Question Number	Acceptable Answers	Reject	Mark
1(a)	CO_2 has polar bonds / oxygen does not have polar bonds **(1)** Ignore O_2 is a non polar molecule (As it vibrates) polarity of CO_2 changes / dipole moment changes / shifts **(1)** Allow "Oxygen has no difference in electronegativity so polarity does not change" for 2 marks	CO_2 is a polar molecule	**2**

Question Number	Acceptable Answers	Reject	Mark
1(b)(i)	Hydrogen bonds can form **with water** Allow full description of hydrogen bonds in absence of name. Ignore incorrect naming of functional groups in aminoethanol.	Just "it is polar"	**1**

Question Number	Acceptable Answers	Reject	Mark
1(b)(ii)	Exothermic, with attempt at a reason OR reverse reaction is endothermic, with attempt at a reason **(1)** Reaction will go in the endothermic direction on heating / equilibrium moves to left to use up heat supplied **(1)** Second mark depends on the reaction being exothermic in first mark	Just "exothermic"	**2**

Question Number	Acceptable Answers	Reject	Mark
1(c)(i)	 Electrons in double bond **(1)** Other electrons **(1)** Second mark dependent on first Only bonding electrons need be shown If inner shell electrons are included they must be correct. Electrons may be on circles, within circles or no circles may be shown.		**2**

Question Number	Acceptable Answers	Reject	Mark
1(c)(ii)	Number of electrons (per molecule) is greater in CO_2 (than methane). If numbers are given must be correct. CO_2 has $22e^-$, methane has $10e^-$. Ignore CO_2 has larger surface area than methane	double bonds in CO_2 as the cause	**1**

Question Number	Acceptable Answers	Reject	Mark
1(c)(iii)	Butane has a greater surface area / butane is less branched **(1)** so more contact between (neighbouring) molecules / (neighbouring) molecules pack better **(1)** OR Reverse argument for 2-methylpropane		**2**

Question Number	Acceptable Answers	Reject	Mark
1(d)(i)	Mg – no colour in flame **(1)** Allow 'no flame visible' Ca brick red / red / yellow-red / red-orange **(1)**	Mg: white flame Bright / white light Clear flame Just orange	**2**

Question Number	Acceptable Answers	Reject	Mark
1(d)(ii)i	**irst mark:** Detect thermal decomposition by Passing gas into / reacting gas with lime water OR By collecting the gas evolved (in syringe or by displacement) OR By measuring change of mass **(1)** **Second mark:** Measure time for (same volume) of lime water to go milky OR Measure volume of gas produced in a measured time OR Measure time for a specified / same volume of gas to form OR Find loss of mass after heating samples for equal time **(1)** The mark for measurement should only be given if it matches the suggested method of detection. **Third and fourth marks:** For fair comparison Any **two** from: Keep strength of flame constant **(1)** Distance of flame from containing tube constant **(1)** Use carbonates with similar particle size **(1)** Same volume of lime water **(1)** Heat equal moles / same amount of each carbonate **(1)** Judge equal milkiness of lime water using a piece of paper marked with a cross **(1)** The marks for fair comparison should only be given if they match the suggested method of detection. Ignore 'heat same mass' and 'known mass' Ignore using water bath as source of heat	First mark: Combustion Heating carbonate solution Second mark: Just "measure volume of gas produced" Measure time for a specified change in mass to occur	**4**

	Ignore 'heat to same temperature' Ignore 'use same heat source' Ignore 'constant heat' These points could be shown on a diagram but marks are for the principles, not the detail of drawing a sketch diagram.		

