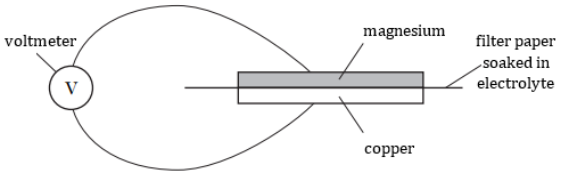
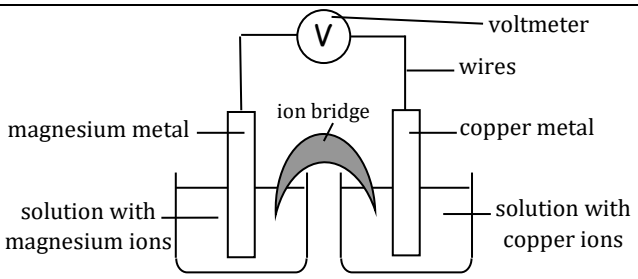
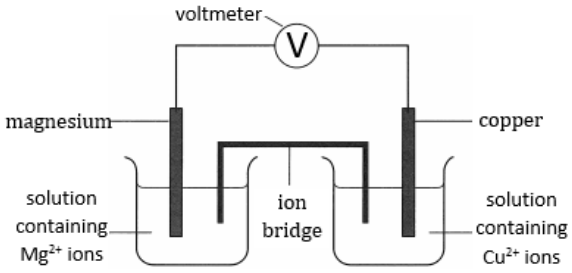
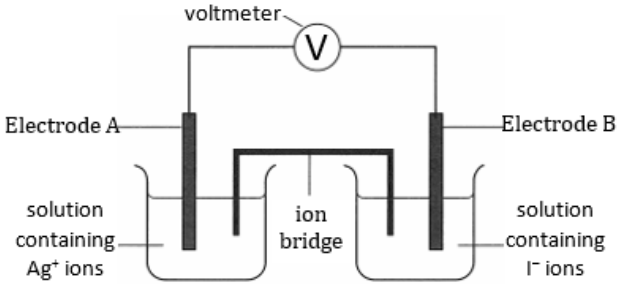
National 5 Chemistry
Unit 3.1e Electrochemical Cells

JAB chem

		Lesson	Traffic Light		
			Red	Amber	Green
16	Electrically conducting solutions containing ions are known as electrolytes. • Movement of ions in the electrolyte completes the circuit		☹	😐	☺
17	A simple cell can be made by placing two metals in an electrolyte. • Electrons move through the voltmeter from the metal higher up the electrochemical series to the metal lower in the series • Ions move in the electrolyte to balance up this movement of charge 		☹	😐	☺
18	Electricity can be produced in a cell by connecting two different metals in solutions of their metal ions. Electrons flow in the external circuit from the metal higher in the electrochemical series to the one lower in the electrochemical series. • Electrons flow from Magnesium to copper in this circuit 		☹	😐	☺
19 20 21	Different pairs of metals produce different voltages. These voltages can be used to arrange the elements into an electrochemical series (p10 of data booklet) • the further apart elements are in the electrochemical series, the greater the voltage produced when they are used to make an electrochemical cell. • electrons flow in the external circuit from the species higher in the electrochemical series to the one lower in the electrochemical series.		☹	😐	☺
22a 23a	For an electrochemical cell ion-electron equations can be written for: • the oxidation reaction • the reduction reaction • the overall redox reactions The direction of flow of electrons can also be worked out in an electrochemical cell.  At Magnesium Electrode: (oxidation) $Mg_{(s)} \rightarrow Mg^{2+}_{(aq)} + 2e^-$ At Copper Electrode: (reduction) $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$ Overall Redox Reaction $Mg_{(s)} + Cu^{2+}_{(aq)} \rightarrow Mg^{2+}_{(aq)} + Cu_{(s)}$ Electrons leave Magnesium (on left) as magnesium atoms form magnesium ions Electrons travel through the wires and Voltmeter Electrons arrive at copper electrode (on right) and join with copper ions to form copper atoms Electrons travel through wires from left to right		☹	😐	☺
22b 23b	Some electrochemical cells involve non-metals as one of their reactions:  At Electrode A: $Ag^+_{(aq)} + e^- \rightarrow Ag_{(s)}$ At Electrode B: $2I^-_{(aq)} \rightarrow I_{2(s)} + 2e^-$ Overall Redox Reaction $Ag^+_{(aq)} + 2I^-_{(aq)} \rightarrow Ag_{(s)} + I_{2(s)}$ Electrons leave Electrode B as I^- ions form I_2 molecules ions Electrons travel through the wires and Voltmeter Electrons arrive at electrode A and join with Ag^+ ions to form Ag atoms Electrons travel through wires from right to left		☹	😐	☺

