repulsion between shells</p> | <p>Ionic radius/ Molecules</p> <p>Just 'less electrons'</p> | 2 |

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|-----------------|--|---|------|
| 2 (b)(i) | <p>Nichrome wire / platinum wire / silica rods (1)</p> <p>(Dip / clean) in (concentrated) HCl/HCl(aq)/dilute HCl and place in Bunsen flame (1)</p> <p>OR</p> <p>Allow alternative procedures such as:</p> <p>Make a salt solution (1)</p> <p>Soak in wooden splint and place in Bunsen flame (1)</p> | <p>Nickel/Ni/ Chromium/Cr/ Metal loop/wire</p> <p>Yellow flame/burn</p> | 2 |

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|------------------|----------------------------------|------------|------|
| 2 (b)(ii) | (Pale/Light) green / apple green | Blue-green | 1 |

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| 2 (b) (iii) | Electrons promoted to higher energy level (1) | Proton | 3 |
| | Electron(s) return to lower energy level (1) | | |
| | Release of (visible/ light) energy/ photon upon return (1) | | |

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| 2 (c) (i) | Barium hydroxide / Ba(OH) ₂ Allow product as part of the equation: Ba + 2H ₂ O → Ba(OH) ₂ + H ₂ | | 1 |

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| 2 (c) (ii) | Bubbles / Fizzing / Effervescence IGNORE The Barium dissolves / forms a colourless solution Increase in temperature | The metal sinks Air bubbles Just 'a gas is produced' | 1 |

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| 2 (d) (i) | Barium is oxidized from 0 to +2 (1) Chlorine is reduced from 0 to -1 (1) Allow one mark if oxidized and reduced are the wrong way round Ignore reference to transfer of electron unless incorrect. | | 2 |

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| 2 (d) (ii) | Ba ²⁺ (aq) + SO ₄ ²⁻ (aq) → BaSO ₄ (s) One mark for chemical symbols (1) One mark for state symbols (1) Allow one mark maximum for: BaCl ₂ (aq) + H ₂ SO ₄ (aq) → BaSO ₄ (s) + 2HCl(aq) OR Ions not cancelled | BaSO ₄ (aq) | 2 |

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| 2 (d) (iii) | To prevent formation of carbonate / sulfite / sulfate(IV) (precipitate) / to remove carbonate / sulfite / sulfate(IV) ions | Just 'to remove other ions' | 1 |

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| 2 (e) (i) | $\text{MgCO}_3 + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2\text{O} + \text{CO}_2$ <p>Ignore state symbols even if incorrect</p> <p>ALLOW</p> $\text{MgCO}_3 + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2\text{CO}_3$ | | 1 |

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| 2 (e)(ii) | <p>Marking Point 1 (Factor) Use larger lumps (1)</p> <p>Marking Point 2 (Explanation) Decreases surface area OR Fewer collisions between the reactants (1)</p> <p>Alternatively Marking Point 1 (Factor) Decreases surface area (1)</p> <p>Marking Point 2 (Explanation) Fewer collisions between the reactants (1)</p> <hr/> <p>Marking Point 3 (Factor) Decrease concentration (of acid) (1)</p> <p>Marking Point 4 (Explanation) Fewer collisions between the reactants OR Fewer particles for the same volume (1)</p> <p>Explanation marking point only awarded for correct factor or a near miss.</p> | <p>Just 'increased size of MgCO₃'</p> <p>Just 'change in volume of acid'</p> | 4 |

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| 2 (f) | Pressure only affects gaseous reactions/ There is no significant volume change/the liquids are incompressible | | 1 |

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| 3(a)(i) | A hydrocarbon (solvent) / volasil / named hydrocarbon solvent / tetrachloromethane Formulae | Ethanol Alkenes | 1 |

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| 3(a)(ii) | Red / brown /orange / amber / yellow Or any combination No TE on incorrect / no reagent | | 1 |

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| 3(b)(i) | Oxidation number of S in $H_2SO_4 = (+)6$ Oxidation number of S in $SO_2 = (+)4$ (1) Oxidation number had decreased (1) ALLOW S has gained electrons for second mark Second mark stands alone provided oxidation numbers have decreased, even if calculated wrongly | Just 'S has gained electrons' without calculating oxidation numbers | 2 |

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| 3(b)(ii) | Black / (shiny) grey solid (1) Purple / violet / pink vapour / fumes (1) Smell of (bad) eggs (1) Yellow solid (1) ALLOW Brown liquid (1) Any two | Purple solid | 2 |

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| 3(b)(iii) | Oxidation number of S has reduced more / to -2 (in H_2S) (1) OR Oxidation number of S is lower in H_2S (than in SO_2) If ON of S in H_2S is calculated it must be correct | | 1 |

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| 3(c) | People can choose whether to take extra fluoride ALLOW Fluoride is not released into the environment | Fluoride can be monitored | 1 |