

- 1 (a) (i) **first reaction**
volume / moles / molecules of reactants and products are different [1]
- second reaction**
volume / moles / molecules of reactants and products are the same [1]
- (ii) first reaction (forward) reaction is endothermic [1]
second reaction (forward) reaction is exothermic [1]
- (b) $C_8H_{18} \rightarrow 2C_4H_8 + H_2$ [1]
- (ii) $2H^+ + 2e \rightarrow H_2$ [2]
or $2H_3O^+ + 2e \rightarrow H_2 + 2H_2O$
accept: $-2e$ on right hand side accept: e
note: not balanced = 1
- (iii) chlorine / Cl_2 / [1]
cond: water treatment / solvents / plastics / PVC / bleach / disinfectants / HCl / kill bacteria / sterilising water / chlorination of water / swimming pools / pesticides / herbicides / insecticides / germicides / pharmaceuticals [1]
sodium hydroxide/NaOH [1]
cond: making soap / degreasing / making paper / detergents / bio-diesel / paint stripper / clearing drains / alumina from bauxite / oven cleaner / bleach [1]
- 2 (a) (i) ions cannot move / no free ions in solid state [1]
ions can move / free ions in liquid state [1]
note: ions can only move in liquid state = 2
- (ii) reduce melting point / reduce energy costs / better conductor when dissolved in cryolite [1]
- (iii) burns in oxygen / reacts with oxygen / oxidised by oxygen / forms carbon dioxide / forms carbon monoxide [1]
- (iv) high melting point / inert / unreactive [1]
- (b) protective / unreactive / resists / prevents corrosion / non-porous (layer) [1]
of (aluminium) oxide [1]
- (c) (i) good conductor (of electricity) [1]
low density / light / lightweight [1]
- (ii) steel core (increased) strength / prevent sagging / to increase separation of pylons / support [1]

- 3 (a) Any one of:
 $\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO}$
 $2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$
 $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$
 for correct equation (2)
 not balanced = (1) only

any four of:

coke burns to form carbon dioxide / $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$

this reacts with more carbon to form carbon monoxide / $\text{C} + \text{CO}_2 \rightarrow 2\text{CO}$

calcium carbonate decomposes to form calcium oxide and carbon dioxide / $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$

calcium oxide / calcium carbonate reacts with silica / silicon oxide / silicon(IV) oxide (in ore) to form calcium silicate / slag / $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$ or $\text{CaCO}_3 + \text{SiO}_2 \rightarrow \text{CaSiO}_3 + \text{CO}_2$

the reaction between carbon and oxygen is exothermic / produces heat / coke is used as a fuel / the slag floats on the (molten) iron / the slag and molten iron can be run off separately

[6]

- (b) (i) greenhouse effect / CO_2 is a greenhouse gas [1]
 global warming / ice caps melting / suitable example [1]
- (ii) burning or combustion of charcoal produces carbon dioxide [1]
 trees use carbon dioxide (in photosynthesis) [1]
- (iii) cathode reaction $\text{Fe}^{3+} + 3\text{e} \rightarrow \text{Fe}$ [1]
 anode reaction $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}$ [2]
 not balanced = (1) only

[Total: 13]

- 4 (a) (i) oxygen; [1]
carbon dioxide / fluorine / carbon monoxide; [1]
- (ii) decrease mpt (of alumina/ Al_2O_3) / lower (operating) temperature (from 1900/2100 ($^{\circ}C$) to 800/1000 ($^{\circ}C$) / reduce energy (accept heat or electrical) requirement; [1]
improve conductivity / dissolves the Al_2O_3 / acts as solvent; (**allow**: makes aluminium oxide conduct / to conduct electricity / making ions free to move) [1]
- (iii) Al_2O_3 (accept alumina) reacts / dissolves / forms a salt and water / is neutralised; [1]
(Fe_2O_3 removed by) filtration / centrifugation / decantation; [1]
- (b) (i) electrolysis / electrolyte / electrodes / anode / cathode / electricity / cell; [1]
chlorine formed at anode (positive electrode); (**note**: can be awarded from a correct or incorrect equation with Cl_2 as the only substance on the right as long as anode is mentioned.) [1]
hydrogen formed at cathode (negative electrode); (**note**: can be awarded from a correct or incorrect equation with H_2 as the only substance on the right as long as cathode is mentioned.) [1]
one correct half equation either $2Cl \rightarrow Cl_2 + 2e$ or $2H^+ + 2e \rightarrow H_2$ [1]
solution remaining contains Na^+ and OH^- / sodium and hydroxide ions / NaOH / sodium hydroxide left behind/remains in solution; [1]
- note: if a mercury cathode is specified
electrolysis / electrolyte / electrodes / anode / cathode / electricity / cell; [1]
chlorine formed at anode (positive electrode); (**note**: can be awarded from a correct or incorrect equation with Cl_2 as the only substance on the right as long as anode is mentioned.) [1]
sodium formed at cathode; (**note**: can be awarded from a correct or incorrect equation with Na as the only substance on the right as long as cathode is mentioned.) [1]
one correct half equation at anode i.e. $2Cl \rightarrow Cl_2 + 2e$ or at cathode $Na^+ + e \rightarrow Na$ (**accept**: equivalent with NaHg amalgam) [1]
NaOH/sodium hydroxide is formed by sodium/sodium mercury amalgam reacting with or when added to water; [1]
note: award the fourth and fifth mark if correct equation given for reaction between sodium or sodium mercury amalgam reacting with water i.e.
 $2Na(Hg) + 2H_2O \rightarrow 2NaOH + H_2 + (2Hg)$
- (ii) H_2 / H / hydrogen **and** making ammonia / making margarine / hardening fats / fuel / energy source / cryogenics / welding; [1]
 Cl_2 / Cl / chlorine **and** (making) bleach / water treatment / kill bacteria (in water) / water purification / swimming pools / making solvents / making PVC / making weed killer / making disinfectants / making hydrochloric acid / HCl / making herbicides / pesticides / insecticides; [1]

- 5 (a) (i) correct arrow from negative terminal of battery or from anode; [1]
- (ii) from battery / power supply / cell; [1]
 from negative electrode of battery to external circuit; [1]
or from anode;
 from iodide ion losing electron **or** oxidation of anion;
- (iii) ions cannot move in solid / ions can move in liquid; [1]
- (b) copper; [1]
 (changes to) sulfuric acid; [1]
- hydrogen; [1]
 (changes to) potassium hydroxide; [1]
- (c) (i) $2\text{H}^+ + 2\text{e} \rightarrow \text{H}_2$ [2]
 not balanced = [1]
- (ii) $4\text{OH} \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}$ [1]
- (iii) water used up; [1]
- (d) it is a cell; [1]
 hydrogen reacts with oxygen; [1]
 this reaction produces energy / is exothermic / produces flow of electrons /
 changes chemical energy to electrical energy; [1]

[Total: 15]