Unit 10 · Inorganic Materials

ANSWER KEY · FOR TEACHERS

Full marks 46

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. catalyst → **d.** changes the rate of a reaction without being permanently changed
2. activation energy → **e.** the energy a collision must have for particles to react
3. amphoteric oxide → **g.** an oxide that reacts with both acids and bases
4. deliquescent → **b.** takes up water from the air and turns damp
5. saponification → **f.** boiling fats with sodium hydroxide to make soap
6. amalgam → **c.** an alloy of mercury with another metal

K · 3

Each carries 0.5 mark.

2 Multiple choice

i. **c.** ZnO — K · 1

Zinc oxide reacts with acids ($ZnO + 2HCl \rightarrow ZnCl_2 + H_2O$) and with bases ($ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$). CaO is basic, SO_2 acidic and CO neutral.

ii. **b.** $FeCl_2$ and H_2 — U · 1

$Fe + 2HCl \rightarrow FeCl_2 + H_2$. The acid takes iron only to valency 2; chlorine gas would give $FeCl_3$.

iii. **c.** high resistance, and it doesn't oxidize when red hot — U · 1

A heating coil must turn current into heat (high resistance) and survive glowing in air for years without burning away (no oxidation at high temperature). Nichrome does both.

iv. **b.** steel and brass — U · 1

In steel, small carbon atoms fit into the gaps between iron atoms (interstitial). In brass, zinc atoms, close to copper's size, take copper's places (substitutional). Bronze and solder are substitutional too.

v. **b.** copper sulphate — A · 1

Copper hydroxide, $Cu(OH)_2$, is blue. Iron(II) hydroxide is dirty green and iron(III) hydroxide reddish brown; sodium chloride gives no precipitate, since sodium hydroxide doesn't react with it.

3 Label the diagram

1. hydrogen peroxide
2. manganese dioxide (catalyst)
3. thistle funnel
4. delivery tube
5. conical flask
6. oxygen

K · 3

Each carries 0.5 mark.

4 Very short answers

a. MARKING SCHEME — K · 1

✓ Ammonia.

b. MARKING SCHEME — K · 1

✓ White to blue.

c. MARKING SCHEME — U · 1

✓ Iron doesn't form an amalgam.

d. MARKING SCHEME — U · 1

✓ Acidic oxide.

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5 Short answers

a. MARKING SCHEME U · 2

- ✓ With water chlorine forms hypochlorous acid, which gives nascent oxygen that oxidizes the colored matter.
- ✓ Dry chlorine forms no hypochlorous acid, so it can't bleach.

b. MARKING SCHEME U · 2

- ✓ Mercury reacts with sulphur even when cold: $Hg + S \rightarrow HgS$.
- ✓ Mercury sulphide is a solid that gives off no poisonous vapor.

c. MARKING SCHEME A · 2

- ✓ The acid's hydrogen ions are not strong enough oxidizing agents to take iron to valency 3.
- ✓ Chlorine gas is a much stronger oxidizing agent, and gives valency 3.

d. MARKING SCHEME U · 2

- ✓ The particles collide more often.
- ✓ Many more of the collisions have enough energy (the activation energy).

6 Long answers

a. ANSWER K · 5

i. $H_2 + Cl_2 \rightarrow 2HCl$ (in sunlight)
ii. $2Fe + 3Cl_2 \rightarrow 2FeCl_3$
iii. $Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$
iv. $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$
v. $Cl_2 + 2KI \rightarrow 2KCl + I_2$

MARKING SCHEME

- ✓ $H_2 + Cl_2 \rightarrow 2HCl$.
- ✓ $2Fe + 3Cl_2 \rightarrow 2FeCl_3$.
- ✓ $Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$.
- ✓ $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$.
- ✓ $Cl_2 + 2KI \rightarrow 2KCl + I_2$.

b. ANSWER U · 4

i. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$: fizzing; the gas burns with a pop.
ii. $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$: brisk fizzing; the gas turns lime water milky.
iii. $CuO + 2HCl \rightarrow CuCl_2 + H_2O$: the black powder dissolves, giving a blue-green solution.
iv. $AgNO_3 + HCl \rightarrow AgCl + HNO_3$: a white precipitate, which darkens in sunlight.

MARKING SCHEME

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c. ANSWER U · 4

In a pure metal the atoms are all one size and sit in regular rows, which can slide over each other. In an alloy, atoms of a different size upset the rows, so they can't slide so easily.
In a **substitutional alloy**, added atoms about the same size as the main metal's take the places of some of its atoms: zinc in copper, brass.
In an **interstitial alloy**, much smaller atoms fit into the gaps between the main metal's atoms: carbon in iron, steel.

MARKING SCHEME

- ✓ In a pure metal the rows of same-sized atoms slide easily.
- ✓ Atoms of a different size upset the rows, so they slide less easily.
- ✓ Substitutional: atoms of about the same size take some places, as zinc in brass.
- ✓ Interstitial: much smaller atoms fit into the gaps, as carbon in steel.

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7 Numerical problems

a. ANSWER A · 2

$$\text{Mass of gold} = \frac{18}{24} \times 35\ \text{g} = 26.25\ \text{g}$$

About 26.3 g of gold (75%).

MARKING SCHEME

- ✓ 18 ÷ 24 × 35 g.
- ✓ 26.25 g, about 26.3 g.

b. ANSWER A · 3

Total mass = 3.9 + 1.1 = 5.0 kg.

$$\text{Copper} = \frac{3.9}{5.0} \times 100\% = 78\% \qquad \text{Tin} = 22\%$$

78% copper and 22% tin: bell metal, the bronze with extra tin that rings well, just right for a bell.

MARKING SCHEME

- ✓ Total mass 3.9 + 1.1 = 5.0 kg.
- ✓ 3.9 ÷ 5.0 × 100% = 78% copper.
- ✓ Bell metal.

c. ANSWER A · 2

Copper: 60 ÷ 100 × 50 g = **30 g**. Nickel and zinc: 20 ÷ 100 × 50 g = **10 g** each. Check: 30 + 10 + 10 = 50 g.

MARKING SCHEME

- ✓ Copper 60 ÷ 100 × 50 g = 30 g.
- ✓ Nickel 10 g and zinc 10 g.

8 Think

ANSWER HA · 3

No. Both have 0.5 g of calcium carbonate and plenty of acid, so both give the **same volume** of carbon dioxide in the end ($CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$). The powder has a much larger surface area, so more acid particles hit it each second and its gas comes out much faster; the chips give the same gas more slowly, over a longer time. A longer fizz means a slower reaction, not more product.

MARKING SCHEME

- ✓ No: the same mass of marble with the acid in excess gives the same volume of carbon dioxide.
- ✓ The powder's larger surface area means more acid particles hit it each second, so its gas comes faster.
- ✓ A longer fizz means a slower reaction, not more product.

9 Activity: What speeds up a reaction?

(not marked)

WHAT STUDENTS SHOULD FIND

The stronger acid, the warm acid and the powder go faster: more particles in each milliliter, faster particles and more surface all mean more successful collisions each second. The acid is in excess, so every flask gives about the same volume of carbon dioxide in the end; the changes alter how fast the gas comes, not how much.

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- **Himalayan Pink Salt** (exhibit): Rock salt is the same sodium chloride, an ionic solid of NaNand ClOions; a trace of iron oxide gives it this pink color.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	14	19	10	3	**46**

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