	JAB chem	**National 5 Chemistry** **Unit 3.1c Redox**	JAB chem	Lesson	Traffic Light: Red	Amber	Green
6a 8a	<u>Reduction</u> is a gain of electrons by a *reactant* in any chemical reaction: $Cu^{2+} + 2e^- \longrightarrow Cu$ • a compound reacting to form a metal element is an example of reduction • reduction reactions have electrons <u>before</u> the arrow				☹	😐	☺
6b 8b	<u>Oxidation</u> is a loss of electrons by a *reactant* in any chemical reaction: $Mg \longrightarrow Mg^{2+} + 2e^-$ • a metal element reacting to form a compound is an example of oxidation • oxidation reactions have electrons <u>after</u> the arrow				☹	😐	☺
7	In a redox reaction, reduction and oxidation take place at the same time.				☹	😐	☺
9	Ion-electron equations can be combined to produce redox equations. <u>Oxidation Reaction</u>: $Mg \longrightarrow Mg^{2+} + 2e^-$ <u>Reduction Reaction:</u> $Cu^{2+} + 2e^- \longrightarrow Cu$ <u>Redox Reaction</u>: $Mg + Cu^{2+} \longrightarrow Mg^{2+} + Cu$				☹	😐	☺

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Past Paper Question Bank
Unit 3.1c Redox

JABchem

Outcome	Original Specimen Paper	New Specimen Paper	Nat5 2014	Nat5 2015	Nat5 2016	Nat5 2017	Nat5 2018	Nat5 2019	Nat5 2020	Nat5 2021						
6a 8a								L8d								
6b 8b			L11a		L10c(i)	L4b L8b	L7b(ii)	L10b(ii)								
7																
9	mc19	mc20	mc17	L9b(i)	L10c(ii)	L10a(ii)	mc18	L10b(iii)								

Nat5	Answer	% Correct	Reasoning
2014 MC 17	B	55	❶ $H_2O_{(l)} + SO_3^{2-}{}_{(aq)} \rightarrow SO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} + 2e^-$ ❷ $Fe^{3+}{}_{(aq)} + e^- \rightarrow Fe^{2+}{}_{(aq)}$ ❶ $H_2O_{(l)} + SO_3^{2-}{}_{(aq)} \rightarrow SO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} + 2e^-$ ❷x2 $2Fe^{3+}{}_{(aq)} + 2e^- \rightarrow 2Fe^{2+}{}_{(aq)}$ Add ❶+❷' (cancelling e^-) $H_2O_{(l)} + SO_3^{2-}{}_{(aq)} + 2Fe^{3+}{}_{(aq)} \rightarrow SO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} + 2Fe^{2+}{}_{(aq)}$
2018 MC 18	B	-	❶ $H_{2(g)} \rightarrow 2H^+{}_{(aq)} + 2e^-$ ❷ $2H_2O_{(l)} + O_{2(g)} + 4e^- \rightarrow 4OH^-{}_{(aq)}$ ❶x2 $2H_{2(g)} \rightarrow 4H^+{}_{(aq)} + 4e^-$ ❷ $2H_2O_{(l)} + O_{2(g)} + 4e^- \rightarrow 4OH^-{}_{(aq)}$ Add ❶'+❷ $2H_{2(g)} + 2H_2O_{(l)} + O_{2(g)} + 4e^- \rightarrow 4H^+{}_{(aq)} + 4e^- + 4OH^-{}_{(aq)}$ cancel down $2H_{2(g)} + 2H_2O_{(l)} + O_{2(g)} + \cancel{4e^-} \rightarrow 4H^+{}_{(aq)} + \cancel{4e^-} + 4OH^-{}_{(aq)}$ redox $2H_{2(g)} + 2H_2O_{(l)} + O_{2(g)} \rightarrow 4H^+{}_{(aq)} + 4OH^-{}_{(aq)}$

