M1.(a) Na_2O is an ionic <u>lattice</u> / 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) SO_3 is a larger molecule than SO_2

Allow greater M_r / surface area

1

So <u>van der Waals</u>' forces <u>between molecules</u> are stronger

Any mention of ions, CE= 0

1

(c) Ionic

Do not allow ionic with covalent character

1

Contains <u>O^{2-}</u> ions / oxide ions

Equations of the form $O^{2-} + H^+ \rightarrow OH^-$ / $O^{2-} + 2H^+ \rightarrow H_2O$ / $O^{2-} + H_2O \rightarrow 2OH^-$ score M2 and M3

1

These / O^{2-} ions (accept protons to) form OH^- / hydroxide / water (must score M2 to gain M3)

1

(d) (i) $SO_2 + H_2O \rightarrow H^+ + HSO_3^-$

Allow $2H^+ + SO_3^{2-}$ 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 <u>between molecules</u> stronger

Allow stronger IMF

1

(c) $Na_2O + H_2O \longrightarrow 2Na^+ + 2OH^-$

Allow 2NaOH

1

14

Allow 12–14

1

$P_4O_{10} + 6H_2O \longrightarrow 4H_3PO_4$

Allow ions

1

0

Allow –1 to +2

1

(d) $6Na_2O + P_4O_{10} \longrightarrow 4Na_3PO_4$

Allow ionic

Allow correct formula of product with atoms in any order

1

[11]

M3. (a) <u>Macro</u>molecular

Or <u>giant</u> molecule

Or <u>giant</u> 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 <u>ionic</u>

Allow <u>ionic</u> + covalent/<u>ionic</u> with covalent character

1

(c) $2Al + 3/2O_2 \rightarrow Al_2O_3$

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) $Na_2O + H_2O \rightarrow 2NaOH$

Or $Na_2O + H_2O \rightarrow 2Na^+ + 2OH^-$

1

(f) (i) $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$

Ionic equations with Al_2O_3 possible
e.g. $Al_2O_3 + 6H^+ \rightarrow 2Al^{3+} + 3H_2O$
Do not allow formation of Al_2Cl_6

1

(ii) $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$

Other equations with Al_2O_3 are possible e.g.
$Al_2O_3 + 2OH^- + 3H_2O \rightarrow 2[Al(OH)_4]^-$
$Al_2O_3 + 2OH^- + 7H_2O \rightarrow 2[Al(H_2O)_2(OH)_4]^-$

1

(g) SiO_2 acidic/Lewis acid/electron pair acceptor

1

$SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$

*Allow SiO_2 **not** amphoteric*
Do NOT allow BL acid
Other equations with SiO_2 are possible e.g.
$SiO_2 + 2OH^- \rightarrow SiO_3^{2-} + H_2O$
$SiO_2 + 2OH^- + 2H_2O \rightarrow Si(OH)_6^{2-}$

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 :- P_4O_{10}, P_2O_5, P_4O_6, P_2O_6)

1

(b) One molecule contains 4P and 10O/the molecular formula is P_4O_{10}

Allow exists as P_4O_{10}
Do not allow reference to combination of two P_2O_5 molecules
Ignore any reference to stability

1

(c) P_4O_{10} is a bigger molecule (than SO_3)/greater M_r/more electrons/ greater surface area

Penalise SO_2 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 / <u>white fumes</u>

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

correct one)

1

$2Mg + O_2 \rightarrow 2MgO$

ignore state symbols

allow multiples

1

ionic

do not allow reference to covalent character

1

(ii) blue flame

do not allow any other colour

Mark flame independent of other observations

1

fumes or misty or pungent/choking/smelly gas

do not allow incorrect smell (e.g. bad eggs)

apply list principle as in (a) (i)

do not allow just 'gas' or 'colourless gas'

$S + O_2 \rightarrow SO_2$

ignore state symbols

allow multiples and S_8

1

covalent

penalise giant covalent

1

(b) ionic

If covalent, can only score M3

1

O^{2-} / oxide ion reacts with water / accepts a proton

M2 requires reference to O^{2-} / oxide ion

1

forming OH^- ions/ NaOH / sodium hydroxide
(can show in equation from Na_2O even if incorrect)

allow

1

$O^{2-} + H_2O \rightarrow 2OH^-$ or

$O^{2-} + H^+ \rightarrow OH^-$ to score M2 & M3

also allow equations with spectator Na+ ions on both sides.

1

(c) (heat until) molten

or dissolve in <u>molten</u> cryolite

do not allow solution in water

1

conducts electricity / can be electrolysed / electrolyse and identify Al / O_2 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) $Al_2O_3 + 6H^+ 2Al^{3+} + 3H_2O$

allow $O^{2-} + 2H^+ \rightarrow H_2O$

and formation of aquated Al^{3+} species

allow spectator Cl^- ions

penalise HCl (not ionic!)

1

(ii) $Al_2O_3 + 2OH^- + 3H_2O \rightarrow 2Al(OH)_4^-$

or $Al_2O_3 + 6OH^- + 3H_2O \rightarrow 2Al(OH)_6^{3-}$

allow formation of $Al(H_2O)_2(OH)_4^-$

allow Na^+ spectator ions

penalise NaOH (not ionic!)

1

[16]