

Metals

IGCSE Chemistry ▪ Topic 9

IGCSE Chemistry

K

Mg

Fe

Au

↓
less reactive

Metals

What we will cover

1

Properties & uses

2

Alloys

3

The reactivity series

4

Rusting & its prevention

5

Extraction of metals

6

The blast furnace

Fe

+ water

+ oxygen

↓

rust

rusting

1

Properties

Metals

Properties

Properties and uses

metals

good conductors; malleable 有展性 & ductile 有延性; high melting points

non-metals

poor conductors; brittle 易碎; low melting points

Uses follow properties: **aluminium** 铝 is light (aircraft, cables); **copper** 铜 conducts & is ductile (wiring).



Aluminium is light and resists corrosion

Metals

Properties

Alloys

layers slide

pure metal

same-size atoms;

layers slide easily (softer)

alloy

different-size atoms

stop the layers sliding (harder)

→ blocked

■ Brass 黄铜 is a mixture of copper and zinc 锌.

■ Stainless steel 不锈钢 is a mixture of iron 铁 with other elements such as chromium 铬, nickel 镍 and carbon 碳.

2

Reactivity

Metals

↳ Reactivity

The reactivity series

most reactive

K

Na

Ca

Mg

Al

C

Zn

Fe

H

Cu

Ag

Au

least reactive

potassium

sodium

calcium

magnesium

aluminium

carbon (non-metal)

zinc

iron

hydrogen (non-metal)

copper

silver

gold

above carbon:

extract by

electrolysis

below carbon:

extract by

reduction with carbon

■ potassium, sodium and calcium react with cold water.

■ magnesium reacts with steam (but only very slowly with cold water).

■ magnesium, zinc and iron react with dilute hydrochloric acid; copper, silver and gold do not.

Metals

↳ Reactivity

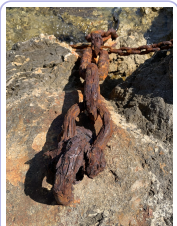
Displacement and aluminium

displacement 置换反应

a more reactive metal pushes out a less reactive one (zinc displaces copper)

aluminium

a tough oxide makes reactive



Rusting is a costly form of corrosion

3

Corrosion

Metals

↳ Corrosion

Rusting

Rusting 生锈 needs both water and oxygen.

The nail rusts only in the tube with both – rust is hydrated iron(III) oxide.

rusts



no rust



no rust



Metals

↳ Corrosion

Preventing rust

electrons to iron

iron stays protected

zinc (corrodes)

■ **barrier** 隔离法 – paint, grease, plastic

■ **galvanising** 镀锌 – a zinc coat

Zinc gives **sacrificial protection** 牺牲保护: being more reactive, it corrodes **instead** of the iron.

4

Extraction

Metals

↳ Extraction

Extraction: reactivity decides

How a metal leaves its **ore** 矿石 depends on its reactivity:

- above carbon → **electrolysis** 电解 (aluminium)
- below carbon → heat with carbon (iron)

(more reactive)

↑

above → electrolysis

carbon

↓

below → heat with carbon

(less reactive)

Metals

↳ Extraction

The blast furnace

Iron from **hematite** 赤铁矿:

- coke burns → CO₂ → **carbon monoxide** 一氧化碳
- CO **reduces** 还原 the iron oxide to iron
- **limestone** 石灰石 removes sandy impurities as **slag** 炉渣

5

Recap

Metals

↳ Recap

Worked example – which extraction method?

Iron is extracted with carbon but aluminium needs electrolysis. Explain.

- The method depends on the metal's place in the **reactivity series**.
- Iron is **below carbon**, so carbon can **reduce** its oxide in a blast furnace – cheap.
- Aluminium is **above carbon**, so carbon cannot take its oxygen away.
- Only **electrolysis** is powerful enough – which is why aluminium is expensive.

Above carbon ⇒ **elec-trolysis**. Below carbon ⇒ **reduce with carbon**. Un-reactive (gold) ⇒ found **native**, just dig it up.

Metals

↳ Recap

Topic 9 – key takeaways

1

Alloys

harder – mixed atom sizes block sliding

2

Reactivity

order of forming positive ions

3

Rust

needs water + oxygen; zinc protects

4

Extraction

above carbon: electrolysis; below: carbon

Metals

↳ Recap

Check yourself

- Why is an alloy harder than a pure metal?
- What two things are needed for iron to rust?
- How does zinc protect iron even when scratched?
- How is a metal above carbon extracted?

K

Fe

Au

↓

Answers 1. different-sized atoms block sliding layers 2. water and oxygen 3. it corrodes sacrificially instead 4. by electrolysis