Assessment Schedule – 2011

Chemistry: Describe oxidation-reduction reactions (90311)

Evidence Statement

<table>
<tr><th>Q</th><th>Evidence</th><th>Achievement</th><th>Achievement with Merit</th><th>Achievement with Excellence</th></tr>
<tr><td>ONE
(a)</td><td>The oxidation number of carbon (in methane) increases from –4 to +4, hence oxidation, and the oxidation number of oxygen (in oxygen) decreases from 0 to –2, hence reduction.</td><td>THREE of

• Oxidation numbers given correctly for a reactant and product and the correct process assigned.
eg C –4 to +4 oxidation.
Roman numerals OK for ONs.</td><td>TWO of

• Explains oxidation in terms of increase in oxidation number for carbon. And reduction in terms of decrease in oxidation number for oxygen.</td><td>ALL

• Part a) full discussion with correct oxidation numbers.</td></tr>
<tr><td>(b)</td><td>The reductant is Fe (which reduces Cu^{2+}). Fe loses electrons as it oxidised to Fe^{2+}. (These electrons are transferred to Cu^{2+}.)</td><td>• Fe is reductant as it loses electrons.
(Can't use oxidation numbers.)</td><td></td><td></td></tr>
<tr><td>(c)(i)</td><td><table><tr><td>Species</td><td>VO^{2+}</td><td>V^{3+}</td><td>V_2O_5</td><td>VO_3^-</td><td>VO_2^+</td></tr><tr><td>Oxdn number</td><td>+4</td><td>**+3**</td><td>**+5**</td><td>**+5**</td><td>**+5**</td></tr></table></td><td>• Three out of four oxidation numbers correct.</td><td></td><td></td></tr>
<tr><td>(ii)</td><td>Zn is the reductant and is oxidised to Zn^{2+}. Zn is oxidised, as the oxidation number of zinc has increased from zero to +2 (or the Zn has lost electrons).
VO^{2+} is the oxidant and is reduced to V^{3+}. VO^{2+} is reduced, as the oxidation number of vanadium has decreased from +4 to +3.
$Zn \rightarrow Zn^{2+} + 2e$
($Zn - 2e \rightarrow Zn^{2+}$ OK)

$VO^{2+} + 2H^+ + e \rightarrow V^{3+} + H_2O$
$Zn + 2VO^{2+} + 4H^+ \rightarrow 2V^{3+} + 2H_2O + Zn^{2+}$</td><td>• Zn identified as species oxidised / reductant AND VO^{2+} identified as species reduced / oxidant.
(OK if V stated as oxidant and VO^{2+} used in equation.)

• Zinc half-equation OR VO^{2+} half-equation.</td><td>• Links zinc as a reductant and is oxidised, to reasons in terms of increase in oxidation number or loss of electrons. (must have correct oxidation numbers)

• Links VO^{2+} as an oxidant and is reduced, to reasons in terms of decrease in oxidation number or loss of electrons. (must have correct oxidation numbers)

• Both zinc half-equation AND VO^{2+} half-equation correct.</td><td>• A full discussion for BOTH zinc as a reductant and is oxidised, with reasons AND VO^{2+} as an oxidant and is reduced, with reasons (electron transfer or oxidation number change).

