

Question	Answer	Marks
1(a)(i)	red and (the Cu^{2+} ion/copper ions) is gaining electrons/is decreasing in oxidation number;	1
1(a)(ii)	formation of Cu^{2+} /copper ions at the anode happens at the same rate as; removal of Cu^{2+} /copper ions at the cathode ora;	2 1 1
1(b)	replace (anode of) copper with nickel; replace electrolyte with nickel(II) sulfate/ NiSO_4 ;	2 1 1
1(c)	(good) catalysts; variable oxidation numbers; form coloured compounds/coloured ions;	3 1 1 1

Question	Answer	Marks	Guidance
2(a)(i)	$Al^{3+} + 3e \rightarrow Al$ formula of Al^{3+} ion; rest correct;	2	multiples I state symbols A – 3e on right

Question	Answer	Marks	Guidance
2(a)(ii)	$2 \rightarrow \text{O}_2 + 4\text{e}$ species; balancing;	2	<p> multiples I state symbols A – 4e on left</p>
2(a)(iii)	end AND (electrical) energy supplied;	1	A energy required to break bonds
2b)(i)	exot AND (electrical) energy release;	1	heat energy
2(b)(ii)	<p>magnesium forms ions (in solution) OR magnesium loses electrons OR magnesium is oxidised;</p> <p>copper is deposited (on the electrode) OR copper ions become copper atoms OR copper ions gain electrons OR copper ions are reduced;</p>	2	<p>A magnesium dissolves/goes into solution A equation (balanced or unbalanced)</p> <p>A equation (balanced or unbalanced) I use of terms anode or cathode</p>
2(b)(iii)	<p>M1 set up a magnesium/manganese cell; M2 the negative electrode (is the more reactive) OR the electrode that loses mass (is more reactive);</p> <p>OR M1 replace magnesium with manganese; M2 if voltage less (positive) manganese is less reactive OR if voltage is more (positive) manganese is more reactive;</p>	2	<p>A replace Cu with Mn A converse</p>
2(c)	$3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$ species; balancing;	2	<p>A multiples I state symbols</p>
2(d)(i)	(light from the) sun/sunlight;	1	A uv
2(d)(ii)	carbon dioxide + water \rightarrow glucose + oxygen;	1	<p>starch/sugar/(named)carbohydrate I energy or light on LHS</p>

- 3 (a) M1 brass [1]
M2 copper **COND** on M1 [1]
- (b) (i) $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$ [2]
species (1) balancing (1)
- (ii) Manufacture of sulfuric acid
or bleach or making wood pulp or making paper
or food or fruit juice or wine preservative
or fumigant or sterilising [1]
- (c) (i) sulfuric acid [1]
- 3 (c) (ii) $\text{Zn}^{2+} + 2\text{e} \rightarrow \text{Zn}$ [1]
oxygen or water Allow O_2 and H_2O if no name seen [1]
sulfuric acid [1]
Allow: H_2SO_4 if no name seen
- 3 (d) (i) from zinc to carbon [1]
(clockwise direction on or near the wire)
- (ii) to allow ions to flow [1]
- (iii) oxidation [1]
and loss of electron(s) or increase in oxidation number/state
- reduction [1]
and decrease in oxidation number/state or gain of electron(s)

[Total: 13]

4 (a) carbon dioxide/CO₂ [1]

(b) $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ [1]

(c) anode/negative electrode **and** electrons lost(by hydrogen/H/H₂)/electrons move from this electrode [1]

(ii) $\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$ / $\text{H}_2 - 2\text{e}^- \rightarrow 2\text{H}^+$ / $\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-$ / $\text{H}_2 + 2\text{OH}^- - 2\text{e}^- \rightarrow 2\text{H}_2\text{O}$ [2]
Species (1) Balancing (1)

(d) Any **two** from:

CELL:

lightweight
quieter
fewer working parts/less maintenance
more efficient **or** less energy wasted **or** more energy produced

SUSTAINABILITY:

conserves a limited resource/petroleum/fossil fuels
unlimited supplies of renewable resource(of hydrogen from water)

POLLUTION:

No or less greenhouse effect
No or less acid rain
No or less toxic gases

POLLUTANTS:

No or less smog
No or less C/soot
No or less CO₂
No or less CO
No or less SO₂
No or less oxides of nitrogen/NO/NO₂/N₂O₄/NO_x
No or less (unburnt) hydrocarbons
No or less low level ozone
H₂O is the **only** product

[Total: 7]

5 (a) (i) incomplete combustion **or** limited oxygen/less oxygen/not enough oxygen (1) [1]

(ii) any **two** from:

(forward) reaction is endothermic (1)

high temperature increases yield/favours forward reaction/shifts equilibrium to right (1)

faster reaction (rate) (1) [2]

(iii) any **two** from:

high pressure reduces yield **or** favours LHS (1)

because LHS has smaller volume **or** number of moles/number of molecules (of gas) ORA (1)

(high pressure plant is) expensive/dangerous/explosion/leaks [2]

5 (b) hydrogen **and** chlorine/ H_2 **and** Cl_2 (1)

sodium hydroxide/ $NaOH/Na^+OH$ (1)

$2H^+ + 2e \rightarrow H_2/2H^+ \rightarrow H_2 - 2e$ (1)

$2Cl \rightarrow Cl_2 + 2e/2Cl - 2e \rightarrow Cl_2$ (1)

Hydrogen/ $H_2/H/H^+$ at cathode **and** chlorine/chloride/ $Cl_2/Cl/Cl$ at anode (1) [5]

5 (c) each chlorine 1 bond pair and 3 non-bond pair (1)

oxygen atom 2 non-bond pairs and 2 bond pairs as double bond (1)

carbon atom 4 bond pairs including 2 bond pairs as double bond (1) [3]

[Total: 13]

6 (a) bauxite (1) [1]

(b) electrolyte alumina/aluminium oxide dissolved in molten cryolite (1)
use cryolite to reduce mp/comparable idea/temperature of electrolyte 900 to 1000 °C (1)

electrodes carbon (1)

aluminium formed at cathode/ $Al^{3+} + 3e \rightarrow Al$ (1)

oxygen formed at anode/ $2O^{2-} \rightarrow O_2 + 4e$ (1)

anode burns/reacts to carbon dioxide/ $C + O_2 \rightarrow CO_2$ (1) [6]

(c) food containers/window frames/cooking foil/cars/bikes/drink cans (1) [1]

(ii) $4OH \rightarrow O_2 + 2H_2O + 4e$ (2) [2]

$4Al + 3O_2 \rightarrow 2Al_2O_3$ (2) [2]

[Total: 12]