

13-5

# ~~13-5~~ $E^\circ$ and the Equilibrium Constant: (14)

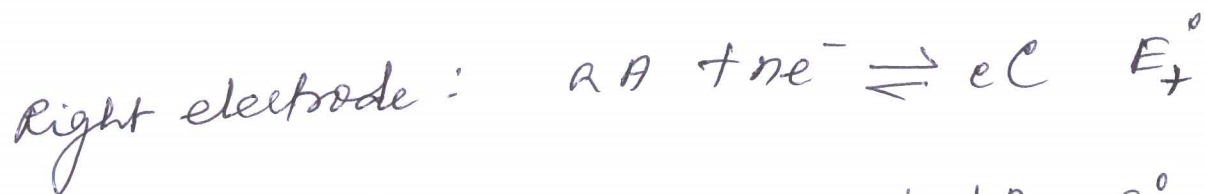
A galvanic cell produces electricity because the cell reaction is not at equilibrium.

At equilibrium,  $E$  (not  $E^\circ$ ) = 0

When a battery (which is a galvanic cell) runs down to 0V, the chemicals inside have reached equilibrium and the battery is "dead."

now let us relate  $E$  for a whole cell to the reaction quotient,  $Q$ , for the net cell reaction.

For the two half-reactions.



the Nernst Equation looks like this:

$$E = E_+ - E_-$$

$$= \left( E_+^0 - \frac{0.05916}{n} \log \frac{[C]^c}{[A]^a} \right) -$$

$$\left( E_-^0 - \frac{0.05916}{n} \log \frac{[B]^b}{[D]^d} \right)$$

$$\therefore E = \underbrace{\left( E_+^0 - E_-^0 \right)}_{E^0} - \frac{0.05916}{n} \log \frac{[C]^c [D]^d}{\underbrace{[A]^a [B]^b}_Q}$$

$$\log a + \log b = \log ab$$

$$E = E^0 - \frac{0.05916}{n} \log Q$$

The above equation is true at any time.

In the special case when the cell is at equilibrium,  $E=0$  and  $Q=k$ , the equilibrium constant.

$\therefore$  the above equation is transformed to these most important forms at equilibrium

$E^0 = \frac{0.05916}{n} \log k$		$\begin{aligned} E &= 0 \\ Q &= k \end{aligned}$
<p>(Finding <math>E^0</math> from <math>k</math>)</p>		

(at 25°C)

Finding  $k$  from  $E^0$

$k = 10^{nE^0/0.05916}$		$E^0 = \frac{0.05916}{n} \log k$
<p>(at 25°C)</p>		$\therefore \log k = \frac{nE^0}{0.05916}$

$$10^{\log k} = 10^{nE^0/0.05916}$$

$$\therefore k = 10^{nE^0/0.05916}$$