Question number	Answer	Marks	Guidance
1 (a)	Charge on oxide ion bigger than on chloride or oxide ion smaller than chloride or charge density on oxide ion greater than chloride Therefore electrostatic attraction is stronger	1 1	 Can be given independent of first mark
1 (b)	MgO (is a white solid that) forms a suspension (or slightly soluble) $MgO + H_2O \rightarrow Mg(OH)_2$ or $\rightarrow Mg^{2+} + 2OH$ pH is 8 to 10 SO_2 dissolves/forms (colourless) solution $SO_2 + H_2O \rightarrow H_2SO_3$ or $\rightarrow H^+ + HSO^-$ or $\rightarrow 2H^+ + SO^{2-}$ pH is 1 to 4	1 1 1 1 1 1	 mark both pH values independently of equations
1 (c)	$Al(OH)_3 + OH^- \rightarrow Al(OH)_4^-$ species mark or forms $Al(OH)_6^{3-}$ etc. Balanced equation $Al(OH)_3 + 3H^+ + 3H_2O \rightarrow Al(H_2O)_6^{3+}$ species mark (or forms $[Al(H_2O)_5(OH)]^{2+}$, Al^{3+}, $AlCl_3$ (salt + water etc.) Balanced equation	1 1 1 1	 must start equations with $Al(OH)_3$ or $Al(OH)_3(H_2O)_n$ where n = 1 to 3
2	Na_2O: vigorous or exothermic reaction; or forms a colourless solution, pH of solution formed is 13 or 14. $Na_2O + H_2O \rightarrow 2NaOH$ P_4O_{10} or P_2O_5: vigorous or exothermic reaction; or forms a colourless solution, pH of solution formed is 0 or 1. $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$	6	 You can write an ionic equation if you prefer. You could write an equation from P_2O_5.
3 (a) (i)	Ionic	1	
3 (a) (ii)	Sodium	1	
3 (a) (iii)	$Na_2O + H_2O \rightarrow 2NaOH$	1	
3 (b) (i)	Covalent	1	
3 (b) (ii)	Phosphorus	1	

3 (b) (iii)	H_3PO_4	1	
3 (c) (i)	macromolecular	1	Accept: giant covalent or giant molecular.
3 (c) (ii)	Silicon	1	
3 (c) (iii)	e.g., $CaO + SiO_2 \rightarrow CaSiO_3$	2	One mark for the base used, i.e., CaO, and one mark for the balanced equation.
4 (a) (i)	P_4O_{10} or SO_3	1	This means it will be an acidic solution and therefore an oxide of a non-metal.
4 (a) (ii)	Na_2O	1	This means it will be an alkaline solution and therefore an oxide of a metal.
4 (b) (i)	$MgO + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$	1	You could also have an ionic equation, i.e., $MgO + 2H^+ \rightarrow Mg^{2+} + H_2O$
4 (b) (ii)	$2NaOH + SiO_2 \rightarrow Na_2SiO_3 + H_2O$	1	You could also have an ionic equation, i.e., $SiO_2 + 2OH^- \rightarrow 2Na^+ + H_2O$
4 (b) (iii)	$3Na2O + 2H_3PO_4 \rightarrow 2Na_3PO_4 + 3H_2O$	1	You could also have an ionic equation, i.e., $Na_2O + 2H^+ \rightarrow 2Na^+ + H_2O$
4 (c)	P_4O_{10} is molecular or simple covalent. This means that there are weak intermolecular forces between molecules. SiO_2 is a macromolecule or giant covalent molecule. Many strong covalent bonds must be broken.	4	These forces are van der Waals forces. These bonds must be stated to be covalent and remember they are between the atoms in the giant molecule.
5 (a)	$Na_2O + H_2O \rightarrow 2NaOH$ pH = 14	2	Remember oxides of metals give alkaline solutions when dissolved and oxides of non-metals give acidic solutions when dissolved.
5 (b)	$SO_2 + H_2O \rightarrow H_2SO_3$ pH = 1–3	2	
6 (a) (i)	**P** is Na_2O or sodium oxide. Ionic Ions are not free to move in the solid state. Ions are free to move when molten or in aqueous solution. $Na_2O + H_2O \rightarrow 2NaOH$	9	Since the identity is asked for, you can give a formula or a name. If a formula is given this must be correct.
6 (a) (ii)	**Q** is SO_2 or sulfur dioxide. covalent Intermolecular forces are weak or van der Waals forces are weak. $SO_2 + H_2O \rightarrow H_2SO_3$		Since the identity is asked for, you can give a formula or a name. If a formula is given this must be correct. The intermolecular forces are not hydrogen bonds.
6 (b) (i)	Amphoteric	6	This is because it reacts with acids and alkalis.

6 (b) (ii)	$Al(OH)_3 + NaOH \rightarrow NaAl(OH)_4$ $2Al(OH)_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6H_2O$		In this equation one mark is for stating that **R** is $Al(OH)_3$ and the other for a balanced equation. You could also have ionic equations, e.g. $Al(OH)_3 + OH^- \rightarrow [Al(OH)]^-$ You could start with the identity of R as $Al(OH)_3(H_2O)_3$ and so the equation would be $Al(OH)(H_2O) + OH^- \rightarrow [Al(OH)(H_2O)]^- + H_2O$ You could start with $Al(OH)(H_2O)$ and have H^+ as the acid, so the equation would be $Al(OH)(H_2O) + H^+ \rightarrow [Al(OH)(H_2O)]^+ + H_2O$ In the equation there is one mark for the correct product and one mark for the balanced equation.
6 (b) (iii)	There is only one mark here and any of the following answers are acceptable: • large lattice energy; • strong covalent bonds; • ΔH_{soln} is very positive; • ΔG is very positive; • The sum of the hydration energies is less than the covalent bond energies.		
7 (a)	White powder / solid / ash / smoke Bright / white light / flame $Mg + H_2O \rightarrow MgO + H_2$	1 1 1	Ignore ppt / fumes Allow glows white / glows bright Ignore state symbols Ignore reference to effervescence or gas produced
7 (b)	Mg^{2+} / magnesium ion has higher charge than Na^+ Attracts delocalised / free / sea of electrons more strongly / metal–metal bonding stronger / metallic bonding stronger	1 1	Allow Mg^{2+} ions smaller / greater charge density than Na^+ ions Allow Mg atoms smaller than Na (atoms) Allow magnesium has more delocalised electrons Must be a comparison Ignore reference to nuclear charge Wrong type of bonding, mention of molecules CE = 0

