

Metals

30 questions: 15 multiple choice, 15 structured.

1 Core Properties of metals [1]

Which property do most metals have that most non-metals do not have?

- A brittle when solid
- B low melting point
- C good conductor of heat
- D poor conductor of electricity

2 Core Properties of metals [1]

Which word equation is correct?

- A calcium + cold water → calcium oxide + hydrogen
- B copper + dilute hydrochloric acid → copper chloride + hydrogen
- C magnesium + steam → magnesium hydroxide + hydrogen
- D zinc + oxygen → zinc oxide

3 Core Alloys and their properties [1]

Brass is an alloy. Which elements are mixed together to make brass?

- A copper and tin
- B copper and zinc
- C iron and carbon
- D iron and chromium

4 Core Reactivity series [1]

Which list shows the metals in order of increasing reactivity (least reactive first)?

- A copper, gold, iron, magnesium
- B magnesium, iron, copper, gold
- C gold, iron, copper, magnesium
- D gold, copper, iron, magnesium

5**Core**

Corrosion of metals

[1]

Iron rusts to form hydrated iron(III) oxide.

Which two substances must both be present for iron to rust?

- A carbon dioxide and water
- B oxygen and sodium chloride
- C oxygen and water
- D nitrogen and water

6**Core**

Extraction of metals

[1]

Which row is correct for aluminium?

	main ore	method of extraction
A	bauxite	electrolysis
B	bauxite	heating with carbon
C	hematite	electrolysis
D	hematite	heating with carbon

The table gives information about four elements, W, X, Y and Z. The letters are not chemical symbols.

element	melting point / °C	electrical conductivity when solid	effect of hitting with a hammer
W	1085	good	flattens without breaking
X	113	poor	shatters into small pieces
Y	3550	poor	shatters into small pieces
Z	98	good	flattens without breaking

- (a) Identify the **two** elements that are metals. Give a reason for your answer using the information in the table.

[2]

- (b) Give **one** physical property of metals that is **not** shown in the table.

[1]

- (c) Element Z reacts with cold water and a gas is given off. Name this gas.

[1]

- (d) Copper is a metal. When copper is heated in air, it reacts with oxygen. Write a word equation for this reaction.

[1]

A teacher demonstrates the reactions of some metals with water and with dilute hydrochloric acid.

(a) Potassium, sodium and calcium all react with cold water.

(i) Name the gas produced in all three reactions.

[1]

(ii) State which of these three metals reacts most vigorously with cold water.

[1]

(iii) Write a word equation for the reaction of calcium with cold water.

[1]

(b) Magnesium reacts only very slowly with cold water, but it reacts quickly when heated in steam. Name the solid product formed when magnesium reacts with steam.

[1]

(c) Small pieces of zinc, copper and silver are added to separate tubes of dilute hydrochloric acid.

Describe what is observed in each tube. Explain your answer in terms of the positions of these metals in the reactivity series.

[3]

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A student sets up four test-tubes, each containing one clean iron nail, and leaves them for one week.

tube	conditions
1	nail half covered by tap water; tube open to the air
2	nail completely covered by water that has been boiled to remove dissolved air; a layer of oil floats on top of the water
3	nail in air with anhydrous calcium chloride (a drying agent); tube sealed with a stopper
4	nail painted all over, then half covered by tap water; tube open to the air

(a)

- (i) State which tube contains the nail that rusts. [1]

- (ii) Name the chemical substance that rust is made of. [1]

- (b) Explain why the nail in tube 2 does **not** rust. [2]

- (c) Explain why the nails in tube 3 and tube 4 do **not** rust. [2]

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Iron is extracted from hematite in a blast furnace. Hematite contains iron(III) oxide, Fe_2O_3 , and sand, SiO_2 , as an impurity.

- (a) In the furnace, carbon dioxide reacts with hot coke (carbon) to form carbon monoxide. Write a balanced symbol equation for this reaction. [1]

- (b) Write a balanced symbol equation for the reduction of iron(III) oxide by carbon monoxide. [2]

- (c) A load of hematite contains 480 kg of iron(III) oxide. Calculate the maximum mass of iron, in kg, that can be produced from this iron(III) oxide. [Ar: Fe = 56; O = 16] [3]

- (d) Calcium oxide in the furnace removes the sand as slag. Write a balanced symbol equation for the formation of slag. [1]

11 **Core** Alloys and their properties

[1]

A textbook shows the structures of four substances, with each atom drawn as a circle. The drawings are described below.

Which description represents an alloy?

