Week 19

IGCSE Chemistry

Homework bundle for this week

本周作业合集

exercises.lol

Contents 目录

9. Metals

Starter Quiz · 课前小测

IGCSE Chemistry Name: _____ Score: _____

1. Metals conduct electricity because they have:

   ☐ free (delocalised) electrons

   ☐ free ions

   ☐ covalent bonds

   ☐ no electrons

2. Copper is used for electrical wiring because it is an excellent:

   ☐ conductor of electricity

   ☐ insulator

   ☐ magnet

   ☐ fuel

3. An alloy is:

   ☐ a mixture of a metal with other elements

   ☐ a pure metal

   ☐ a non-metal

   ☐ a type of acid

4. Which of these metals is the most reactive?

   ☐ potassium

   ☐ iron

   ☐ copper

   ☐ gold

5. Rusting of iron requires which two things? (Select all that apply.)

   ☐ water

   ☐ oxygen

   ☐ nitrogen

   ☐ sunlight

   Tick every correct option.

6. A rock containing enough of a metal compound to extract is called an:

   ☐ ore

☐ alloy

☐ acid

☐ isotope

7. Which are typical properties of metals? (Select all that apply.)

   ☐ shiny

   ☐ malleable

   ☐ good heat conductors

   ☐ poor electrical conductors

   Tick every correct option.

8. Iron is strong but a drawback is that it rusts.

   ☐ True ☐ False

9. Most metals have high melting points.

   ☐ True ☐ False

10. A metal's _____ properties (such as strength and conductivity) decide its uses.

    _____

IGCSE Chemistry

1. **free (delocalised) electrons**

   Mobile electrons carry the current.

2. **conductor of electricity**

   Copper conducts electricity very well.

3. **a mixture of a metal with other elements**

   Alloys are mixtures based on a metal.

4. **potassium**

   Potassium is near the top of the reactivity series.

5. **water; oxygen**

   Both water and oxygen are needed.

6. **ore**

   Metals are extracted from their ores.

7. **shiny; malleable; good heat conductors**

   Metals are good electrical conductors, not poor ones.

8. **True**

   Rusting is a downside of using iron.

9. **True**

   Strong metallic bonding gives high melting points.

10. **physical**

    Physical properties match the metal to the job.

IGCSE CHEMISTRY • EXERCISE SHEET

9.1 Properties of metals

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

KEY WORDS oxygen 氧气 • metals 金属 • oxide 氧化物 • salt 盐 • hydrogen 氢气

Objective

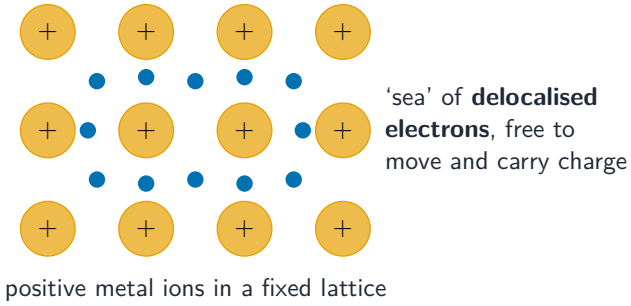
Build the skills to answer exam questions on the **properties of metals** 金属的性质 — physical properties vs non-metals, and the chemical reactions of metals.

You must be able to:

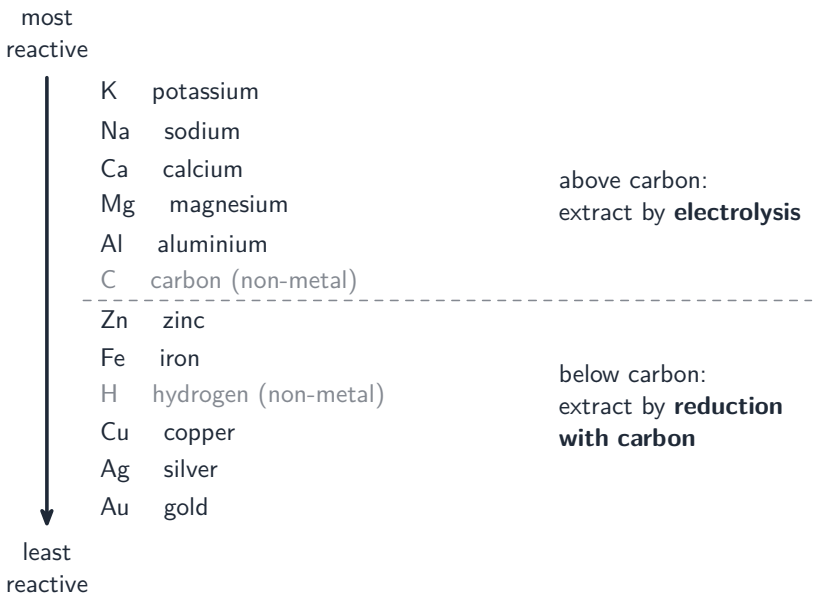
- contrast the physical properties of metals and non-metals
- give the products of metals with acids, water/steam and oxygen
- link properties to uses

1 Worked examples

Metal properties



Delocalised electrons make metals good conductors; sliding layers make them malleable



Reactivity is a key chemical property of a metal

- **metals:** good conductors, malleable/ductile, high melting points.
- **reactions:** + acid → salt + hydrogen; + oxygen → metal oxide; + water/steam → hydroxide/oxide + hydrogen.

2 Practice

2.1 State two physical properties of metals. [2]

2.2 Give the products when a metal reacts with a dilute acid. [1]

3 Exam-style questions

3.1 Which property is typical of a non-metal? [1]

- **A** good electrical conductor
- **B** malleable
- **C** brittle
- **D** high density

3.2 Magnesium reacts with dilute hydrochloric acid.

(a) Name the two products. [2]

(b) Name the gas given off and a test for it. [2]

3.3 State why metals are good electrical conductors. [1]

Solutions

2.1 any two of: good conductor of heat/electricity; malleable; ductile; high melting point.

