

28.1 General properties of the transition elements

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS complex 配合物 • complex ion 配离子 • transition element 过渡元素 • oxidation state 氧化态
• catalyst 催化剂

Objective

Build the skills to answer exam questions on **transition elements** 过渡元素 — the definition and the four characteristic properties.

You must be able to:

- define a transition element and explain why Sc and Zn are excluded
- state the four key properties (variable oxidation state, catalysis, complexes, colour) and why

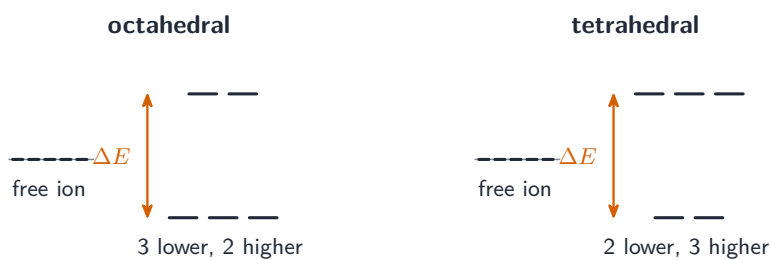
1 Worked examples

■ What a transition element is

A **transition element** is a d-block element that forms one or more stable ions with **incomplete d orbitals**. (Sc and Zn are excluded: their stable ions have empty or full d orbitals.)



Coloured compounds are one of the four characteristic properties of transition elements



the complex absorbs light of energy ΔE , so we see the **complementary colour**

d-orbital splitting explains colour and variable oxidation states

property	reason
variable oxidation state	the 3d and 4s sub-shells are close in energy
act as a catalyst	more than one oxidation state; vacant d orbitals form dative bonds
form complex ions	vacant d orbitals accept lone pairs
coloured compounds	electrons move between split d orbitals

2 Practice

2.1 Define a **transition element**.

[2]

2.2 State the four characteristic properties of transition elements.

[2]

3 Exam-style questions

3.1 Why is zinc **not** classed as a transition element? [1]

- **A** it is not in the d-block
 - **B** its stable ion (Zn^{2+}) has a full d sub-shell ($3d^{10}$)
 - **C** it is colourless
 - **D** it has no electrons
-

3.2 Transition elements show variable oxidation states because: [1]

- **A** their atoms are large
 - **B** the 3d and 4s sub-shells are close in energy
 - **C** they are coloured
 - **D** they are catalysts
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3.3 Explain why transition metals can act as catalysts. [2]

3.4 Explain why scandium is not classed as a transition element, with reference to its ion. [2]

Solutions

2.1 a d-block element that forms one or more stable ions with incomplete (partly filled) d orbitals.

2.2 variable oxidation state; catalytic behaviour; form complex ions; form coloured compounds.

3.1 B. Zn^{2+} is $3d^{10}$ (a full d sub-shell), so it is not a transition element.

3.2 B. The close energies of 3d and 4s allow different numbers of electrons to be removed.

3.3 they have more than one stable oxidation state; and vacant d orbitals that can form dative bonds with reactants, providing a surface/intermediate.

3.4 scandium's only stable ion is Sc^{3+} , which has an empty d sub-shell ($3d^0$), so it has no incomplete d orbitals.