

18 Which oxide has a simple structure rather than a giant structure?

- A MgO B Al_2O_3 C SiO_2 D P_4O_{10}

18 Compound X is an oxide of a Period 3 element.

Compound X is a white solid at 25 °C. It reacts with water to form an acidic solution.

What is compound X?

- A aluminium oxide
B silicon dioxide
C sulfur dioxide
D phosphorus(V) oxide

23 Element E is in Period 3. It forms a chloride which reacts with a small amount of water to produce a white precipitate and steamy fumes. This precipitate is soluble in $NaOH(aq)$ and in $HCl(aq)$.

What is element E?

- A magnesium
B aluminium
C silicon
D phosphorus

16 A student investigated the chloride of a Period 3 element. This is what the student wrote down as their observations.

The compound was a white crystalline solid. It dissolved easily in water to give a solution of pH 12. When placed in a test-tube and heated in a roaring Bunsen flame, the compound melted after several minutes' heating.

What can be deduced from these observations?

- A At least one of the recorded observations is **not** correct.
B The compound was magnesium chloride, $MgCl_2$.
C The compound was phosphorus pentachloride, PCl_5 .
D The compound was sodium chloride, $NaCl$.

2 The Period 3 elements show trends in physical and chemical properties across the period.

(a) Fig. 2.1 shows the variation in atomic and ionic radii of the Period 3 elements Na to Cl.

The ionic radius of Si is **not** shown.

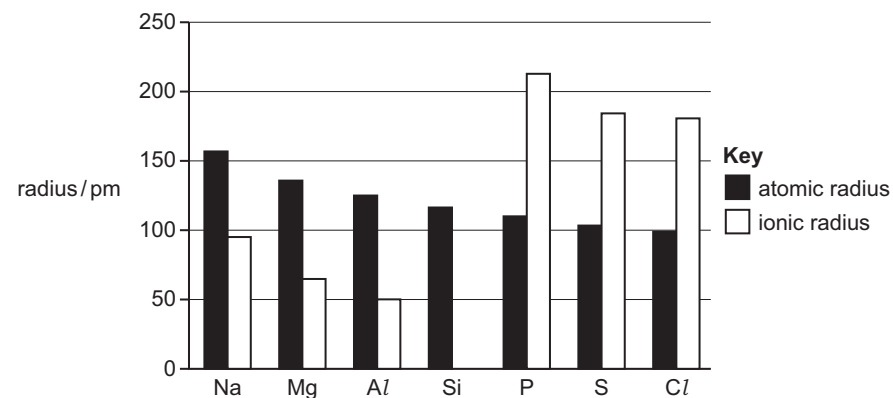


Fig. 2.1

(i) Explain the trend shown in the atomic radii of the Period 3 elements Na to Cl.

.....

 [2]

(ii) Explain why there is a large difference in the ionic radii of Al and P.

.....

 [2]

(b) Table 2.1 gives some information about some of the Period 3 oxides.

Row B gives the pH of the solution that forms when the Period 3 oxide is added to water.

Table 2.1

	formula of Period 3 oxide	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₄ O ₁₀	SO ₃
A	oxidation number of Period 3 element			+3			
B	pH of solution			—	—		

(i) Complete Table 2.1. [2]

(ii) State why there is no data given in row B for Al₂O₃ and SiO₂. [1]

(c) (i) Write an equation for the reaction of Na₂O with dilute hydrochloric acid. [1]

(ii) Construct an equation for the reaction of Al₂O₃ with a base to form NaAlO₂. [1]

(d) Group 2 nitrates decompose on heating to form oxides.

(i) State the trend in thermal stability of the Group 2 nitrates down the group. [1]

(ii) Identify the other products of the thermal decomposition of Group 2 nitrates. [1]

[Total: 11]

2 The Period 3 elements show trends in physical and chemical properties across the period.

(a) (i) Explain why the elements Na to Al are good electrical conductors.

..... [1]

(ii) Explain why the elements P, S and Cl do not conduct electricity.

..... [1]

(b) Fig. 2.1 shows the variation in melting point of the Period 3 elements Si to Cl.