2.2 a salt + hydrogen.

3.1 C. Non-metals are usually brittle.

3.2 (a) magnesium chloride; hydrogen.
(b) hydrogen; it gives a 'squeaky pop' with a lighted splint.

3.3 they have delocalised (free) electrons that can move and carry charge.

2 Calcium is an element in Group II of the Periodic Table.

(a) Identify the element in Group II which has only five occupied electron shells.

..... [1]

(b) Name and describe the type of bonding found in elements in Group II.

name .....

description .....

.....

.....

.....
[4]

(c) When a piece of calcium is added to some cold water containing universal indicator a reaction takes place.

(i) Give **three** observations when this reaction takes place.

1 .....

2 .....

3 .....
[3]

(ii) Name the **two** products of this reaction.

..... and ..... [2]

(d) Calcium burns in oxygen.

(i) State the colour of the flame.

..... [1]

(ii) Write the symbol equation for this reaction.

..... [2]

(e) Crystals of hydrated calcium nitrate contain water molecules.

The formula of hydrated calcium nitrate is $Ca(NO_3)_2 \cdot \mathbf{x}H_2O$.
x is a whole number.

(i) State the term given to the water molecules present in hydrated crystals.

..... [1]

(ii) When hydrated calcium nitrate is heated gently, the following reaction occurs.

$$Ca(NO_3)_2 \cdot \mathbf{x}H_2O \rightarrow Ca(NO_3)_2 + \mathbf{x}H_2O$$

A sample of hydrated calcium nitrate is heated gently. 3.28 g of $Ca(NO_3)_2$ forms and the mass of the crystals decreases by 1.44 g.

[M_r: $Ca(NO_3)_2$, 164; H_2O, 18]

Determine the value of **x** in $Ca(NO_3)_2 \cdot \mathbf{x}H_2O$ using the following steps.

- Calculate the number of moles of $Ca(NO_3)_2$ that remain.

..... mol

- Calculate the number of moles of H_2O given off.

..... mol

- Determine the value of **x**.

x = ...
[3]

[Total: 17]

5 This question is about metallic compounds.

(a) Insoluble metal salts, such as lead(II) sulfate, are made by precipitation.

When aqueous lead(II) ions react with aqueous sulfate ions, a precipitate of lead(II) sulfate forms.

A sample of pure lead(II) sulfate can be obtained from the precipitate formed.

(i) Write an ionic equation for this precipitation reaction. Include state symbols.

..... [3]

(ii) State the name of an aqueous solution containing lead(II) ions.

..... [1]

(iii) State the name of an aqueous solution containing sulfate ions.

..... [1]

(iv) The lead(II) sulfate precipitate is separated from the rest of the reaction mixture by filtration. The impure lead(II) sulfate remains on the filter paper.

State the general term given to an insoluble substance that remains on the filter paper during filtration.

..... [1]

(v) Describe how the lead(II) sulfate is purified after filtration.

.....

..... [2]

(b) Copper is a transition element.

A list of properties of copper is shown.

- It has good electrical conductivity.
- It has variable oxidation states.
- It forms soluble salts.
- It forms coloured compounds.
- It forms basic oxides.
- It acts as a catalyst.

(i) Give **two** properties from the list that show how copper is similar to metals in Group I of the Periodic Table.

1 .....

2 .....
[2]

(ii) Give **two** properties from the list that show how copper is different from metals in Group I of the Periodic Table.

1 .....

2 .....
[2]

[Total: 12]

IGCSE CHEMISTRY • EXERCISE SHEET

9.2 Uses of metals

Name: _____ Class: _____ Date: _____ **Total: 7 marks**

KEY WORDS aluminium 铝 • density 密度 • corrosion 腐蚀 • uses of metals 金属的用途 • copper 铜

Objective

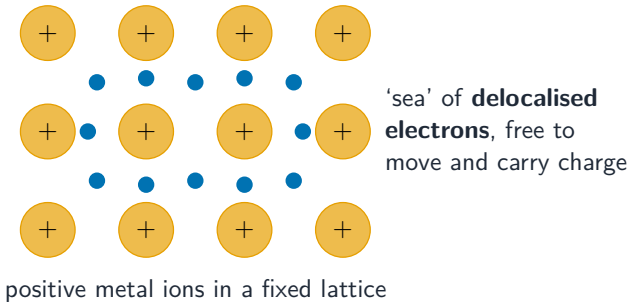
Build the skills to answer exam questions on **uses of metals** 金属的用途 — choosing a metal for a job from its properties.

You must be able to:

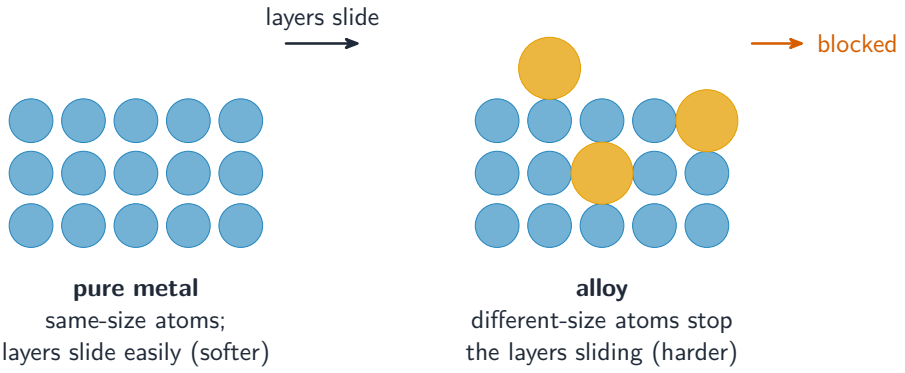
- link a use to the property that makes the metal suitable
- explain the uses of aluminium and copper

1 Worked examples

■ **Property → use**



A metal is chosen for a job because of its properties



Most metals are used as alloys

- **aluminium** — low density (aircraft); low density + conductivity (overhead cables); resists corrosion (food containers).
- **copper** — good conductor + ductile (electrical wiring).