Question Number	Acceptable Answers	Reject	Mark
24(d)(iii)	$CaCO_3$ more stable / $MgCO_3$ less stable **(1)** Mg^{2+} is smaller than Ca^{2+} / magnesium ions are smaller than calcium ions / charge density of Mg^{2+} is greater than Ca^{2+} / Ca^{2+} has more shells **(1)** EITHER Mg^{2+} causes more distortion of carbonate ion / more weakening of C-O / more polarisation of carbonate / more polarisation of anion / has more polarising power OR More energy is given out when MgO forms as the MgO lattice is stronger than CaO /as the 2+ ions can get closer to the 2^- ions on decomposition **(1)** Second and third marks can be scored if conclusion given in first mark is wrong	Mg is smaller "It" (unspecified) is smaller $MgCO_3$ is smaller More disruption of ion Polarisation of carbonate molecules CaO is less stable than MgO	**3**

Question Number	Acceptable Answers	Reject	Mark
***2(a)**	**ALLOW reverse arguments in each case** **Any three from:-** • **sodium atoms/sodium ions** are larger (than magnesium atoms/ions) **NOTE:** Allow symbols (eg Na or Na^+) **(1)** • sodium ions are Na^+ whereas magnesium ions are Mg^{2+} OR Na^+/sodium **ions** have smaller charge (density) than Mg^{2+}/ magnesium **ions** **(1)** **[NOTE:** It follows that the statement that "Na^+ ions are larger than Mg^{2+} ions" would score the first two scoring points above**]** • sodium has fewer **delocalized** electrons (than magnesium) **(1)** • attraction between the positive ions and (delocalized) electrons is weaker in sodium (than magnesium) **(1)** • sodium is not close-packed (but magnesium is close-packed) **(1)** • less energy needed (to break bonds) **(1)**	Attraction between **nucleus** and (delocalized) electrons Mention of **intermolecular forces/molecules** negates the energy mark **NOTE:** Arguments based on ionization energies **OR** suggestion of removal of outer shell electrons as part of the melting process scores **(0) overall**	**3**

Question Number	Acceptable Answers	Reject	Mark
***2(b)**	**First mark:** Idea of (breaking) **covalent bonds** in silicon **(1)** **Second and third marks:** **ANY TWO FROM** • Silicon is **giant** covalent / giant atomic/giant molecular/ macromolecular/giant structure/giant lattice IGNORE just "giant" **(1)** • Phosphorus made up of simple molecules /small molecules/ P_4 molecules /phosphorus is molecular covalent /molecular/simple covalent IGNORE just "simple"/"simple structure" **(1)** • Between phosphorus molecules: weak forces/weak intermolecular forces/weak London forces/weak van der Waals' forces/weak dispersion forces/weak induced-dipole forces **(1)** **[ALLOW** "weak bonds" if implies between phosphorus **molecules]** • More energy needed (to break bonds in silicon) **(1)**	Intermolecular forces broken in silicon/ covalent bonds broken in phosphorus "silicon giant ionic"/"silicon giant metallic" Weak bonds between phosphorus **atoms**	**3**

Question Number	Acceptable Answers	Reject	Mark
***2(c)**	**IGNORE any references to "energy" in this part of the question** Argon monatomic/argon (composed of) single atoms **NOTE:** This must be stated in words, not just by use of its symbol Ar IGNORE any comments about argon atoms having a full outer shell or argon being a noble gas IGNORE any comment about forces/bonds between argon particles	Any suggestion that argon is molecular Argon having a giant structure (of atoms)	**1**

Question Number	Acceptable Answers	Reject	Mark
***2(d)**	**First mark:** Mg has mobile electrons/delocalized electrons/free electrons/sea of electrons (to carry the charge) ALLOW Mg^{2+} instead of Mg or magnesium **(1)** **Second mark:** Sulfur's electrons are fixed (in covalent bonds)/sulfur's electrons are involved in bonding/sulfur's electrons are not free (to move)/no delocalized electrons in sulfur/no mobile electrons in sulfur **(1)**	Mg has free ions/Mg has mobile ions Sulfur has 'no free **ions**'/sulfur **has** delocalized electrons/just "sulfur has covalent bonds"/ just "sulfur is not a metal"	**2**

Question Number	Acceptable Answers	Reject	Mark
3(a)(i)	**Time** for the first (permanent) cloudiness to appear in the limewater ALLOW **Time** for the limewater to turn milky/cloudy ALLOW **Time** for the limewater to turn milky/cloudy and (ppt) to dissolve ALLOW how long for time IGNORE references to volume of CO_2	How fast/how quickly	**1**