- A circles all the same size, packed closely together in regular layers
- B circles all the same size, arranged randomly and far apart from each other
- C circles of two different sizes, joined in pairs (one large, one small), with the pairs arranged randomly and far apart
- D mostly circles of one size packed closely in layers, with some circles of a different size mixed in among them, disrupting the layers

12 **Core** Reactivity series

[1]

A student tests four metals, P, R, T and V. The letters are not chemical symbols.

metal	observations with cold water	observations with dilute hydrochloric acid
P	no reaction	slow bubbling
R	fizzes steadily	not tested (too dangerous)
T	no reaction	no reaction
V	no reaction	rapid bubbling

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

- A R, P, V, T
- B V, R, P, T
- C R, V, P, T
- D T, P, V, R

13**Supplement**

Reactivity series

[1]

A piece of metal is added to an aqueous solution in each of four experiments.

experiment	metal	aqueous solution
1	zinc	silver nitrate
2	copper	iron(II) sulfate
3	iron	magnesium sulfate
4	magnesium	zinc sulfate

In which experiments does a displacement reaction take place?

- A 1 and 4 only
- B 1 and 2 only
- C 2 and 3 only
- D 1, 2 and 4 only

14**Core**

Corrosion of metals

[1]

The chain of a bicycle is made of steel. The chain has many moving parts.

Which method is most suitable for stopping the chain from rusting while still letting it move freely?

- A coating it with plastic
- B greasing it
- C painting it
- D washing it regularly with water

Metal M forms an oxide that is **not** reduced when it is heated with carbon.

Which row identifies a possible metal M and the method used to extract it from its ore?

	metal M	method of extraction
A	copper	electrolysis
B	magnesium	electrolysis
C	magnesium	heating with carbon
D	zinc	electrolysis

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The table gives some information about aluminium and copper.

property	aluminium	copper
density / g/cm ³	2.7	8.9
electrical conductivity (copper = 100)	61	100
resistance to corrosion	very good	good

- (a) Aluminium is used to make the bodies of aircraft. State the property of aluminium that makes it suitable for this use.

[1]

- (b) Overhead electrical cables carried by pylons are usually made from aluminium, even though copper is the better electrical conductor. Use the table to explain why aluminium is used.

[2]

- (c) Copper is used for the electrical wiring inside houses. Give **two** properties of copper that make it suitable for this use.

[2]

- (d) Aluminium is used to make food containers. State the property of aluminium that makes it suitable for this use.

[1]

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Knives, forks and spoons (cutlery) are often made from stainless steel.

- (a) Stainless steel is an alloy. State what is meant by the term *alloy*.

[1]

- (b) Stainless steel is made mainly of iron. Name **two** other elements that stainless steel may contain.

[2]

- (c) Give **two** reasons why stainless steel is used for cutlery.

[2]

- (d) A 250 g sample of stainless steel contains 45 g of chromium and 20 g of nickel. The rest of the sample is iron.

Calculate the percentage by mass of iron in the sample.

[2]

A student places an iron nail in blue aqueous copper(II) sulfate. After an hour, a pink-brown solid has formed on the nail and the solution has turned pale green.

- (a) Explain these observations. [2]

- (b) Write the ionic equation for the reaction. [2]

- (c) The student then places a piece of silver in aqueous iron(II) sulfate. There is no reaction. Explain, in terms of the tendency of metals to form positive ions, why there is no reaction. [2]

Steel fence posts on a farm are galvanised.

- (a) State what is meant by *galvanising*.

[1]

- (b) Galvanising protects steel as a barrier method. Explain how.

[1]

- (c) A post is scratched deeply, so that some of the steel is exposed to rain and air. The exposed steel does not rust.

Explain why, in terms of the reactivity series and electron loss.

[3]

- (d) A student suggests that coating the posts with copper instead of zinc would give the same protection when the coating is scratched. Explain why the student is wrong.

[2]

Iron is extracted in a blast furnace. Hematite (iron ore), coke and limestone are added at the top of the furnace, and hot air is blown in near the bottom.

- (a) Coke is almost pure carbon. Give **two** reasons why coke is burned in the furnace. [2]

- (b) Name the gas that reduces iron(III) oxide to iron in the furnace. [1]

- (c) Limestone (calcium carbonate) undergoes thermal decomposition in the furnace. Name the **two** products of this decomposition. [2]

- (d) Hematite contains impurities such as sand. Describe how slag is formed in the furnace and why its formation is useful. [2]

21 **Supplement** Alloys and their properties

[1]

Why is an alloy usually harder than the pure metal it is made from?

