

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.

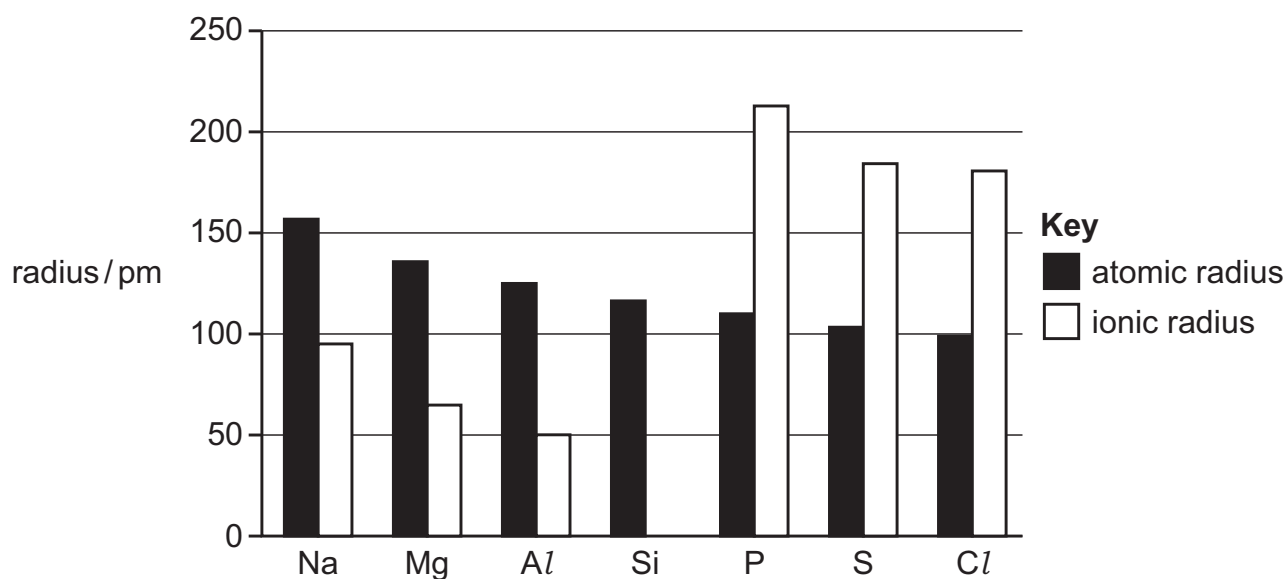


Fig. 2.1

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

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..... [2]

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

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..... [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.

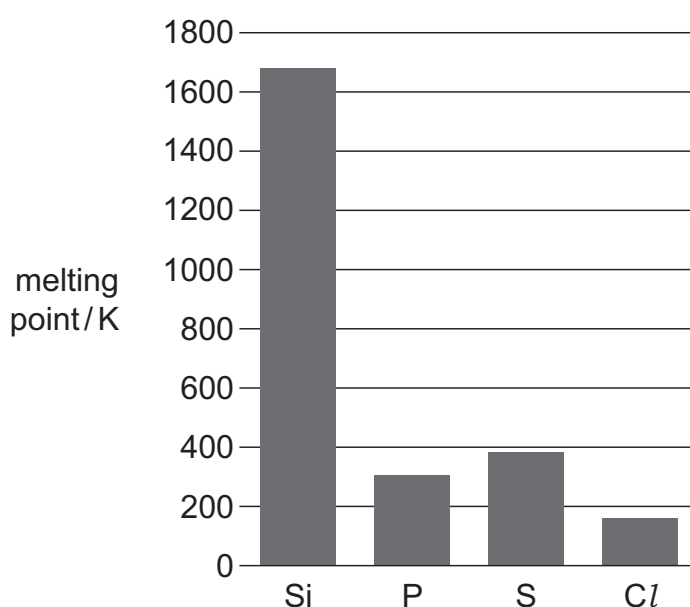


Fig. 2.1

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.

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.....
.....
..... [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]

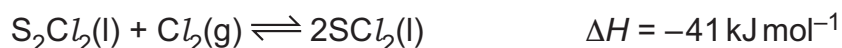
(d) (i) Write an equation for the formation of AlCl_3 from its elements.

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

(ii) Write an equation for the formation of H_3PO_4 from PCl_5 .

..... [1]

(e) $\text{S}_2\text{Cl}_2(\text{l})$ reacts with $\text{Cl}_2(\text{g})$ in a reversible reaction to form $\text{SCl}_2(\text{l})$. Under certain conditions, a dynamic equilibrium is established.



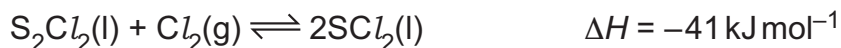
(i) State what is meant by dynamic equilibrium.

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

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

..... [1]

(iii) $\text{S}_2\text{Cl}_2(\text{l})$ is yellow and $\text{SCl}_2(\text{l})$ is red.



State what is observed when the following changes are made to an equilibrium mixture of $\text{S}_2\text{Cl}_2(\text{l})$ and $\text{SCl}_2(\text{l})$.

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 MgCl_2 reacts with aqueous Na_2CO_3 to form a white precipitate. Upon heating, the white precipitate undergoes thermal decomposition.

- (i) Construct an equation to show the reaction of aqueous MgCl_2 with aqueous Na_2CO_3 . 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 $2072^\circ C$. The melting point of P_4O_{10} is $340^\circ C$.

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

.....

 [3]

(b) A 5.00 dm^3 sealed flask contains 0.400 mol of $CO(g)$ and 0.800 mol of $H_2(g)$ and an Al_2O_3 catalyst. The flask is heated to a temperature of $290^\circ C$ 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 $CH_3OH(g)$.

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 H_2 to form CH_3OH .



P_4O_{10} then acts as a dehydrating agent, causing CH_3OH to form CH_3OCH_3 .

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

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

(ii) Construct an equation for the dehydration reaction of CH_3OH to form CH_3OCH_3 .

..... [1]

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

..... [1]

[Total: 11]