Assessment Schedule – 2007

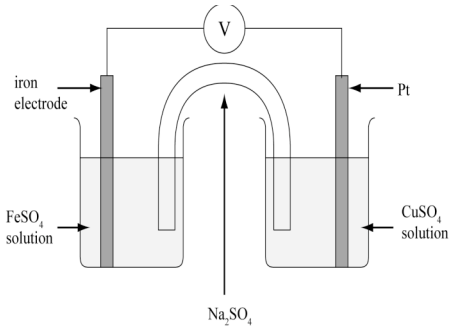
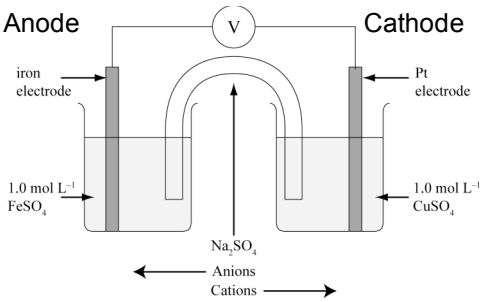
Chemistry: Describe oxidation-reduction processes (90696)

Evidence Statement

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE (a)(i)	$E°_{cell}$ = –0.44 V – (– 0.76 V) = 0.32 V	Correct numerical answer.	Correct numerical answer, correct sign and unit with correct working.	
(ii)	$Zn \rightarrow Zn^{2+} + 2e$ $Fe^{2+} + 2e \rightarrow Fe$ $Zn + Fe^{2+} \rightarrow Zn^{2+} + Fe$	Correct equation. [*No follow on*]		

(b)	Because the E^o for the reduction of Fe^{2+} is less negative than the E^o for the reduction of Zn^{2+}, Zn(*s*) is easier to oxidize than Fe(s). When the zinc coating is broken, and the iron is exposed to water and oxygen, the iron acts as a cathode and the zinc as the anode in an electrochemical cell as the zinc is oxidized (sacrificed) in preference to the iron, thus preventing corrosion of the iron. The zinc is corroded instead of the iron. The cell diagram for the cell reaction is $Fe/Fe^{2+}//Zn^{2+}/Zn$.
	
	$E_{cell} = E°_{red} – E°_{oxn}$
	= –0.76V – (-0.44V)
	= –0.32V
	
	Because the $E°$ for the reduction of Fe^{2+} is more negative than the E^o for the reduction of Sn^{2+}, Sn(*s*) is harder to oxidize than Fe(*s*). When the tin coating is broken, and the iron is exposed to water and oxygen, the iron is corroded instead of the tin. The corrosion of the iron is accelerated by the presence of any Sn^{2+}.
	
	The cell diagram for the spontaneous cell reaction is $Fe/Fe^{2+}//Sn^{2+}/Sn$.
	
	$E_{cell} = E°_{red} – E°_{oxn}$
	= –0.14V – (-0.44V)
	= 0.30V
		Recognises that zinc is higher on the activity series than iron
		AND
		more reactive than iron.
		OR
		tin is lower on the activity series than iron
		AND
		less reactive than iron.
		OR
		
		equivalent statement using an E° value.
		
		OR
		
		ONE electrochemical cell calculation correct.
			$E°$ value for the cell $Zn/Zn^{2+}//Fe^{2+}/Fe$ (0.32V) OR $Fe/Fe^{2+}//Zn^{2+}/Zn$ (–0.32V)
			AND
			E^o value for the cell $Sn/Sn^{2+}//Fe^{2+}/Fe$ (–0.30V) $Fe/Fe^{2+}//Sn^{2+}/Sn$ (0.30V)
			With calculations shown.
			
			OR
			ONE calculation with correct explanation
				Correct explanation of answer using the $E°$ value for the cell $Zn/Zn^{2+}//Fe^{2+}/Fe$ (0.32V) $Fe/Fe^{2+}//Zn^{2+}/Zn$ (–0.32V)
				AND
				correct explanation of the answer using the E^o value for the cell $Sn/Sn^{2+}//Fe^{2+}/Fe$ (–0.30V) $Fe/Fe^{2+}//Sn^{2+}/Sn$ (0.30V)
				AND
				Summary statement about rusting for each can
				AND
				Zinc will react.