2 Practice

2.1 State why copper is used for electrical wiring. [1]

2.2 State why aluminium is used to build aircraft. [1]

3 Exam-style questions

3.1 Aluminium is used for overhead power cables mainly because it is: [1]

- **A** very dense
- **B** low density and a good conductor
- **C** magnetic
- **D** very reactive

3.2 A metal is needed for food and drink cans.

(a) Name a suitable metal. [1]

(b) State the property that makes it suitable. [1]

3.3 Explain why copper, rather than aluminium, is normally chosen for the wiring inside a house. [2]

Solutions

2.1 it is a good electrical conductor (and ductile).

2.2 it has a low density (it is light).

3.1 B. Low density and good conductivity suit overhead cables.

3.2 (a) aluminium.
(b) it resists corrosion.

3.3 copper is a better electrical conductor than aluminium; and it is ductile, so it can be drawn into wires.

25 Which statement about the properties and uses of copper is correct?

A It is used in electrical wiring, and it is ductile.

B It is mixed with tin to make the alloy brass.

C It is used in overhead electrical cables because it has a low density.

D It is used in takeaway food containers because of its resistance to corrosion.

IGCSE CHEMISTRY • EXERCISE SHEET

9.3 Alloys and their properties

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

KEY WORDS alloy 合金 • brass 黄铜 • carbon 碳 • mixture 混合物 • ore 矿石

Objective

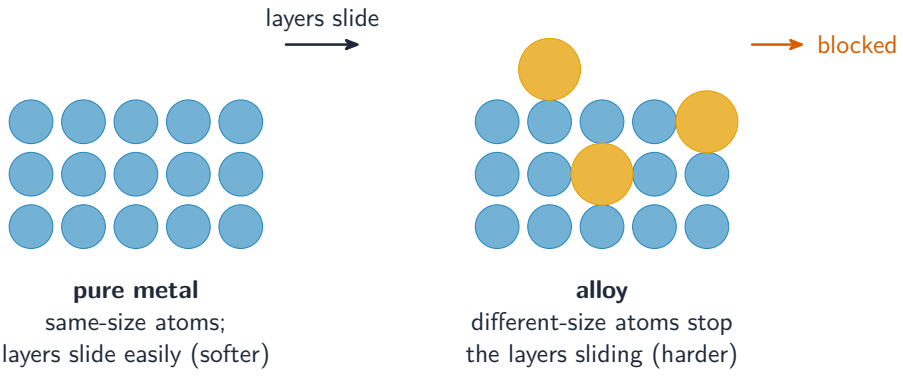
Build the skills to answer exam questions on **alloys** 合金 — what they are, examples, and why they are harder than pure metals.

You must be able to:

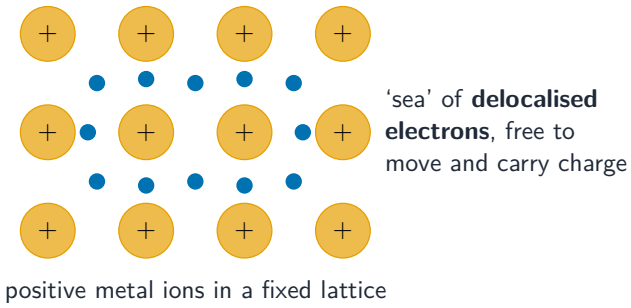
- define an alloy and give examples (brass, stainless steel)
- explain why alloys are harder than pure metals
- link the property to a use

1 Worked examples

■ Why alloys are harder



Different-sized atoms stop the layers sliding, so the alloy is harder than the pure metal



Alloying distorts the metallic lattice, changing properties

- **alloy:** a mixture of a metal with other element(s).
- **brass** = copper + zinc; **stainless steel** = iron + chromium/nickel/carbon.

2 Practice

2.1 Define an alloy. [1]

2.2 Name the two metals in brass. [2]

3 Exam-style questions

3.1 Alloys are usually harder than pure metals because the different-sized atoms: [1]

- **A** are more reactive
- **B** stop the layers sliding over each other
- **C** make the metal lighter
- **D** conduct better

3.2 Stainless steel is used for cutlery.

(a) Name two elements (other than iron) found in stainless steel. [2]

(b) State two properties that make it suitable for cutlery. [2]

3.3 Explain, using their structures, why an alloy is harder than the pure metal it is made from. [2]

Solutions

2.1 a mixture of a metal with one or more other elements.

2.2 copper; zinc.

3.1 B. Different-sized atoms stop the layers sliding.

3.2 (a) chromium and nickel (or carbon).
(b) it is hard and does not rust (resists corrosion).

3.3 in a pure metal the atoms are the same size, so layers slide easily; in an alloy different-sized atoms distort the layers and stop them sliding, making it harder.

25 Brass is an alloy of copper.

Which statement about brass or copper is correct?

A Brass does **not** conduct electricity because it is a compound.

B Copper conducts electricity because its atoms are free to move.

C Brass is harder than copper because its layers of atoms **cannot** easily slide over each other.

D Copper is stronger than brass because it is a pure metal.

26 Brass is a mixture of copper and zinc.

Which statement describes and explains the relative strength of brass compared to copper?

A Brass is stronger than copper because the layers of atoms in brass **cannot** easily slide over each other.

