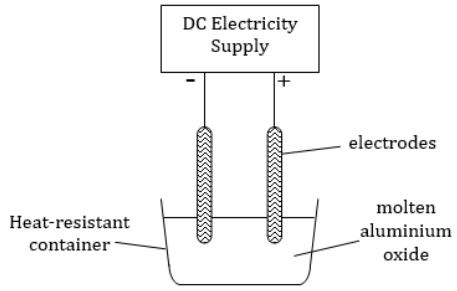
National 5 Chemistry
Unit 3.1d Extraction of Metals

JAB chem

		Lesson	Traffic Light: Red	Amber	Green
10	During the extraction of metals, metal ions are reduced forming metal atoms.		☹	😐	☺
11a 12a	The least reactive metals are obtained by heating metals compounds alone e.g. silver, gold, platinum and mercury silver (I) oxide → silver + oxygen $2Ag_2O \rightarrow 4Ag + O_2$		☹	😐	☺
11b 12b	Metals with medium reactivity are obtained by heating metal compounds with carbon or carbon monoxide e.g. copper, lead, tin, iron and zinc Copper (II) oxide + carbon → copper + carbon dioxide $2CuO + C \rightarrow 2Cu + CO_2$ iron (III) oxide + carbon monoxide → iron + carbon dioxide $2Fe_2O_3 + 3CO \rightarrow 4Fe + 3CO_2$		☹	😐	☺
11c 12c	The most reactive metals must be obtained by molten electrolysis of metal compounds e.g. potassium, sodium, lithium, calcium, magnesium and aluminium aluminium oxide → aluminium + oxygen $2Al_2O_3 \rightarrow 4Al + 3O_2$		☹	😐	☺
13 14	Electrolysis is the decomposition of an ionic compound into its elements using electricity • a d.c. supply must be used if the products of electrolysis are to be identified. 		☹	😐	☺
15	Positive metal ions gain electrons at the negative electrode (reduction) e.g. $Cu^{2+} + 2e^- \rightarrow Cu$ Negative non-metal ions lose electrons at the positive electrode (oxidation) e.g. $2Cl^- \rightarrow Cl_2 + 2e^-$		☹	😐	☺

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Past Paper Question Bank
Unit 3.1d Extraction of Metals

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Outcome	Original Specimen Paper	New Specimen Paper	Nat5 2014	Nat5 2015	Nat5 2016	Nat5 2017	Nat5 2018	Nat5 2019	Nat5 2020	Nat5 2021						
10		L11a	L12a				L11d									
11a 12a	mc16	mc17	mc16			mc16										
11b 12b					mc15											
11c 12c			L12c													
13 14				mc7		mc4										
15		L11b														

Nat5	Answer	% Correct	Reasoning
2014 MC 16	D	73	**Method** / Electrolysis / Heat With Carbon / Heat Alone **Metals Made This Way**: Potassium, Sodium, Lithium, Calcium, Magnesium, Aluminium; Zinc, Iron, Nickel, Tin, Lead, Copper; Mercury, Silver, Gold, Platinum **Reason**: most reactive metals / medium reactive metals / least reactive metals
2015 MC 7	C	46	☒A Calcium at surface as it is less dense ($1.54 g\ cm^{-3}$) than calcium chloride ($2.15 g\ cm^{-3}$) ☒B Calcium would be a solid at 800°C as it melts at 842°C ☑C Solid calcium would float on the surface of the molten calcium chloride ☒D Calcium would be a solid at 800°C as it melts at 842°C
2016 MC 15	D	64	**Method** / Electrolysis / Heat With Carbon / Heat Alone **Metals Made This Way**: Potassium, Sodium, Lithium, Calcium, Magnesium, Aluminium; Zinc, Iron, Nickel, Tin, Lead, Copper; Mercury, Silver, Gold, Platinum **Reason**: most reactive metals / medium reactive metals / least reactive metals
2017 MC 4	D	60	☒A Magnesium melts at 650°C ∴ temperature is 730°C so magnesium is liquid ☒B Magnesium melts at 650°C ∴ temperature is 730°C so magnesium is liquid ☒C Magnesium has density 1.74 g cm^{-3} and floats in magnesium chloride (2.32g cm^{-3}) ☑D Magnesium formed is a liquid at 730°C and floats in molten magnesium chloride as magnesium metal has a lower density.
2017 MC 16	C	79	☒A tin is a medium reactivity metal and is found combined in the Earth's crust ☒B magnesium is a upper reactivity metal and found combined in the Earth's crust ☑C gold is a very unreactive metal and found uncombined in the Earth's crust ☒D sodium is a very reactivity metal and found combined in the Earth's crust

