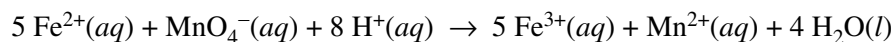
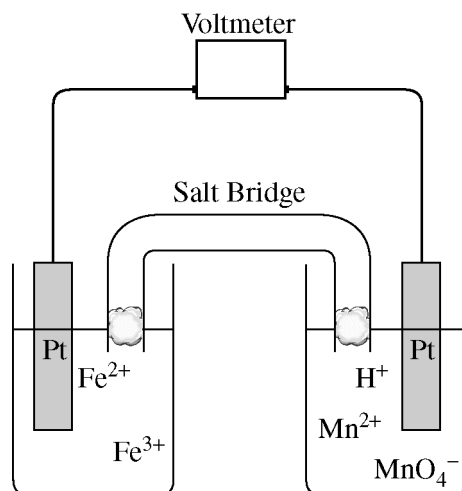


2010 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS (Form B)



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	$E^{\circ}$ (V) at 298 K
$\text{Fe}^{3+}(aq) + e^{-} \rightarrow \text{Fe}^{2+}(aq)$	+0.77
$\text{MnO}_4^{-}(aq) + 8 \text{H}^{+}(aq) + 5 e^{-} \rightarrow \text{Mn}^{2+}(aq) + 4 \text{H}_2\text{O}(l)$	+1.49

- (a) On the diagram, clearly label the cathode.
- (b) Calculate the value of the standard potential,  $E^{\circ}$ , for the spontaneous cell reaction.
- (c) How many moles of electrons are transferred when 1.0 mol of  $\text{MnO}_4^{-}(aq)$  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  $\text{Fe}^{2+}(aq)$ , one containing  $\text{MnO}_4^{-}(aq)$ , and one containing  $\text{H}^{+}(aq)$ , are mixed in a beaker and allowed to react. The initial concentrations of the species in the mixture are 0.60 M  $\text{Fe}^{2+}(aq)$ , 0.10 M  $\text{MnO}_4^{-}(aq)$ , and 1.0 M  $\text{H}^{+}(aq)$ .

- (e) When the reaction mixture has come to equilibrium, which species has the higher concentration,  $\text{Mn}^{2+}(aq)$  or  $\text{MnO}_4^{-}(aq)$ ? Explain.
- (f) When the reaction mixture has come to equilibrium, what are the molar concentrations of  $\text{Fe}^{2+}(aq)$  and  $\text{Fe}^{3+}(aq)$ ?