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Past Paper Question Bank
Unit 3.1e Electrochemical Cells

JABchem

Outcome	Original Specimen Paper	New Specimen Paper	Nat5 2014	Nat5 2015	Nat5 2016	Nat5 2017	Nat5 2018	Nat5 2019	Nat5 2020	Nat5 2021						
16					L10a											
17							L11b	L10a								
18	mc17				L10b(i) L10b(ii)	L10a(i)	L11a	L10b(i)								
19 20 21	mc18	mc18 mc19	mc18	mc16			mc19	mc18								
22a 23a							L11c									
22b 23b																

Nat5	Answer	% Correct	Reasoning
2014 MC 18	B	75	Magnesium Aluminium Zinc Iron Nickel Tin Lead Copper Silver A B C D
2015 MC 16	D	76	☒A zinc & tin give lower voltage as they are closer together on electrochemical series ☒B electrons would flow from Y (zinc) to X (tin) ☒C electrons would flow from Y (magnesium) to X (copper) ☑D magnesium and copper would give the biggest voltage as they are further apart on electrochemical series and electrons flow from X (magnesium) to Y (copper) as magnesium is higher up ECS
2018 MC 19	A	-	largest Voltage Order in Electrochemical series Zinc Nickel Tin Lead smallest voltage
2019 MC 18	D	-	☒A Largest voltage = largest separation on electrochemical series (Magnesium-silver) ☒B 2nd Largest voltage = 2nd largest separation on electrochemical series (zinc-silver) ☒C 3rd Largest voltage = 3rd largest separation on electrochemical series (iron-silver) ☑D Smallest voltage = smallest separation on electrochemical series (copper-silver)

<table>
<tr><th>Nat5</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>2016
10a</td><td>Electrolyte</td><td>An electrolyte is a solution containing ions which helps to complete a circuit by ions moving to balance the movement of charge</td></tr>
<tr><td>2016
10b(i)</td><td>Arrow showing movement from right to left through wires</td><td>Zinc is higher up the electrochemical series than copper so electrons move from zinc to copper
$Zn_{(s)} \rightarrow Zn_{(aq)} + 2e^-$
$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$</td></tr>
<tr><td>2016
10b(ii)</td><td>ion/salt bridge</td><td>Ion bridge is usually filter paper soaked in an ion solution. Ions move through the paper to balance the movement of charge through the wires.</td></tr>
<tr><td>2017
10a(i)</td><td>$3Cu^{2+} + 2Al$
↓
$3Cu + 2Al^{3+}$</td><td>❶ $Al \rightarrow Al^{3+} + 3e^-$
❷ $Cu^{2+} + 2e^- \rightarrow Cu$
❶x2 $2Al \rightarrow 2Al^{3+} + 6e^-$
❷x3 $3Cu^{2+} + 6e^- \rightarrow 3Cu$
❶'+❷' $2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$</td></tr>
<tr><td>2018
11a</td><td>Arrow showing flow through wires from magnesium/right to copper/left</td><td>Electrons travel through wires while ions flow through the solution.
Electrons travel from higher metal in electrochemical series (magnesium on right) to metal lower down electrochemical series (copper on left).</td></tr>
<tr><td>2018
11b</td><td>One answer from:</td><td><table><tr><td>Completes the circuit/cell</td><td>allows ions to flow/move/transfer
(between the two beakers)</td><td>provide ions to complete circuit/cell</td></tr></table></td></tr>
<tr><td>2018
11c</td><td>$Cu^{2+} + 2e^- \longrightarrow Cu$</td><td>Reduction is the gain of electrons by the reactant.
Cu^{2+} ions will gain 2 electrons to become Cu metal.</td></tr>
<tr><td>2019
10a</td><td>Ion bridge
or salt bride</td><td>The ion bridge is a piece of filter paper soaked in electrolyte. Electrolyte is a salt solution which provides the ions to complete the circuit and allow current to flow through the wires.</td></tr>
<tr><td>2019
10b(i)</td><td>Arrow
through wires
from right to left</td><td>Electrons flow through wires and ions flow through the solution.
Electrons are generated in the reaction in beaker B:
$2I^-_{(aq)} \longrightarrow I_{2(l)} + 2e^-$
Electrons flow through voltmeter to Beaker A and join up by the Fe^{3+} ions
$Fe^{3+}_{(aq)} + e^- \longrightarrow Fe^{2+}_{(aq)}$</td></tr>
</table>

