A-LEVEL CHEMISTRY • EXERCISE SHEET

28.1 General properties of the transition elements

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

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

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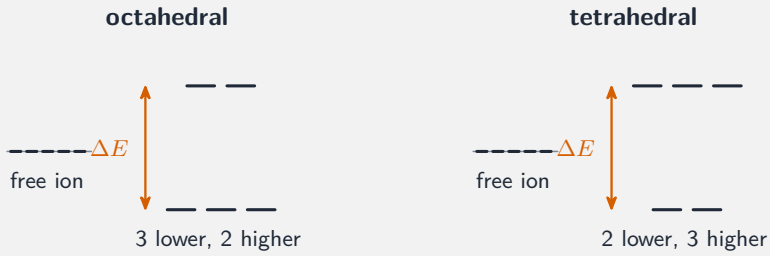

the complex absorbs light of energy ΔE, so we see the **complementary colour**

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 ($3d^1$)
- **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

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]

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4 Go further

You are now ready for the real exam questions on this subtopic. Open the **28.1 Transition elements** past-paper sheet in the Library, or try these in **Practice mode**:

- 9701/31 N25 —Q3 (general properties of the transition elements)
- 9701/41 N25 —Q2 (general properties of the transition elements)
- 9701/41 N25 —Q5 (general properties of the transition elements)

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 $3d^{1}$ (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), so it has no incomplete d orbitals.