Nat5	Answer	Reasoning
2014 **11a**	$2Cl^- \rightarrow Cl_2 + 2e^-$	$2Cl^-$ → Cl_2 + $2e^-$ Chloride Cl^- ions are a reactant as chloride ions are pumped into the fuel cell. Chlorine Cl_2 gas is the product as it emerges from the fuel cell Oxidation: Cl^- ions must lose electrons to become neutral
2015 **9b(i)**	$4Al^{3+} + 6O^{2-}$ ↓ $4Al + 3O_2$	$4Al^{3+} + 6O^{2-} \longrightarrow 4Al + 3O_2$
2016 **10c(i)**	oxidation	$Br_{2(l)} + 2e^- \longrightarrow 2Br^-_{(aq)}$ Reduction (gain of electrons) $SO_3^{2-}{}_{(aq)} + H_2O_{(l)} \longrightarrow SO_4^{2-}{}_{(aq)} + 2H^+_{(aq)} + 2e^-$ Oxidation (loss of electrons)
2016 **10c(ii)**	$Br_2 + SO_3^{2-} + H_2O$ ↓ $2Br^- + SO_4^{2-} + 2H^+$	$Br_2 + SO_3^{2-} + H_2O \longrightarrow 2Br^- + SO_4^{2-} + 2H^+$
2017 **4b**	$Fe^{2+} \rightarrow Fe^{3+} + e^-$	The reduction step $Fe^{3+} + e^- \rightarrow Fe^{2+}$ is in the data booklet. The reversal of the equation means the equation becomes oxidation
2017 **8b**	Magnesium	MgO contains Mg^{2+} ions ∴ Mg $\longrightarrow$ $Mg^{2+} + 2e^-$ (oxidation)
2017 **10a(ii)**	$3Cu^{2+} + 2Al$ ↓ $3Cu + 2Al^{3+}$	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' $2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$
2018 **7b(ii)**	oxidation	$2Cl^-_{(aq)} \longrightarrow Cl_{2(g)} + 2e^-$ chloride ions — chlorine gas — Loss of two electrons by the reactants
2019 **8d**	Reduction	Beryllium ions $\longrightarrow$ Beryllium atoms Turn information in question in to chemical formulae $Be^{2+} \longrightarrow Be$ Balance charge difference by adding electrons to the most positive side $Be^{2+} + 2e^- \longrightarrow Be$
2019 **10b(ii)**	oxidation	$2I^-_{(aq)} \longrightarrow I_{2(l)} + 2e^-$
2019 **10b(iii)**	$2Fe^{3+}+2I^-$ ↓ $2Fe^{2+}+I_2$	$2I^- \rightarrow I_2 + 2e^-$ $Fe^{3+} + e^- \rightarrow Fe^{2+}$ Multiple equations to get same number of electrons $2I^- \rightarrow I_2 + 2e^-$ $2Fe^{3+} + 2e^- \rightarrow 2Fe^{2+}$ Cancel out electrons add equations together $2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$

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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
6a 8a		L13a			mc22	L4c(i)	L3b									
6b 8b	L13d		L3a	L13a		mc28	L12b(ii)		L14b(i)	mc28 L14b				L15b	L12b	L13b
7	mc17		L13b(i)		L12a											
9		L14a		L3b				L12b	L14b(ii)		mc28				mc29	

Int2	Answer	% Correct	Reasoning
2000 MC 17	C	52	☒A Redox has both Reduction: $2H^+ + 2e^- \rightarrow H_2$ and Oxidation: $Zn \rightarrow Zn^{2+} + 2e^-$ ☒B Redox has both Reduction: $Br_2 + 2e^- \rightarrow 2Br^-$ and Oxidation: $Fe^{2+} \rightarrow Fe^{3+} + e^-$ ☑C Precipitation Reaction: ions come together to form insoluble solid ☒D Redox has both Reduction: $2H^+ + 2e^- \rightarrow H_2$ and Oxidation: $Zn \rightarrow Zn^{2+} + 2e^-$
2004 MC 22	C	69	☒A oxidation is loss of electrons ∴ electrons appear after arrow ☒B oxidation is loss of electrons ∴ electrons appear after arrow ☑C reduction is gain of electrons: Fe^{3+} gains electron to become Fe^{2+} ☒D reduction is gain of electrons but Fe^{3+} is on wrong side of equation
2005 MC 28	B	41	☒A Electrons before arrow is gain of electrons ∴ reduction reaction ☑B Fe^{2+} ions are losing electrons ∴ Fe^{2+} ions are being oxidised ☒C Fe atoms are losing electrons ∴ Fe atoms are being oxidised ☒D Electrons before arrow is gain of electrons ∴ reduction reaction
2009 MC 28	C	53	☒A Electrons are gained in reduction and appear before the arrow in an equation ☒B Electrons are gained in reduction and appear before the arrow in an equation ☑C Titanium atoms are oxidised as electrons are lost (electrons after the arrow) ☒D Titanium ions are products and are the products of the oxidation
2010 MC 28	A	35	❶ $Mg \rightarrow Mg^{2+} + 2e^-$ ❷ $Ag^+ + e^- \rightarrow Ag$ ❶ $Mg \rightarrow Mg^{2+} + 2e^-$ ❷x2 $2Ag^+ + 2e^- \rightarrow 2Ag$ Add ❶+❷ $Mg + 2Ag^+ + 2e^- \rightarrow Mg^{2+} + 2e^- + 2Ag$ Cancel e^- $Mg + 2Ag^+ + \cancel{2e^-} \rightarrow Mg^{2+} + \cancel{2e^-} + 2Ag$ $Mg + 2Ag^+ \rightarrow Mg^{2+} + 2Ag$
2014 MC 29	B	49	❶ $H_2O_{(l)} + SO_3^{2-}{}_{(aq)} \rightarrow SO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} + 2e^-$ ❷ $Fe^{3+}{}_{(aq)} + e^- \rightarrow Fe^{2+}{}_{(aq)}$ ❶ $H_2O_{(l)} + SO_3^{2-}{}_{(aq)} \rightarrow SO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} + 2e^-$ ❷x2 $2Fe^{3+}{}_{(aq)} + 2e^- \rightarrow 2Fe^{2+}{}_{(aq)}$ Add ❶+❷' (cancelling $2e^-$) $H_2O_{(l)} + SO_3^{2-}{}_{(aq)} + 2Fe^{3+}{}_{(aq)} \rightarrow SO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} + 2Fe^{2+}{}_{(aq)}$