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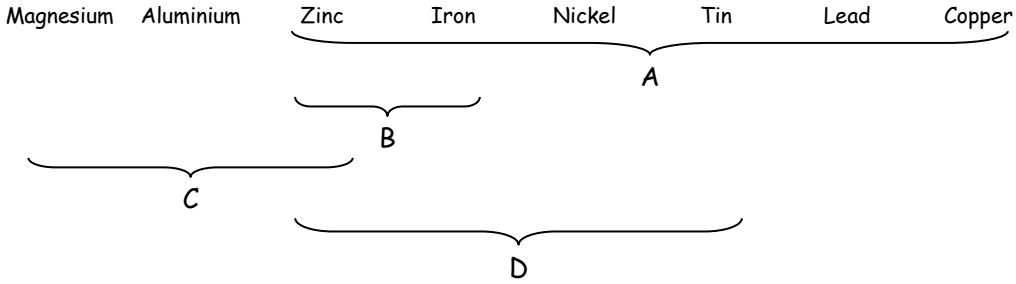
Past Paper Question Bank
Unit 3.1e Electrochemical Cells

JABchem

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
16		L14b							L14a			L14d			mc28 L13a	L11c
17																
18				L3c												
19 20 21	mc24	mc25	L6c	L3a	mc27 mc29	mc26	mc26	mc27 L13b	mc26 mc27	mc27	L14b(i)	L14a L14b L14c	mc23	mc26 mc27	L13b(i) L13b(ii)	L11b(i) L11b(ii) L16b
22a 23a													mc28			
22b 23b																

Int2	Answer	% Correct	Reasoning
2000 MC 24	D	79	☒A electrons will flow from more reactive copper (Z) to less reactive gold (Y) ☒B electrons will flow from more reactive tin (Z) to less reactive copper (Y) ☒C electrons will flow from more reactive tin (Z) to less reactive gold (Y) ☑D electrons will flow from more reactive tin (Y) to less reactive copper (Z)
2001 MC 25	A	67	Electrochemical Series The bigger the difference in the metals on the electrochemical series, the bigger the voltage is. Order in Electrochemical Series: Magnesium; Zinc; Tin; Copper
2004 MC 27	D	60	☒A Electrons travel through wires, ions travel through the solution ☒B Electrons travel through wires, ions travel through the solution ☒C Electrons travel from zinc (higher metal) to tin (lower metal) ☑D Electrons travel through wires from zinc (higher metal) to tin (lower metal)
2004 MC 29	D	60	Cell A: 1.5V, Silver, zinc — biggest difference in metals ∴ highest voltage Cell B: 1.1V, copper, zinc — 2nd biggest difference in metals ∴ 2nd highest voltage Cell C: 0.6V, Tin, zinc — 2nd smallest difference in metals ∴ 2nd lowest voltage Cell D: 0.3V, Iron, zinc — smallest difference in metals ∴ lowest voltage
2005 MC 26	A	53	☑A electrons travel from higher metal (zinc) to lower metal (tin) through the wires ☒B electrons travel from higher metal (zinc) to lower metal (tin) ☒C ions travel through he electrolyte, electrons travel through the wires ☒D ions travel through he electrolyte, electrons travel through the wires
2006 MC 26	A	76	Silver – Copper has the closest pairing of metals on the electrochemical series ∴silver - copper cell has the smallest voltage