B Brass is stronger than copper because the intermolecular forces are greater in brass than in copper.

C Brass is weaker than copper because the layers of atoms slide more easily over each other in brass than in copper.

D Brass is weaker than copper because the intermolecular forces are weaker in brass than in copper.

4 Chromium is the element with atomic number 24 in the Periodic Table.

(a) The main ore of chromium is chromite. Chromite contains $FeCr_2O_4$.

$FeCr_2O_4$ reacts with carbon.

(i) Complete the equation for this reaction.

$$FeCr_2O_4 + 4C \rightarrow Fe + 2Cr + \text{.....} \quad [1]$$

(ii) Suggest **one** disadvantage of extracting chromium by reacting chromite with carbon.

..... [1]

(b) Chromium can be mixed with nickel and other elements to form stainless steel.

Name the type of substance formed when a metal is mixed with other elements.

..... [1]

(c) $(NH_4)_2Cr_2O_7$ is a compound containing chromium.

The negative ion in $(NH_4)_2Cr_2O_7$ is $Cr_2O_7^{2-}$.

(i) State the sum of the oxidation numbers in the $Cr_2O_7^{2-}$ ion.

..... [1]

(ii) The oxidation number of each O in $Cr_2O_7^{2-}$ ions is –2.

Determine the oxidation number of each Cr in $Cr_2O_7^{2-}$ ions. Show your working.

..... [2]

(iii) When $(NH_4)_2Cr_2O_7$ is heated the following reaction occurs.

$$(NH_4)_2Cr_2O_7 \rightarrow Cr_2O_3 + 4H_2O + N_2$$

Calculate the volume of nitrogen gas produced at r.t.p., in cm^3, when 1.26 g of $(NH_4)_2Cr_2O_7$ is heated using the following steps.

The M_r of $(NH_4)_2Cr_2O_7$ is 252.

- Calculate the number of moles of $(NH_4)_2Cr_2O_7$ used.

..... mol

- Determine the number of moles of N_2 formed.

..... mol

- Calculate the volume of N_2 formed at r.t.p. in cm^3.

..... cm^3
[3]

[Total: 9]

28 Which statement about alloys is correct?

A Alloys are harder than pure metals because they contain strong intermolecular forces.

B Brass is an alloy containing mainly copper and tin.

C The different-sized atoms in an alloy mean that the layers **cannot** easily slide over each other.

D There are no alloys containing carbon because carbon is a non-metal.

IGCSE CHEMISTRY • EXERCISE SHEET

9.4 Reactivity series

Name: _____ Class: _____ Date: _____ **Total: 8 marks**

KEY WORDS ions 离子 • magnesium 镁 • calcium 钙 • reactivity series 金属活动性顺序 • displacement 置换

Objective

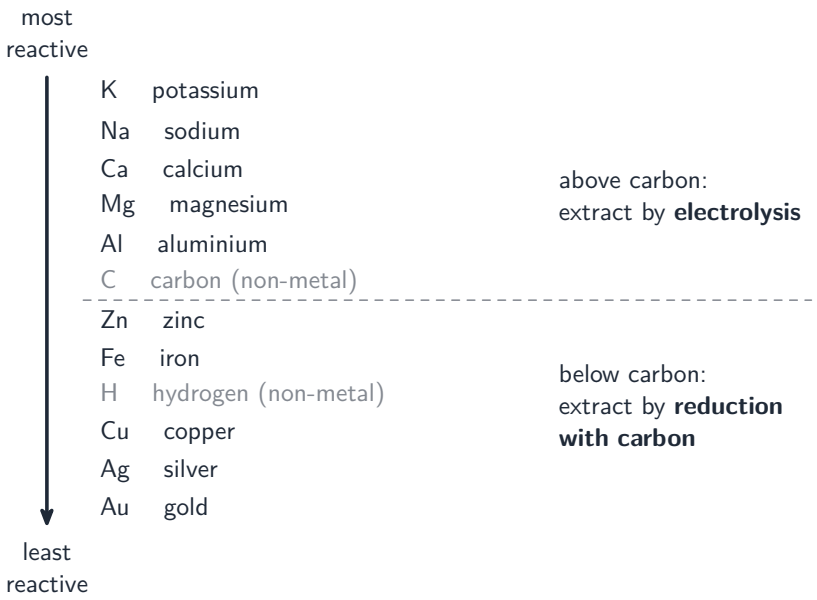
Build the skills to answer exam questions on the **reactivity series** 金属活动性顺序 — the order, reactions with water/acid, **displacement** 置换, and the special case of aluminium.

You must be able to:

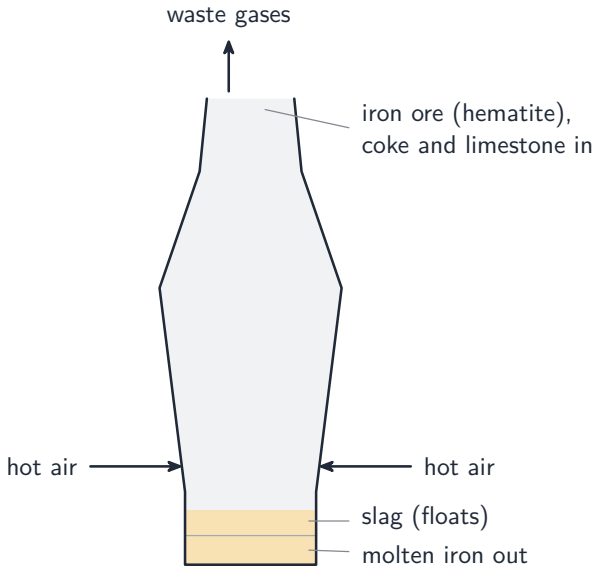
- recall the reactivity series and use it to predict reactions
- predict displacement reactions of metals
- explain why aluminium seems less reactive than expected

1 Worked examples

■ Using the series



A more reactive metal displaces a less reactive one from solution



$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
(carbon monoxide reduces the ore)

Reactivity decides how a metal is extracted

- K, Na, Ca react with cold water; Mg with steam; Mg/Zn/Fe with dilute acid; Cu/Ag/Au do not.
- **displacement:** zinc displaces copper from copper(II) sulfate (zinc is more reactive).
- **aluminium:** a strong oxide layer makes it seem less reactive.

