Question	Answer	Marks
2(a)	as a reducing agent; source of heat / energy;	**2**
(b)	$_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ species; balancing;	**2**
(c)	silica reacts with limestone or calcium oxide; to form a slag or calcium silicate or $CaSiO_3$; (liquid) slag floats (above molten iron);	**3**
(d)	blow or pass oxygen through (molten) iron; $C + O_2 \rightarrow CO_2$; carbon dioxide escapes or carbon dioxide is a gas;	**3**

Question	Answer	Marks
3(a)	Na / sodium **and** Li / lithium;	**1**
(b)	Cu / copper **and** Rh / rhodium;	**1**
(c)	$Fe_2(SO_4)_3$;	**1**
(d)	Mg^{2+};	**1**
(e)	copper sulfate (solution); add manganese / Mn to solution; copper displaced or forms / blue colour changes; **or** (a solution of) an iron salt or a zinc salt; add copper and manganese to each; only manganese reacts / displaces; **or** (a solution of a) manganese salt and a copper salt; add, e.g. iron / zinc; copper (displaced) and manganese not; **or** to a (dilute) acid / any named acid / water / steam; add Mn and Cu / both metals to the liquid; rate faster or shorter time or more bubbles or more hydrogen or more gas with Mn or with the more reactive metal / reaction only with Mn or with the more reactive metal; **or** copper oxide; add manganese and heat; evidence of reaction; **or** burn manganese and copper / both elements; in air / oxygen; Mn or more reactive metal burns brighter / only Mn or more reactive metal burns / evidence that manganese reacts faster; **or** add carbon; to both metal oxides and heat; evidence that reaction occurs with copper oxide more readily / least reactive metal oxide;	**3**

Question	Answer	Marks
	or both metal nitrates or carbonates; heat; evidence that manganese compound is most stable / most reactive compound is most stable; **or** (electrochemical) cell / use of voltmeter / electrolyte; copper and manganese (as electrodes); manganese is the negative terminal;	
(f)	*physical properties* any three from: hard; strong; high density; malleable; ductile; sonorous; shiny; high melting point / high boiling point; (good) conductor (of heat/electricity); forms coloured compounds / coloured ions / coloured salts; *chemical properties* any two: catalytic behaviour; more than one or different or variable oxidation state or oxidation number or valency / variable charges / many differently charged ions; forms complex (ions); forms coloured compounds / coloured ions / coloured salts; amphoteric oxide / amphoteric / basic oxide / alkaline oxides / acidic oxide; (other metallic reactions) with acids / water / steam; reducing agent / electron donor / reacts with non-metal to form ionic compound / forms positive ions;	**5**

Question	Answer	Marks	Guidance
4(a)	*Forming an oxide* (all) elements or (all) impurities become oxides; M2 *Gaseous oxides* carbon dioxide or sulfur (di)oxide escape / are removed as gases; M3 *Acidic oxides* silicon(IV) oxide or phosphorus(III / V) oxide react / are neutralised by calcium oxide / lime; M4 *Equation mark* any one of the following equations $S + O_2 \rightarrow SO_2$; $C + O_2 \rightarrow CO_2$ or $2C + O_2 \rightarrow 2CO$; $Si + O_2 \rightarrow SiO_2$; $4P + 5O_2 \rightarrow 2P_2O_5$ or $P_4 + 5O_2 \rightarrow 2P_2O_5$; $4P + 3O_2 \rightarrow 2P_2O_3$ or $P_4 + 3O_2 \rightarrow 2P_2O_3$; M5 *Word equation mark* any one of the following word equations calcium oxide + silicon(IV) oxide → calcium silicate; calcium oxide + phosphorus(III / V) oxide → calcium phosphate;	**5**	(All) elements or (all) impurities react with oxygen **A** M1 for any one element becoming an oxide **A** formulae / carbon monoxide **A** oxides of sulfur / carbon **I** sulfur trioxide **A** silicon (di)oxide for silicon(IV) oxide **A** phosphorus (tri/pent)oxide for phosphorus(III / V) oxide **A** multiples **I** state symbols **I** unbalanced equations **R** other combustion equations with incorrect species **A** calcium oxide + silicon(IV) oxide → slag **A** correct symbol equation for M5 but **R** other equations with incorrect species used as M5

Question	Answer	Marks	Guidance
4(b)(i)	*Any **one** from:* (making) car (bodies); machinery; chains; pylons; white goods; nails; screws; as a building material; sheds / roofs; reinforcing concrete;	**1**	**A** bridges **A** tools **I** cutlery
4(b)(ii)	*Any **one** from:* knives; drills; railway tracks; machine / cutting tools / hammers; razor blades; chisels;	**1**	**I** cutlery items **I** bridges
4(b)(iii)	M1 atoms or cations or (positive) ions or metal ions; M2 arranged in a lattice or in layers or in rows or in a regular structure; M3 rows or layers slide over one another;	**3**	**I** (sea of) electrons **R** protons or nuclei for M1 **A** M2 non-directional forces **A** ECF on particle named in M1 for M3 **I** 'atoms' slide over one another
4b)(iv)	carbon **atoms** or **particles** in structure different size (to cations); M2 so reduce moving or interrupt movement;	**2**	**R** ions and molecules for M1 **A** M2 for prevents sliding **A** M2 for 'stops' sliding
4(a)(i)	to Zn^{2+} ; because electron loss;	**2**	**A** because oxidation number has increased for M2

5 **(a** Bauxite [1]

(b) carbon / graphite [1]

(c) improves conductivity / better conductor [1]

Lower (operating) temperature / save energy / saves electricity / saves heat [1]

(d) anode: $2O^{2} \rightarrow O_2 + 4e$ / $2O^{2} - 4e \rightarrow O_2$ [1]

cathode: $Al^{3+} + 3e \rightarrow Al$ / $Al^{3+} \rightarrow Al - 3e$ [1]

(e) **(i)** Iron carbon aluminium / Fe, C, Al [1]

(ii) Aluminium oxide is not reduced by carbon but iron(III) oxide is [1]

(f) haematite / hematite

(g) **Allow:** multiples in **(i)** to **(iv)**

(i) $C + O_2 \rightarrow CO_2$ [1]

(ii) $CO_2 + C \rightarrow 2CO$ [1]

(iii) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ / $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ / $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$ [1]

(iv) $CaO + SiO_2 \rightarrow CaSiO_3$ / $CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$ [1]

[Total:13]