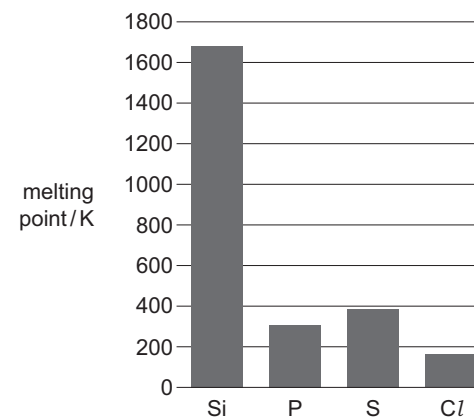


Fig. 2.1

The Period 3 elements Si to Cl are all non-metals.

Explain why there is a large difference between the melting point of Si and the melting points of P, S and Cl.

..... [2]

(c) Table 2.1 gives some information about some Period 3 chlorides.

Row B refers to the pH of the solution that forms when the Period 3 chloride is added to water.

Table 2.1

	formula of Period 3 chloride	NaCl	MgCl ₂	AlCl ₃	SiCl ₄	PCl ₅
A	oxidation number of element bonded to Cl					
B	pH of solution		6.5			
C	bonding			ionic		
D	structure			giant		

Complete Table 2.1.

You may use the following abbreviations.

I = ionic, C = covalent, M = metallic
G = giant, S = simple

[4]

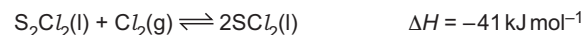
(d) (i) Write an equation for the formation of AlCl₃ from its elements.

.....
..... [1]

(ii) Write an equation for the formation of H₃PO₄ from PCl₅.

..... [1]

(e) S₂Cl₂(l) reacts with Cl₂(g) in a reversible reaction to form SCl₂(l). Under certain conditions, a dynamic equilibrium is established.



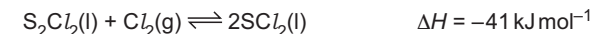
(i) State what is meant by dynamic equilibrium.

.....
..... [1]

(ii) Identify the condition necessary to establish dynamic equilibrium.

..... [1]

(iii) S₂Cl₂(l) is yellow and SCl₂(l) is red.



State what is observed when the following changes are made to an equilibrium mixture of S₂Cl₂(l) and SCl₂(l).

Explain your answers.

- The equilibrium mixture is warmed gently.

observation

explanation

.....

.....

- The overall pressure of the equilibrium mixture is increased.

observation

explanation

.....

..... [4]

(f) Aqueous MgCl₂ reacts with aqueous Na₂CO₃ to form a white precipitate. Upon heating, the white precipitate undergoes thermal decomposition.

(i) Construct an equation to show the reaction of aqueous MgCl₂ with aqueous Na₂CO₃. Use state symbols in your equation.

..... [2]

(ii) Identify the products of the thermal decomposition of the white precipitate.

..... [1]

(iii) State the trend in thermal stability of the Group 2 carbonates down the group.

..... [1]

[Total: 20]

2 Aluminium oxide, Al_2O_3 , and phosphorus(V) oxide, P_4O_{10} , are both used as reagents and catalysts.

- (a) The melting point of Al_2O_3 is 2072 °C. The melting point of P_4O_{10} is 340 °C.

Explain the difference in the melting points of these two compounds.

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.....
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..... [3]

- (b) A 5.00 dm³ sealed flask contains 0.400 mol of CO(g) and 0.800 mol of H₂(g) and an Al_2O_3 catalyst. The flask is heated to a temperature of 290 °C and allowed to reach equilibrium. Equation 1 shows the reaction.



The equilibrium constant, K_c , of equation 1 is given.

$$K_c = \frac{[CH_3OH]}{[CO][H_2]^2}$$

- (i) State the units of K_c .

..... [1]

- (ii) The equilibrium mixture contains 0.280 mol of CH₃OH(g).

Calculate the value of K_c .

Give your answer to **three** significant figures.

value of K_c = [3]

- (iii) State and explain the effect, if any, on the value of K_c when the overall pressure in the sealed flask is increased.

.....
..... [1]

- (c) P_4O_{10} catalyses the reversible reaction of CO with H₂ to form CH₃OH.



P_4O_{10} then acts as a dehydrating agent, causing CH₃OH to form CH₃OCH₃.

- (i) Explain how the presence of a catalyst affects a chemical reaction.

.....
.....
..... [1]

- (ii) Construct an equation for the dehydration reaction of CH₃OH to form CH₃OCH₃.

..... [1]

- (iii) Write an equation to show the reaction of P_4O_{10} with an excess of water.

..... [1]

[Total: 11]