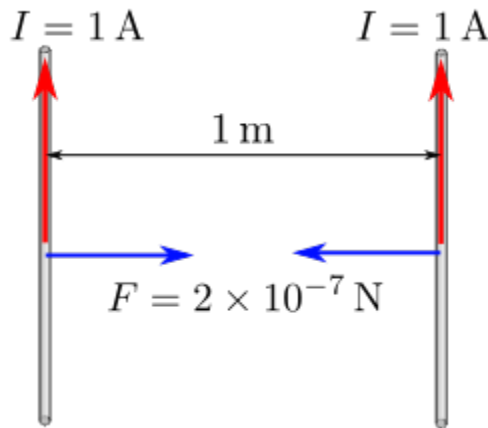


1.1 The original "International Ampere" was defined electrochemically as the current required to deposit 1.118 mg of silver per second from a solution of silver nitrate. Using this definition, how does the international ampere compare to the SI version? (Note that the SI version is based on the Ampere force law).

$$\frac{1.118 \times 10^{-3} \text{ g Ag}}{\text{s}} \left| \frac{\text{mol Ag}}{107.8682 \text{ g Ag}} \right| \left| \frac{96485.33 \text{ C}}{\text{equivalent}} \right| \left| \frac{1 \text{ equivalent}}{\text{mol Ag}} \right| = 1.00022 \text{ A}$$

The international Ampere is slightly larger than the SI one, which is the current required to create a force of 2×10^{-7} N for two parallel wires separated by a distance of 1 m.



Chapter 1, problem 2*deposition of Mo from molten salt*

$$\text{MW} = 95.94 \text{ [g/mol]}$$

$$F = 96485 \text{ [coulomb/mol]}$$

$$m = 12.85 \text{ [g]}$$

$$I = 7 \text{ [coulomb/s]}$$

$$t = 3600 \text{ [s]}$$

$$m = I \cdot t \cdot \frac{\text{MW}}{F \cdot z}$$

$$z=1.95$$

SOLUTION

Unit Settings: SI C kPa kJ mass deg

$$F = 96485 \text{ [coulomb/mol]}$$

$$m = 12.85 \text{ [g]}$$

$$t = 3600 \text{ [s]}$$

$$I = 7 \text{ [coulomb/s]}$$

$$\text{MW} = 95.94 \text{ [g/mol]}$$

$$z = 1.95$$

No unit problems were detected.

Chapter 1, problem 3

amount of hydrogen needed to run fuel cell

$$F = 96485 \text{ [coulomb/mol]}$$

$$\text{Power} = 50000 \text{ [W]}$$

$$V = 0.7 \text{ [V] cell voltage}$$

$$\text{Power} = I \cdot V$$

$$t = 3600 \cdot 3 \cdot 1 \text{ [s]}$$

$$\text{MW} = 0.002 \text{ [kg/mol] molecular weight of hydrogen}$$

$$n = 2$$

$$m = I \cdot t \cdot \frac{\text{MW}}{F \cdot n}$$

SOLUTION

Unit Settings: SI C kPa kJ mass deg

$$F = 96485 \text{ [coulomb/mol]}$$

$$m = 7.995 \text{ [kg]}$$

$$n = 2$$

$$t = 10800 \text{ [s]}$$

$$I = 71429 \text{ [coulomb/s]}$$

$$\text{MW} = 0.002 \text{ [kg/mol]}$$

$$\text{Power} = 50000 \text{ [W]}$$

$$V = 0.7 \text{ [V]}$$

No unit problems were detected.

Chapter 1, problem 4*Al production from Electrolysis*

$$\text{MW} = 26.982 \text{ [g/mol]}$$

$$F = 96485 \text{ [coulomb/mol]}$$

$$I = 200000 \text{ [coulomb/s]}$$

$$t = 24 \cdot 3600 \text{ [s]}$$

$$\eta = 0.95$$

$$m = \eta \cdot I \cdot t \cdot \frac{\text{MW}}{F \cdot z}$$

$$z = 3$$

$$\text{cf1} = 1000 \text{ [g/kg]}$$

$$\text{prod}_{\text{rate}} = \frac{m}{\text{cf1}}$$

SOLUTION

Unit Settings: SI C kPa kJ mass deg

$$\text{cf1} = 1000 \text{ [g/kg]}$$

$$F = 96485 \text{ [coulomb/mol]}$$

$$m = 1.530\text{E}+06 \text{ [g]}$$

$$\text{prod}_{\text{rate}} = 1530 \text{ [kg]}$$

$$z = 3$$

$$\eta = 0.95$$

$$I = 200000 \text{ [coulomb/s]}$$

$$\text{MW} = 26.98 \text{ [g/mol]}$$

$$t = 86400 \text{ [s]}$$

No unit problems were detected.