2007 MC 27	C	90	The highest voltage is achieved by having the biggest difference between metals on the electrochemical series. Magnesium Aluminium Zinc Iron Nickel Tin Lead Copper
2008 MC 26	D	61	☒A Electrons travel through the wires not the solution ☒B Electrons travel through the wires not the solution ☒C Electrons flow from the higher metal (zinc) to the lower metal (tin) ☑D Electrons flow through the wires from the higher metal zinc to the lower tin
2008 MC 27	D	74	Order of metals in electrochemical series: Zinc Iron Tin Copper Copper is the closest metal to silver in the electrochemical series Smallest voltage is obtained from the closest pairing
2009 MC 27	A	80	☑A Highest voltage and electrons flow from X (magnesium) to Y (copper) ☒B Electron flow is from Y to X as Y (magnesium) is more reactive than X (copper) ☒C Not highest voltage as zinc/tin is not as far apart magnesium/copper ☒D Electron flow is from Y to X as Y (zinc) is more reactive than X (tin)
2012 MC 23	A	87	Electrochemical Series Order: Magnesium, zinc, iron, copper and silver (p7 data booklet) Cell | Mg-Ag | Zn-Ag | Fe-Ag | Cu-Ag Voltage | 2.7V | 1.1V | 0.9V | 0.5V
2012 MC 28	D	66	☒A At zinc electrode: $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$ ∴ zinc electrode decreases in mass ☒B At zinc electrode: $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$ ∴ zinc electrode decreases in mass ☒C At copper electrode: $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$ ∴ copper electrode increases in mass ☑D copper electrode gets heavier as copper deposits on electrode, zinc electrode gets lighter as zinc atoms break off as Zn^{2+} ions into the solution
2013 MC 26	D	60	☒A electrons always flow through wires not solutions ☒B electrons always flow through wires not solutions ☒C copper is lower down than tin so electrons flow from tin to copper ☑D electrons flow through wires from higher up metals to lower down metals
2013 MC 27	A	68	
2014 MC 28	C	48	☒A hexane C_6H_{14} is covalent and cannot be used as an electrolyte ☒B copper(II) oxide is ionic but cannot be used as an electrolyte as it is insoluble ☑C Calcium chloride is ionic and soluble and can be used as an electrolyte ☒D carbon chloride CCl_4 is covalent and cannot be used as an electrolyte

Int2	Answer	Reasoning
2001 14b	Completes the circuit	Electrolytes complete the circuit by balancing the movement of charged electrons by allowing ions to move too.
2002 6c	Voltage above 0.5V e.g. 0.7V	The further apart metals are from each other on the electrochemical series, the higher the voltage of the cell. A zinc is further from copper than iron is from copper, the zinc-copper cell will have a high voltage than an iron-copper cell
2003 3a	← From right (B) to left (A)	Electrons are released by the reaction at electrode B (right) Electrons move from electrode B to electrode A Electrons are picked up by the reaction at electrode A (left)
2003 3c	To complete circuit	The ion bridge completes the circuit as it allows ions to travel from side to side to balance the movement of charge moving within the circuit.
2007 13b	The higher metal is in electrochemical series the higher the voltage	The voltage from a cell is directly linked to the position of the two metals in the electrochemical series. The bigger the difference the higher the voltage.
2008 14a	To complete the circuit	Ions are able to move to complete the circuit
2010 14b(i)	← From right to left	Electrons are generated on iron electrode (right): $Fe \rightarrow Fe^{2+} + 2e^-$ Electrons are accepted by iodine at carbon electrode (left): $I_2 + 2e^- \rightarrow 2I^-$
2011 14a	3	Metal 3 is above copper in electrochemical series as electrons flow to copper Metal 3 gives biggest voltage so is furthest from copper in electrochemical series
2011 14b	2 + 3	Metals furthest apart in electrochemical series give biggest voltage • Metal 3 is the highest metal in electrochemical series (see above) • Metal 2 is the lowest metal in the electrochemical series o Metal 2 is below copper in electrochemical series as electrons flow from copper o Metal 2 gives bigger voltage of metals below copper in ECS
2011 14c	0 or zero	Same metal attached to each other gives zero voltage in a cell
2011 14d	Glucose is covalent and has no ions	A solution containing ions is required for the electrolyte. Glucose ($C_6H_{12}O_6$) is covalent as it only contains non-metal atoms and therefore does not complete the circuit as it contains no ions.
2014 13a	To complete the circuit	The ions in an electrolyte complete the circuit by moving charge to balance the movement of electrons through the cell.
2014 13b(i)	10.92	Number of Pairs of Discs: 1 | 2 | 3 | 4 | 5 | 6 | 7 Voltage (V): 1.56 | 3.12 | 4.68 | 6.24 | 7.80 | 9.36 | - Difference: 1.56 | 1.56 | 1.56 | 1.56 | 1.56 | (1.56) Prediction (V): - | - | - | - | - | - | 10.92
2014 13b(ii)	Decrease in voltage	Copper and silver are closer together on the electrochemical series