• Both half-equations and overall equation correct.</td></tr>
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TWO (a)(i)	Pale green / green / colourless to orange / brown / yellow and combinations, eg orange-yellow / red-orange / orange-brown / rust colour	THREE of • Colour change for Fe^{2+} to (Fe^{3+}) correct. • Colour change for $Cr_2O_7^{2-}$ (to Cr^{3+}) correct. Both colours needed. • Colour change for iodine solution (to I^-) correct. • H_2O_2 half-equation correct. OR HSO_3^- half-equation correct. $Cr_2O_7^{2-}$ half-equation correct. OR I_2 half-equation correct.	Observations correctly linked to species for two reactions from (a) (b) and (c). Both colours needed for (b). AND Any two half-equations for these two reactions correct (two out of four half-equations). The half equations must link to an observation Note: Correct reaction must be HSO_3^- part (c) for merit.	Part (a) fully correct. OR Part (b) fully correct. AND Full discussion for (c) that allows for $KHSO_3$ and KBr to be identified with observations linked to species, half-equations and overall equation correct.
(ii)	The pale green colour is due to Fe^{2+}. The orange-brown colour is due to Fe^{3+}.			
(iii)	$H_2O_2 + 2H^+ + 2e \rightarrow 2H_2O$			
(b)(i)	Orange			
(ii)	Green / Blue-green / blue Cr^{3+}			
(iii)	$Cr_2O_7^{2-} + 14H^+ + 6e \rightarrow 2Cr^{3+} + 7H_2O$			
(c)	Add iodine solution to each unknown solution. For $KBr + I_2$ There is no reaction; the solution will remain brown due to I_2. For $KHSO_3 + I_2$ The brown / yellow / orange I_2 solution will turn colourless due to the formation of I^- and SO_4^{2-} (both colourless) Hence both solutions can be identified. For $KHSO_3 + I_2$ This is an oxidation-reduction reaction. Iodine acts as an oxidant; it oxidises HSO_3^- (to SO_4^{2-}) and is reduced to I^-. Oxidation half-equation $HSO_3^- + H_2O \rightarrow SO_4^{2-} + 3H^+ + 2e$ OR $HSO_3^- + H_2O \rightarrow HSO_4^- + 2H^+ + 2e$ (Allow $SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^+ + 2e$) Reduction half-equation $I_2 + 2e \rightarrow 2I^-$ Overall equation $HSO_3^- + H_2O + I_2 \rightarrow SO_4^{2-} + 3H^+ + 2I^-$			

THREE	Al forms at the cathode (negative electrode). It is seen as a grey molten metal. O_2 forms at the anode (positive electrode). It is seen as bubbles of a colourless gas. Al^{3+} move to the cathode, therefore a reduction reaction occurs. Al^{3+} is reduced to Al. O^{2-} move to the anode, therefore an oxidation reaction occurs. O^{2-} is oxidised to O_2. Electrons are produced at the anode, as shown by the equation below: $2O^{2-} \rightarrow O_2 + 4e$ These electrons travel through the wire to the cathode, where the following reaction occurs: $Al^{3+} + 3e \rightarrow Al$ Overall equation not required	THREE of: • Aluminium produced at cathode OR oxygen at anode. • ONE correct half equation. • ONE correct observation. O_2 gas is OK and silver grey metal (solid) Anode getting smaller (CO_2 gas) or cathode getting bigger for achieved only. • Cations move to the negative electrode (cathode) or anions move to the positive electrode (anode). • Reduction occurs at cathode or Al^{3+} is reduced AND oxidation occurs at anode or oxide is oxidised. • Electron movement from anode to cathode (through an external wire) Note – if electrodes assigned incorrectly in first bullet point allow fourth bullet point.	Correct explanation of reaction occurring at one electrode linked to observation, oxidation reduction process, and half-equation. Electrode must be assigned correctly. O_2 gas is OK for merit only and silver grey metal (solid) No contradictions.	Discussion demonstrates understanding of the reaction of O^{2-} at anode and Al^{3+} at cathode including observations, oxidation reduction process, movement of ions and electrons and half-equations. Must have correct assignment of electrodes and discussion of electron and ion movement. Allow aluminium solid observation if that is all that is incorrect. Require observation of bubbles or gas seen for excellence (Accept $2O^{2-} \rightarrow O_2 + 2e$ if this is all that is incorrect.) Movement of ions can be attraction to electrodes, movement of electrons can be from anode to cathode or electrons lost to anode and gained at cathode.

Judgement Statement

Achievement	Achievement with Merit	Achievement with Excellence
2 **A**	2 **M** + 1 **A** *OR* 1 **E** + 1 **M**	2 **E**