Answer on Question# 56944 - Chemistry - General chemistry

Question:

A battery is constructed at 25ºC using the voltaic cell with initial concentrations Zn|Zn2+ (0.100 M) ||Ag+ (1.500 M) |Ag

How much does the cell voltage drop when 95% of the capacity (i.e., the concentration of Ag drops to 5% of its starting value) is consumed? The standard reduction potentials for the two half-cells are

Zn^{2+} + 2e- → Zn Eº = – 0.76 V

Ag^{+} + e- → Ag Eº = 0.80 V

Solution

The balanced equation is

Zn+2Ag^{+} = Zn^{2+} + 2Ag

The final concentration of Ag+ is 0.05×1.5 = 0.075 M

The ICE table of this reaction is as follows

Zn+2Ag^{+} = Zn^{2+} + 2Ag

	Zn	2Ag^{+}	Zn^{2+}	2Ag
Initial	-	1.5	0.1	-
Change	-	-2x	+x	-
Equilibrium	-	0.075	0.1+0.713 = 0.813	-

1.5-2x = 0.075;

x = 0.713

The Nernst equation for this reaction is (for final concentrations)

$$E = E^{o} - \frac{RT}{zF} lnQ$$

$$E^{o} = 0.80 - (-0.76) = 1.56\ V$$

$$E = 1.56 - \frac{0.059}{2} lg \frac{0.813}{0.075^2} = 1.50\ V$$

The Nernst equation for this reaction is (for initial concentrations)

$$E = 1.56 - \frac{0.059}{2} lg \frac{0.1}{1.5^2} = 1.6\ V$$

The cell voltage drop is 1.600-1.50 = 0.10 V

Answer: 0.10 V.