

Math of the Nernst Equation

IBDP Chemistry Extended Essay

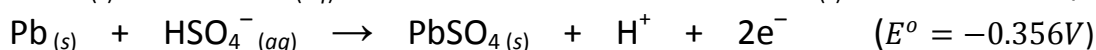
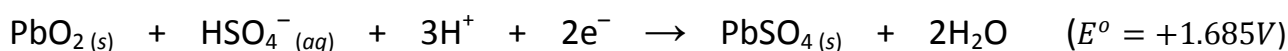
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Essay Title

Investigation into the effects of Sulphation on Lead-Acid battery cells by means of the Nernst Equation.

The Nernst Equation:

$$E = E^o + \frac{RT}{nF} \ln a_{H_2SO_4}$$



$$E_{cell}^o = E_{reduction}^o - E_{oxidation}^o$$

$$= 1.685 - (-0.356)$$

$$= +2.041V$$

$$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$$

(Universal gas constant)

$$F = 96,485.34 \text{ C mol}^{-1}$$

(Faraday constant)

$$n = 2$$

(no. of moles of electrons transferred)

$$a = 4\gamma^3 C^3$$

(effective concentration)

$$\gamma_{6M H_2SO_4} = 0.2441$$

(activity coefficient)

$$C = 6 \text{ mol kg}^{-1}$$

(molarity)

$$a = 12.5666 \text{ mol}^3 \text{ kg}^{-3}$$

$$E = 2.041 + 0.0128 \ln 12.5666$$

With:

$$E = E^{\circ} + \frac{2.303RT}{F} \times \log a_{H_2SO_4}$$

$$a_{H_2SO_4} = 4(\gamma m)^3$$

$$m = M\rho$$

Variables that can be tested:

E
 E°
 T
 a
 R
 F
 m
 γ

With the formation of lead sulphate on the cathode, the concentration of the sulphuric acid electrolyte decreases. From the Nernst equation, the emf of the cell hence decreases with lower effective concentration. This is thus the effect of sulfation.

Task: to find a way of determining change in concentration of sulphuric acid in electrolyte due to presence of lead sulphate.

Standardisation of sulphuric acid with sodium carbonate



Weigh mass of Na_2SO_4 precipitate and determine number of moles. Reaction is in 1:1 molar ratio.