2 Practice

2.1 State which is more reactive: zinc or copper. [1]

2.2 Name a metal that reacts with cold water. [1]

3 Exam-style questions

3.1 Which metal will **not** react with dilute hydrochloric acid? [1]

- **A** magnesium
- **B** zinc
- **C** iron
- **D** copper

3.2 A piece of iron is placed in copper(II) sulfate solution.

(a) State what you would observe. [2]

(b) Explain why this reaction happens. [1]

3.3 Aluminium is high in the reactivity series but appears unreactive. Explain why. [2]

Solutions

2.1 zinc.

2.2 potassium, sodium or calcium.

3.1 D. Copper is below hydrogen, so it does not react with dilute acid.

3.2 (a) the iron becomes coated with (pink/brown) copper; the blue solution fades.
(b) iron is more reactive than copper, so it displaces copper from the solution.

3.3 aluminium is covered by a thin, strong oxide layer; this stops other substances reaching the metal underneath, so it seems unreactive.

26 What is the correct order of reactivity of the following metals, from least reactive to most reactive?

A calcium → magnesium → zinc → copper

B copper → zinc → magnesium → calcium

C copper → zinc → calcium → magnesium

D zinc → copper → magnesium → calcium

27 The equation for the reaction between aluminium and iron(III) oxide is shown.

$$2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$$

Which statement about this reaction is correct?

A The aluminium acts as an oxidising agent.

B It shows that iron is more reactive than aluminium.

C The oxidation number of the aluminium decreases during the reaction.

D It shows that aluminium has a greater tendency to form ions than iron.

26 Four different metals are separately added to water.

The oxide of each metal is separately heated with carbon.

The results are shown.

metal	metal with water	metal oxide with carbon
Q	no reaction	brown solid forms
R	rapid fizzing	no reaction
S	a few bubbles	no reaction
T	a few bubbles	grey solid forms

What is the order of reactivity of the four metals, least reactive first?

A Q → T → S → R

B Q → S → T → R

C R → S → T → Q

D R → T → S → Q

28 Some information about four metals P, Q, R and S is listed.

Metal P does **not** react with dilute hydrochloric acid.

Metal Q is more reactive than magnesium.

Metal R reacts rapidly with cold water to produce hydrogen.

Metal S reacts with dilute hydrochloric acid to produce hydrogen.

Which row identifies P, Q, R and S?

	P	Q	R	S
A	gold	aluminium	sodium	copper
B	copper	potassium	calcium	magnesium
C	silver	calcium	iron	zinc
D	magnesium	sodium	potassium	iron

26 Three statements about solid Z are listed.

- It reacts with dilute hydrochloric acid to produce hydrogen.
- It reacts very slowly with cold water and quickly with steam.
- It is a good thermal conductor.

What is solid Z?

A gold

B magnesium

C potassium

D silver

27 Four metals J, K, L and M are added separately to aqueous solutions of their ions.

The results are shown.

	aqueous ions			
metal	J^{2+}	K^{2+}	L^{2+}	M^{2+}
J	✗	✓	✓	✓
K	✗	✗	✗	✓
L	✗	✓	✗	✓
M	✗	✗	✗	✗

key

✓ = reaction

✗ = no reaction

Which statement about the metals is correct?

A J has a greater tendency to form positive ions than K.

B L has a greater tendency to form positive ions than J.

C K has a greater tendency to form positive ions than L.

D M has a greater tendency to form positive ions than K.

26 The ionic equations for some reactions between metals and aqueous metal ions are shown.

$$Cu + 2Ag^{+} \rightarrow 2Ag + Cu^{2+}$$

$$Mg + Zn^{2+} \rightarrow Mg^{2+} + Zn$$

$$Zn + Cu^{2+} \rightarrow Cu + Zn^{2+}$$

$$Sn + Cu^{2+} \rightarrow Sn^{2+} + Cu$$

Which further information can be used to place copper, magnesium, silver, tin and zinc in order of their reactivity?

A Zinc reacts with Sn^{2+} ions.

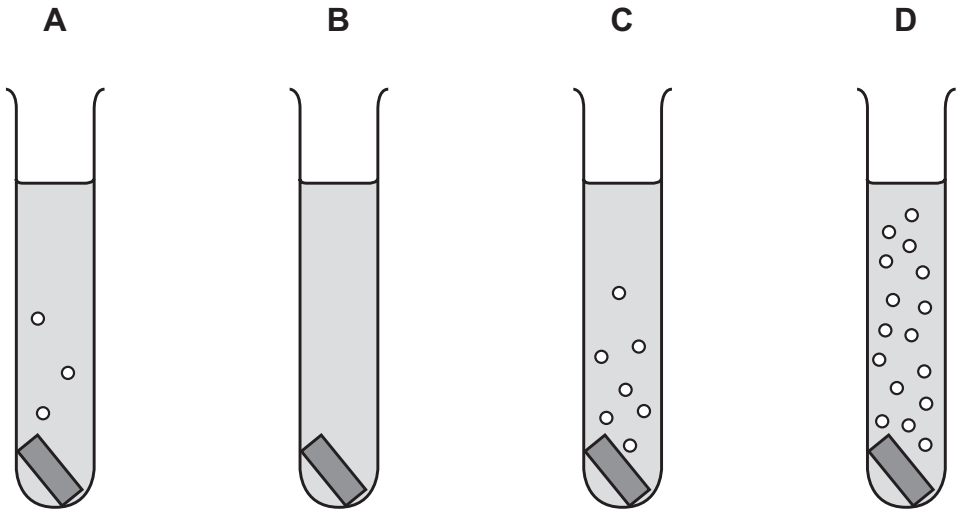
B Copper does **not** react with Sn^{2+} ions.

