

# Crystal properties

## Question Paper

Level	Pre U
Subject	Chemistry
Exam Board	Cambridge International Examinations
Topic	Crystal properties- Crystal structures
Booklet	Question Paper

**Time Allowed:** 28 minutes

**Score:** /23

**Percentage:** /100

**Grade Boundaries:**

1 The elements scandium to zinc in the Periodic Table make up the first row of the d-block elements.

(a) Why are these elements referred to as *d-block* elements?

.....[1]

(b) (i) Give the full ground state electronic configuration of an atom of zinc.

.....[1]

(ii) Explain why zinc is **not** a transition element.

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

(c) The graph in Fig. 1.1 shows the pattern of first ionisation energies for the elements sodium to zinc.

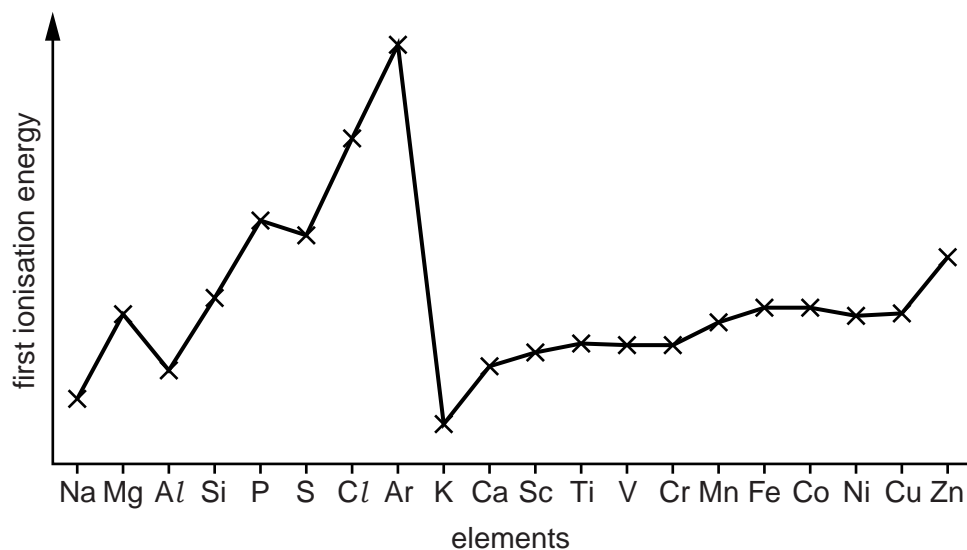


Fig. 1.1

(i) With reference to the graph in Fig. 1.1, explain the pattern of first ionisation energies across Period 3, Na to Ar.

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

- (ii) With reference to the graph in Fig. 1.1, explain why the first ionisation energies of the elements Sc to Cu are relatively constant with only a slight general increase.

.....  
.....  
.....  
..... [2]

- (d) The crystal structures of the elements iron, copper and zinc are described, using the standard abbreviations, as BCC, CCP and HCP, respectively.

- (i) What does the abbreviation CCP stand for?

..... [1]

- (ii) In terms of layer structure representations, describe the HCP and CCP crystal structures.

HCP .....

CCP .....

[2]

- (e) A chloride of a transition metal, *M*, has a unit cell consisting of a CCP framework of chloride anions, with the metal ions occupying half of the tetrahedral holes between the anions.

- (i) What is meant by the term *unit cell*?

.....  
.....  
..... [2]

- (ii) State, and explain in terms of the ratio of anions to tetrahedral holes, what the formula of this compound is.

formula .....

explanation .....

.....  
..... [2]

(f) Cobalt(II) chloride exists in two forms, **A**, which is blue, and **B**, which is pink.

Addition of a small amount of either of these solids to water results in a pink solution in which the colour is due to the presence of a complex ion, **C**.

On addition of concentrated hydrochloric acid this solution turns blue as another complex ion, **D**, forms with a different shape to the complex ion **C**.

(i) Give the formulae of **A**, **B**, **C**, and **D**.

**A** .....

**B** .....

**C** .....

**D** .....

[4]

(ii) Give the shape of, and bond angles in, the ion **C**.

shape .....

bond angle .....

[2]

(iii) Write an equation to illustrate the ligand exchange reaction involved in the conversion of **C** to **D**.

..... [1]

(iv) State and explain why the ion **D** has a different shape to the ion **C**.

.....

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..... [1]

[Total: 23]