Redox potentials, Cell Diagrams and EMF. Cadmium and nickel.

AIM

We are learning to:

- work out e.m.f. of a cell from Redox potentials
- write overall equation for the reaction

QUESTION

Use the following data to work out the e.m.f. and write the overall equation for the reaction in a nickel-cadmium alkaline battery.

 $\begin{array}{rll} \text{NiO(OH)} (s) + \text{H}_2\text{O} + e^- & \rightleftharpoons & \text{Ni(OH)}_2 + \text{OH}^- & \text{E}^\circ = +0.52 \text{ V} \\ \text{Cd(OH)}_2 & + & 2e^- & \rightleftharpoons & \text{Cd} & + & 2\text{OH}^- & \text{E}^\circ = -0.88 \text{ V} \end{array}$

DEFINITIONS

A	+	e⁻	≠	A⁻	$E^o=\ +1.0V$
В	+	e−	#	B−	$E^{o} = +2.0V$

the more **positive** electrode will proceed in the **forward** direction

WORKING THROUGH THE EXAMPLE

 $NiO(OH) + H_2O + e^{-} \Rightarrow Ni(OH)_2 + OH^{-}$ $E^{\circ} = +0.52 V$

 $Cd(OH)_2 + 2e \Rightarrow Cd + 2OH$ $E^{\circ} = -0.88 V$

∴ E.M.F =

To write out full equation, re-write with more negative electrode reversed

 $NiO(OH) + H_2O + e^- \Rightarrow Ni(OH)_2 + OH^ Cd + 2OH^- \Rightarrow Cd(OH)_2 + 2e^-$

SUMMARY

1) to determine the cell EMF

a) more **positive** electrode will proceed in the **forward** direction

A + $e^- \Rightarrow A^- E^\circ = -0.6V$ B + $2e^- \Rightarrow B^{2-} E^\circ = -1.5V$

b) $EMF = E_o$ more positive electrode – E^o more negative electrode

2) to write a balanced equation

a) re-write half equations with more negative electrode reversed

 $A + e^{-} \rightleftharpoons A^{-}$ $B^{2-} \rightleftharpoons B + 2e^{-}$

b) multiply up to balance electrons, then add half equations together.

ASSESSMENT

What would the correct EMF and equation be for the reaction which would occur between Cd^{2+} , Cd and V^{3+} , V^{2+} ?

Cd ²⁺	+	2e-	#	Cd	$E^{\circ} = -0.40V$
V 3+	+	e⁻	#	V ²⁺	$E^{o} = -0.26V$

A)	$Cd + 2V^{3+}$	⇒	Cd^{2+}	$+ 2V^{2+}$	$E_{cell} = +0.66V$

B) $Cd + 2V^{3+} \Rightarrow Cd$	$I^{2+} + 2V^{2+} \qquad E_{cell} = +0.1$	4V
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C)
$$Cd^{2+} + 2V^{2+} \Rightarrow Cd + 2V^{3+} = +0.66V$$

D) $Cd^{2+} + 2V^{2+} \Rightarrow Cd + 2V^{3+} \qquad E_{cell} = +0.14V$

ANSWER: B