

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 \rightarrow 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, Na₂O, and phosphorus pentoxide, P₄O₁₀, are both solids at room temperature.

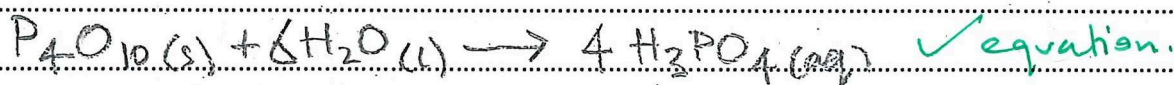
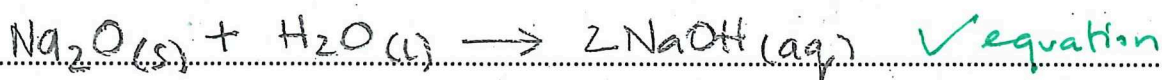
(i) State and explain the electrical conductivity of both sodium oxide and phosphorus pentoxide.

[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 Na₂O (s) and P₄O₁₀ (s) with water, including state symbols.

[3]



\checkmark state symbols in both.

(iii) Predict how the reactions above in (ii), between Na₂O (s) and P₄O₁₀ (s) and water, would affect the pH and the electrical conductivity of water.

[2]

Na₂O pH will go up (more alkaline)

P₄O₁₀ pH will go down (more acidic)

both \checkmark

(Both) will increase electrical conductivity.
(as more ions will be present)

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

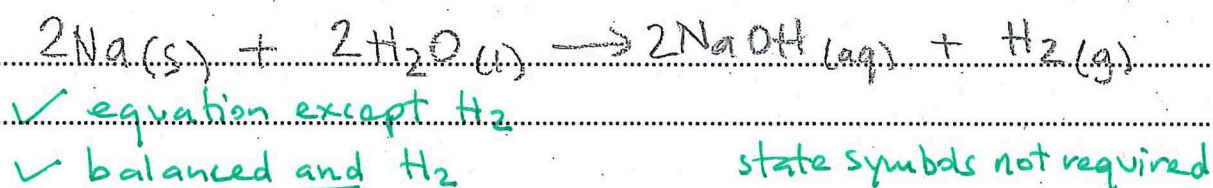
[2]

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]



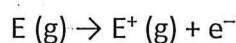
(ii) State two **observations** for the reaction of sodium, Na (s) , with water.

[2]

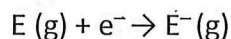
floats / moves / effervescence (bubbling) / melts / orange flame

ANY [2] ✓✓

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



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



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

[2]

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

(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]



✓ 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)