

M1.(a) Na₂O is an ionic lattice / giant ionic / ionic crystal
CE= 0 if molecules, atoms, metallic mentioned
Mention of electronegativity max 1 out of 2 1

With strong forces of attraction between ions
Allow strong ionic bonds / lots of energy to separate ions 1

(b) SO₃ is a larger molecule than SO₂
Allow greater M, / surface area 1

So van der Waals' forces between molecules are stronger
Any mention of ions, CE= 0 1

(c) Ionic
Do not allow ionic with covalent character 1

Contains O²⁻ ions / oxide ions
Equations of the form O²⁻ + H⁺ → OH⁻ / O²⁻ + 2H⁺ → H₂O / O²⁻ + H₂O → 2OH⁻ score M2 and M3 1

These / O²⁻ ions (accept protons to) form OH⁻ / hydroxide / water (must score M2 to gain M3) 1

(d) (i) SO₂ + H₂O → H⁺ + HSO₃⁻
Allow 2H⁺ + SO₃²⁻ but no ions, no mark
Only score (d)(ii) if (d)(i) correct 1

- (ii) Reaction is an equilibrium / reversible reaction displaced mainly to the left / partially ionised / dissociated

Allow reaction does not go to completion

1

- (e) SiO_2 reacts with bases / NaOH / CaO / CaCO_3

Ignore incorrect formulae for silicate

1

[10]

- M2.(a) (i) Ionic lattice / solid / giant ionic

CE = 0/2 if molecules / IMFs / atoms / metallic

1

Strong (electrostatic) forces/attraction between ions

Allow strong ionic bonds for M2 only

Allow lot of energy to break ionic bonds

1

- (ii) Molecular/molecules

1

Weak dipole-dipole and/or van der Waals forces between molecules

QoL

Type of force must be mentioned

1

- (b) P_4O_{10} bigger molecule/has larger surface area than SO_2

Allow M_r of P_4O_{10} greater than for SO_2

If P_4O_{10} macromolecule/ionic, CE = 0/2

1

van der Waals forces between molecules stronger

Allow stronger IMF

1



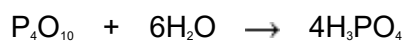
Allow 2NaOH

1

14

Allow 12–14

1



Allow ions

1

0

Allow –1 to +2

1



Allow ionic

Allow correct formula of product with atoms in any order

1

[11]

M3. (a) Macromolecular

Or giant molecule

Or giant covalent (also gains M2)

Do not allow giant atomic

Ionic/metallic CE=0 for all 3 marks

1

Covalent bonding (between atoms)

Do NOT allow if between molecules

1

Many/strong bonds to be broken (or lots of energy required)

Lose both bonding marks if contradiction e.g. mention of intermolecular forces

*Note: 'covalent bonds between molecules' loses M2 but **not** M3*

1

(b) Al_2O_3 ionic

Allow ionic + covalent/ionic with covalent character

1

(c) $2\text{Al} + 3/2\text{O}_2 \rightarrow \text{Al}_2\text{O}_3$

Allow multiples

Ignore state symbols

1

(d) Insoluble/impermeable/non-porous

Or does not react/inert

Do not allow thick layer

Must imply property of Al_2O_3 not Al

1

(e) $\text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{NaOH}$

Or $\text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{Na}^+ + 2\text{OH}^-$

1

(f) (i) $\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2\text{O}$

Ionic equations with Al_2O_3 possible

e.g. $\text{Al}_2\text{O}_3 + 6\text{H}^+ \rightarrow 2\text{Al}^{3+} + 3\text{H}_2\text{O}$

Do not allow formation of Al_2Cl_6

1

(ii) $\text{Al}_2\text{O}_3 + 2\text{NaOH} + 3\text{H}_2\text{O} \rightarrow 2\text{NaAl}(\text{OH})_4$

Other equations with Al_2O_3 are possible e.g.

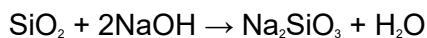
$\text{Al}_2\text{O}_3 + 2\text{OH}^- + 3\text{H}_2\text{O} \rightarrow 2[\text{Al}(\text{OH})_4]^-$

$\text{Al}_2\text{O}_3 + 2\text{OH}^- + 7\text{H}_2\text{O} \rightarrow 2[\text{Al}(\text{H}_2\text{O})_2(\text{OH})_4]^-$

1

(g) SiO₂ acidic/Lewis acid/electron pair acceptor

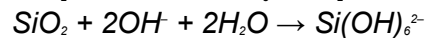
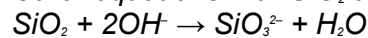
1



*Allow SiO₂ **not** amphoteric*

Do NOT allow BL acid

Other equations with SiO₂ are possible e.g.



