Unit 10 · Inorganic Materials

HARDER PRACTICE QUESTIONS · ANSWER KEY

Full marks 41

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

1 Spot the error

ANSWER U · 4

a. Chlorine gives iron its higher valency, 3: **$2Fe + 3Cl_2 \rightarrow 2FeCl_3$**.
b. The acid takes iron only to valency 2: **$Fe + 2HCl \rightarrow FeCl_2 + H_2$**.
c. Copper is below hydrogen in the reactivity series, so **there is no reaction**.
d. It isn't balanced: **$Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$**.

MARKING SCHEME

✓ a. $2Fe + 3Cl_2 \rightarrow 2FeCl_3$.
✓ b. $Fe + 2HCl \rightarrow FeCl_2 + H_2$.
✓ c. No reaction: copper is below hydrogen.
✓ d. $Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$.

2 Work backwards

ANSWER A · 5

A is $CuSO_4$, **B** $FeSO_4$, **C** $FeCl_3$, **D** NH_4Cl, **E** NaCl.
A: $CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$.
D: $NH_4Cl + NaOH \rightarrow NaCl + NH_3 + H_2O$.
E: $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$.

MARKING SCHEME

✓ A, B and C, from the colors of their hydroxides.
✓ D and E: ammonia marks the ammonium salt, and silver chloride a chloride.
✓ $CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$.
✓ $NH_4Cl + NaOH \rightarrow NaCl + NH_3 + H_2O$.
✓ $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$.

3 Read the table

ANSWER A · 4

a. Powder: $90 \div 30 =$ **3 cm^3/s**. Chips: $22 \div 30 \approx$ **0.73 cm^3/s**.
b. All its marble is used up. The acid is in excess, so the marble decides how much gas there is.
c. No. The chips were still fizzing at 180 s. The same mass of marble gives the same gas in the end, only more slowly.
d. The next two steps add 10 and 8 cm^3: $102 + 10 + 8 = 120$ cm^3 at **240 s**.

MARKING SCHEME

✓ 3 cm^3/s and about 0.73 cm^3/s.
✓ The marble in the powder is used up.
✓ No: the chips hadn't finished, and the same mass gives the same gas.
✓ 240 s.

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4 Predict, then explain

ANSWER U · 4

a. **Both.** It is amphoteric: $ZnO + 2HCl \rightarrow ZnCl_2 + H_2O$; $ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$.
b. **The dry paper stays blue; the damp paper turns red.** Dry HCl molecules aren't split into ions; in water they form the H^+ ions that make it an acid.
c. **The alkali eats into it, giving hydrogen:** $2Al + 2NaOH + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$.
d. **Nothing.** Copper doesn't react with water at all.

MARKING SCHEME

- ✓ a. Both: it is amphoteric, with either equation.
- ✓ b. Only the damp paper turns red: H^+ ions form only in water.
- ✓ c. The pot dissolves, giving hydrogen.
- ✓ d. No reaction.

5 Fix the plan

ANSWER HA · 4

He has changed the temperature, the volume of acid, the mass of marble and chips for powder, as well as the concentration, so he couldn't tell which caused any difference.
Fair plan: 40 mL of each acid, at the same temperature, with 0.5 g of marble chips each, added at the same moment. Time how long each takes to stop fizzing. Only the concentration changes.

MARKING SCHEME

- ✓ He has changed several things besides the concentration: temperature, volume, mass, and chips for powder.
- ✓ So he can't tell which caused any difference.
- ✓ Same volume, temperature, mass and form of marble; only the concentration differs.
- ✓ Time how long each takes to stop fizzing.

6 Which explanation fits the evidence?

ANSWER U · 3

Sneha's. If the oxygen came from the manganese dioxide, it would lose mass, but its mass doesn't change. And it would wear out, but it works just as well in fresh tubes, time after time. So it is unchanged, and the oxygen must come from the hydrogen peroxide: $2H_2O_2 \rightarrow 2H_2O + O_2$.