Int2	Answer	Reasoning
2000 13d	$2I^- \rightarrow I_2 + 2e^-$	$2I^- \rightarrow I_2 + 2e^-$ Iodine ions — Iodine molecule
2001 13a	$Fe^{3+} + e^- \longrightarrow Fe^{2+}$	From the question, $Fe^{3+} \longrightarrow Fe^{2+}$ (difference on charge of 1+) $1e^-$ is added to the most positive side: $Fe^{3+} + e^- \longrightarrow Fe^{2+}$
2001 14a	$O_2 + 2H_2 \rightarrow 2H_2O$	❶ $H_2 \rightarrow 2H^+ + 2e^-$ ❷ $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ ❶x2 $2H_2 \rightarrow 4H^+ + 4e^-$ ❷ $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ add $O_2 + 2H_2 \rightarrow 2H_2O$
2002 3a	$Fe \rightarrow Fe^{2+} + 2e^-$	Iron atoms oxidise (lose electrons) to become Fe^{2+} ions and further oxidise to become Fe^{3+} ions during the process of rusting.
2002 13b(i)	$Zn+Cu^{2+} \rightarrow Zn^{2+}+Cu$	$Zn \rightarrow Zn^{2+} + 2e^-$ $Cu^{2+} + 2e^- \rightarrow Cu$ Add together equations cancelling out electrons $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$
2003 3b	$2Ag^+ + 2I^- \rightarrow 2Ag + I_2$	$2Ag^+ + 2e^- \rightarrow 2Ag$ $2I^- \rightarrow I_2 + 2e^-$ Add together equations cancelling out electrons $2Ag^+ + 2I^- \rightarrow 2Ag + I_2$
2003 13a	$Zn \rightarrow Zn^{2+} + 2e^-$	Oxidation is the loss of electrons. Metals reacting to become compounds are oxidation reactions. See data booklet p7 for reduction version of this equation.
2004 12a	$2H_2O+2Cl^- \rightarrow Cl_2+H_2$	$2Cl^- \rightarrow Cl_2 + 2e^-$ $2H_2O + 2e^- \rightarrow 2OH^- + H_2$ Add together equations cancelling out electrons $2H_2O + 2Cl^- \rightarrow Cl_2 + H_2$
2005 4c(i)	Copper ions gain electrons	$Cu^{2+} + 2e^- \longrightarrow Cu$
2006 3b	$Fe^{3+} + 3e^- \rightarrow Fe$	Fe^{3+} ions at start and Fe atoms at end of reaction. Three electrons must be gained by the Fe^{3+} ions to become Fe atoms
2006 12b(ii)	oxidation	Oxidation is loss of electrons (electrons after the arrow) Reduction is gain of electrons (electrons before the arrow)
2007 12b	$2Na^+ + 2H^- \rightarrow 2Na + H_2$	2x❶ $2Na^+ + 2e^- \rightarrow 2Na^+$ ❷ $2H^- \rightarrow H_2 + 2e^-$ add ❶′ + ❷ $2Na^+ + 2H^- \rightarrow 2Na + H_2$
2008 14b(i)	Oxidation	Oxidation is Loss of Electrons (electrons after the arrow on right hand side)
2008 14b(ii)	Aluminium hydroxide	$Al^{3+}(aq) + OH^-(aq) \longrightarrow Al^{3+}(OH^-)_3(s)$