<table>
<tr><th>Nat5</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>2014
12a</td><td>Reduction</td><td>Metal ores are compounds of metals and the metals are in the form of positive ions. Positive ions are turned back in atoms again be reduction where electrons are gained by the positive ions e.g. $Mg^{2+} + 2e^- \rightarrow Mg$</td></tr>
<tr><td>2014
12c</td><td>(molten)
Electrolysis</td><td>
<table>
<tr><th>Method</th><th>Electrolysis</th><th>Heat With Carbon</th><th>Heat Alone</th></tr>
<tr><td>Metals Made This Way</td><td>Potassium, Sodium
Lithium, Calcium
Magnesium, Aluminium</td><td>Zinc, Iron
Nickel, Tin
Lead, Copper</td><td>Mercury, Silver
Gold, Platinum</td></tr>
<tr><td>Reason</td><td>most reactive metals</td><td>medium reactive metals</td><td>least reactive metals</td></tr>
</table>
</td></tr>
<tr><td>2018
11d</td><td>Insoluble</td><td>Magnesium is insoluble (p8 of data booklet) and the ions are not able to move so the circuit would not be complete.</td></tr>
</table>

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Past Paper Question Bank
Unit 3.1d Extraction of Metals

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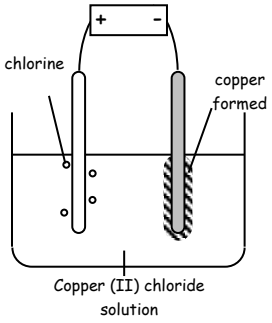
Outcome	Int2 2000	Int2 2001	Int2 2002	Int2 2003	Int2 2004	Int2 2005	Int2 2006	Int2 2007	Int2 2008	Int2 2009	Int2 2010	Int2 2011	Int2 2012	Int2 2013	Int2 2014	Int2 2015
10	L2b	L6a										L12a		mc29	L14c	
11a 12a		L6b	mc23				mc28		mc28			mc28			mc30	
11b 12b													mc29	mc30		
11c 12c	L2c				mc30						mc29					
13 14		L7a		L12c					L4a L4b							
15			mc8		mc7	L14c	mc27	mc28 mc29 L12a	L4c(i)	mc10		L12b(ii)	L12a	L1b	mc8	mc30

Int2	Answer	% Correct	Reasoning
2002 MC 8	C	31	☒A negative ions are attracted to the negative electrode not positive ions ☒B neutral atoms are not attracted to the negative electrode ☑C negative Cl^- ions lose electrons at the negative electrode and form Cl_2 molecules ☒D neutral atoms are not attracted to the negative electrode
2002 MC 23	D	39	☒A Calcium is too reactive: Calcium is made by molten elecrolysis ☒B Copper is too reactive: Copper is made by heating copper ore with carbon ☒C Zinc is too reactive: Zinc is made by heating zinc ore with carbon ☑D Silver is unreactive and can be made by heating silver ores to release silver
2004 MC 7	A	48	☑A Reaction at negative electrode: $Ag^+ + e^- \rightarrow Ag$ ☒B Positive ions gain electrons to become neutral atoms not lose electrons ☒C Positive ions travel to the negative electrode not the positive electrode ☒D Positive ions travel to the negative electrode not the positive electrode
2004 MC 30	A	58	☑A Aluminium is so reactive that it must be made by molten electrolysis ☒B Copper is made by heating copper ore with carbon ☒C Iron is made by heating iron ore with carbon in a blast furnace ☒D Gold ore releases gold metal by heating the ore alone
2006 MC 27	C	55	☒A Copper ions are reacting into copper atoms at the negative electrode ☒B Copper ions are reacting into copper atoms at the negative electrode ☑C Copper ions gain electrons (reduction) to become copper atoms: $Cu^{2+} + 2e^- \rightarrow Cu$ ☒D Copper ions gain electons (reduction) and do no lose electrons (oxidation)
2006 MC 28	B	58	☒A Lead is too reactive to made my heating lead oxide alone ☑B Mercury is an unreactive metal and can be made my heating mercury oxide ☒C Tin is too reactive to made my heating tin oxide alone ☒D Zinc is too reactive to made my heating zinc oxide alone
2007 MC 28	B	47	☒A $2I^- \rightarrow I_2 + 2e^-$ is the oxidation reaction not a reduction reaction ☑B $2I^- \rightarrow I_2 + 2e^-$ is the oxidation reaction at the positive electrode ☒C Positive ions move to the negative electrode ☒D Positive ions move to the negative electrode

