**Assessment schedule 2009 for AS 90696 Chemistry 3.3-** Describe oxidation – reduction processes

| Question number | Evidence | Achievement | Merit | Excellence |
|---|---|---|---|---|
| **One (a)** | Reductant: $H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$<br>Oxidant: $H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$ | Two of three equations correct | | |
| **One (b)** | $2OCl^- + 4H^+ + 2e^- \rightarrow Cl_2 + 2H_2O$ | | | |
| **One (c)** | The chlorine has been both oxidised and reduced.<br>In one reaction the oxidation state of chlorine goes both up and down, from 0 to -1 in HCl and from 0 to +1 in HOCl. | Identifies that $Cl_2$ is both oxidised and reduced. | Links the 3 oxidation numbers of Cl to the species. | |
| **One (d)** | Mn is reduced from +7 down to +4. $MnO_4^-$ is the oxidant.<br><br>C is oxidised from -2 up to +2. $CH_3OH$ is the reductant. | Has determined the change in oxidation states for both reactants. | Has linked the change in oxidation state to a redox process for both pairs. | Has clearly justified which is the oxidant and reductant. |
| **One (e)(i)** | The brown coin would react with the acid and gradually disappear.<br>The colourless acid solution would gradually turn blue/green. This is due to the formation of $Cu^{2+}$ (when Cu is oxidised).<br>A brown / pungent brown gas would be evolved / given off. This is due to $NO_2$ (that is formed when $NO_3^-$ is reduced). | Has given two observations or one observation linked to a species. | Has given two linked observations. | Has linked the observations and stated the reduction/oxidation that occurred. |
| **One (e)(ii)** | $NO_3^- + 2H^+ + e^- \rightarrow NO_2 + H_2O$<br>$Cu \rightarrow Cu^{2+} + 2e^-$<br>$2NO_3^- + 4H^+ + Cu \rightarrow 2NO_2 + 2H_2O + Cu^{2+}$ | Two equations correct. | All three equations correct. | |
| **Two (a)** | $E^0cell = E_{reduction} - E_{oxidation} = +1.51 - (-0.45) = +1.96V$ | Correct numerical answer | With correct sign, unit and working | |
| **Two (b)** | The pale green colour of the solution of $Fe^{2+}$ will **strengthen.**<br>The purple colour of $MnO_4^-/Mn^{2+}$ mixture will **get paler**. | Both correct | | |
| **Two (c)** | (i) platinum<br>(ii) Iron<br>(iii) from Iron / anode to platinum / cathode<br>(iv) towards the anode half cell / towards the $Fe^{2+}/Fe$ half cell | Three of these correct | | |

<table>
<tr><td>Two<br>(d)</td><td>The voltage of -0.31V suggests that the reaction is not spontaneous in that direction. However, if the voltmeter was reversed the spontaneous voltage of +0.31V would be gained. This means that the Fe is no longer undergoing oxidation, but that the $Fe^{2+}$ is reducing to Fe, and that it is the Zn that is instead oxidising to $Zn^{2+}$.<br>$Zn_{(s)}/Zn^{2+}_{(aq)}//Fe^{2+}_{(aq)}/Fe_{(s)}$</td><td>Reverse the voltmeter or reverse the value or gives the diagram.</td><td>Explains that now $Fe^{2+}$ is reducing. And includes the diagram.</td><td></td></tr>
<tr><td>Two<br>(e)(i)</td><td>---(1) x 5 and ---(2) x 2 {Not<br>$5Fe \rightarrow 5Fe^{2+} + 10e^-$ {required<br>$2MnO_4^- + 16H^+ + 10e^- \rightarrow 2Mn^{2+} + 8H_2O$ {to be shown<br>$2MnO_4^- + 16H^+ + 5Fe \rightarrow 2Mn^{2+} + 8H_2O + 5Fe^{2+}$</td><td>Correct equation given.</td><td></td><td></td></tr>
<tr><td>Two<br>(e)(ii)</td><td>$n = cV = 0.0300molL^{-1} \times 0.050L = 0.00150mol$ of $MnO_4^-$.<br>$0.0015mol \times (^5/_2) = 0.00375mol$ of Fe.<br>$m = nM = 0.00375mol \times 55.8gmol^{-1} = 0.209g$</td><td>Calculation of amount of substance (mol) of $MnO_4^-$.</td><td>Calculation steps applied using Two(e)(i)’s mole ratio. One error in calculation.</td><td>Correct answer including units correct to 3sig.figs (using student’s own Two(e)(i) mole ratio)</td></tr>
<tr><td>Two<br>(f)</td><td>$E^0cell = E_{reduction} – E_{oxidation} = +1.51 – (Sn^{2+}/Sn) = +1.65V$<br>$Sn^{2+}/Sn = -0.14V$</td><td>Correct numerical answer</td><td>With correct unit and working</td><td></td></tr>
<tr><td>Three</td><td>Only $Cl_2$ reduces spontaneously against Ag, so best oxidiser.<br>$Ag^+$ is the next best oxidiser, because all other reactions have $Ag^+$ undergoing reduction.<br>Least positive voltage difference is with $Fe^{2+}$, so $Fe^{3+}$ is the third best oxidiser, then $Sn^{4+}$, then $H^+$.<br>The $H^+/H_2$ must be 0.00V, and $Ag^+/Ag$ must therefore be +0.80V.<br>$Cl_2/Cl^-$ is +0.56V higher than +0.80V, so +1.36V.<br>$Fe^{3+}/Fe^{2+}$ is 0.03V below +0.80V, so +0.77V<br>$Sn^{4+}/Sn^{2+}$ is 0.65V below +0.80V, so +0.15V
<table>
<tr><td>Oxidised form / reduced form</td><td>$E^0$ half cell (V)</td></tr>
<tr><td>$Cl_2$/Cl-</td><td>+1.36</td></tr>
<tr><td>$Ag^+/Ag$</td><td>+0.80</td></tr>
<tr><td>$Fe^{3+}/Fe^{2+}$</td><td>+0.77</td></tr>
<tr><td>$Sn^{4+}/Sn^{2+}$</td><td>+0.15</td></tr>
<tr><td>$H^+/H_2$</td><td>+0.00</td></tr>
</table></td><td>Three half cells placed in the correct order relative to other.<br><br>OR<br><br>Three $E^0$cell values correct for any right or wrongly placed half cell.</td><td>Three half cells placed in the correct order relative to each other<br>AND<br>Any three $E^0$cell values correct for any right or wrongly placed half cell.<br>AND<br>Some valid explanation presented.</td><td>The whole table correct for both columns.<br>AND<br>Valid justification for the order and determined $E^0$ half cell values, based upon the $E^0$cell values given.</td></tr>
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**Judgement Statement**

| **Achievement** | **Achievement with Merit** | **Achievement with Excellence** |
|---|---|---|
| EIGHT questions answered correctly.<br><br>Minimum of 8 x A | NINE questions answered correctly including at least FIVE at Merit level.<br><br>Minimum of 5 x M + 4 x A | TEN questions answered correctly including at least TWO at Excellence level and FIVE at Merit level.<br><br>Minimum of 2 x E + 5 x M + 3 x A |