C Magnesium reacts with Cu^{2+} ions.

D Magnesium reacts with Ag^{+} ions.

25 Four test-tubes contain dilute hydrochloric acid. Each test-tube has one piece of a different metal added to it. The metals are copper, iron, magnesium and zinc.

Which test-tube contains iron and dilute hydrochloric acid?



29 Separate pieces of aluminium foil and copper foil are heated in air.

The copper foil reacts to give a black solid.

The aluminium foil does **not** react.

Which statement explains these observations?

A Aluminium has an unreactive layer, but copper does **not**.

B Aluminium is below copper in the reactivity series.

C Copper reacts with moisture in the air, but aluminium does **not**.

D Copper reacts with nitrogen in the air, but aluminium does **not**.

IGCSE CHEMISTRY • EXERCISE SHEET

9.5 Corrosion of metals

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

KEY WORDS rusting 生锈 • sacrificial protection 牺牲保护 • galvanising 镀锌 • electrons 电子 • barrier methods 隔

Objective

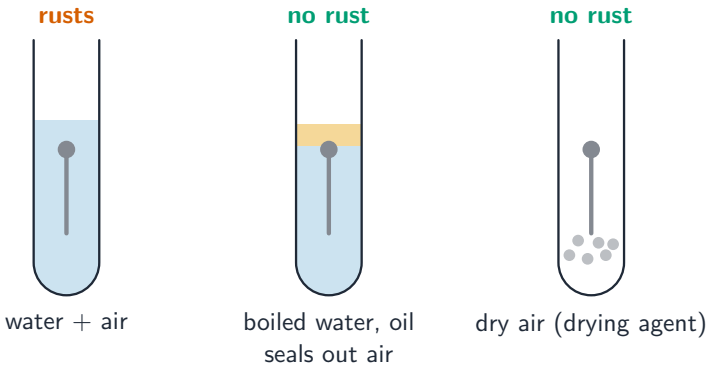
Build the skills to answer exam questions on the **corrosion of metals** 金属腐蚀 — **rusting** 生锈, what it needs, and how to prevent it (including **sacrificial protection** 牺牲保护).

You must be able to:

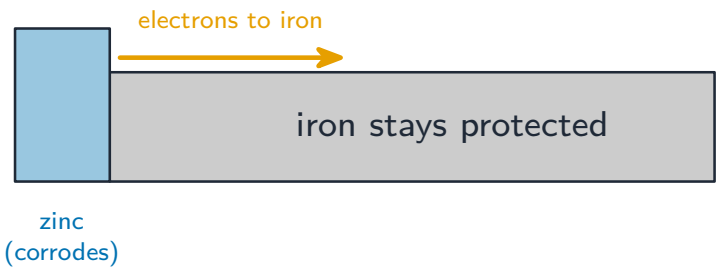
- state that rusting needs oxygen and water
- describe barrier methods and galvanising
- explain sacrificial protection

1 Worked examples

■ Preventing rust



Rusting needs both water and oxygen



The more reactive zinc corrodes instead of the iron — sacrificial protection

- **barrier methods:** painting, greasing, plastic coating.

2 Practice

2.1 State the two substances needed for iron to rust. [2]

2.2 Name the process of coating iron with zinc. [1]

3 Exam-style questions

3.1 Rust is: [1]

- **A** iron(II) sulfate
- **B** hydrated iron(III) oxide
- **C** iron carbonate
- **D** zinc oxide

3.2 In an experiment, an iron nail is kept in (i) water and air, (ii) boiled water under oil, and (iii) dry air with a drying agent.

(a) State in which tube the nail rusts, and why. [2]

(b) State the purpose of the boiled water in tube (ii). [1]

3.3 A block of zinc is attached to the steel hull of a ship. Explain how this protects the steel from rusting, even if the surface is scratched. [3]

Solutions

2.1 oxygen; water.

2.2 galvanising.

3.1 B. Rust is hydrated iron(III) oxide.

3.2 (a) only tube (i); because it is the only one with both water and oxygen present.
(b) boiling removes the dissolved oxygen from the water.

3.3 zinc is more reactive than iron, so it corrodes instead of the iron; the zinc loses electrons / gives them to the iron; so the iron is protected even where the surface is scratched.

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28 Which row identifies methods used to prevent iron from rusting?

	greasing	painting	washing with distilled water
A	✓	✗	✓
B	✗	✓	✓
C	✓	✓	✗
D	✓	✓	✓

key

✓ = yes

✗ = no

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27 An iron nail is fully covered with zinc to prevent it from rusting.

Which row describes this method of protection and explains why zinc is used to protect the iron nail?

	method of protection	reason zinc is used
A	barrier method and sacrificial protection	zinc is more reactive than iron
B	barrier method and sacrificial protection	iron is more reactive than zinc
C	sacrificial protection only	zinc is more reactive than iron
D	barrier method only	iron is more reactive than zinc

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29 Galvanising prevents iron from rusting.

Which statements about galvanising are correct?

1 Galvanising involves coating the iron with silver.

2 Galvanising prevents oxygen and water from coming into contact with the iron.

3 Galvanising works because the metal coating loses electrons more readily than iron.

A 1, 2 and 3 **B** 1 and 3 only **C** 2 and 3 only **D** 2 only

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27 Zinc is used to galvanise iron to prevent it from rusting.

