M1. (a) Na_2O 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

SiO_2 macromolecular

Allow giant molecular/giant covalent.

If ions mentioned, CE = 0

1

Strong <u>covalent bonds</u> (between atoms)

Allow lots of energy to break <u>covalent</u> 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 O^{2-} ion more strongly

Allow stronger ionic bonding

Allow additional attraction due to polarisation in Li_2O

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

$P_4O_{10} + 6H_2O \rightarrow 12H^+ + 4PO_4^{3-}$ (or $4H_3PO_4$)

Allow balanced equations to form HPO_4^{2-} or $H_2PO_4^-$

ignore state symbols

1

Allow 12 to 14

1

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

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

Mark independently

1

(e) $6Na_2O + P_4O_{10} \rightarrow 4Na_3PO_4$

1

Acid-base

Allow neutralisation, mark independently of M1

Do not allow Acid + Base → Salt + Water

1

[16]

M2. (a) Electronegativity increases

1

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 <u>bond pair</u> to nucleus increases

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

1

(b) Big <u>difference</u> in electronegativity leads to ionic bonding, smaller covalent

Lose a mark if formula incorrect

1

Sodium oxide ionic lattice

1

Strong forces of attraction <u>between ions</u>

1

P_4O_{10} 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 Na_2O greater than for P_4O_{10}

Or argument relating mpt to strength of forces

1

(c) Moles NaOH = 0.0212 × 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

[15]

M3. (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) $MgO + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$ or an ionic equation **(1)**
i.e. $MgO + 2H^+ \rightarrow Mg^{2+} + H_2O$
not $O^{2-} + 2H^+ \rightarrow H_2O$

(ii) $2NaOH + SiO_2 \rightarrow Na_2SiO_3 + H_2O$ or ionic equation **(1)**
i.e. $SiO_2 + 2OH^- \rightarrow SiO_3^{2-} + H_2O$

(iii) $3Na_2O + 2H_3PO_4 \rightarrow 2Na_3PO_4 + 3H_2O$ etc or ionic equation **(1)**
i.e. $Na_2O + 2H^+ \rightarrow 2Na^+ + H_2O$

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]

M4. (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 $CaCO_3 \rightarrow CaO + CO$

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]