1 **(a** $C + O_2 \rightarrow CO_2$ [1]

(b) (i) CO_2 already formed (from C burning or from $CaCO_3$); [
then carbon reacts with carbon dioxide; [1]
or
$C + CO_2 \rightarrow 2CO$ = [2] If equation not balanced = [1]

(ii) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ [2]
not balanced = [1]
not: reduction by carbon

(c) to remove / neutralise silica / silicon dioxide / silicon(IV) oxide / sand; [1]
reacts with limestone to form slag / calcium silicate; [1]
$CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$ [1]
or $CaO + SiO_2 \rightarrow CaSiO_3$
or $CaCO_3 \rightarrow CaO + CO_2$

(d) galvanising / galvanisation / sacrificial protection; [1]

(ii) sacrificial protection / zinc is sacrificed;
zinc corrodes rather than iron;
zinc is oxidised in preference to iron;
zinc reacts with oxygen and / water in preference to iron;
zinc more reactive / electropositive than iron;
zinc loses electrons more readily than iron;
electrons move on to iron
any **three** [3]

[Total: 12]

2 **(a)** any four max 4
carbon forms carbon dioxide / carbon monoxide [1]
this is a gas it escapes / blown out / diffuses [1]
silicon forms silicon(IV) oxide / silica [1]
/ silicon(IV) oxide present in impure iron
silicon(IV) oxide reacts with calcium oxide to form slag **or** calcium silicate [1]
slag removed from surface [1]
accept skimmed, syphoned, poured off
not tapped max [4]
accept correct formula or equations
not calcium oxide reacts with silicon

(b) **(i)** any sensible suggestion – harder/stronger/can be tailored for a specific use/more resistant to corrosion [1]
not steel does not rust

(ii) mild steel – cars or any vehicle/bicycles/white goods/screws or nails/roof/bridges/tools/ buildings/ships/pipes/machinery etc. [1]

stainless steel – chemical plants/cooking utensils/jewellery/cutlery/surgical equipment/ kitchen sinks/pipes/etc. [1]

(c) **(i)** strong attractive forces / strong bonds / bonds hard to break / requires a lot of energy to break bonds [1]
not between ions, **not** between positive and negative ions,
not between electrons

between positive ions and (negative) electrons / opposite charges attract [1]

(ii) because the layers, lattice or rows of ions/cations [1]
accept sheets of ions
not atoms / molecules / protons / nuclei

can move / slip / slide past each other [1]

3 (b) metal A is magnesium

[1]

cond most reactive or fastest reaction [1]

metal B is aluminium [1]
cond faster reaction after removal of oxide layer / it would give more hydrogen / aluminium more reactive than zinc [1]

metal C is zinc [1]
zinc least reactive [1]
NOTE MAX [5]
If you encounter different reasoning which is correct, please award the appropriate marks.

(b) for magnesium and zinc same <u>volume</u> of hydrogen [1]

because both have valency of 2 / 1 mole of metal gives 1 mole of hydrogen / 1 mole of metal reacts with 2 moles of acid [1]

bigger volume for aluminium because its valency is 3 / 1 mole of metal gives 1.5 moles of hydrogen / 1 mole of metal reacts with 3 moles of acid [1]

If you encounter different reasoning which is correct, please award the appropriate marks.

accept balanced equations
accept ionic charges as alternative to valency

4 **One** redox equation [1]
accept $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$
$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$
$C + O_2 \rightarrow CO_2$
$CO_2 + C \rightarrow 2CO$

one acid/base equation [1]
$CaO + SiO_2 \rightarrow CaSiO_3$
or $CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$

three more equations or comments [3]
carbon <u>burns</u> to form carbon dioxide
this reaction is <u>exothermic</u> or <u>produces heat</u>
carbon dioxide is <u>reduced</u> to carbon monoxide
carbon monoxide <u>reduces</u> hematite to iron
carbon <u>reduces</u> hematite to iron
limestone removes silica <u>which is an impurity</u>
to form slag <u>which is a waste product</u>
limestone <u>decomposes or</u> symbol/word equation

5 **(a)** alloy / mixture [1]
iron and carbon / another metal or element etc. [1]

(ii) electron loss [1]

(b) electrons move from / lost from Mg [1]
to steel / iron [1]

(c) **(i)** $2H^+ + 2e \rightarrow H_2$ [2]
not balanced = 1

(ii) sacrificial protection – is a <u>cell</u> [1]
cathodic protection – is electrolysis NOT electrical cell [1]
or:
sacrificial protection – electrons from more reactive metal [1]
cathodic protection – electrons from battery etc. [1]
or:
sacrificial protection – does not need or use power / battery / electricity / electrical cell [1]
cathodic protection – does [1]
or:
sacrificial protection uses up / needs a sacrificial / more reactive metal [1]
cathodic protection doesn't [1]

6 **(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 $\rightarrow$ 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 / Cu^{2+} [1]
if labels on electrodes reversed [0]

(iv) wires / pipes / jewellery / nails / roofing / ammunition / coins / cookware / catalyst / sculpture [1]

[Total: 15]

7 **(a (i)** heat / roast / combustion / high temperature [1]
accept burn
in air / oxygen [1]
any incorrect Chemistry MAX [1]

(ii) $ZnO + C \rightarrow Zn + CO$ [1]
OR $2ZnO + C \rightarrow 2Zn + CO_2$
the equation must balance, if not [0]
not carbon monoxide as a reactant /

(iii) fractional [1]
distillation [1]

(b) making alloys / brass / named alloy which contains zinc [1]

galvanising / sacrificial protection / electroplating [1]
accept galvanising / one specific use which depends on galvanising
zinc coated screws / roofing / buckets / sinks
not just plating other metals

(ii) positive ions / cations [1]
not nuclei / atoms

delocalised / free / mobile or sea of electrons [1]

bond is attraction between (positive) ions and delocalised electrons [1]

it is a good conductor because there are delocalised / free / mobile electrons [1]
Note must be clear that electrons are moving / carry charge / reason why it is a good conductor

[Total: 11]