Which statements are correct?

1 Galvanising is an example of a barrier method.

2 If the zinc is scratched, the iron will rust very quickly.

3 Galvanising is an example of sacrificial protection.

4 Zinc is more reactive than iron and so accepts electrons more readily.

A 1, 2 and 4 **B** 1 and 3 **C** 2. 3 and 4 **D** 2 and 3 only

27 An example of sacrificial protection is the fitting of zinc blocks to the outside of a ship's steel hull.

Which statement explains why zinc is used to protect the iron in the steel from rusting?

A Zinc is more reactive than iron so it loses electrons more easily.

B Zinc is less reactive than iron so it loses electrons more easily.

C Zinc is more reactive than iron so it gains electrons more easily.

D Zinc is less reactive than iron so it gains electrons more easily.

9.6 Extraction of metals

Name: _____ Class: _____ Date: _____ **Total: 8 marks**

KEY WORDS blast furnace 高炉 • reduction 还原 • electrolysis 电解 • limestone 石灰石 • cathode 阴极

Objective

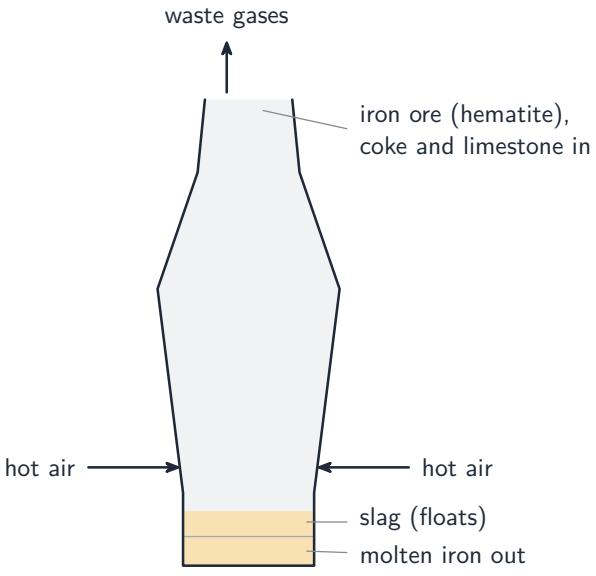
Build the skills to answer exam questions on the **extraction of metals** 金属的提取 — choosing the method, the **blast furnace** 高炉 for iron, and **electrolysis** 电解 for aluminium.

You must be able to:

- link the extraction method to the metal's place in the reactivity series
- describe the reduction of iron oxide in the blast furnace
- describe the extraction of aluminium by electrolysis

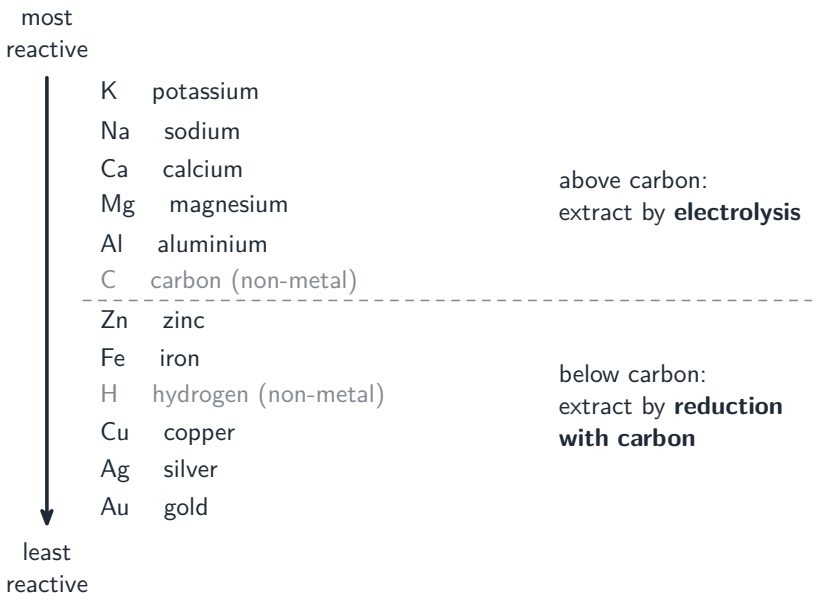
1 Worked examples

■ Iron and aluminium



$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
(carbon monoxide reduces the ore)

Carbon monoxide reduces iron(III) oxide; limestone removes impurities as slag



Metals above carbon → electrolysis; metals below carbon → heat with carbon

- **iron:** CO reduces Fe_2O_3 to iron.
- **aluminium:** electrolysis of Al_2O_3 dissolved in molten cryolite.

2 Practice

2.1 State which metal-extraction method is used for metals **above** carbon in the reactivity series. [1]

2.2 Name the ore that iron is extracted from. [1]

3 Exam-style questions

3.1 Aluminium is extracted by electrolysis rather than by heating with carbon because it is: [1]

- **A** less reactive than carbon
- **B** more reactive than carbon
- **C** a non-metal
- **D** a transition metal

3.2 Iron is extracted in the blast furnace.

(a) Name the substance that reduces the iron(III) oxide. [1]

(b) State the role of the limestone. [2]

3.3 In the extraction of aluminium, state why cryolite is used and name the product at the cathode. [2]

Solutions

2.1 electrolysis.

2.2 hematite (iron(III) oxide).

3.1 B. Aluminium is more reactive than carbon, so carbon cannot reduce it.

3.2 (a) carbon monoxide.
(b) it decomposes to calcium oxide, which reacts with sandy impurities to form slag.

3.3 cryolite lowers the melting point of the aluminium oxide (saving energy); aluminium forms at the cathode.