<table>
<tr><td>2007
MC
29</td><td>A</td><td>53</td><td>☑A Calcium is a solid at 800°C and is less dense so floats on top
☒B Calcium has not melted at 800°C so calcium is still a solid
☒C Calcium is less dense than molten calcium chloride so calcium floats on top
☒D Calcium has not melted at 800°C so calcium is still a solid</td></tr>
<tr><td>2008
MC
28</td><td>D</td><td>75</td><td>☒A Alumiunium is too reactive to be uncombined (made by molten electrolysis)
☒B Iron is too reactive to be found uncombined (made by heating ore with carbon)
☒C Lead is too reactive to be found uncombined (made by heating ore with carbon)
☑D Silver is unreactive and found uncombined in the Earth's crust</td></tr>
<tr><td>2009
MC
10</td><td>D</td><td>48</td><td>☒A copper ions gain electrons to become copper atoms: $Cu^{2+} + 2e^- \rightarrow Cu$
☒B bromide ions lose electrons to become bromine molecules: $2Br^- \rightarrow Br_2 + 2e^-$
☒C bromide ions lose electrons to become bromine molecules: $2Br^- \rightarrow Br_2 + 2e^-$
☑D copper ions gain electrons to become copper atoms: $Cu^{2+} + 2e^- \rightarrow Cu$</td></tr>
<tr><td>2010
MC
29</td><td>D</td><td>59</td><td><table><tr><td>Method</td><td>Electrolysis</td><td>Heat With Carbon</td><td>Heat Alone</td></tr><tr><td>Metals Made This Way</td><td>Potassium, Sodium, Lithium, Calcium, Magnesium, Aluminium</td><td>Zinc, Iron, Copper, Tin, Lead</td><td>Mercury, Silver, Gold, Platinum</td></tr><tr><td>Reason</td><td>most reactive metals</td><td>medium reactive metals</td><td>least reactive metals</td></tr></table></td></tr>
<tr><td>2011
MC
28</td><td>D</td><td>56</td><td>☒A Calcium is only made from calcium oxide by molten electrolysis
☒B Copper can be made by heating copper oxide with carbon
☒C Zinc can be made by heating zinc oxide with carbon
☑D silver is unreactive and can be made by heating silver oxide alone</td></tr>
<tr><td>2012
MC
29</td><td>C</td><td>65</td><td>☒A metal is below Zn and Mg in reactivity (metal between would need electrolysis)
☒B metal is below Mg and K in reactivity (metal between would need electrolysis)
☑C zinc is made by heating with carbon and copper can be made by heat alone
☒D metal is above copper and gold in reactivity (they can be made by heat alone)</td></tr>
<tr><td>2013
MC
29</td><td>B</td><td>45</td><td>☒A displacement: higher up metals displace lower down ions from compounds
☑B metal atoms lose electrons to become metal ions (oxidation is loss of electrons)
☒C precipitation: insoluble substance formed when two solutions are mixed
☒D metal atoms lose electrons to become metal ions (reduction is gain of electrons)</td></tr>
<tr><td>2013
MC
30</td><td>D</td><td>58</td><td><table><tr><td>Method</td><td>Electrolysis</td><td>Heat With Carbon</td><td>Heat Alone</td></tr><tr><td>Metals Made This Way</td><td>Potassium, Sodium, Lithium, Calcium, Magnesium, Aluminium</td><td>Zinc, Iron, Nickel, Tin, Lead, Copper</td><td>Mercury, Silver, Gold, Platinum</td></tr><tr><td>Reason</td><td>most reactive metals</td><td>medium reactive metals</td><td>least reactive metals</td></tr></table></td></tr>
<tr><td>2014
MC
8</td><td>A</td><td>56</td><td>☑A H^+ ions move to the negative electrode and form H_2 gas
☒B H_2 is formed in the reaction at the -ve electrode but not present at the start
☒C Cl^- ions move to the positive electrode and form Cl_2 gas
☒D Cl_2 is formed in the reaction at the +ve electrode but not present at the start</td></tr>
<tr><td>2014
MC
30</td><td>B</td><td>68</td><td><table><tr><td>Method</td><td>Electrolysis</td><td>Heat With Carbon</td><td>Heat Alone</td></tr><tr><td>Metals Made This Way</td><td>Potassium, Sodium, Lithium, Calcium, Magnesium, Aluminium</td><td>Zinc, Iron, Nickel, Tin, Lead, Copper</td><td>Mercury, Silver, Gold, Platinum</td></tr><tr><td>Reason</td><td>most reactive metals</td><td>medium reactive metals</td><td>least reactive metals</td></tr></table></td></tr>
<tr><td>2015
MC
30</td><td>A</td><td>58</td><td>☑A calcium forms as a solid on the surface due to density and melting point.
☒B calcium is a solid as it melts at 842°C and the temperature used is 800°C
☒C Calcium formed on surface as it has a lower density than calcium chloride
☒D Calcium formed on surface as it has a lower density than calcium chloride</td></tr>
</table>

