Assessment Schedule – 2006

Chemistry: Describe oxidation-reduction processes (90696)

Evidence Statement

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
1(a)	In $Cr_2O_7^{2-}$ ox number of Cr is +6 but in Cr^{3+} it is +3, so decrease of oxidation number or gain of electrons therefore a reduction.	Correct oxidation numbers with valid statement.		
1(b)	$Cu \rightarrow Cu^{2+} + 2e$ OR $Cu - 2e \rightarrow Cu^{2+}$ $Cr_2O_7^{2-} + 14H^+ + 6e \rightarrow 2Cr^{3+} + 7H_2O$ $Cr_2O_7^{2-} + 14H^+ + 3Cu \rightarrow 2Cr^{3+} + 7H_2O + 3Cu^{2+}$	Two half equations correctly balanced.	All three equations correct.	
1(c)	Changes in half-cells are: In copper half-cell • Copper electrode erodes or starts to disappear. • Solution goes (darker) blue (Cu^{2+} forming). In dichromate half-cell • Solution goes from orange ($Cr_2O_7^{2-}$) to blue/green (Cr^{3+}).	Identifies one observed change in each half cell.		
2(a)	The E^o_{cell} for the reaction between MnO_4^- and Mn^{2+} is -0.64V, and being negative means the reaction will not spontaneously occur. **OR** Recognizes reduction potential of E^o (MnO_4^-/Mn^{3+}) is less than E^o(Mn^{3+}/Mn^{2+}) so MnO_4^- cannot be spontaneously reduced by Mn^{2+}.	Identify a negative value of E^o_{cell} means no reaction **OR** Recognises reduction potential of E^o (MnO_4^-/Mn^{3+}) is less than E^o(Mn^{3+}/Mn^{2+}).	Shows calculation to determine E^o_{cell} value of –0.64V and links to fact that no reaction occurs. **OR** Explanation that correctly links reduction potentials to strength of oxidant and reductant so that no reaction occurs.	

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2(b)	(i) • In the acidified solution, observation is purple to colourless or pale pink solution because the purple MnO_4^- is reduced to colourless Mn^{2+} (both the sulfite and sulfate ion produced by oxidation are colourless species). • In the weakly alkaline solution, the purple solution of MnO_4^- forms a black or brown precipitate of MnO_2 solid. • In the strongly alkaline solution the MnO_4^- solution is reduced to a green solution of MnO_4^{2-}. (ii) $5SO_3^{2-} + 2MnO_4^- + 6H^+ \rightarrow 5SO_4^{2-} + 2Mn^{2+} + 3H_2O$	At least two correct observations linked to species involved **OR** Correct observations for all three reactions of MnO_4^-. **OR** All four species correctly linked to their colours **OR** Redox reactants and products identified: SO_3^{2-} and MnO_4^-, Mn^{2+} and SO_4^{2-}	All observations correct and linked to species involved. **OR** Fully balanced equation correct.	All correct observations with links to species and correctly balanced equation.
3(a) (b)	In Cell One the beakers are connected by a bridge containing methanol, which is a non-electrolyte and therefore will not allow flow of ions. Needs to be replaced with a salt bridge or solution of an ionic substance such as KNO_3. In Cell Two a spontaneous reaction occurs in the right-hand beaker where the Zn is oxidised and Cu^{2+} reduced. There would be no reaction in the left-hand beaker and no flow of charge. Reversing the electrodes or the solutions in the beakers would result in a flow of charge between the half-cells.	Correctly explains the problem in one cell and how the problem can be fixed.	Identifies and explains the problem in both cells.	
4(a)	(i) • e^- flow from left to right • left electrode negative / right electrode positive. (ii) $E^o_{cell} = +0.74\ V = E^o(H^+/H_2) - E^o(X^{3+}/X)$ $E^o(X^{3+}/X) = -0.74\ V$ The H^+/H_2 electrode is positive because electrons are flowing towards this electrode. This electrode has a standard reduction potential of 0.00 V, so the voltage on the voltmeter gives the difference between this electrode where reduction occurs and the other electrode where oxidation occurs. The other electrode must be more negative than 0.00 V by the reading on the voltmeter.	Direction of electron flow consistent with sign on electrodes, ie as written or both direction of electron flow and signs on electrodes reversed. **OR** $E^o(X^{3+}/X) = -0.74\ V$ with no working shown. **OR** Recognition that difference in reduction potential between $E^o(X^{3+}/X)$ and $E^o(H^+/H_2) = 0.00\ V$ gives value of 0.74 V.	$E^o(X^{3+}/X) = -0.74\ V$ is calculated or explained correctly by comparison with $E^o(H^+/H_2) = 0.00\ V$ and either direction of e^- flow or labeling of electrodes is correct. **OR** Comparison with $E^o(H^+/H_2) = 0.00\ V$ gives $E^o(X^{3+}/X) = +0.74\ V$, and direction of electron flow and signs of electrodes both reversed. **OR** Direction of electron flow and reduction potential correct, but no or limited explanation/calculation.	All correct with valid explanation / calculation for electrode potential.

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(b)	$Mn \rightarrow Mn^{2+} + 2e$ $X^{3+} + 3e \rightarrow X$ $2X^{3+} + 3Mn \rightarrow 2X + 3Mn^{2+}$ $n(Mn) = \dfrac{200\ g}{54.9\ g\ mol^{-1}} = 3.64\ mol$ $n(X) = \dfrac{2}{3} \times n(Mn) = \dfrac{2}{3} \times 3.64\ mol$ $= 2.43\ mol$	Method correct but mathematical error. This includes correct balanced equation but use inverted ratio to get n(X) =5.46 mol. **OR** incorrectly balanced eqn but application of ratio in that eqn correct.	Answer correct.	
5(a) (b)	Zn > Ga > Fe Answer discusses fact that $E°(Fe^{2+}/Fe) >(E°(Ga^{3+}/Ga) > E°(Zn^{2+}/Zn)$. Ie as zinc can reduce both Ga^{3+} and Fe^{2+} it is the strongest reductant ($E°(Ga^{3+}/Ga)$ and $E°(Fe^{2+}/Fe)$ must be greater than $E°(Zn^{2+}/Zn)$). Ga is a stronger reductant than Fe as Ga can reduce Fe^{2+}, but Fe cannot reduce Ga^{3+} and $E°(Fe^{2+}/Fe)$ must be greater than $E°(Ga^{3+}/Ga)$.	Order of reductants (in part a) correct without valid justification. **OR** In part (b) identifies order of $E°(Fe^{2+}/Fe) >(E°(Ga^{3+}/Ga) > E°(Zn^{2+}/Zn)$.	Order of reductants correct and linked to information in table in terms of species that react and don't react. **OR** Links info in table to order of $E°(Fe^{2+}/Fe) >(E°(Ga^{3+}/Ga) > E°(Zn^{2+}/Zn)$ but lists reductants as ions (ie order of oxidants $Fe^{2+} > Ga^{3+} > Zn^{2+}$.	Answer shows correct order of metals as reductants and discussion clearly relates the order to the relevant E^o values. eg best reductant will have most negative E^o value and will be metal reacting with both of the other metal ions.

Judgement Statement

Chemistry: Describe oxidation-reduction processes (90696)

Achievement	Achievement with Merit	Achievement with Excellence
FIVE questions answered correctly. Minimum of 5 × A	SIX questions answered correctly, including at least FOUR at Merit level. Minimum of 4 × M + 2 × A	SEVEN questions answered correctly, including at least THREE at Merit level and at least TWO at Excellence level. Minimum of 2 × E + 3 × M + 2 × A