29 Which statement about the extraction of aluminium by electrolysis is correct?

A Aluminium oxide is dissolved in molten cryolite to increase its melting point.

B At the cathode, oxygen ions lose electrons to form oxygen gas.

C The carbon in the graphite anode reacts with oxygen gas forming carbon dioxide.

D The reaction at the anode is $Al^{3+} + 3e^- \rightarrow Al$.

28 Iron is extracted from hematite in the blast furnace.

Which reaction increases the temperature in the blast furnace to over 1500 °C?

A calcium carbonate → calcium oxide + carbon dioxide

B calcium oxide + silicon(IV) oxide → calcium silicate

C carbon + oxygen → carbon dioxide

D carbon dioxide + carbon → carbon monoxide

29 Aluminium is extracted by the electrolysis of purified bauxite.

Which row shows the half-equations at the electrodes and explains why one of the electrodes has to be replaced regularly?

	half-equation at anode	half-equation at cathode	electrode replacement
A	$2O^{2-} \rightarrow O_2 + 4e^-$	$Al^{3+} + 3e^- \rightarrow Al$	cathode replaced as it gets coated with aluminium
B	$2O^{2-} \rightarrow O_2 + 4e^-$	$Al^{3+} + 3e^- \rightarrow Al$	anode replaced as it burns away in oxygen
C	$Al^{3+} + 3e^- \rightarrow Al$	$2O^{2-} \rightarrow O_2 + 4e^-$	cathode replaced as it burns away in oxygen
D	$Al^{3+} + 3e^- \rightarrow Al$	$2O^{2-} \rightarrow O_2 + 4e^-$	anode replaced as it gets coated with aluminium

32 Iron is extracted from iron(III) oxide in the blast furnace.

Three steps in the process are listed.

1 Carbon (coke) is completely oxidised.

2 Iron(III) oxide is reduced.

3 Carbon dioxide is reduced to carbon monoxide.

What is the correct order of the steps in the extraction of iron?

A $1 \rightarrow 2 \rightarrow 3$ **B** $1 \rightarrow 3 \rightarrow 2$ **C** $2 \rightarrow 1 \rightarrow 3$ **D** $3 \rightarrow 1 \rightarrow 2$

33 Three different reactions that occur during the extraction of aluminium from purified bauxite are listed.

1 $Al^{3+} + 3e^- \rightarrow Al$

2 $C + O_2 \rightarrow CO_2$

3 $2O^{2-} \rightarrow O_2 + 4e^-$

Which reactions occur at the anode?

A 1 and 2 **B** 1 only **C** 2 and 3 **D** 3 only

2 Iron is extracted from iron ore in a blast furnace.

(a) The iron compound in the main iron ore used in the blast furnace is iron(III) oxide.

(i) State the name of the main iron ore used in the blast furnace.

..... [1]

(ii) State how the main source of heat is provided in the blast furnace.

..... [1]

(iii) Name the gaseous reducing agent in the blast furnace.

..... [1]

(iv) Write a symbol equation for the reduction of iron(III) oxide by the gaseous reducing agent in **(a)(iii)**.

..... [2]

(v) The main impurity in iron ore is silicon(IV) oxide.

Write **two** symbol equations to show the role of limestone in removing silicon(IV) oxide from iron ore.

1 .....

2 .....
[2]

(b) Table 2.1 shows four different isotopes of iron, **A**, **B**, **C** and **D**.

Table 2.1

A	**B**	**C**	**D**
^{54}Fe	^{56}Fe	^{57}Fe	^{58}Fe

Explain why **A**, **B**, **C** and **D** are isotopes of iron.

.....

..... [2]

(c) Iron can form two different ions, Fe^{2+} and Fe^{3+}.

(i) Complete Table 2.2 to show the number of protons, neutrons and electrons in the two iron ions shown.

Table 2.2

	$^{54}Fe^{2+}$	$^{58}Fe^{3+}$
protons		
neutrons		
electrons		

[3]

(ii) Describe a test for aqueous Fe^{2+} ions.

test .....

observations .....

.....

[2]

(d) An oxidising agent converts Fe^{2+} ions to Fe^{3+} ions.

(i) Define the term oxidising agent.

.....

..... [2]

(ii) Explain why the conversion of Fe^{2+} ions to Fe^{3+} ions is described as oxidation.

..... [1]

(iii) The oxidising agent for the conversion of Fe^{2+} ions to Fe^{3+} ions is aqueous potassium manganate(VII).

State **one** condition needed for the oxidation to take place.

..... [1]

(e) Iodide ions, I^-, reduce Fe^{3+} ions to Fe^{2+} ions in aqueous solution.

Suggest the identity of the other product formed in this reaction.

.... [1]

[Total: 19]

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28 Which process is used in the extraction of iron from hematite?

A electrolysis

B precipitation

C reduction

D fractional distillation

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28 Which equation represents a reaction that occurs in a blast furnace during the extraction of iron from hematite?

A $Ca + CO_2 \rightarrow CaO + CO$

B $Fe_2O_3 + 3Ca \rightarrow 2Fe + 3CaO$

C $Ca(OH)_2 \rightarrow CaO + H_2O$

D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

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30 Which row gives the symbol equation for the formation of carbon monoxide and for the reduction of iron(III) oxide in a blast furnace?

	equation for the formation of carbon monoxide	equation for the reduction of iron(III) oxide
A	$2C + O_2 \rightarrow 2CO$	$FeO + CO \rightarrow Fe + CO_2$
B	$CO_2 + C \rightarrow 2CO$	$FeO + CO \rightarrow Fe + CO_2$
C	$C + O_2 \rightarrow CO_2$	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
D	$CO_2 + C \rightarrow 2CO$	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$