1

[11]

M4.(a) To prevent it coming into contact/reacting with oxygen/air

Allow because it reacts with air/oxygen

And because with air/oxygen it forms an oxide. (Oxide, if identified, must be correct :- P₄O₁₀, P₂O₅, P₄O₆, P₂O₆)

1

(b) One molecule contains 4P and 10O/the molecular formula is P₄O₁₀

Allow exists as P₄O₁₀

Do not allow reference to combination of two P₂O₅ molecules

Ignore any reference to stability

1

(c) P₄O₁₀ is a bigger molecule (than SO₃)/greater M./more electrons/ greater surface area

Penalise SO₂ for one mark (max 1)

CE = 0 if mention of hydrogen bonding/ionic/ giant molecule/breaking of covalent bonds

1

Van der Waals / vdW forces between molecules are stronger/require more energy to break

Do not allow just more vdW forces

Ignore any reference to dipole-dipole forces

1

- (d) $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$
 Allow correct ionic equations
 Ignore state symbols

1

pH must be in the range -1 to +2

Allow -1 to +2

Mark independently

1

- (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 $MgO + H_3PO_4 \rightarrow MgHPO_4 + H_2O$
 Allow $MgO + 2H^+ \rightarrow Mg^{2+} + H_2O$
 Allow magnesium phosphates shown as ions and ionic equations
 Ignore state symbols

1

- (ii) MgO is sparingly soluble/insoluble/weakly alkaline
 Excess/unreacted MgO can be filtered off/separated

1

- (iii) An excess of NaOH would make the lake alkaline/toxic/kill wildlife
 Allow pH increases

1

[9]

- M5. (a) (i) white flame / white light
 Mark flame independent of other observations

1

solid / powder / smoke / ash / white fumes

penalise precipitate

penalise wrong colour

if more than one observation for M2 apply list principle. (If an observation is incorrect, the incorrect observation negates a

	<i>correct one)</i>	1
	$2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ <i>ignore state symbols</i> <i>allow multiples</i>	1
	ionic <i>do not allow reference to covalent character</i>	1
(ii)	blue flame <i>do not allow any other colour</i> <i>Mark flame independent of other observations</i>	1
	fumes or misty or pungent/choking/smelly gas <i>do not allow incorrect smell (e.g. bad eggs)</i> <i>apply list principle as in (a) (i)</i> <i>do not allow just 'gas' or 'colourless gas'</i>	
	$\text{S} + \text{O}_2 \rightarrow \text{SO}_2$ <i>ignore state symbols</i> <i>allow multiples and S₈</i>	1
	covalent <i>penalise giant covalent</i>	1
(b)	ionic <i>If covalent, can only score M3</i>	1
	O^{2-} / oxide ion reacts with water / accepts a proton <i>M2 requires reference to O²⁻ / oxide ion</i>	1
	forming OH ⁻ ions/ NaOH / sodium hydroxide (can show in equation from Na ₂ O even if incorrect) <i>allow</i>	1
	$\text{O}^{2-} + \text{H}_2\text{O} \rightarrow 2\text{OH}^-$ or $\text{O}^{2-} + \text{H}^+ \rightarrow \text{OH}^-$ to score M2 & M3 <i>also allow equations with spectator Na⁺ ions on both sides.</i>	1

- (c) (heat until) molten
or dissolve in molten cryolite
do not allow solution in water 1
- conducts electricity / can be electrolysed / electrolyse and
 identify Al / O₂ at an electrode
M2 can only be gained if M1 scored 1
- (d) insoluble (in water)
allow oxide impermeable to air / water
or oxide is unreactive / inert 1
- (e) (i) $\text{Al}_2\text{O}_3 + 6\text{H}^+ \rightarrow 2\text{Al}^{3+} + 3\text{H}_2\text{O}$
allow $\text{O}^{2-} + 2\text{H}^+ \rightarrow \text{H}_2\text{O}$
and formation of aquated Al^{3+} species
allow spectator Cl^- ions
penalise HCl (not ionic!) 1
- (ii) $\text{Al}_2\text{O}_3 + 2\text{OH}^- + 3\text{H}_2\text{O} \rightarrow 2\text{Al}(\text{OH})_4^-$
 or $\text{Al}_2\text{O}_3 + 6\text{OH}^- + 3\text{H}_2\text{O} \rightarrow 2\text{Al}(\text{OH})_6^{3-}$
allow formation of $\text{Al}(\text{H}_2\text{O})_2(\text{OH})_4^-$
allow Na^+ spectator ions
penalise NaOH (not ionic!) 1

[16]