Int2	Answer	Reasoning
2000 2b	Reduction	Copper ions in $Cu^{2+}O^{2-}$ are reduced to form Cu atoms: $Cu^{2+} + 2e^- \rightarrow Cu$
2000 2c	Any metal from:	potassium | sodium | lithium | calcium | magnesium | aluminium i.e. any metal above zinc in the reactivity series
2001 6a	Reduction	In the production of a metal, the metal ion gains electrons to become a an uncharged metal atom e.g. $Fe^{3+} + 3e^- \longrightarrow Fe$
2001 6b	Mercury, silver or gold	Only the least reactive metals in metal oxide will release the metal on heating alone
2001 7a	d.c. supply has steady + and – so ions move in one direction	D.C. (direct current) has constant positive and negative terminals and the oppositely charged ion is attracted to that terminal to be electrolysed back to the elements. A.C. (alternating current) has reversing positive and negative terminals and ions cannot move to the terminals to be electrolysed.
2003 12c		At Positive electrode: $2Cl^- \longrightarrow Cl_2 + 2e^-$ At Negative electrode: $Cu^{2+} + 2e^- \longrightarrow Cu$
2005 14c	$Mg^{2+} + 2e^- \rightarrow Mg$	Molten magnesium chloride contains magnesium ions. Magnesium ions pick up electrons from negative electrode to become magnesium atoms.
2007 12a	Electrode A or positive electrode	Hydrogen is produced by: $2H^- \rightarrow H_2 + 2e^-$ $\therefore$ Negative hydride H^- ions will travel to the positive electrode.
2008 4a	Compound breaks down to elements by passing electricity through it	Electrolysis used d.c. electricity to provide the energy to break compounds down into its constituent elements
2008 4b	Direction of electron flow remains the same	D.C. electricity has a single direction of electron flow which means a constant positive and negative electrode. • Positive ions (usually metal ions) move to the negative electrode and pick electrons to become atoms • Negative ions move to the positive electrode to lose electrons and become an element again
2008 4c(i)	positive: Bubbles of gas negative: Brown solid made	Positive electrode: $2Cl^- \rightarrow Cl_2 + 2e^-$ Negative electrode: $Cu^{2+} + 2e^- \rightarrow Cu$
2011 12a	reduction	Metal compounds contain metal ions. When metals are extracted from metal compounds the metal ions turn into metal atoms. This involves the reduction of metals ions into metal atoms as the metal ions must gain electrons to become metal atoms. Cu^{2+} (copper (II) ions) + $2e^-$ (gain of electrons) $\longrightarrow$ Cu (copper atoms)

<table>
<tr><td>2011
12b(ii)</td><td>Positive | Negative</td><td>Bubbles of Gas = Chlorine gas
$2Cl^- \longrightarrow Cl_2 + 2e^-$
Positive electrode picks up electrons

Brown Solid = copper metal
$Cu^{2+} + 2e^- \longrightarrow Cu$
Negative electrode supplies electrons</td></tr>
<tr><td>2012
12a</td><td>Hydrogen</td><td>All acids contain H^+ ions which will be attracted to the negative electrode where they turn into hydrogen gas: $2H^+_{(aq)} + 2e^- \rightarrow H_{2(g)}$</td></tr>
<tr><td>2013
1b</td><td>Positive electrode
Negative electrode</td><td>Chlorine gas is formed at the positive electrode:
$2Cl^-_{(l)} \longrightarrow Cl_{2(g)} + 2e^-$
Strontium metal is formed at the negative electrode:
$Sr^{2+}_{(l)} + 2e^- \longrightarrow Sr_{(l)}$</td></tr>
<tr><td>2014
14c</td><td>Reduction</td><td>Al_2O_3 contains Al^{3+} ions which are reduced to form atoms of Al
$Al^{3+} + 3e^- \rightarrow Al$</td></tr>
</table>