MARKING SCHEME

- ✓ Sneha's explanation.
- ✓ The powder's mass stays 0.50 g, so it gives away no oxygen.
- ✓ It works as well in every fresh tube, so it isn't used up.

7 Estimate

ANSWER A · 2

From 35 °C to 5 °C is three steps of 10 °C, so the rate is about $2 \times 2 \times 2 = 8$ times less. Time: $10 \times 8 =$ **about 80 minutes**. It is rough because the doubling is only a rule of thumb, true of many reactions and not exactly of any.

MARKING SCHEME

- ✓ Three steps of 10 °C, so about 8 times slower.
- ✓ About 80 minutes; the doubling is only a rough rule.

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8 Two steps with alloys

ANSWER A · 5

a. Gold in it: $22 \div 24 \times 24$ g = **22 g**. It stays 22 g, but must become 18 parts in 24, or 75%. New total: $22 \div 0.75$ = **29.3 g**. Copper to add: $29.3 - 24$ = **5.3 g**.

b. Copper: 90% of 5 kg = 4.5 kg, and it stays 4.5 kg. New total: $4.5 \div 0.78$ = **5.77 kg**. Tin to add: $5.77 - 5$ = **0.77 kg**. Check: tin is now $0.5 + 0.77 = 1.27$ kg, and $1.27 \div 5.77$ = 22%.

MARKING SCHEME

- ✓ 22 g of gold.
- ✓ New total $22 \div 0.75 = 29.3$ g.
- ✓ Add 5.3 g of copper.
- ✓ Copper stays 4.5 kg; new total $4.5 \div 0.78 = 5.77$ kg.
- ✓ Add 0.77 kg of tin.

9 Correct the misconceptions

ANSWER U · 3

a. A compound is a new substance with its own properties. Salt is made of Na^+ and Cl^- ions, stable and harmless in the amounts we eat; Cl^- ions are not chlorine molecules.

b. A catalyst changes only the rate. Both tubes would give the same volume of oxygen in the end; the one without it would just take months.

c. It has no silver in it: about 60% copper, 20% nickel and 20% zinc. It only looks silvery.

MARKING SCHEME

- ✓ a. A compound has its own properties: Cl^- ions are not chlorine molecules.
- ✓ b. It changes the rate; the volume of oxygen in the end is the same.
- ✓ c. It has no silver: copper, nickel and zinc.

10 Plan a route

ANSWER A · 4

a. $2NaCl + 2H_2O \rightarrow 2NaOH + H_2 + Cl_2$ (electrolysis of brine), then $Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$ (cold and dilute).

b. The first step makes 2NaOH and one Cl_2, and the second step needs exactly 2NaOH and one Cl_2.

c. **Hydrogen**, which could be sold or burned as a fuel, and **sodium chloride**, one of the first step's two, which can go back in as brine.

MARKING SCHEME

- ✓ $2NaCl + 2H_2O \rightarrow 2NaOH + H_2 + Cl_2$.
- ✓ $Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$.
- ✓ It makes exactly what the second step needs: 2NaOH to one Cl_2.
- ✓ Left over: hydrogen, and sodium chloride to use again.

11 Reason from the sizes

ANSWER A · 3

a. Zinc and copper: $(134 - 128) \div 128 \times 100$ = **4.7%**. Carbon and iron: $(126 - 77) \div 126 \times 100$ = **39%**.

b. A zinc atom is about the size of a copper atom, so it can take a copper atom's place: a substitutional alloy. A carbon atom is much smaller, so it fits into the gaps between iron atoms: an interstitial alloy.

c. **Substitutional**: 130 pm differs from iron's 126 pm by only about 3%, so it is about the same size and can't fit in the gaps.

MARKING SCHEME

- ✓ 4.7% and 39%.
- ✓ About the same size takes a place (brass); much smaller fits in the gaps (steel).
- ✓ Substitutional: only about 3% different.

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See it at Science Playground

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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	0	14	23	4	**41**

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