

- 1 (a) (i) roast or heat or burn in air / roast or heat or burn in oxygen
need both of the above [1]
- (ii) $\text{ZnO} + \text{C} \rightarrow \text{Zn} + \text{CO}$ / $2\text{ZnO} + \text{C} \rightarrow 2\text{Zn} + \text{CO}_2$ / $\text{ZnO} + \text{CO} \rightarrow \text{Zn} + \text{CO}_2$ [1]
- (b) $\text{ZnO} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2\text{O}$ [1]
- (ii) zinc reduces / gives electrons / displaces (copper / cobalt / nickel ions) [1]
forming copper / cobalt / nickel (metal which is precipitated) [1]
- (c) $\text{Zn}^{2+} + 2\text{e} \rightarrow \text{Zn}$ [1]
- (ii) $\text{OH} \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + \dots\text{e}$ (1) only
 $4\text{OH} \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}$ [2]
- (iii) sulfuric acid / hydrogen sulfate [1]
ACCEPT: sulfuric acid
- (d) Any two of:
appearance
more resistant to corrosion
harder (accept stronger)
easier to cast [2]
- (ii) zinc more reactive (than iron or steel) [1]
zinc loses electrons [1]
electrons move (from zinc) to iron [1]
zinc reacts (with air and water) / zinc corrodes / is oxidised / forms positive ions / anodic
or
iron and steel don't react (with air and water) / not oxidised / do not form ions / do not lose electrons [1]

[Total: 15]

- 2 (a) (i) zinc mixed with an element(s) or metal(s) or non-metal; [1]
- (ii) galvanising / baths / coating steel (i.e. description of galvanising) / roofing / sacrificial protection / protection from rusting / electroplating / zinc plating / batteries; [1]
- (iii) (lattice) positive ions / cations / metal ions / sea of electrons / delocalised or free or mobile or moving electrons; [1]
 attraction between positive ions and electrons; [1]
 the layers (of ions) or particles can slide or slip or shift past each other; [1]
- (iv) different atom / ion / particle of different size; [1]
 prevents (layers / atoms / ions / particles / molecules) moving / slipping / sliding / shifting; [1]
- (b) (i) heat with carbon or coke or carbon monoxide; [1]
- (ii) $\text{ZnO} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2\text{O}$ [2]
 [1] for correct reacta [1] for correct produ
- (iii) zinc (**not**: ions) more reactive than silver and lead; [1]
 zinc displaces both metals / silver **and** lead produced / ions become atoms / zinc reduces silver ions and lead ions; [1]
 (silver and lead) can be removed by filtering / centrifugation / decanting; [1]
- an ionic equation; i.e.
 $\text{Zn} + 2 \text{Ag}^+ \rightarrow \text{Zn}^{2+} + 2\text{Ag}$ or $\text{Zn} + \text{Pb}^{2+} \rightarrow \text{Zn}^{2+} + \text{Pb}$ [1]
allow: any two correct half equations
- (iv) cathode labelled carbon / zinc / platinum; [1]
 zinc deposited at cathode; [1]
 oxygen formed (at anode); [1]
 (electrolyte becomes) sulfuric acid / remaining solution contains H^+ and SO_4^{2-} ; [1]

[Total: 18]

- 3 (a) (i) harder / stronger / any sensible suggestion which relates to better properties for purpose
e.g. stays sharp longer / cuts better / more corrosion resista [1]
- (ii) zinc [1]
- (b) lattice [1]
- (ii) regular pattern of one type of atom [1]
with different atom interspersed [1]
can show the difference – size, shading, label etc.
- (iii) can change its shape by force / plastically deform / can be hammered into sheets / can
bend etc. [1]
- (iv) particles / ions / atoms / layers [1]
cond can slide past each other [1]
or metallic bond is non-directional [1]
particles can move past each other [1]
- (c) tin(IV) oxide + carbon → tin + carbon dioxide [1]
not carbon monoxide as a reductant
accept carbon monoxide as a product
not tin(IV)
accept correct symbol equation
- (ii) water [1]
carbon dioxide [1]
- (iii) correct labels for
(pure) copper cathode [1]
impure copper anode [1]
electrolyte copper(II) sulfate / any soluble copper(II) salt / Cu²⁺ [1]
if labels on electrodes reversed [0]
- (iv) wires / pipes / jewellery / nails / roofing / ammunition / coins / cookware / catalyst /
sculpture [1]

[Total: 15]

- 4 (a) (i) chromium is harder
 has higher density
 has higher melting point / boiling point / fixed points
 stronger
 any **TWO** [2]
 accept sodium comments
must be comparison chromium is hard [0]
- (ii) both chromium and sodium have to be mentioned explicitly or implicitly.
 sodium is more reactive is **acceptable**
 sodium is a reactive metal is **not acceptable**
 chromium has more than one oxidation state, sodium has one
 chromium forms coloured compounds, sodium compounds are white
 / sodium does not
 sodium reacts with cold water, chromium does not
 chromium forms complex ions, sodium does not
accept chromium has catalytic properties, sodium does not
 any **TWO** [2]
- (b) (appearance/shiny/more attractive/decoration
 resist corrosion / rusting
 hard surface
 any **TWO** [2]
NOT becomes harder / stronger
- (ii) $\text{Cr}_2(\text{SO}_4)_3$ [1]
ignore correct charges on ions
- (iii) $\text{Cr}^{3+} + 3e \rightarrow \text{Cr}$ [2]
 Cr^{3+} to Cr only [1]
ignore comments about sulfate ion
- (iv) oxygen / O_2 [1]
- (v) to replace chromium ions (used to plate steel) [1]
 / chromium sulfate used up
- copper ions replaced from copper anode [1]
 / solution of copper sulfate does not change
not just that anode is not made of chromium

[Total: 12]