7 (c)	**Structure**: Macromolecular / giant molecule / giant covalent **Bonding**: Covalent / giant covalent **Physical Properties**: Any **two** from: • Hard • Brittle / not malleable • Insoluble • Non conductor	1 1 2	Mark independently Ignore correct chemical properties Ignore strong, high boiling point, rigid
7 (d)	**Formula**: P_4O_{10} **Structure**: Molecular **Bonding**: Covalent / shared electron pair van der Waals' / dipole–dipole forces between molecules	1 1 1 1	Mention of ionic or metallic, can score M1 only If macromolecular, can score M1 & M3 only Allow van der Waals intermolecular forces, and dipole–dipole intermolecular forces but do not allow intermolecular forces alone
7 (e)	$SO + H O \rightarrow H^+ + HSO^-$	1	Products must be ions Allow $SO_2 + H_2O \rightarrow 2H^+ + SO^{2-}$ Allow two equations showing intermediate formation of H_2SO_3 that ends up as ions Ignore state symbols Allow multiples
7 (f)	$P_4O_{10} + 6MgO \rightarrow 2Mg_3(PO_4)_2$ **OR** $P O + 6MgO \rightarrow 6Mg^{2+} + 4PO^{3-}$ **OR** $P_2O_5 + 3MgO \rightarrow Mg_3(PO_4)_2$	1	Ignore state symbols Allow multiples
8 (a)	MgO is ionic Melt it (Molten oxide) conducts electricity	1 1 1	If not ionic, CE = 0 If solution mentioned, cannot score M2 or M3 Allow acts as an electrolyte. Cannot score M3 unless M2 is correct
8 (b)	Macromolecular Covalent bonding Water cannot (supply enough energy to) break the covalent bonds / lattice	1 1 1	CE = 0 if ionic, metallic or molecular. Allow giant molecule. Giant covalent scores M1 and M2 Hydration enthalpy < bond enthalpy.

8 (c)	(Phosphorus pentoxide's melting point is) lower Molecular with covalent bonding Weak / easily broken / not much energy to break intermolecular forces **OR** weak van der Waals / dipole-dipole forces of attraction between molecules	1 1 1	If M1 is incorrect, can only score M2 M2 can be awarded if molecular mentioned in M3 Intermolecular / IMF means same as between molecules.
8 (d)	Reagent (water or acid) Equation, e.g., $MgO + 2HCl \rightarrow MgCl_2 + H_2O$	1 1	Can be awarded in the equation. $MgO + H_2O \rightarrow Mg(OH)_2$ Equations can be ionic but must show all of the reagent, e.g., $H^+ + Cl^-$ Simplified ionic equation without full reagent can score M2 only. Allow $6MgO + P_4O_{10} \rightarrow 2Mg_3(PO_4)_2$
8 (e)	$P_4O_{10} + 12NaOH \rightarrow 4Na_3PO_4 + 6H_2O$	1	Allow P_2O_5 and acid salts. Must be NaOH not just hydroxide ions.
9 (a)	To prevent it coming into contact/reacting with oxygen/air	1	Allow because it reacts with air/oxygen And because with air/oxygen it forms an oxide. (Oxide, if identified, must be correct P_4O_{10}, P_2O_5, P_4O_6, P_2O_6)
9 (b)	One molecule contains 4P and 10O/the molecular formula is P_4O_{10}	1	Allow exists as P_4O_{10} Do not allow reference to combination of two P_2O_5 molecules Ignore any reference to stability
9 (c)	P_4O_{10} is a bigger molecule (than SO_3)/greater Mr/more electrons/ greater surface area Van der Waals / vdW forces between molecules are stronger/require more energy to break	1 1	Penalise SO_2 for one mark (max 1) CE = 0 if mention of hydrogen bonding/ionic/giant molecule/breaking of covalent bonds Do not allow just more van der Waals forces Ignore any reference to dipole–dipole forces
9 (d)	$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$ pH must be in the range −1 to +2	1 1	Allow correct ionic equations Ignore state symbols Allow −1 to +2 Mark independently

9 (e) (i)	$3MgO + 2H_3PO_4 \rightarrow Mg_3(PO_4)_2 + 3H_2O$ OR $MgO + 2H_3PO_4 \rightarrow Mg(H_2PO_4)_2 + H_2O$ OR $MgO + H_3PO_4 \rightarrow MgHPO_4 + H_2O$	1	Allow $MgO + 2H^+ \rightarrow Mg^{2+} + H_2O$ Allow magnesium phosphates shown as ions and ionic equations Ignore state symbols
9 (e) (ii)	MgO is sparingly soluble/insoluble/weakly alkaline	1	Excess/unreacted MgO can be filtered off/separated
9 (e) (iii)	An excess of NaOH would make the lake alkaline/toxic/kill wildlife	1	Allow pH increases