<table>
<tr><td>2015
11b(i)</td><td>Any answer from:</td><td><table><tr><td>The greater the difference in reactivity (between the metals) the greater the voltage</td><td>The more reactive, the less the voltage</td></tr><tr><td>Metals close to Mg on the Electrochemical Series will produce lower voltage</td><td>The less reactive the metal, the greater the voltage</td></tr></table></td></tr>
<tr><td>2015
11b(ii)</td><td>Value greater than 2.25</td><td>Magnesium and Lead produce a voltage of 2.25V. Magnesium and Copper will produce a bigger voltage because Copper is lower on the electrochemical series than Lead.
There is a greater voltage in a Magnesium/Copper cell than Magnesium/Lead cell.</td></tr>
<tr><td>2015
11c</td><td>Complete the circuit
or
allow ions to move</td><td>The ionic solution of sodium chloride provide the ions needed to complete the circuit. Ions move to balance the charge in the cell caused by the movement of electrons through the wires from the magnesium electrode to the lead electrode.</td></tr>
<tr><td>2015
16b</td><td>left to right
(through wires)</td><td><table><tr><td>Electrons formed in Beaker A (left)</td><td>$4OH^- \longrightarrow 2H_2O + O_2 + 4e^-$</td></tr><tr><td>Electrons travel to Beaker B (right) to be gained by Fe^{3+}</td><td>$Fe^{3+} + e^- \longrightarrow Fe^{2+}$</td></tr></table></td></tr>
</table>

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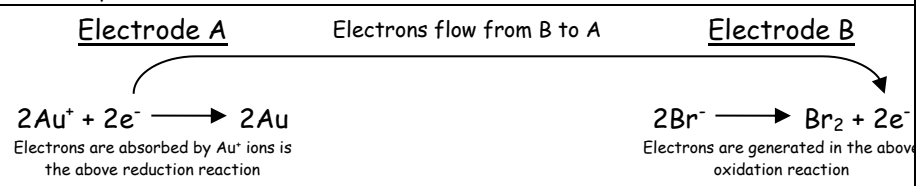
Past Paper Question Bank
Unit 3.1e Electrochemical Cells

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		
16	14a		13c(ii)	19a(ii)		19b		19c(ii)				21c		14c(ii)		
17				19a(i)												
18																
19 20 21	14c			19a(iii)												
22a 23a			13c(i)								17d			14c(i)		
22b 23b		15a 15b(i) 15b(ii) 15c		16a(i) 16a(ii)		19a	10a			17b		21a	19b			

SG Credit	Answer	Reasoning
2000C 14a	to complete the circuit	ions move from one beaker to the other beaker to balance movement of electrons through the wires.
2000C 14c	Any metal below tin in electrochemical series	The further apart the metals on the electrochemical series, the greater the voltage produced
2001C 15a	Arrow from B (RIGHT) to A (LEFT) through wires	Electrons travel through wires (not solution) From Question: Reaction in beaker B produces electrons
2001C 15b(i)	Oxidation	Oxidation is loss of electrons (electrons right of arrow)
2001C 15b(ii)	pH decreases	H^+ ions (acid) produced as reaction proceeds
2001C 15c	$Br_2 + 2e^- \rightarrow 2Br^-$	Equation on page 10 of data booklet
2002C 13c(i)	copper silver silver nitrate solution	In cells, a metal electrode is placed in a solution of its own ions e.g. silver in silver nitrate solution
2002C 13c(ii)	precipitate produced in ion bridge	sodium carbonate will react with copper nitrate to form copper carbonate precipitate. Sodium carbonate will react with silver nitrate to form silver carbonate precipitate. Precipitate may stop ion bridge from completing the circuit.
2003C 16a(i)	From B(RIGHT) to A(LEFT) through the wires	At Electrode A: $Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$ Electrons are moving from B to A for Fe^{3+} ion to gain electrons

