

1.1		max 2 for incorrect reference to particles or bonds		AO1 5.2.2.3
	dissolved (in water) or aqueous	allow in solution	1	
	molten / liquid		1	
	so ions are mobile or free moving		1	

2.1	solid (zinc chloride) does not conduct (electricity) or zinc chloride needs to be in solution or molten (because) ions cannot move in the solid or (as) ions can (only) move in liquid / solution	allow liquid / aqueous do not accept references to movement of electrons in zinc chloride	1 1	AO1 4.4.3.1
-----	---	---	------------	----------------

3.1	metal is too reactive to be extracted using carbon or metal reacts with carbon	allow metal is more reactive than carbon	1	AO1 5.4.3.3
-----	---	--	---	----------------

3.2	aluminium oxide cryolite	either order ignore bauxite or aluminium ore	1	AO1 5.4.3.3
			1	

3.3	negative electrode: $\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{Cu}$	allow multiples	1	AO2 5.4.3.2 5.4.3.5
	positive electrode: $2\text{Cl}^{-} \rightarrow \text{Cl}_2 + 2\text{e}^{-}$	allow $2\text{Cl}^{-} - 2\text{e}^{-} \rightarrow \text{Cl}_2$	1	

4.1	mixture has a lower melting point (than aluminium oxide)	allow cryolite lowers melting point (of aluminium oxide) ignore boiling point do not accept cryolite is a catalyst	1	AO1 4.4.3.3
	(so) less energy needed	ignore cost	1	

4.2	aluminium ions gain electrons		1	AO1 4.4.1.4 4.4.3.3
-----	-------------------------------	--	---	---------------------------

4.3	$2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$	allow multiples allow 1 mark for an unbalanced equation containing correct species	2	AO2 4.1.1.1 4.4.3.1 4.4.3.3
-----	---	--	---	--------------------------------------

4.4	the electrode reacts with oxygen		1	AO1 4.4.3.3
	the electrode is carbon / graphite		1	
	(so) carbon dioxide is produced	allow (so) the electrode / carbon / graphite is used up allow (so) the electrode / carbon / graphite is burned away ignore (so) the electrode / carbon / graphite is worn away ignore (so) the electrode / carbon / graphite is corroded	1	

4.5	hydrogen (gas) would be produced (instead of sodium) (because) sodium is more reactive than hydrogen		1 1	AO3 4.4.1.2 4.4.3.3 4.4.3.4
-----	---	--	------------	--------------------------------------

5.2	(delocalised) electron(s)		1	AO1
	ion(s)		1	AO2
	(delocalised) electron(s)		1	AO1
				5.2.2.3 5.2.2.8 5.2.3.2

6.1	CrO_4^{2-} / chromate ions moved to the positive electrode (because) opposite charges attract	allow anode for positive electrode	1	AO2
		allow yellow (coloured) ions moved to the positive electrode allow (because) negative ions are attracted to the positive electrode		
				AO1 4.4.3.1 RPA 3

6.2	water	ignore copper chromate solution	1	AO1 4.4.3.4 RPA 3
-----	-------	---------------------------------	---	-------------------------

6.3	copper ions gain two electrons	allow Cu^{2+} for copper ions allow 1 mark for copper ions gain electrons or allow 1 mark for copper ions are reduced do not accept copper ions are oxidised	2	AO2
	(to) form copper (atoms)	allow Cu for copper (atoms) the equation: $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$ scores 3 marks	1	AO3 4.4.3.1 4.4.3.4 RPA 3

6.4	(negative electrode) hydrogen	allow H ₂	1	AO2
	(positive electrode) iodine	allow I ₂	1	4.4.3.4 RPA 3

7.1	reduction	ignore electrolysis	1	AO2
	(as H ⁺ ions) gain electrons		1	AO1 5.4.1.4 5.4.3.1 5.4.3.4 RPA 9

7.2	$2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$	allow $2\text{Cl}^- - 2\text{e}^- \rightarrow \text{Cl}_2$ ignore state symbols allow 1 mark for $\text{Cl}_2 + \text{e}^-$ allow 1 mark for – e^- (on lhs) and Cl_2 (on rhs)	2	AO2 5.4.1.4 5.4.3.1 5.4.3.4 RPA9
-----	--	--	---	--