- A The atoms in the alloy are joined by covalent bonds.
 - B The alloy has no delocalised electrons, so the layers cannot move.
 - C The different-sized atoms in the alloy disrupt the layers, so the layers can no longer slide over each other easily.
 - D All the atoms in the alloy are the same size, so they pack together more tightly.
-

22 **Supplement** Reactivity series

[1]

Aluminium is above zinc in the reactivity series. However, an aluminium saucepan does not appear to react when water is boiled in it.

What is the reason for this?

- A The aluminium is covered by a thin layer of aluminium oxide that stops it reacting.
 - B Aluminium is below hydrogen in the reactivity series.
 - C Aluminium atoms do not readily lose electrons.
 - D Aluminium has a low density.
-

23 **Supplement** Corrosion of metals

[1]

Blocks of metal are attached to the steel hull of a ship to stop the hull rusting in seawater.

Which row gives a suitable metal for the blocks **and** the correct reason?

	metal	reason
A	copper	it is less reactive than iron, so it does not corrode
B	magnesium	it loses electrons more readily than iron
C	silver	it gains electrons more readily than iron
D	zinc	it is less reactive than iron

In the extraction of aluminium, purified aluminium oxide is dissolved in molten cryolite.

What is the purpose of the cryolite?

- A to react with the carbon anodes and stop them wearing away
- B to react with the oxygen produced at the anode
- C to remove impurities from the bauxite
- D to dissolve the aluminium oxide so that electrolysis can take place at a lower temperature

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Pure aluminium is too soft to make ladders. Ladders are made from an alloy of aluminium containing a small amount of magnesium. Magnesium atoms are a different size from aluminium atoms.

- (a) Describe the arrangement of atoms in pure aluminium and explain why pure aluminium is soft. [2]

- (b) Explain why the aluminium–magnesium alloy is harder than pure aluminium. [2]

- (c) A student says: "The alloy is a compound, because it contains more than one element."
Explain why the student is wrong. [2]

Steel is made by adding small amounts of carbon to iron. An engineer measures the hardness of pure iron and of three samples of steel.

percentage of carbon in the sample	hardness (arbitrary units)
0 (pure iron)	70
0.2	120
0.4	160
0.8	210

- (a) Describe how the hardness changes as the percentage of carbon increases. [1]

- (b) Explain why the samples containing carbon are described as alloys. [1]

- (c) Predict the hardness of a sample containing 0.6% carbon. [1]

- (d) Use the data to give **one** reason why steel is often more useful than pure iron. [1]

A student carries out three experiments on four metals, E, G, J and L. The letters are not chemical symbols.

Experiment 1: each metal is placed in cold water. E fizzes steadily and the solution becomes alkaline. G, J and L show no visible reaction.

Experiment 2: G, J and L are each placed in dilute hydrochloric acid. G bubbles slowly. J shows no bubbles. L bubbles rapidly. E is not tested.

Experiment 3: powdered L is heated with the oxide of G. The mixture glows, and metal G is formed.

- (a) Deduce the order of reactivity of the four metals, from most reactive to least reactive. [2]

- (b) One of the metals is copper. Identify which metal is copper and explain your answer. [2]

- (c) Metal E is either calcium or magnesium. Deduce which metal E is. Explain your answer. [2]

- (d) State **one** variable that the student should keep the same in Experiment 2 so that it is a fair test. [1]

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Core

Corrosion of metals

[6]

Many everyday objects are made from steel, and are protected from rusting by barrier methods.

(a) Suggest a suitable barrier method for each object.

(i) a steel garden gate

[1]

(ii) a steel wire dish rack used next to a kitchen sink

[1]

(b) Describe how barrier methods prevent iron and steel from rusting.

[2]

(c) After several years, the paint on a steel gate is scratched. Rust appears only where the paint has been scratched.

Explain why rust forms only at the scratch.

[2]

Aluminium is extracted by the electrolysis of aluminium oxide dissolved in molten cryolite. The electrodes are made of carbon.

- (a) Aluminium is formed at the cathode. Write the ionic half-equation for this reaction. [2]

- (b) Oxygen is formed at the anode. Write the ionic half-equation for this reaction. [2]

- (c) The carbon anodes have to be replaced regularly. Explain why. [2]

Metals are obtained from the Earth in different ways, depending on their position in the reactivity series.

- (a) Gold is found in the ground as the uncombined metal. Explain why. [1]

- (b) Zinc and iron can be extracted by heating their oxides with carbon. Explain why carbon can be used. [1]

- (c) Sodium is extracted by electrolysis. Explain why sodium cannot be extracted by heating its compounds with carbon. [1]

- (d) State how the ease of obtaining a metal from its ore is related to the metal's position in the reactivity series. [1]