2003C 16a(ii)	Reduction	Reduction is Gain of Electrons: $Fe^{3+} + e^- \longrightarrow Fe^{2+}$
2003C 19a(i)	1st clip on zinc rod 2nd clip on copper can	cells which produce electricity often have two different metals in them.
2003C 19a(ii)	ions cannot move through glass	ions need to move through porous cardboard container to complete circuit (glass blocks movement of ions)
2003C 19a(iii)	reading decreases	tin is closer to copper in the electrochemical series so voltage/current will be lower.
2005C 19a	Arrow showing movement of electron through wires from A(left) to B(right)	Reaction at Electrode A produces electrons Reaction at electrode B accepts electrons ∴ electrons travel from A to B through wires
2005C 19b	To complete the circuit	Ions in electrolyte are able to flow and complete the circuit between the electrodes
2006C 10a	Arrow pointing from Left (X) to Right (Y)	In question Fe^{3+} ions (at electrode Y) are accepting electrons so electrons must be moving from Left (X) to Right (Y)
2007C 19c(ii)	to complete circuit	The ions in the electrolyte move between electrodes to complete the circuit
2009C 17b	(←) From Right to Left or from Y to X	The reaction at electrode Y produces electrons: $2I^- \rightarrow I_2 + 2e^-$ Electrons travel from electrode Y to electrode X The reaction at electrode X uses up these electrons: $Br_2 + 2e^- \rightarrow Br_2$
2010C 17d	iron silver silver nitrate	As Iron is higher up electrochemical series than silver (p10 data booklet) • Iron electrode must be on left as electrons flow from left to right • Silver electrode must be on right as electrons flow from left to right Silver nitrate solution is used with silver electrode 1st line of question states silver nitrate is used
2011C 21a	from B to A through the wires	
2011C 21c	Ion bridge	Ion bridge completes the circuit by balancing the movement of charge through the wires e.g. ions bridge can be filter paper soaked in ionic solution
2012C 19b	From A to B through the wires	At Electrode A: $Zn \rightarrow Zn^{2+} + 2e^-$ .Electrons leave electrode A and travel to electrode B. Electrons travel though the wires (Ions travel through the solution)
2013C 14c(i)	zinc copper zinc sulphate solution	The metals in a cell should be placed in solutions of that metal • Copper electrode is placed in copper sulphate solution • Zinc electrode is placed in a zinc sulphate solution (any soluble zinc compound can be used as the electrolyte in the zinc electrode beaker)
2013C 14c(ii)	To complete the circuit	The ion bridge contains an ionic solution which allows ions to move through the ion bridge to balance the movement of charge from zinc to copper

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Past Paper Question Bank
Unit 3.1e Electrochemical Cells

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		
16				17b	15a		19a				19d	21a(i)				
17		15a(i)	11a(i)													
18				17a		12a(i)	19b					21a(ii)	16a			
19 20 21		15b(ii)		17d	15c	12a(ii)		15b(ii)		15b(i)	19c		16b	18a(ii)		
22a 23a		15b(i)			15b			15b(i)			19a			18a(i)		
22b 23b																

