

## 2.2 Reactivity, rusting and metals

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

**Total: 21 marks**

### Objective

Cover the reactivity series, rusting and metals (2.15–2.27C): ordering metals, displacement, redox terms, rusting prevention, (C) extraction by carbon or electrolysis, alloys. Original IGCSE-level practice.

### 1 Key knowledge and worked examples

#### ■ The ladder

|           |               |
|-----------|---------------|
| potassium | more reactive |
| sodium    |               |
| lithium   |               |
| calcium   |               |
| magnesium |               |
| aluminium |               |
| zinc      |               |
| iron      |               |
| copper    |               |
| silver    |               |
| gold      |               |

carbon sits between aluminium and zinc; hydrogen between iron and copper

$K > Na > Li > Ca > Mg > Al > \text{(C)} > Zn > Fe > \text{(H)} > Cu > Ag > Au$ . Metals above hydrogen – down to iron – fizz with dilute acids giving  $H_2$ . A metal displaces a less reactive metal's ions from solution or its oxide.

#### ■ Rusting and redox

Rusting needs **oxygen and water**. Barrier methods, galvanising (zinc coat) and sacrificial protection prevent it. **Oxidation = loss of electrons; reduction = gain**. In  $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$ , zinc is oxidised (the reducing agent) and  $Cu^{2+}$  is reduced (copper(II) sulfate is the oxidising agent).

#### ■ (C) Extraction and alloys

Below carbon (iron): reduce the ore with carbon. Above (aluminium): electrolyse the molten ore. Alloys are harder than pure metals – different-sized atoms stop the layers sliding.

### 2 Practice

**2.1** State the order of reactivity of potassium, zinc, copper and gold. [2]

**2.2** Name the two substances iron needs to rust, and one barrier prevention. [3]

**2.3** Zinc is added to copper(II) sulfate solution. Write the ionic equation and state which ion is reduced. [3]

**2.4** (C) Why is sacrificial zinc bolted to a ship's steel hull? [2]

**2.5** (C) State why stainless steel resists rusting, and one use. [2]

### 3 Exam-style questions

**3.1** Explain, using the reactivity series, why magnesium reacts with dilute hydrochloric acid but copper does not, and name the gas formed. [3]

**3.2** (C) Aluminium is above carbon in the reactivity series. Explain why this decides its extraction method, naming the process and the molten substance electrolysed. [3]

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**3.3** (C) Explain why a pure metal is soft and malleable but an alloy is harder, in terms of particle arrangement. [3]

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## Solutions

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**2.1** potassium > zinc > copper > gold.

**2.2** Oxygen and water; any barrier: paint, oil/grease, plastic coating, galvanising.

**2.3**  $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$ ;  $\text{Cu}^{2+}$  is reduced – it gains two electrons.

**2.4** (C) Zinc is more reactive than iron, so it corrodes preferentially, protecting the steel even where the coat is scratched.

**2.5** (C) It contains chromium which forms an oxide layer resisting corrosion; cutlery/surgical instruments/sinks.

**3.1** Magnesium lies above hydrogen in the series, so it displaces hydrogen from the acid; copper lies below hydrogen and cannot. The gas formed is hydrogen.

**3.2** (C) Carbon cannot reduce aluminium's oxide because aluminium is more reactive than carbon; so the oxide must be split by electrolysis ; molten aluminium oxide/alumina (often in molten cryolite) is electrolysed.

**3.3** (C) In a pure metal the identical ions sit in regular layers that slide over each other when a force is applied – soft and malleable; in an alloy the different-sized atoms distort the layers, so they cannot slide – harder.