

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 / P₄

1

(iii) P₄O₁₀ + 6H₂O → 4H₃PO₄

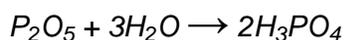
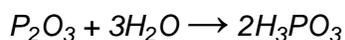
Mark independently of (a)(ii)

Accept multiples/fractions

Ignore state symbols

Allow ions on the RHS (→ 12H⁺ + 4PO₄³⁻)

Allow correct equations from P₄O₆, P₂O₃ and P₂O₅



1

(b) (i) Ionic

Ignore giant / lattice

1

(ii) Na / Sodium

1

(iii) 2Na + 2H₂O → 2Na⁺ + 2OH⁻ + H₂

Allow equation to form 2NaOH

Accept multiples/fractions

Ignore state symbols

1

(iv) Na₂O + 2HCl → 2NaCl + H₂O

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) $\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{Al}^{3+} + 6\text{Cl}^- + 3\text{H}_2\text{O}$
 $\text{Al}_2\text{O}_3 + 6\text{H}^+ \rightarrow 2\text{Al}^{3+} + 3\text{H}_2\text{O}$
Allow equation to form 2AlCl_3 (but not Al_2Cl_6)
Allow equations with other acids 1
- $\text{Al}_2\text{O}_3 + 2\text{NaOH} + 3\text{H}_2\text{O} \rightarrow 2\text{Na}^+ + 2[\text{Al}(\text{OH})_4]^-$
 $\text{Al}_2\text{O}_3 + 2\text{OH}^- + 3\text{H}_2\text{O} \rightarrow 2[\text{Al}(\text{OH})_4]^-$
 $\text{Al}_2\text{O}_3 + 2\text{NaOH} + 7\text{H}_2\text{O} \rightarrow 2\text{Na}^+ + 2[\text{Al}(\text{OH})_4(\text{H}_2\text{O})_2]^-$
 $\text{Al}_2\text{O}_3 + 2\text{OH}^- + 7\text{H}_2\text{O} \rightarrow 2[\text{Al}(\text{OH})_4(\text{H}_2\text{O})_2]^-$
Allow equations to form $2\text{Na}[\text{Al}(\text{OH})_4]$ or $2\text{Na}[\text{Al}(\text{OH})_4(\text{H}_2\text{O})_2]$
Allow equations with other alkalis
Allow correct equations which form $[\text{Al}(\text{OH})_6]^{3-}$
Allow equations to form $[\text{Al}(\text{OH})_x(\text{H}_2\text{O})_{6-x}]^{3-x}$ etc
Ignore state symbols 1

[12]

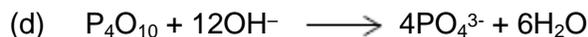
2

- (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



1



1

[7]

3



ignore state symbols

1

White solid / powder / ash / smoke

ignore precipitate

ignore fumes

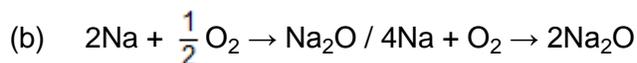
1

(Bright) white light / flame

allow glow

penalise effervescence under list principle

1



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

SO₂ smaller (molecule) (than P₄O₁₀) (or converse)

also SO₂ has lower M_r / less surface area / less polarisable / fewer electrons

penalise SO₃ and P₂O₅ for M2 only

1

vdW forces between molecules 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) SO₂ + H₂O → H₂SO₃ / H⁺ + HSO₃⁻ / 2H⁺ + SO₃²⁻

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

SiO₂ + 2NaOH → Na₂SiO₃ + H₂O

Allow CaO + SiO₂ → CaSiO₃ or equation with any suitable base

M2 can score M1 even if equation unbalanced or incorrect

1

[10]

5

(a) White powder / solid / ash / smoke

Ignore ppt / fumes

1

Bright / white light / flame

Allow glows white / glows bright

1

Mg + H₂O → MgO + H₂

Ignore state symbols

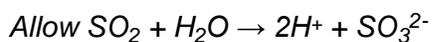
Ignore reference to effervescence or gas produced

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 delocalised / free / sea of 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 between molecules
Allow vdW, imf and dipole–dipole imf but do not allow imf alone 1



Products must be ions

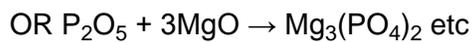
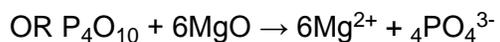


Allow two equations showing intermediate formation of H_2SO_3 that ends up as ions

Ignore state symbols

Allow multiples

1



Ignore state symbols

Allow multiples

1

[15]