TWO (a) (i)	<table><tr><th>Species</th><th>Oxidation number</th></tr><tr><td>K_2MnO_4</td><td>+6</td></tr><tr><td>MnO_2</td><td>+4</td></tr><tr><td>MnO_4^{-1}</td><td>+7</td></tr></table>	THREE correct.		
(ii)	A disproportionation reaction is an oxidation-reduction in which the same substance is oxidised and reduced. **OR** the oxidation number of the same substance is increased and reduced.	Correct description.		
(b)	The solution is initially green due to the presence of MnO_4^{2-} (*aq*). It then turns purple due to the presence of MnO_4^{1-} (*aq*) and a dark brown / black precipitate of MnO_2 forms.	TWO colour observations correctly linked to species.	THREE colour observations correctly linked to species.	
(i)	($MnO_4^{2-} \rightarrow MnO_4^{-} + 1e) \times 2$ $\underline{MnO_4^{2-} + 4H^+ + 2e \rightarrow MnO_2 + 2H_2O}$ $3MnO_4^{2-} + 4H^+ \rightarrow MnO_2 + 2MnO_4^{-} + 2H_2O$	BOTH half-equations correctly balanced and in correct box. **OR** Correctly balanced full equation	BOTH half-equation correctly balanced and in correct box. **AND** Correct balanced full equation.	
(ii)	$n(K_2MnO_4) = 1.05 \div 197.1$ $= 0.00533$ mol From eqn above, $n(MnO_2) = \frac{1}{3} (0.00533)$ $= 0.00178$ mol $m(MnO_2) = 0.00178 \times 86.9$ $= 0.1543$ g $= 0.154$ g (3 sig figs)	Calculation of number of moles of K_2MnO_4 correct.	Correct procedure with one minor mathematical error. Rounding up DURING the calculation is a minor mathematical error (0.155g)	Correct answer including units and 3 sig figs.

3 (a)	Fe | Fe^{2+} || Cu^{2+} | Cu	Non-spontaneous reaction given.	Correct answer.	
(b)	0.34 –(–0.44) = 0.78 V	Correct answer and unit.		
(c) (i)		TWO half cell solutions correctly identified (Fe^{2+}, Cu^{2+}) **OR** Salt bridge solution identified.	TWO half cell solutions **AND** The salt bridge solution correctly identified.	
(ii)	The electrode must be iron as it is a reactant in this half cell.	Electrode correctly identified.		
(iii)	Any inert electrode can be used in the Cu^{2+} half-cell as it is providing a surface for the reaction $Cu^{2+} + 2e \rightarrow Cu$. In the Fe^{2+} half-cell the electrode must be iron as the electrode acts as a source of Fe^{2+} ions. $Fe \rightarrow Fe^{2+} + 2e$	Pt electrode linked to reaction in correct half cell **OR** Iron electrode linked to to reaction in correct half cell.	Pt electrode linked to reaction in correct half cell **AND** iron electrode linked to to reaction in correct half cell.	Pt electrode linked to Cu^{2+} solution $Cu^{2+} + 2e \rightarrow Cu$ **AND** iron electrode linked to Fe^{2+} solution $Fe \rightarrow Fe^{2+} + 2e$ **AND** Pt is inert.
(d)	 Electrons move from the iron electrode to the platinum electrode because electrons are produced by $Fe \rightarrow Fe^{2+} + 2e$. Anions in the salt bridge move through the salt bridge to the Fe^{2+} solution to balance the charges. Cations in the salt bridge move through the salt bridge to the Cu^{2+} solution to balance the charges. Cu^{2+} ions are being removed from the RHS solution. Fe^{2+} ions are being produced in the LHS solution.	Correct movement of electrons with reason. **OR** Correct movement of salt bridge anion OR cation. **OR** Correct movement of Cu^{2+} and Fe^{2+} ions out of and into solution.	Correct movement of electrons with reason. **AND** correct movement of salt bridge anion **AND** cation.	Full description including reason for movement of ions and electrons. [*Check for correct movement of ions and electrons with reasons]*

Judgement Statement

Achievement	Achievement with Merit	Achievement with Excellence
EIGHT opportunities answered at Achievement level (or higher). Minimum of 8 × A	NINE opportunities answered including at least FIVE at Merit level (or higher) and FOUR at Achievement level (or higher). Minimum 5 × M + 4 × A	TEN opportunities answered including at least TWO at Excellence level plus FIVE at Merit level (or higher) and THREE at Achievement level (or higher). Minimum 2 × E + 5 × M + 3 × A