Exercise walk-through

1.3 Transition metals – chemistry only (4.1.3)

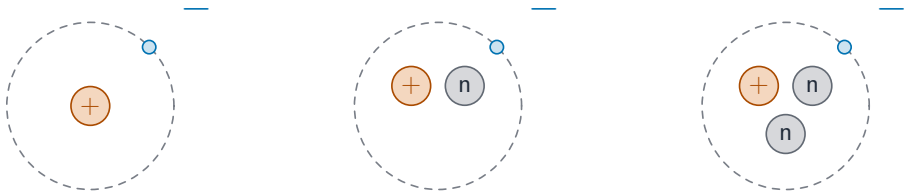
AQA · GCSE · Chemistry

How evidence changed the model of the atom

- **Around 1800**, John Dalton described atoms as tiny spheres that could not be divided.
- **In 1897**, J. J. Thomson discovered the **electron**, a tiny negative particle inside atoms. So atoms must have parts. He proposed the **plum pudding model** : a ball of positive charge with negative electrons scattered through it.
- **In 1909**, Hans Geiger and Ernest Marsden, working for Ernest Rutherford in Manchester, fired positive alpha particles at a sheet of gold foil only a few hundred atoms thick.

Figure: Inside the atom: particles, size and isotopes

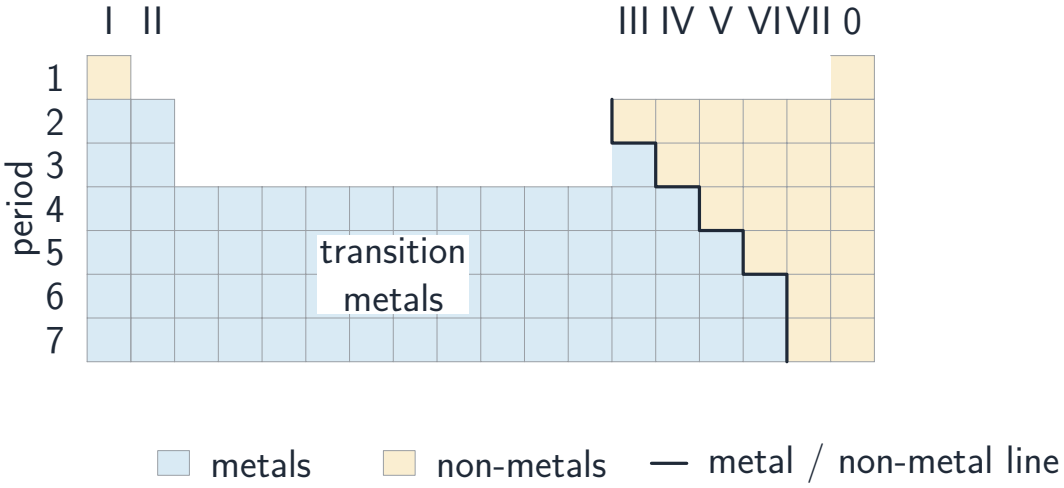
Hydrogen isotopes (not to scale)



hydrogen-1	hydrogen-2	hydrogen-3
$^{1}_{1}\mathrm{H}$	$^{2}_{1}\mathrm{H}$	$^{3}_{1}\mathrm{H}$
1 proton	1 proton	1 proton
0 neutrons	1 neutron	2 neutrons
1 electron	1 electron	1 electron

- Isotopes differ only in the number of neutrons
- Match each part of the diagram to the text.

Figure: Building the periodic table; metals and non-metals



- Groups are the columns and periods are the rows; metals lie to the left of the staircase, non-metals to the right
- Match each part of the diagram to the text.

Exercise 2.1

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



Exercise 2.1

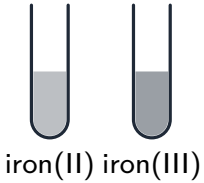
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2.1 Any two: transition metals have higher melting points; higher densities; harder; stronger.

Exercise 2.2

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

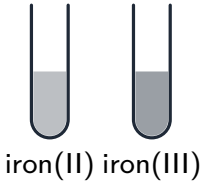


2.3 Name the transition metal used as a catalyst in the Haber process. [1]



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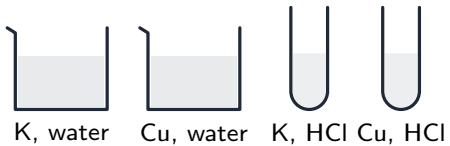
2.2 Fe^{2+} – pale green compounds; Fe^{3+} – yellow/brown compounds.

2.3 Iron.

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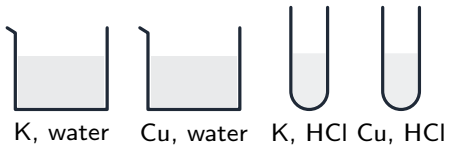
Exercise 3.1

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



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3.1 Potassium reacts vigorously with cold water – fizzing, melting into a ball, producing hydrogen and potassium hydroxide; copper has no reaction with water. Potassium reacts explosively/fast with dilute acid; copper does not react with dilute hydrochloric acid – it is below hydrogen in the reactivity series. Transition metals are much less reactive than Group 1 metals.

Setup for exercise 3.2

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

iron(II) sulfate

iron(III) sulfate

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]



chromium

Exercise 3.2

3.4 Fictional metalsP/Q have densities 0.8/8.0g/cm^3 and melting points 80/1400°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]

	density	m.p.
P	0.8	80
Q	8.0	1400

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]

Fe^{2+} Fe^{3+} SO_4^{2-}

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]



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3.2 The iron is present as different ions – Fe^{2+} in iron(II) sulfate and Fe^{3+} in iron(III) sulfate; transition elements form ions with different charges; so the two compounds have different formulae ($FeSO_4$, $Fe_2(SO_4)_3$) and different colours/properties despite containing the same elements.

3.3 Any three distinct physical predictions: high melting point, high density, hard, strong.

Full solution on next slide

Full solution 3.2

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3.3 Any three distinct physical predictions: high melting point, high density, hard, strong. Catalyst example: iron in the Haber process or nickel in hydrogenation. These are typical comparisons with Group 1, not universal properties of every transition compound.

3.4 Q: higher density, higher melting point, lower reactivity with cold water fit the typical comparison. These observations support a classification; they do not identify the exact element or prove all its compounds are coloured.

3.5 $FeSO_4$; $Fe_2(SO_4)_3$. Fe^{2+} and $SO_4{}^{2-}$ balance 1:1; two Fe^{3+} (+6) balance three $SO_4{}^{2-}$ (−6). The same element names do not guarantee the same compound.

3.6 Catalyst increases rate; measure product volume per time or time to a specified endpoint with other conditions controlled. Colour alone is not evidence of faster reaction/catalytic behaviour. A catalyst is regenerated/not consumed overall; product atoms come from reactants.