2009 14b	$Fe^{2+} \rightarrow Fe^{3+} + e^-$	$Fe^{2+} \longrightarrow Fe^{3+} + e^-$
2013 15b	$Na \rightarrow Na^+ + e^-$	$Na \longrightarrow Na^+ + e^-$ 2,8,1 (sodium atom) 2,8 (sodium ion)
2014 12b	$Ni \rightarrow Ni^{2+} + 2e^-$	Equation is on page 11 of data booklet but in the reverse direction.
2015 13b	$Al \rightarrow Al^{3+} + 3e^-$	Electrons are always on the right of an equation to be a corrosion reaction. The data book always list equations as reduction reactions with electrons on the left of the equation. The equation is flipped to become an oxidation reaction.

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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		
6a 8a							10b			17d	17c					
6b 8b			13b	16b(ii)	16c	10a(i)	14c		13b	17a		21b	16b(ii) 19a	14b		
7																
9																

SG Credit	Answer	Reasoning
2002C 13b	$Cu \rightarrow Cu^{2+} + 2e^-$	Redox Reaction: $Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$ Separate equations: $2Ag^+ \rightarrow 2Ag$; $Cu \rightarrow Cu^{2+}$ Reduction: $2e^- + 2Ag^+ \rightarrow 2Ag$ Oxidation: $Cu \rightarrow Cu^{2+} + 2e^-$
2003C 16b(ii)	Reduction	Reduction is Gain of Electrons: $Fe^{3+} + e^- \longrightarrow Fe^{2+}$
2004C 16c	$2Cl^- \longrightarrow Cl_2 + 2e^-$	reverse of equation on p10 of data booklet
2005C 10a(i)	$Zn \rightarrow Zn^{2+} + 2e^-$	Equation for reduction of Zn^{2+} ions to Zn atoms is on page 10 of data booklet. Oxidation is the reverse of reaction in data booklet
2006C 10b	Reduction	Fe^{3+} ions are gaining electrons $\therefore$ reduction
2006C 14c	$H_2 \rightarrow 2H^+ + 2e^-$	reverse of equation on page 10 of data booklet
2008C 13b	$2Cl^- \rightarrow Cl_2 + 2e^-$	From p10 pf data booklet: $Cl_2 + 2e^- \longrightarrow 2Cl^-$ Question asks for the formation of chlorine so reverse equation
2009C 17a	Oxidation	Oxidation is loss of electrons (electrons after the arrow) Reduction is gain of electrons (electrons before the arrow)
2009C 17d	$Br_2 + 2e^- \rightarrow 2Br^-$	Solution at electrode X contains Bromine Br_2 which reacts with the electrons travelling through the wires from electrode Y to form Bromide Br^- ions. This equation is found on p10 of data booklet.
2010C 17c	$Ag^+ + e^- \rightarrow Ag$	$Fe(s) + 2Ag^+(aq) \rightarrow Fe^{2+}(aq) + 2Ag(s)$ redox Separate out equations and balance charge with e^- $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$ oxidation $2e^- + 2Ag^+(aq) \rightarrow 2Ag(s)$ reduction
2011C 21b	$Au^+ + 2e^- \rightarrow Au$	Au^+ ions must pick up electrons from electrode B to form Au atoms
2012C 16b(ii)	$2Cl^- \rightarrow Cl_2 + 2e^-$	Chloride ions (Cl^-) are attracted to the positive electrode where they lose an electron each as they turn into Chlorine atoms. Chlorine atoms then pair up into a diatomic molecule Cl_2. This oxidation reaction is the reverse of the reduction reaction on page 10 of the data booklet.
2012C 19a	Oxidation	Type: oxidation — OILRIG: loss of electrons — Position of Electrons: Electrons after arrow Type: reduction — OILRIG: gain of electrons — Position of Electrons: Electrons before arrow
2013C 14b	$Zn \rightarrow Zn^{2+} + 2e^-$	$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$ Split the redox reaction into its component halves $Zn(s) \rightarrow Zn^{2+}(aq)$ $Cu^{2+}(aq) \rightarrow Cu(s)$ Balance equations by adding electrons into ion-electrons equations $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ Oxidation reactions have electrons <u>after</u> the arrow Reduction Reactions have electrons <u>before</u> the arrow

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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		
6a 8a																
6b 8b																
7																
9																