Question Number	Acceptable Answers	Reject	Mark
3(a)(ii)	**Any three from** Constant Bunsen flame/electrical heater setting Fixed height of test tube above the flame Fixed moles/(ALLOW mass/amount) of carbonate Fixed volume/amount/mass of limewater Penalise use of quantity once only Same surface area/particle size (of solid) Standardise cloudiness of limewater using the disappearance of a cross (or similar) IGNORE repeats & use same measuring instruments /same person	 Constant temp/ heat Water bath Fixed angle Volume/quantity Concentration / quantity	**3**

Question Number	Acceptable Answers	Reject	Mark
3(b)(i)	More stable/(thermal stability) increases (as the group is descended)		**1**

Question Number	Acceptable Answers	Reject	Mark
3(b)(ii)	Ignore an incorrect answer to 19b(i) and mark statements given independently Cation/positive (ALLOW metal) ion becomes larger (charge unchanged) OR cation charge density reduced **(1)** IGNORE references to shielding Polarisation/distortion reduced **(1)** (ALLOW polarising power reduced) of carbonate electron cloud/ carbonate ion/C-O bonds /anion **(1)** OR reverse argument for stability *decreasing* as group *ascended*	Atomic/metal radius/charge density of **atom**/ molecule	**3**

Question Number	Acceptable Answers	Reject	Mark
4(a)(i)	$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$ Correct formulae (1) Balancing (1) **ALLOW** multiples or equation divided by 2 Second mark on correct species only Ignore state symbols even if incorrect **ALLOW** N_2O_4 Extra oxygen molecules on both sides in a balanced equation		**2**

Question Number	Acceptable Answers	Reject	Mark
4(a)(ii)	Stand alone marks Mg^{2+} / Magnesium **ion** smaller or fewer electron **shells** / greater charge density (1) **OR** Magnesium **ion** has same charge (as calcium ion) but is smaller (1) Causes more polarisation /distortion of nitrate / anion (electron clouds) / N—O (bond)(1) **OR** MgO produced has stronger lattice (1) **OR** production of MgO is more exothermic (1) **OR** reverse argument based on Ca^{2+}	Magnesium / calcium / atoms / molecules	**2**

Question Number	Acceptable Answers	Reject	Mark
4(b)	$2NaNO_3 \rightarrow 2NaNO_2 + O_2$ **ALLOW** multiples or equation divided by 2 Ignore state symbols even if incorrect **ALLOW** Extra oxygen molecules on both sides in a balanced equation		**1**

Question Number	Acceptable Answers	Reject	Mark
4(c)	No as…. double bond would be shorter (than single bond) / shorter than dative (covalent) bond. **ALLOW** Structure has double and single bonds (between N and O) Double and single bonds have different lengths	Implication that the single covalent and dative covalent bonds have different lengths	**1**

Question Number	Acceptable Answers	Reject	Mark
4(d)(i)	Mark independently Goes darker (brown) (1) ALLOW Goes browner Ignore comments on mixture first becoming paler if volume increases Equilibrium moves in the endothermic direction (1) **OR** Equilibrium moves left as forward reaction is exothermic (1) For second mark **ALLOW** Equilibrium moves left to counteract addition of heat / increase in temperature(1) **OR** Reaction removes added heat by moving left (1)	Brown (gas evolved)	**2**

Question Number	Acceptable Answers	Reject	Mark
4(d)(ii)	Equilibrium moves right (ALLOW forwards) (so NO_2 concentration decreases) (1) **OR** Reaction reduces pressure (1) As fewer moles / molecules(ALLOW particles) (of gas) on RHS (1) Stand alone marks		**2**

Question Number	Acceptable Answers	Reject	Mark
4(e)	At T_2 more molecules/collisions have energy greater than (or equal to) E_A (1) This can be shown on the diagram by indicating areas to right of vertical line Energy must be at least E_A for successful collision / for reaction (1) **OR** So more collisions have sufficient energy to react(1) Ignore references to the average energy and speed of the molecules		**2**