1.3 Transition metals

Name: _____ Class: _____ Date: _____ **Total: 27 marks**

KEY WORDS transition metal • catalyst • coloured compound

Objective

Compare transition metals with Group 1 and describe their typical properties. Chemistry only. Original questions for spec statement 4.1.3.

1 Key knowledge and worked examples

The **transition elements** (Cr, Mn, Fe, Co, Ni, Cu are your examples) sit between Groups 2 and 3. Compared with Group 1 they have:

- **higher melting points** for the named examples;
- **higher densities**;
- greater **strength** and **hardness**;
- **lower reactivity** with oxygen, water and halogens.

Typical properties:

- **many form ions with more than one charge** – Fe^{2+} and Fe^{3+}, Cu^{2+} and Cu^{+} (Group 1 is always +1);
- **coloured compounds** – aqueous iron(II) salts can be pale green, iron(III) salts yellow-brown and copper(II) salts blue; colour depends on the compound and conditions;
- **catalytic activity** – iron in the Haber process, nickel in hydrogenation.

Worked example (3 marks). A student says "copper and sodium are both metals so they behave the same." Correct them with two properties.

No – copper is a transition element and sodium a Group 1 alkali metal; copper is harder, denser and has a much higher melting point; copper is much less reactive – it does not react with cold water, while sodium fizzes violently.

2 Practice

2.1 Give two differences between transition metals and Group 1 metals in physical properties. [2]

2.2 Give the formulas of the two common iron ions, and typical colours of their aqueous salts. [3]

2.3 Name the transition metal used as a catalyst in the Haber process. [1]

3 Exam-style questions

3.1 Compare the reactions of potassium and copper with water and with dilute hydrochloric acid, explaining the difference in terms of reactivity. [4]

3.2 Explain why iron(II) sulfate and iron(III) sulfate are different compounds, even though both contain only iron, sulfur and oxygen. [3]

3.3 Chromium is a transition metal. Predict three characteristic physical properties and give one example of a transition metal used as a catalyst. [4]

3.4 Fictional metalsP/Q have densities0.8/8.0g/cm^3 and melting points80/1400°C. P reacts rapidly with cold water; Q does not. Which is more consistent with a transition metal rather than Group 1? Use three independent observations. [3]

3.5 Sulfate ions areSO_4^{2-}. Give the formulas of iron(II) sulfate and iron(III) sulfate and explain how the ion charges determine the different proportions. [3]

3.6 A reaction is repeated with and without a transition-metal catalyst under otherwise identical conditions. Suggest the expected rate difference and one suitable measurement. Explain why a coloured compound is not automatically a catalyst and why a catalyst is not a source of product atoms. [4]