

CRITERIA FOR SPONTANEOUS REDOX REACTIONS

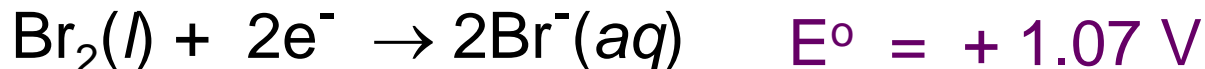
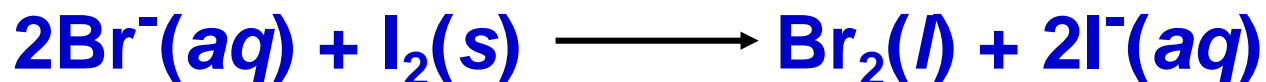
At Standard Conditions	At Non-standard Conditions	Spontaneity of Reaction
$E^{\circ}_{cell} > 0$	$E_{cell} > 0$	The reaction occurs spontaneously.
$E^{\circ}_{cell} = 0$	$E_{cell} = 0$	The reaction is at equilibrium.
$E^{\circ}_{cell} < 0$	$E_{cell} < 0$	The reaction is non-spontaneous.

PREDICTING SPONTANEITY OF A REDOX REACTION

Determination of E°_{cell} and predict spontaneity of a cell reaction at standard conditions

Example 1

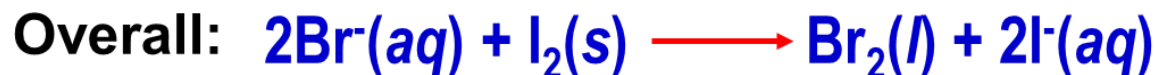
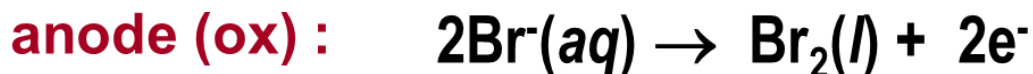
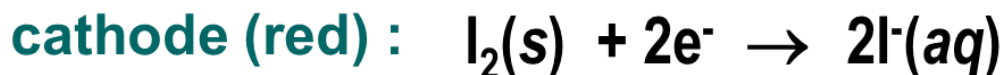
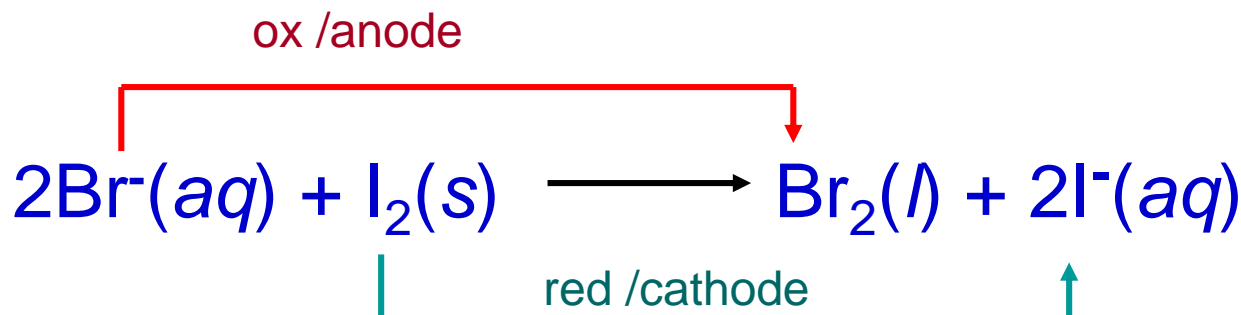
By calculating the E° , determine whether Br^- ion can reduce I_2 under standard conditions.



Note :

In predicting the spontaneity of a reaction, anode and cathode is based on equation given, not based on E° .

Solution :



$$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$$

$$= E^\circ_{\text{I}_2/\text{I}^-} - E^\circ_{\text{Br}_2/\text{Br}^-}$$

$$= 0.53 - 1.07$$

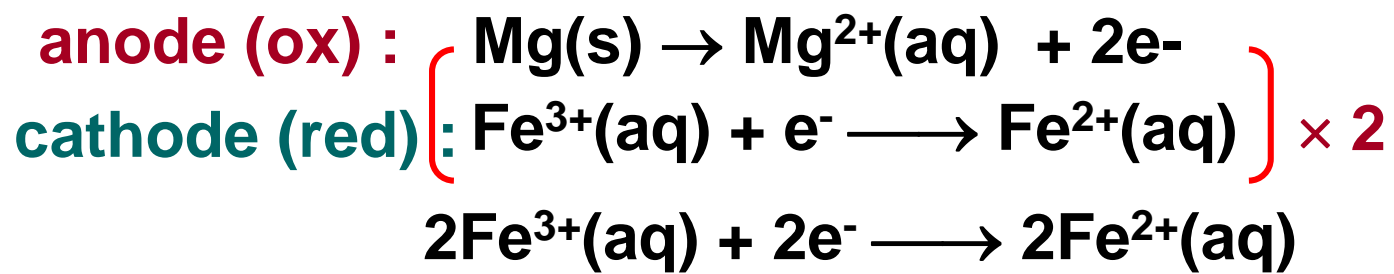
$$= -0.54 \text{ V} //$$

$$E^\circ_{\text{cell}} < 0$$

∴ The Br⁻ ions will not reduce I₂ spontaneously.

Determination of E_{cell} and predict spontaneity of a cell reaction at non-standard conditions

Example



Nernst equation :

$$E_{\text{cell}} = E^{\circ}_{\text{cell}} - \frac{0.0592}{n} \log Q$$

$n = 2$

$$E_{\text{cell}} = E^{\circ}_{\text{cell}} - \frac{0.0592}{2} \log \frac{[\text{Mg}^{2+}][\text{Fe}^{2+}]^2}{[\text{Fe}^{3+}]^2}$$

$$\begin{aligned} E^{\circ}_{\text{cell}} &= E^{\circ}_{\text{cathode}} - E^{\circ}_{\text{anode}} \\ &= E^{\circ}_{\text{Fe}^{3+}/\text{Fe}^{2+}} - E^{\circ}_{\text{Mg}/\text{Mg}^{2+}} \\ &= +0.77 - (-2.37) \\ &= +3.14 \text{ V} \end{aligned}$$

Nernst equation :

$$E_{\text{cell}} = E^{\circ}_{\text{cell}} - \frac{0.0592}{2} \log \frac{[\text{Mg}^{2+}][\text{Fe}^{2+}]^2}{[\text{Fe}^{3+}]^2}$$

$$\begin{aligned} E_{\text{cell}} &= 3.14 - \frac{0.0592}{2} \log \frac{(10.0)(1.0)^2}{(5.0)^2} \\ &= +3.153 \text{ V} \end{aligned}$$

$$E_{\text{cell}} > 0$$

∴ The reaction occurs spontaneously.