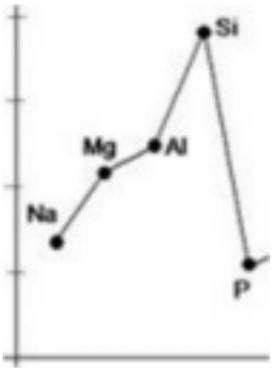
1. Sketch a graph to show the melting points of the first five elements in Period 3.



2.

Some of the common chlorides of Period 3 elements are shown in the list.

$$NaCl \quad MgCl_2 \quad AlCl_3 \quad SiCl_4 \quad PCl_5$$

a. From this list, identify: all the chlorides that have giant ionic structures in the solid state

- NaCl, MgCl2

b. From this list, identify: all the chlorides that react vigorously with water to form strongly acidic solutions

- AlCl3, SiCl4, PCl5

3.

A series of reactions for phosphorus and its compounds is shown.

$$P \xrightarrow[\text{reaction 1}]{\text{excess } Cl_2} PCl_5 \xrightarrow[\text{reaction 2}]{H_2O} H_3PO_4 \xrightarrow[\text{reaction 3}]{NH_3} (NH_4^+)(H_2PO_4^-)$$

State what you would observe in reaction 1.

- Green gas fades // white solid/ white powder/ white smoke/ white fumes

State the type of reaction that occurs in reaction 2.

- Hydrolysis

4. Describe the appearance of silicon(IV) chloride at room temperature and pressure. State its structure and bonding.

- Appearance: colourless/yellow liquid
- Structure and bonding: simple molecular AND covalent

5. Fill in the table:

	magnesium chloride	phosphorus(V) chloride
appearance at room temperature		
one similarity in observation on addition to cold water		
one difference in observation on addition to cold water		
pH of final solution		

	$MgCl_2$	PCl_5	
appearance	• (white) crystals / solid	• (white OR pale yellow) crystals / solid	[1]
one similarity in observation	(colourless) solution made		[1]
one difference in observation	no (misty / steamy) fumes	misty / steamy fumes	[1]
pH	• 6.5–7	• 0–4	[1]

6. Explain why electronegativity increases across a period.
   - increase in nuclear charge
   - similar shielding
   - so increase in nuclear attraction for bonding / outer / valence electrons OR bonding / outer / valence electron(s) are more strongly attracted to nucleus

7. Write an equation for the reaction between an excess of cold water and the chloride of silicon.

   $SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$

   Suggest the pH of the solution produced in the above reaction
   - 1–4

8. Write an equation for the reaction between an excess of cold water and the chloride of phosphorus.

   $PCl_5 + 4H_2O \rightarrow 5HCl + H_3PO_4$

Suggest the pH of the solution produced in the above reaction

- 1–4

9. When pure aluminium is added to cold water, bubbles of gas are seen.
   Name one other Period 3 element that also produces bubbles of gas when added to cold water
   - Sodium

10. Write an equation, with state symbols, for the reaction of aluminium oxide with an excess of NaOH(aq).

    M1 correct state of correct aluminium product
    M2 balanced equation for reaction of aluminium oxide with NaOH
    $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4(aq)$
    OR
    $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2(aq) + H_2O$

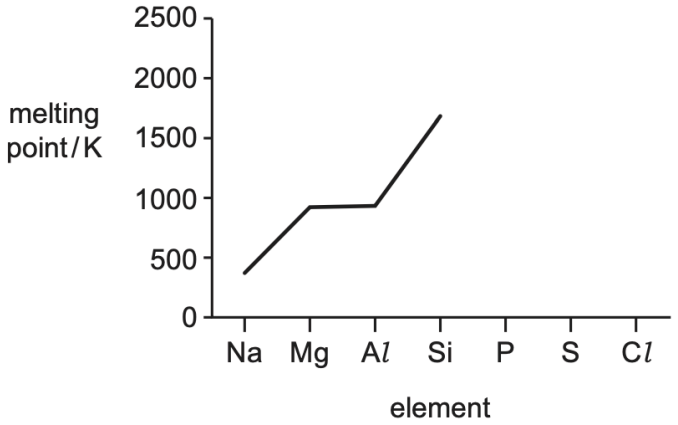
11. Explain why the solution produced after aluminium chloride is added to water has a pH of 1–2.
    - HCl(g) dissolves in water to make hydrochloric acid

12. Name the chlorides of Period 3 elements that are liquid at room temperature and produce misty fumes when added to water
    - Silicon (IV) chloride // silicon tetrachloride
    - Phosphorus (III) chloride // phosphorus trichloride
    - Sulfur chloride

13. State and explain the difference in the ionic radius of Al3+ compared to Mg2+ .
    - Al3+ is smaller compared to Mg2+
    - greater nuclear attraction for remaining electrons
    - same shielding effect AND greater nuclear charge

14.