7.3	water molecules		1	AO1 5.4.1.4 5.4.3.1 5.4.3.4 5.4.3.5 RPA9
	break down to produce OH ⁻ ions	allow dissociate to produce OH ⁻ ions	1	
	(which are) attracted to the positive electrode		1	
	(where OH ⁻ ions are) oxidised or (where OH ⁻ ions) lose electrons	ignore discharged ignore oxygen is produced as no halide is present	1	

8.1	$2 \text{Br}^- \rightarrow \text{Br}_2 + 2 \text{e}^-$	allow multiples allow 1 mark for Br_2 and e^-	2	AO2 4.1.1.1 4.4.3.1 4.4.3.2 4.4.3.5
-----	--	--	---	---

8.2	Salt solution	Product at positive electrode	Product at negative electrode	1	AO2 4.4.1.2 4.4.3.4 RPA3
	(copper nitrate)	oxygen (1)	(copper)		
	(potassium iodide)	iodine (1)	hydrogen (1)		
				2	

8.3	copper ions are discharged (from the solution)	allow the solution becomes less concentrated allow copper ions are removed (from the solution) allow copper ions are used up (from the solution)	1	AO3 4.4.3.1
-----	---	---	---	----------------

9.1	$\text{Na}^+ + \text{e}^- \rightarrow \text{Na}$		1	AO2 4.4.3.2 4.4.3.5
-----	--	--	---	---------------------------

9.2	so the products do not react (to reform sodium chloride)		1	AO3 4.4.3.2
-----	--	--	---	----------------

9.3	ion		1	AO3 4.4.3.2
-----	-----	--	---	----------------

9.4	hydrogen / H^+ (ions)		1	AO1 4.4.3.4
	hydroxide / OH^- (ions)		1	

9.5	sodium hydroxide	allow NaOH	1	AO2 4.4.3.4
-----	------------------	------------	---	----------------

9.6	sodium ions and hydroxide ions are left (in solution)		1	AO2 4.4.3.4
	(because) hydrogen ions are discharged / reduced (at the negative electrode to form hydrogen)	allow (because) hydrogen ions gain electrons (at the negative electrode to form hydrogen) allow (because at the negative electrode) $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$	1	
	(and because) chloride ions are discharged / oxidised (at the positive electrode to form chlorine)	allow (and because) chloride ions lose electrons (at the positive electrode to form chlorine) allow (and because at the positive electrode) $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$	1	

10.1	ions are not free to move		1	AO1 5.2.2.3 5.4.3.1
------	---------------------------	--	---	---------------------------

10.2	liquid or molten	allow (when) the solid is melted ignore references to aqueous solutions ignore references to dissolving	1	AO1 5.4.3.1 5.4.3.2
------	-------------------------	---	---	---------------------------

10.3	carbon / graphite	allow platinum / gold / silver	1	AO3 5.4.3.1 5.4.3.4 RPA9
------	-------------------	--------------------------------	---	-----------------------------------

10.4	$2 \text{Cl}^- \rightarrow \text{Cl}_2 + 2 \text{e}^-$	ignore state symbols allow 1 mark for $\text{Cl}_2 + \text{e}^-$	2	AO2 5.4.1.4 5.4.3.1 5.4.3.4 5.4.3.5 RPA9
------	--	--	---	---

10.5	water (molecules) break down to produce (equal numbers of) H^+ and OH^- (ions)		1	AO3
	(so) the hydrogen / H^+ ions are attracted to the negative electrode (where) hydrogen ions are discharged / reduced		1	AO1
	(because) hydrogen is less reactive than sodium		1	AO3
	(so there is) a decrease in (the relative number of) hydrogen / H^+ ions or (so there is) an increase in the relative number of hydroxide / OH^- ions		1	AO3 5.4.2.4 5.4.3.1 5.4.3.4 5.4.3.5 RPA9

11.1	$\text{Al}^{3+} + 3\text{e}^{-} \rightarrow \text{Al}$	allow multiples	1	AO2 4.1.1.1 4.4.3.3 4.4.3.5
------	--	-----------------	---	--------------------------------------

11.2	sodium is more reactive than aluminium		1	AO3 4.4.3.4
------	--	--	---	----------------

11.3		allow hydroxide ions for OH ⁻ throughout		AO1 4.4.3.4
	water (molecules) break down		1	
	(to) produce (H ⁺ and) OH ⁻ (ions)		1	
	(so) OH ⁻ (ions) are attracted / move to the positive electrode		1	
	(where) OH ⁻ (ions) are discharged / oxidised to give oxygen (molecules)	allow (where) OH ⁻ (ions) lose electrons to give oxygen (molecules)	1	