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Past Paper Question Bank
Unit 3.1d Extraction of Metals

Outcome	2000 Credit	2001 Credit	2002 Credit	2003 Credit	2004 Credit	2005 Credit	2006 Credit	2007 Credit	2008 Credit	2009 Credit	2010 Credit	2011 Credit	2012 Credit	2013 Credit		
10		11d							16d							
11a 12a		11b	15a					17e	16c		16b(ii)			16a		
11b 12b			15a						16b		16b(ii)			16a		
11c 12c			15a						16b		16b(ii)		21a	16a		
13 14							17a			10a	13a	18a				
15																

<table>
<tr><th>SG Credit</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>2001C
11b</td><td>W: Pt, Au, Ag or Hg
Y: K, Na, Li, Ca or Mg</td><td>W must be the least reactive metals if heating alone releases the metal from the ore.
Y must be the most reactive metals if they react with cold water.</td></tr>
<tr><td>2001C
11d</td><td>Reduction</td><td>Reduction is gain of electrons e.g. $M^{2+} + 2e^- \longrightarrow M$</td></tr>
<tr><td>2002C
15a</td><td>
<table>
<tr><th>Metal</th><th>Extraction Method</th></tr>
<tr><td>mercury</td><td>heat alone</td></tr>
<tr><td>lead</td><td>heat + carbon</td></tr>
<tr><td>magnesium</td><td>molten electrolysis</td></tr>
</table>
</td><td>
<table>
<tr><th>Method</th><th>Reactivity</th><th colspan="6">Metals Made this Method</th></tr>
<tr><td>heat alone</td><td>least reactive</td><td>Hg</td><td>Ag</td><td>Au</td><td>Pt</td></tr>
<tr><td>heat + carbon</td><td>Medium reactive</td><td>Zn</td><td>Fe</td><td>Sn</td><td>Pb</td><td>Cu</td></tr>
<tr><td>molten electrolysis</td><td>Most Reactive</td><td>K</td><td>Na</td><td>Li</td><td>Ca</td><td>Mg</td><td>Al</td></tr>
</table>
</td></tr>
<tr><td>2006C
17a</td><td>Electrolysis</td><td>Electrolysis is the process where electricity splits an ionic compound to form elements</td></tr>
<tr><td>2007C
17e</td><td>gold or silver
or mercury or platinum</td><td>Only the least reactive metals will release them metal from the metal ore by heat alone.</td></tr>
<tr><td>2008C
16b</td><td>
<table>
<tr><th>Metal</th><th>Extraction</th></tr>
<tr><td>Aluminium</td><td>molten electrolysis</td></tr>
<tr><td>Lead</td><td>heat with carbon</td></tr>
</table>
</td><td>Aluminium is too reactive to be made by heating with carbon. Carbon is not powerful enough to take oxygen away from aluminium in aluminium oxide. Molten electrolysis is the best method to split oxygen from aluminium.</td></tr>
<tr><td>2008C
16c</td><td>X is less reactive than Lead and Aluminium</td><td>The least reactive metals (e.g. mercury, silver and gold) can be made by heating their ores and the metals are formed without the need of carbon being present.</td></tr>
<tr><td>2008C
16d</td><td>reduction</td><td>Reduction is gain of electrons: $Al^{3+} + 3e^- \longrightarrow Al$</td></tr>
<tr><td>2009C
10a</td><td>Electrolysis</td><td>Electrolysis: Passing electricity through a substance and the substance breaks back down to its elements.</td></tr>
<tr><td>2010C
13a</td><td>Electrodes have same charge at all times</td><td>Direct current (d.c.) must be used as this give constant positive and negative electrodes as the direction of electron flow is always the same.
Alternating current (a.c.) has reversing current direction so the charge on each electrode would keep changing.</td></tr>
<tr><td>2010C
16b(ii)</td><td>
<table>
<tr><td>Mercury</td></tr>
<tr><td>Aluminium</td></tr>
<tr><td>Copper</td></tr>
</table>
</td><td>
<table>
<tr><th>Method</th><th>Metals Made This Way</th><th>Reason</th></tr>
<tr><td>Electrolysis</td><td>Potassium, Sodium, Lithium, Calcium, Magnesium, Aluminium</td><td>most reactive metals</td></tr>
<tr><td>Heat With Carbon</td><td>Zinc, Iron, Tin, Lead, Copper</td><td>medium reactive metals</td></tr>
<tr><td>Heat Alone</td><td>Mercury, Silver, Gold, Platinum</td><td>least reactive metals</td></tr>
</table>
</td></tr>
<tr><td>2011C
18a</td><td>d.c.</td><td>d.c. is direct current and has a flow of electrons is a steady direction.
a.c. is alternating current with the direction of electron flow changing.</td></tr>
<tr><td>2012C
21a</td><td>By electrolysis</td><td>
<table>
<tr><th>Method</th><th>Electrolysis</th><th>Heat With Carbon</th><th>Heat Alone</th></tr>
<tr><td>Metals Made This Way</td><td>Potassium, Sodium, Lithium, Calcium, Magnesium, Aluminium</td><td>Zinc, Iron, Tin, Lead, Copper</td><td>Mercury, Silver, Gold, Platinum</td></tr>
<tr><td>Reason</td><td>most reactive metals</td><td>medium reactive metals</td><td>least reactive metals</td></tr>
</table>
</td></tr>
<tr><td>2013C
16a</td><td>
<table>
<tr><td>heat alone</td></tr>
<tr><td>reacting with carbon</td></tr>
<tr><td>electrolysis</td></tr>
</table>
</td><td>
<table>
<tr><th>Method</th><th>Electrolysis</th><th>Heat With Carbon</th><th>Heat Alone</th></tr>
<tr><td>Metals Made This Way</td><td>Potassium, Sodium, Lithium, Calcium, Magnesium, Aluminium</td><td>Zinc, Iron, Tin, Lead, Copper</td><td>Mercury, Silver, Gold, Platinum</td></tr>
<tr><td>Reason</td><td>most reactive metals</td><td>medium reactive metals</td><td>least reactive metals</td></tr>
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</td></tr>
</table>