Fig. 1.1 shows the variation in melting point of some Period 3 elements in their standard states at room temperature and pressure.



Complete Fig. 1.1 to show the variation in the melting points of the elements P, S and Cl.

- all 3 melting points lower than Mg
- melting point Cl < P < S

15. Explain why Si has a high melting point.
    - Large amount of energy required to break bonds in giant covalent structure

16. Write an equation to describe the reaction that occurs when aluminium hydroxide, Al(OH)3, reacts with NaOH(aq).

$$Al(OH)_3 + NaOH \rightarrow NaAl(OH)_4$$

17. State what determines the maximum oxidation number of the Period 3 elements in their oxides.
    number of outer / valence electrons

18. Give the state of Al_2O_3 and P_4O_{10} at room temperature.
    - Al_2O_3: solid
    - P_4O_{10}: solid

19. Write an equation for the reaction of P_4O_{10} with an excess of NaOH(aq) at room temperature.

$$P_4O_{10} + 12NaOH \rightarrow 4Na_3PO_4 + 6H_2O$$

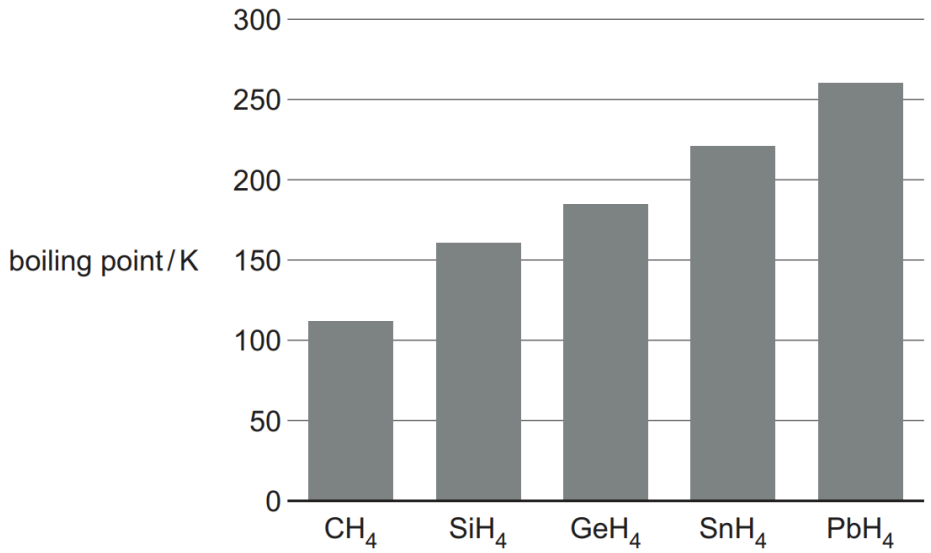
20. Explain the general increase in the first ionisation energies of the Period 3 elements.

- increasing proton number but similar shielding
- greater attraction of nucleus (for outer / valence electrons)

21. Describe what you would see when solid aluminium chloride reacts with water.
    - solid disappears
    - misty/ steamy fumes
    - temperature increases

22.

Fig. 3.2 shows the boiling points of the simplest hydrides of the Group 14 elements, C to Pb.



Explain the trend in the boiling points of the Group 14 hydrides shown in Fig. 3.2.

- molecules CH4 to PbH4 have greater number of electrons/ number of electrons increase
- greater / stronger instantaneous dipole–induced forces / London forces / dispersion forces OR more energy required to overcome the instantaneous dipole–induced forces / London forces / dispersion forces

23. Describe what is observed when a small sample of SiCl4 is added to water.
    - effervescence / misty / steamy fumes

    NOTE: white solid (SiO2) is not observed, as only a small sample is added

24. Write an equation for the reaction of NaCl with water. Include state symbols.

$$NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$$

25. Write an equation for the reaction of PCl5 with water. Include state symbols.

$$PCl_5(s) + 4H_2O(l) \rightarrow H_3PO_4(aq) + 5HCl(aq)$$

NOTE: HCl (aq) forms NOT HCl (g)