Appendix

A. Electrochemical Equivalent of Metal

Consider a metal of formula weight M with valence change n when oxidized

$$M \rightarrow M^{n+} + ne \tag{A1}$$

Quantity of charge produced per mole substance is

$$N_A ne = nF(C) = nF(As) = \frac{nF}{3600}(Ah) \tag{A2}$$

where N_A is the Avogadro's constant and F is the Faraday's constant.

Therefore the oxidation of x-gram of substance would deliver a charge quantity of

$$\frac{nxF}{3600M} = \frac{26.8nx}{M}(Ah) \tag{A3}$$

The electrochemical equivalent of 1-gram of zinc metal is thus

$$\frac{26.8(2)}{65.37} = 0.82(Ahg^{-1}) \tag{A4}$$

B. Theoretical Energy Density of a Zinc-Air Cell

The amount of energy delivered per mole of zinc is

$$nFE = (2)(26.8\,Ah)(1.65V) = 88.44Wh \tag{A5}$$

Considering the final discharge product as ZnO (81.37 x 10^{-3} kg/mole), thus the theoretical energy density

$$\frac{88.44(Wh)}{81.37\times10^{-3}(kg)} = 1087(Whkg^{-1}) \tag{A6}$$

B. Estimating the discharge duration of a zinc-air cell

The electrochemical equivalent of x-gram of zinc anode is

$$0.82x\,(Ah) = 820x\,(mAh) = 49200x\,(mA\text{–min}) \qquad \text{(A7)}$$

If the closed circuit discharge current is I (mA), at 100% efficiency, the discharge would last for

$$\frac{820x}{I}\,(hour) = \frac{49200x}{I}\,(\text{min}) \qquad \text{(A8)}$$

C. Conversion formulas between various concentration units

Solute concentration SOUGHT	**Solute Concentration GIVEN**				
	A	**N**	**G**	**M**	**F**
A	—	$\frac{100N\times E}{N\times E+(1-N)B}$	$\frac{100G\times E}{1000+G\times E}$	$\frac{M\times E}{10R}$	$\frac{F}{10R}$
N	$\frac{A/E}{(\frac{A}{E})+\frac{100-A}{B}}$	—	$\frac{B\times G}{B\times G+1000}$	$\frac{B\times M}{M(B-E)+1000R}$	$\frac{B\times F}{F(B-E)+1000R\times E}$
G	$\frac{1000A}{E(100-A)}$	$\frac{1000N}{B-N\times B}$	—	$\frac{1000M}{1000R-(M\times E)}$	$\frac{1000F}{E(1000R-F)}$
M	$\frac{10R\times A}{E}$	$\frac{1000R\times N}{N\times E+(1-N)B}$	$\frac{1000R\times G}{1000+E\times G}$	—	$\frac{F}{E}$
F	$10AR$	$\frac{1000R\times N\times E}{N\times E+(1-N)B}$	$\frac{1000R\times G\times E}{1000+G\times E}$	$M\times E$	—

A: Weight % of solute; B: Molecular weight of solvent; E: Molecular weight of solute

F: Grams of solute per liter of solution; G: Molality; M: Molarity; N: Mole fraction

R: Density of solution in grams per milliliter