Question number	Answer	Accept	Reject	Marks
1 (a)	**M1 (n**egative electrode) – graphite **M2** (positive electrode) – graphite	carbon carbon		2
(b) (i)	it/aluminium oxide/alumina has a (very) high m. **IGNORE** high b.pt/references to strong bonding/bauxite has a high m.pt/lot of energy		aluminium has a high melting point	1
(ii)	needed to melt it aluminium oxide/alumina is dissolved in/mixed with (molten/liquid) cryolite **IGNORE** cryolite lowers the m.pt of aluminium oxide/alumina	added to Na_3AlF_6 for cryolite cryolite is used as the solvent (for aluminium oxide/alumina)	aluminium is dissolved in cryolite	1
(c)	**M1** reduction **M2** (it/aluminium ions/Al^{3+}) gain of electron(s) **IGNORE** references to loss of oxygen **M2** dep on **M1**	 reacts with/combines with decrease in oxidation number/oxidation number changes from +3 to 0	redox for **M1** only Al/aluminium gains electrons	1 1
(d)	**M1** oxygen formed/produced (at the positive electrode/anode) **IGNORE** oxygen from the aluminium oxide **M2** reacts with the carbon/the (positive) electrode **M2** not dep on **M1**, but must mention oxygen	oxygen from the electrolysis anode / graphite	any indication that the oxygen is from the air for **M1** only cathode/negative electrode	1 1
(e)	Any two from: **M1** malleable **M2** low density	 easy to shape/easy to bend/easy to extrude bend		2

	M3 does not react <u>with food/drink(s)</u> **IGNORE** light(er)/high strength to weight ratio/references to cost/lightweight/does not rust	non-toxic/does not corrode		
			Total	**10**

Question number	Answer	Notes	Marks
2 (a) (i)	electrolysis		1
(ii)	carbon / graphite		1
(iii)	negative		1
(iv)	cryolite	Accept Na_3AlF_6	1
	solvent (for alumina) OR to lower operating temperature / to lower melting point of mixture / electrolyte	Reject to lower melting or boiling point of alumina / aluminium oxide / aluminium Ignore refs to boiling point of mixture / electrolyte Accept to reduce (heat) energy requirement Accept to increase conductivity of electrolyte ~~Ignore references to boiling point~~ Reject acts as catalyst M2 indep of M1	1
(b) (i)	oxygen / O_2	Ignore O	1
(ii)	decreases capacity of blood to carry oxygen	Accept correct reference to haemoglobin / oxyhaemoglobin / carboxyhaemoglobin Accept ref to CO bonding to red blood cells but not to <u>white</u> blood cells	1
(iii)	(pass through) limewater / calcium hydroxide solution	Ignore incorrect formulae eg CaOH Accept $Ca(OH)_2$ solution / $Ca(OH)_2(aq)$ but not just $Ca(OH)_2$	1
	turns milky / cloudy / white	Accept chalky / white ppte etc Ignore refs to later going clear M2 dep on M1	1

2 (c) (i)		(positive) ions / cations / Al^{3+}	Do not accept atoms / negative ions / anions as alternative	1
		(delocalised) electrons		1
	(ii)	layers of ions/particles	Accept planes / sheets / rows Do not penalise atoms instead of ions here Reject molecules / protons / electrons	1
		slide over each other	Accept explanation in terms of non-directional bonding Do not award mark if wrong particles named, eg protons / electrons	1
	(iii)	delocalised / sea of electrons	Accept free	1
		move (through structure) / mobile	"ions free to move" scores 0	1
	(iv)	low density / high strength to weight ratio	Ignore light Accept lightweight / not dense	1

Total 16 marks

Question number	Answer	Notes	Marks
3 (a)	**M1** chromate (ions) are negative **M2** so they are attracted/move towards positive electrode/electrode B	accept 'anions' accept 'anode'	2
(b) (i)	2 2 (1) (1)	accept halves and multiples	1
(ii)	B (HCl(aq))		1
(c) (i)	aq aq aq s	Do not accept words eg aqueous	1
(ii)	**M1** filter (off the precipitate) **M2** wash (with distilled/deionised/pure water) **M3** dry in a warm oven / leave to dry / dry with filter paper	allow 'decant' reject refs to crystallisation for **M2** and **M3** allow 'heat it'	3