

Mark schemes

1

(a) Na₂O ionic

*mention of molecules/intermolecular forces/delocalised electrons,
CE = 0*

1

Strong forces between ions/strong ionic bonding

Allow lots of energy to break bonds provided M1 scored

1

SiO₂ macromolecular

Allow giant molecular/giant covalent.

If ions mentioned, CE = 0

1

Strong covalent bonds (between atoms)

Allow lots of energy to break covalent bonds

If breaking intermolecular forces are mentioned, CE = 0 for M4

1

(b) Higher

1

Li⁺ (or Li ion) smaller than Na⁺

Must imply Li⁺ ion

*Allow Li⁺ has higher charge/size ratio **not** charge/mass*

1

Attracts O²⁻ ion more strongly

Allow stronger ionic bonding

Allow additional attraction due to polarisation in Li₂O

M3 can only be scored if M2 gained

1

(c) (i) Molecular

*Do not allow simple covalent BUT simple covalent molecule scores
M1 and M2*

1

Covalent bonds (between P and O)

Ignore reference to van der Waals' or dipole-dipole

1

- (ii) Weak van der Waals' forces and/or dipole-dipole forces
between molecules

*Allow weak inter-molecular forces – can score “between” molecules
in (c)(i)*

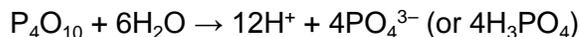
CE = 0 if ionic or macromolecular mentioned in (c)(i)

*Must state van der Waals' forces are weak OR low energy needed
to break van der Waals' forces*

1

- (d) Allow –1 to +2

1

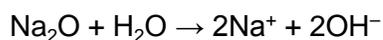


*Allow balanced equations to form HPO_4^{2-} or H_2PO_4^-
ignore state symbols*

1

Allow 12 to 14

1



Allow $2\text{Na}^+ + \text{O}^{2-}$ on LHS, 2NaOH on RHS, ignore s.s.

Mark independently

1

- (e) $6\text{Na}_2\text{O} + \text{P}_4\text{O}_{10} \rightarrow 4\text{Na}_3\text{PO}_4$

1

Acid-base

Allow neutralisation, mark independently of M1

Do not allow Acid + Base \rightarrow Salt + Water

1

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2

(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

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(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.

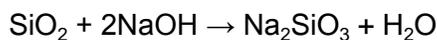
$\text{Al}_2\text{O}_3 + 2\text{OH}^- + 3\text{H}_2\text{O} \rightarrow 2[\text{Al}(\text{OH})_4]^-$

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

1

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

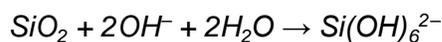
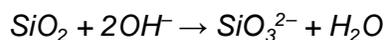
1



*Allow SiO₂ **not** amphoteric*

Do NOT allow BL acid

Other equations with SiO₂ are possible e.g.



1

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3

(a) Electronegativity increases

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Proton number increases (increase in nuclear charge)

1

Same number of electron shells/levels

Or same radius or Shielding of outer electrons remains the same

1

Attraction of bond pair to nucleus increases

Allow 'electrons in bond' instead of 'bond pair'

1

(b) Big difference in electronegativity leads to ionic bonding, smaller covalent

Lose a mark if formula incorrect

1

Sodium oxide ionic lattice

1

Strong forces of attraction between ions

1

P₄O₁₀ covalent molecular

Must have covalent and molecular (or molecules)

1

Weak (intermolecular) forces between molecules

Or weak vdW, or weak dipole–dipole between molecules

1

melting point Na₂O greater than for P₄O₁₀

Or argument relating mpt to strength of forces

1

- (c) Moles NaOH = $0.0212 \times 0.5 = 0.0106$
M1 moles of NaOH correct 1
- Moles of $H_3PO_4 = 1/3$ moles of NaOH (= 0.00353)
M2 is for 1/3 1
- Moles of P in 25000 l = $0.00353 \times 10^6 = 3.53 \times 10^3$
M3 is for factor of 1,000,000 1
- Moles of $P_4O_{10} = 3.53 \times 10^3/4$
M4 is for factor of 1/4 (or 1/2 if P_2O_5) 1
- Mass of $P_4O_{10} = 3.53 \times 10^3/4 \times 284 = 0.251 \times 10^6$ g
 = 251 kg
(Or if P_2O_5 $3.53 \times 10^3/2 \times 142$)
M5 is for multiplying moles by M_r with correct units
allow conseq on incorrect M4
(allow 250-252) 1

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4

- (a) (i) Oxide 1 B 1
- Oxide 2 E 1
- Explanation Low melting point or weak van der Waals' forces
 between molecules 1
- (ii) Chemical test Add water or flame test 1
- Test pH or flame colour 1
- Observation pH = 13/14 or colour yellow 1

- (b) (i) Equation $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}$ 1
- (ii) Product CaSO_3 1
- (iii) Disposal of large quantities of CaSO_3 (allow CaSO_4) 1
- Produces CO_2 or uses up CaCO_3 1
- [10]**

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- (a) (i) *can form a solution with pH less than 3: P_4O_{10} or SO_3 (1)*
- (ii) *can form a solution with with a pH greater than 12: Na_2O (1)*
- penalise any wrong answer to zero 2
- (b) (i) $\text{MgO} + 2\text{HNO}_3 \rightarrow \text{Mg}(\text{NO}_3)_2 + \text{H}_2\text{O}$ or an ionic equation (1)
 i.e. $\text{MgO} + 2\text{H}^+ \rightarrow \text{Mg}^{2+} + \text{H}_2\text{O}$
not $\text{O}^{2-} + 2\text{H}^+ \rightarrow \text{H}_2\text{O}$
- (ii) $2\text{NaOH} + \text{SiO}_2 \rightarrow \text{Na}_2\text{SiO}_3 + \text{H}_2\text{O}$ or ionic equation (1)
 i.e. $\text{SiO}_2 + 2\text{OH}^- \rightarrow \text{SiO}_3^{2-} + \text{H}_2\text{O}$
- (iii) $3\text{Na}_2\text{O} + 2\text{H}_3\text{PO}_4 \rightarrow 2\text{Na}_3\text{PO}_4 + 3\text{H}_2\text{O}$ etc or ionic equation (1)
i.e. $\text{Na}_2\text{O} + 2\text{H}^+ \rightarrow 2\text{Na}^+ + \text{H}_2\text{O}$ 3
- (c) P_4O_{10} is a molecular (structure) or simple covalent (1)
 Weak intermolecular forces or van der Waals forces (between molecules) (1)
 SiO_2 is a macromolecule / giant covalent / giant molecule (1)
Not giant lattice
- (Strong) covalent bonds (between atoms) must be broken (1) 4
- [9]**