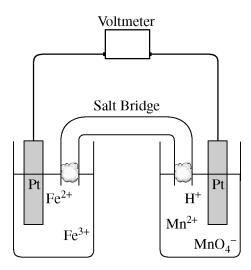
2010 AP® CHEMISTRY FREE-RESPONSE QUESTIONS (Form B)



$$5 \text{ Fe}^{2+}(aq) + \text{MnO}_4^-(aq) + 8 \text{ H}^+(aq) \rightarrow 5 \text{ Fe}^{3+}(aq) + \text{Mn}^{2+}(aq) + 4 \text{ H}_2\text{O}(l)$$

2. A galvanic cell and the balanced equation for the spontaneous cell reaction are shown above. The two reduction half-reactions for the overall reaction that occurs in the cell are shown in the table below.

Half-Reaction	<i>E</i> ° (V) at 298 K
$Fe^{3+}(aq) + e^{-} \rightarrow Fe^{2+}(aq)$	+ 0.77
$MnO_4^-(aq) + 8 H^+(aq) + 5 e^- \rightarrow Mn^{2+}(aq) + 4 H_2O(l)$	+1.49

- (a) On the diagram, clearly label the cathode.
- (b) Calculate the value of the standard potential, E° , for the spontaneous cell reaction.
- (c) How many moles of electrons are transferred when 1.0 mol of $MnO_4^-(aq)$ is consumed in the overall cell reaction?
- (d) Calculate the value of the equilibrium constant, K_{eq} , for the cell reaction at 25°C. Explain what the magnitude of K_{eq} tells you about the extent of the reaction.

Three solutions, one containing $\mathrm{Fe^{2+}}(aq)$, one containing $\mathrm{MnO_4^-}(aq)$, and one containing $\mathrm{H^+}(aq)$, are mixed in a beaker and allowed to react. The initial concentrations of the species in the mixture are $0.60~M~\mathrm{Fe^{2+}}(aq)$, $0.10~M~\mathrm{MnO_4^-}(aq)$, and $1.0~M~\mathrm{H^+}(aq)$.

- (e) When the reaction mixture has come to equilibrium, which species has the higher concentration, $Mn^{2+}(aq)$ or $MnO_4^-(aq)$? Explain.
- (f) When the reaction mixture has come to equilibrium, what are the molar concentrations of $Fe^{2+}(aq)$ and $Fe^{3+}(aq)$?

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