Mark schemes

1

(a) (i) Covalent

Ignore simple / molecular

Do not allow macromolecular/giant covalent/dative/dipole-dipole/Hydrogen bonds

Ignore VdW

1

(ii) P / phosphorus / P_4

1

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

*Mark independently of **(a)(ii)***

Accept multiples/fractions

Ignore state symbols

Allow ions on the RHS ($\longrightarrow 12H^+ + 4PO_4^{3-}$)

Allow correct equations from P_4O_6, P_2O_3 and P_2O_5

$P_4O_6 + 6H_2O \longrightarrow 4H_3PO_3$

$P_2O_3 + 3H_2O \longrightarrow 2H_3PO_3$

$P_2O_5 + 3H_2O \longrightarrow 2H_3PO_4$

1

(b) (i) Ionic

Ignore giant / lattice

1

(ii) Na / Sodium

1

(iii) $2Na + 2H_2O \longrightarrow 2Na^+ + 2OH^- + H_2$

Allow equation to form 2NaOH

Accept multiples/fractions

Ignore state symbols

1

(iv) $Na_2O + 2HCl \longrightarrow 2NaCl + H_2O$

Accept multiples/fractions

Ignore state symbols

Allow ions, but do not allow H+ only for the acid

1

(c) (i) Ionic

Allow ionic and covalent / ionic with covalent character

1

(ii) Al_2O_3

Ignore state symbols

1

(iii) Reacts with acids and bases

Allow reacts with acids and alkalis / acts as both an acid and a base / shows acidic and basic properties

1

(iv) $Al_2O_3 + 6HCl \longrightarrow 2Al^{3+} + 6Cl^- + 3H_2O$

$Al_2O_3 + 6H^+ \longrightarrow 2Al^{3+} + 3H_2O$

Allow equation to form $2AlCl_3$ (but not Al_2Cl_6)

Allow equations with other acids

1

$Al_2O_3 + 2NaOH + 3H_2O \longrightarrow 2Na^+ + 2[Al(OH)_4]^-$

$Al_2O_3 + 2OH^- + 3H_2O \longrightarrow 2[Al(OH)_4]^-$

$Al_2O_3 + 2NaOH + 7H_2O \longrightarrow 2Na^+ + 2[Al(OH)_4\ (H_2O)_2]^-$

$Al_2O_3 + 2OH^- + 7H_2O \longrightarrow 2[Al(OH)_4\ (H_2O)_2]^-$

Allow equations to form $2Na[Al(OH)_4]$ or $2Na[Al(OH)_4(H_2O)_2]$

Allow equations with other alkalis

Allow correct equations which form $[Al(OH)_6]^{3-}$

Allow equations to form $[Al(OH)_x(H_2O)_{6-x}]^{3-x}$ etc

Ignore state symbols

1

[12]

2 (a) The number of protons increases (across the period) / nuclear charge increases

1

Therefore, the attraction between the nucleus and electrons increases

Can only score M2 if M1 is correct

1

(b) S_8 molecules are bigger than P_4 molecules

Allow sulfur molecules have bigger surface area and sulfur molecules have bigger M_r

1

Therefore, van der Waals / dispersion / London forces between molecules are stronger in sulfur

1

(c) Sodium oxide contains O^{2-} ions

1

These O^{2-} ions react with water forming OH^- ions

$O^{2-} + H_2O \longrightarrow 2OH^-$ scores M1 and M2

1

(d) $P_4O_{10} + 12OH^- \longrightarrow 4PO_4^{3-} + 6H_2O$

1

[7]

3

(a) $Mg + H_2O \rightarrow MgO + H_2$

ignore state symbols

1

White solid / powder / ash / smoke

ignore precipitate

ignore fumes

1

(Bright) white light / flame

allow glow

penalise effervescence under list principle

1

(b) $2Na + \frac{1}{2}O_2 \rightarrow Na_2O$ / $4Na + O_2 \rightarrow 2Na_2O$

Allow multiples, ignore state symbols

Allow $2Na + O_2 \rightarrow Na_2O_2$

1

white / yellow solid / ash / smoke

ignore precipitate

ignore fumes

1

orange / yellow flame

1

[6]

4

(a) (i) 1500

1

(ii) Ionic lattice / giant ionic

Mention of vdW / covalent bonding / molecules / atoms / metal etc.

CE = 0

1

Strong attraction between oppositely charged ions / Na^+ and O^{2-}

OR

lots of energy required to separate / overcome attraction between oppositely charged ions / Na^+ and O^{2-}

Do not allow incorrect formulae for ions.

1

(iii) 200 (K)

Allow range 10−273 (K)

CE = 0 if temperature >573 K, otherwise mark on

Allow correct answers in °C but units must be given.

1

SO_2 smaller (molecule) (than P_4O_{10}) (or converse)

also SO_2 has lower M_r / less surface area / less polarisable / fewer electrons

penalise SO_3 and P_2O_5 for M2 only

1

vdW forces <u>between molecules</u> are weaker / require less energy to separate molecules

ignore dipole−dipole

If covalent bonds broken lose M2 and M3 but can gain M1

1

(b) $SO_2 + H_2O \rightarrow H_2SO_3$ / $H^+ + HSO_3^-$ / $2H^+ + SO_3^{2-}$

can be equilibrium sign instead of arrow

1

1

Allow values between 1−3

mark independently

1

(c) Reacts with / neutralises bases / alkalis

Allow any given base or alkali including OH^-

1

$SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$

Allow $CaO + SiO_2 \rightarrow CaSiO_3$ or equation with any suitable base

M2 can score M1 even if equation unbalanced or incorrect

1

[10]

5 (a) <u>White</u> powder / solid / ash / smoke

Ignore ppt / fumes

1

Bright / white light / flame

Allow glows white / glows bright

1

$Mg + H_2O \rightarrow MgO + H_2$

Ignore state symbols

Ignore reference to effervescence or gas produced

1

(b) Mg^{2+} / magnesium ion has higher charge than Na^{+}

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

1

Attracts <u>delocalised / free / sea of</u> electrons more strongly / metal–metal bonding stronger / metallic bonding stronger

Wrong type of bonding (vdW, imf), mention of molecules CE = 0

1

(c) **Structure:** Macromolecular / giant molecule / giant covalent

Mark independently

1

Bonding: Covalent / giant covalent

1

Physical Properties:

Any **two** from: Hard/
Brittle / not malleable
Insoluble
Non conductor

Ignore correct chemical properties

Ignore strong, high boiling point, rigid

2

(d) **Formula:** P_4O_{10}

Mention of ionic or metallic, can score M1 only

1

Structure: Molecular

If macromolecular, can score M1 & M3 only

1

Bonding: Covalent / shared electron pair

1

van der Waals' / dipole–dipole forces <u>between molecules</u>

Allow vdW, imf and dipole–dipole imf but do not allow imf alone

1

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

Products must be ions

Allow $SO_2 + H_2O \rightarrow 2H^+ + SO_3^{2-}$

Allow two equations showing intermediate formation of H_2SO_3 *that ends up as ions*

Ignore state symbols

Allow multiples

1

(f) $P_4O_{10} + 6MgO \rightarrow 2Mg_3(PO_4)_2$

OR $P_4O_{10} + 6MgO \rightarrow 6Mg^{2+} + {}_4PO_4^{3-}$

OR $P_2O_5 + 3MgO \rightarrow Mg_3(PO_4)_2$ etc

Ignore state symbols

Allow multiples

1

[15]