PERIODICITY Core (SL & HL)

1. (a) With reference to the type of bonding present, explain the following trends across period 3.

(i) The melting point of magnesium is higher than that of sodium.

[2]

Magnesium has a higher nuclear charge / 2+ ion than sodium / 1+ ion ✓
Magnesium gives 2 (vs 1) electrons to sea of electrons ✓
Metallic bonds in magnesium are stronger ✓
any 2

(ii) Silicon has the highest melting point of any element in the period.

[2]

Silicon has a giant covalent / macromolecular structure ✓
with many strong covalent bonds (that need to be broken) ✓
must mention covalent for 2 marks

(iii) Phosphorus, sulfur, and chlorine all have low melting and boiling points.

[2]

They are all (simple) molecules / have molecular structures ✓
with only weak London dispersion forces (between the molecules) (that are easily broken) ✓

(iv) Chlorine has a higher boiling point than argon.

[2]

Chlorine is a molecule / Cl_2 where as Argon is a monatomic gas / single atoms. ✓
The London dispersion forces / intermolecular forces are stronger in chlorine. ✓

(b) Explain why electronegativity increases across period 3 between Na and Cl, and explain why argon does not have an electronegativity value.

[2]

(Electronegativity increases) Na → Cl because the nuclear charge increases / atoms get smaller / bonding electrons are closer to the nucleus. ✓

(Argon has no value) as it does not form covalent bonds / is inert. ✓

2. (a) Sodium oxide, Na_2O, and phosphorus pentoxide, P_4O_{10}, are both solids at room temperature.

(i) State and explain the electrical conductivity of both sodium oxide and phosphorus pentoxide.

[2]

(Sodium oxide is ionic) so will not conduct electricity when solid but will when molten / dissolved in water, as ions can move ✓

phosphorus pentoxide (is molecular) and has no mobile ions or electrons, so will not conduct. ✓

(ii) Write equations for the reactions of Na_2O (s) and P_4O_{10} (s) with water, including state symbols.

[3]

$Na_2O_{(s)} + H_2O_{(l)} \longrightarrow 2NaOH_{(aq)}$ ✓ equation

$P_4O_{10(s)} + 6H_2O_{(l)} \longrightarrow 4H_3PO_{4(aq)}$ ✓ equation.

✓ state symbols in both.

(iii) Predict how the reactions above in (ii), between Na_2O (s) and P_4O_{10} (s) and water, would affect the pH and the electrical conductivity of water.

[2]

Na_2O pH will go up (more alkaline)

P_4O_{10} pH will go down (more acidic) ✓ both

(Both) will increase electrical conductivity. ✓

(as more ions will be present)

(b) Explain why Na^+ has a smaller ionic radius than O^{2-}.

[2]

Both ions have the same number of electrons / same configuration / $1s^2 2s^2 2p^6$ / same electron-electron repulsion ✓
But sodium has a higher nuclear charge / number of protons / greater nuclear-electron attraction. ✓

(c) Sodium is a soft, shiny, silver-coloured metal.

(i) Write an equation for the reaction of sodium, Na (s), with water.

[2]

$2Na_{(s)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + H_{2(g)}$

✓ equation except H_2
✓ balanced and H_2 state symbols not required

(ii) State two **observations** for the reaction of sodium, Na (s), with water.

[2]

floats / moves / effervescence (bubbling) / melts / orange flame

ANY 2 ✓✓

3. Ionisation energy can be represented for an element, E, as shown below:

$$E\ (g) \rightarrow E^+\ (g) + e^-$$

Electron affinity can be represented for an element, E, as shown below:

$$E\ (g) + e^- \rightarrow E^-\ (g)$$

(a) State and explain the general trend in first ionisation energy across period 2.

[2]

Increases (as a general trend) across period 2 ✓ needed, and
because the electrons are being removed from the same energy level (n=2) (2s and 2p)
but the nuclear charge is increasing. ✓

(b) Predict the general trend in first electron affinity across period 2.

[1]

becomes more negative (across period 2). ✓
allow "increases" (in magnitude)

4. Group 17, the halogens, consist of relatively reactive non-metals.

(a) Justify why chlorine is classified as a non-metal by giving two of its **chemical** properties.

[2]

forms acidic oxides / forms covalent bonds / forms anions (or Cl^-) / accepts electrons (oxidising agent) or easily reduced.

Any 2 ✓✓

(b) Chlorine is more reactive than bromine and can replace bromine in its compounds. Write an equation to show the reaction between chlorine and sodium bromide.

[2]

$Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$

✓ formulae
✓ balanced

(c) State and explain the trend in atomic radius going down group 17

[2]

(Atomic radii) increase (going down group 17) ✓
because new/more energy levels of electrons are added ✓
(and there is greater shielding.)

Total 32 marks (48 minutes)