SG General	Answer	Reasoning
2001G 15a(i)	chemical reaction	A chemical reaction inside a battery produces the electricity
2001G 15b(i)	From left to right → (iron to copper)	Iron is higher up the electrochemical series than copper (p7 data booklet) Electrons always flow from the higher up metal to the lower down metal.
2001G 15b(ii)	higher voltage	The bigger the gap in the electrochemical series, the higher the voltage. • Aluminium is higher up electrochemical series than iron Al/Cu cell has a bigger voltage than an Fe/Cu cell
2002G 11a(i)	chemicals run out	Cells/batteries are portable but run out when the chemicals in the battery are used up
2002G 11a(iii)	ions cannot move when dry	Ions cannot move in the solid state but can move when in solution or molten
2003G 17a	electrons	Electrons are charged particles which travel through the wires Ions are charged particles which travel though the solution.
2003G 17b	to complete the circuit	The electrolyte completes the circuit as the ions move through the filter paper to balance the movement of charge as electrons move through the wires.
2003G 17d	magnesium or aluminium	Magnesium or aluminium are higher up the electrochemical series and would produce a higher voltage than zinc in a cell with copper. Potassium, sodium, lithium and calcium are also higher up but would not work in practice as they would react with the water in the solution.
2004G 15a	to complete the circuit	The salt solution electrolyte completes the circuit as the ions move through the filter paper to balance the movement of electrons through the wires.
2004G 15b	nickel ↓ Copper (through wires & ammeter)	Nickel is higher up the electrochemical series than copper. Electrons always flow from the higher up metal to the lower metal
2004G 15c	any metal below copper	Any metal below copper in the electrochemical series will result in a change of direction of electron flow: mercury | silver | gold | platinum
2005G 12a(i)	electrons	electrons travel through wires, ions travel through solutions.
2005G 12a(ii)	voltage below 0.92V	tin/copper are closer together than zinc/copper on electrochemical series. Smaller gap on electrochemical series means smaller voltage
2006G 19a	to complete circuit	electrolyte must be an ionic/salt solution
2006G 19b	silver then gold	silver is higher up electrochemical series than gold so electrons flow from the higher metal (silver) to the lower metal (gold)
2007G 15b(i)	right to left ← (Zinc to Nickel)	Electrons flow through the wires from the higher up metal to the lower down metal in the electrochemical series (p10 of data booklet)

<table>
<tr><td>2007G
15b(ii)</td><td>higher voltage</td><td>Replacing nickel with copper makes the difference between zinc and copper greater on the electrochemical series (p10 of data booklet)</td></tr>
<tr><td>2009G
15b(i)</td><td>Value between
0.5V – 2.7V</td><td>Magnesium is higher up electrochemical series than iron
∴voltage will be less than 2.7V
Tin is lower down electrochemical series than iron
∴voltage will be more than 0.5V</td></tr>
<tr><td>2010G
19a</td><td>From right to left
←
(iron to copper)</td><td>Iron is higher up the electrochemical series than copper (p10 data booklet)
Electrons always flow from the higher up metal to the lower down metal.</td></tr>
<tr><td>2010G
19c</td><td>Nickel,
Tin or Lead</td><td>The electrochemical series is found on p10 of the data booklet
Magnesium
Aluminium
Zinc
Iron ←
Nickel ←
Tin ←
Lead ←
Copper
Replacing iron with one of these metals will decrease the voltage</td></tr>
<tr><td>2010G
19d</td><td>To complete the circuit</td><td>The ion bridge is a piece of filter soaked in an electrolyte e.g. salt solution.
The ion bridge completes the circuit by allow charged ions to travel from side to side to balance out the movement of negative charge in the electrical current.</td></tr>
<tr><td>2011G
21a(i)</td><td>electrolyte</td><td>Electrolytes are ionic compounds which complete a circuit as they allow ions to move between electrodes to balance the movement of charge.</td></tr>
<tr><td>2011G
21a(ii)</td><td>copper
zinc wires</td><td>Electrons always flow from metals higher in the electrochemical series to metals lower in the electrochemical series ∴ zinc to copper
Electrons flow through the wires, ions flow through the solution/paste.</td></tr>
<tr><td>2012G
16a</td><td>Electrons</td><td>Electrons flow through wires, ions move through solutions.</td></tr>
<tr><td>2012G
16b</td><td>Any metal lower than zinc in ECS</td><td>Any one from:<table><tr><td>iron</td><td>nickel</td><td>tin</td><td>lead</td></tr><tr><td>copper</td><td>mercury</td><td>silver</td><td>gold</td><td>platinum</td></tr></table></td></tr>
<tr><td>2013G
18a(i)</td><td>Arrow on wires
L ⟶ R</td><td>Electrons always travel through wires, not through the electrolyte solution.
Electrons will travel from the metal higher up the electrochemical series (iron) to the metal lower down the electrochemical series (copper)</td></tr>
<tr><td>2013G
18a(ii)</td><td>Increase in voltage</td><td>iron/copper cell gives a voltage related to the positions on ECS
Aluminium Zinc Iron Nickel Tin Lead Copper
aluminium/copper cell gives a bigger voltage as there is a bigger separation on ECS</td></tr>
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