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Past Paper Question Bank
Unit 3.1d Extraction of Metals

Outcome	2000 General	2001 General	2002 General	2003 General	2004 General	2005 General	2006 General	2007 General	2008 General	2009 General	2010 General	2011 General	2012 General	2013 General		
10												14b				
11a 12a																
11b 12b													18d			
11c 12c																
13 14	18a	12a				15a		17a(i)			15b			14a		
15		12b 12c				15c		17a(ii)		12a 12b				14b 14c		

SG General	Answer	Reasoning
2000G 18a	electrolysis	Passing electricity through molten or solution of an ionic compound. The compound breaks back down into its elements.
2001G 12a	electrolysis	Passing electricity through molten or solution of an ionic compound. The compound breaks back down into its elements.
2001G 12b	metal ions are positive	Metals always form positive ions. Non-metals form negative ions (except hydrogen)
2001G 12c	bubbles of gas	Chloride Cl^- ions move to the positive electrode and turn into chlorine gas $2Cl^- \longrightarrow Cl_2 + 2e^-$
2005G 15a	The breaking up of a compound using electricity	Molten ionic compounds conduct by electrolysis
2005G 15c	Chlorine	Cl^- ions move to positive electrode where $2Cl^-(l) \longrightarrow Cl_2(g)$
2007G 17a(i)	battery or d.c. power supply	The power supply must be a d.c. power supply so that the electrode maintain the same positive and negative electrodes.
2007G 17a(ii)	lead iodide ↓ lead + iodine	lead iodide ⟶ lead + iodine
2009G 12a	chlorine	Positive electrode: $2Cl^- \longrightarrow Cl_2 + 2e^-$ Negative Electrode: $Cu^{2+} + 2e^- \longrightarrow Cu$
2009G 12b	electrons	Electrons travel through the wires Ions travel through the solution
2010G 15b	electrolysis	Electrolysis is the passing of d.c. current resulting in the breakdown of the compound back into elements. The ionic substance must be molten or in solution as ions are not free to move in the solid state.
2011G 14b	ore	Ores are chemicals from which metals can be extracted e.g. metal oxides
2012G 18d	carbon or carbon monoxide	Reduction with C: $2Fe_2O_3 + 3C \longrightarrow 4Fe + 3CO_2$ Reduction with CO: $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$
2013G 14a	Electrolysis	Electrolysis is the process where d.c. electricity is used to split ionic compounds in the liquid or solution state back to the elements. • negative ions are attracted to the positive electrode: $2Cl^- \longrightarrow Cl_2 + 2e^-$ • positive ions are attracted to the negative electrode: $Cu^{2+} + 2e^- \longrightarrow Cu$
2013G 14b	Negative	
2013G 14c	Gas (chlorine) is given off	