



Mark schemes

- 1.** (a) copper, zinc, sodium chloride solution 1
- (b) a reactant is used up
allow the reaction stops
allow electrolyte / electrode / ions / metal / metal hydroxide / alkali for reactant 1
- (c) the reaction is not reversible 1
- (d) $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
allow fractions / multiples
allow 1 mark for O_2 2
- (e) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given. 5–6
- Level 2:** Some logically linked reasons are given. There may also be a simple judgement. 3–4
- Level 1:** Relevant points are made. This is not logically linked. 1–2
- No relevant content** 0



Indicative content

reasons why fuel cells could be judged as better

from the table	from other knowledge
<ul style="list-style-type: none">time for refuelling a fuel cell is faster than recharging <p>or</p> <ul style="list-style-type: none">a fuel cell does not need to be rechargeda fuel cell has a greater range	<ul style="list-style-type: none">hydrogen can be renewable if made by electrolysis using renewable energylithium-ion batteries can catch fireproduces only water <p>or</p> <ul style="list-style-type: none">no pollutants producedlithium-ion batteries may release toxic chemicals on disposallithium-ion batteries (eventually cannot be recharged so) have a finite life

reasons why the lithium-ion battery could be judged as better

from the table	from other knowledge
<ul style="list-style-type: none">lithium-ion uses energy more efficientlycost of lithium-ion car much lesscost of recharging much less than refuelling with hydrogen	<ul style="list-style-type: none">hydrogen is often made from fossil fuels so is not renewablecharging points are more widely available than hydrogen filling stationshydrogen takes up a lot of space <p>or</p> <ul style="list-style-type: none">is difficult to storehydrogen can be highly flammable / explosiveno emissions produced(catalyst in the hydrogen fuel-cell eventually becomes poisoned so) have a finite life

[11]

2.

- (a) magnesium
zinc
iron
tin
(copper)

three in the correct order scores 1 mark

all correct scores 2 marks



(b) use 4 cells (each of voltage 1.5 V)

1

connect in series

1

(c) reaction stops

1

(because) one of the reactants is used up

1

(d) (hydrogen +) oxygen (→ water)

1

(e) any **two** from:

- produces water
- water is not harmful / polluting
- does not produce carbon dioxide
- does not produce other named pollutant

*allow an answer of **only** produces water for 2 marks*

2

[9]

3.

(a) the chemical reaction is reversible

1

(b) any **two** from:

- type of electrode
- electrolyte
- concentration of electrolyte
- temperature

2

(c) $\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-$

allow multiples

1

(d) contains OH^- ions

1



(e) (bonds broken)

$$((6 \times 412) + (2 \times 360) + (2 \times 464) + (3 \times 498)) = 5614$$

1

(bonds made)

$$((4 \times 805) + (8 \times 464)) = 6932$$

1

(overall energy change)

$$(6932 - 5614) = -1318 \text{ (kJ / mol)}$$

allow ecf from marking point 1 and / or marking point 2

1

an answer of 1318 (kJ / mol) scores 3 marks

[8]

4.

(a) (zinc has) lost electron(s)

accept loss of electrons

1

(b) copper is the least reactive

1

because it gave the most negative voltage when it was metal 2

or

it gave the biggest voltage with chromium

or

it gave the most positive voltage when it was metal 1

1

(c) -0.7 V

1

The voltage with chromium and copper is 1.2

accept use of other cell pairings such as tin with copper and tin with iron

1

The voltage with chromium and iron is 0.5 and copper is less reactive (than iron)

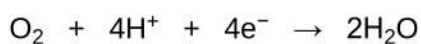
1

(d) hydrogen + oxygen = water

1

(e) $\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$

1



1

[9]



- 5.** (a) electrical 1
- (b) using hydrogen saves petrol / diesel / *crude oil*
allow crude oil is non-renewable
ignore hydrogen is renewable 1
- using hydrogen (in fuel cells) does not cause pollution*
accept no carbon dioxide produced
allow less carbon dioxide produced
allow hydrogen produces only water 1
- (c) (i) (-)486
correct answer with or without working gains 3 marks
if answer is incorrect:
(2 × 436) + 498 or 1370 gains 1 mark
4 × 464 or 1856 gains 1 mark
correct subtraction of ecf gains 1 mark 3
- (ii) products lower than reactants 1
- reaction curve correctly drawn* 1
- activation energy labelled 1
- [9]**