"!Chapter 1, problem 5"

"Power for Chlor-alkali process"

MW=70.9052[g/mol]; "molecular weight of Cl2"

F=96485 [coulomb/mol]

$m = I * MW / (F * z)$

z=2

cf1=24*365*3600 [s/year]

prod_rate=45e12 [g/year]

$m = \text{prod_rate} / \text{cf1}$

V=3.4 [V]

$P = I * V$

SOLUTION

Unit Settings: SI C kPa kJ mass deg

cf1 = 3.154E+07 [s/year]

I = 3.883E+09 [coulomb/s]

MW = 70.91 [g/mol]

prod_rate = 4.500E+13 [g/year]

z = 2

F = 96485 [coulomb/mol]

m = 1.427E+06 [g/s]

P = 1.320E+10 [W]

V = 3.4 [V]

No unit problems were detected.

"!Chapter 1, problem 6"

"deposition of Fe from molten salt"

$$MW=55.845[\text{g/mol}]$$

$$F=96485 [\text{coulomb/mol}]$$

$$m=50 [\text{g}]$$

$$I=25 [\text{coulomb/s}]$$

$$m=I*t*MW/(F*z)$$

$$z=3$$

"calculate the volume of chlorine gas"

$$MWg=70.9052 [\text{g/mol}]$$

$$R=8.314 [\text{J/mol-K}]$$

$$Tk=273 [\text{K}]$$

$$p=1e5 [\text{N/m}^2]$$

"from stoichiometry, get moles of Cl2"

$$n=(m/MW)*(3/2)$$

$$p*V=n*R*Tk$$

SOLUTION

Unit Settings: SI C kPa kJ mass deg

$$F = 96485 [\text{coulomb/mol}]$$

$$m = 50 [\text{g}]$$

$$MWg = 70.91 [\text{g/mol}]$$

$$p = 100000 [\text{N/m}^2]$$

$$t = 10366 [\text{s}]$$

$$V = 0.03048 [\text{m}^3]$$

$$I = 25 [\text{coulomb/s}]$$

$$MW = 55.85 [\text{g/mol}]$$

$$n = 1.343 [\text{mol}]$$

$$R = 8.314 [\text{J/mol-K}]$$

$$Tk = 273 [\text{K}]$$

$$z = 3$$

No unit problems were detected.

"!Chapter 1, problem 7"

"Al production from Electrolysis"

MW=26.982[g/mol]

F=96485 [coulomb/mol]

I=150000 [coulomb/s]

t=24*(3600 [s])

eta=0.89

m=eta*I*t*MW/(F*z)

z=3

cf1=1000 [g/kg]

prod_rate=m/cf1

SOLUTION

Unit Settings: SI C kPa kJ mass deg

cf1 = 1000 [g/kg]

F = 96485 [coulomb/mol]

m = 1.075E+06 [g]

prod_rate = 1075 [kg]

z = 3

$\eta = 0.89$

I = 150000 [coulomb/s]

MW = 26.98 [g/mol]

t = 86400 [s]

No unit problems were detected.

"!Chapter 1, problem 8"

"Electrodeposition of copper"

"use a basis of 1 m2"

A=1 [m^2]

MW=0.063546[kg/mol]

rho=8930 [kg/m^3]

F=96485 [coulomb/mol]

cd=1750 [A/m^2]

I=cd*A

loading=1.22 [kg/m^2]

m=loading*A

angle=165/360

d=loading/rho; "desired thickness of deposit"

eta=0.95

m=eta*I*t*MW/(F*z)

z=2

cf=3600 [s/h]

t=angle*cf/rotationrate

SOLUTION

Unit Settings: SI C kPa kJ mass degA = 1 [m²]cd = 1750 [A/m²]

d = 0.0001366 [m]

F = 96485 [coulomb/mol]

loading = 1.22 [kg/m²]

MW = 0.06355 [kg/mol]

rotationrate = 0.7404 [1/h]

z = 2

angle = 0.4583

cf = 3600 [s/h]

η = 0.95

I = 1750 [coulomb/s]

m = 1.22 [kg]

ρ = 8930 [kg/m³]

t = 2228 [s]

No unit problems were detected.

Chapter 1, problem 9*amount of lithium in battery*

$$\text{MW} = 6.941 \text{ [g/mol]} \text{ molecular weight of Li}$$

$$\text{Cap} = 1.32 \text{ [A-h]}$$

$$\text{cf1} = 3600 \text{ [coulomb/A-h]}$$

$$F = 96485 \text{ [coulomb/mol]}$$

$$m = \text{Cap} \cdot \text{cf1} \cdot \frac{\text{MW}}{F \cdot z}$$

$$z = 1$$

SOLUTION

Unit Settings: SI C kPa kJ mass deg

$$\text{Cap} = 1.32 \text{ [A-h]}$$

$$F = 96485 \text{ [coulomb/mol]}$$

$$\text{MW} = 6.941 \text{ [g/mol]}$$

$$\text{cf1} = 3600 \text{ [coulomb/A-h]}$$

$$m = 0.3419 \text{ [g]}$$

$$z = 1$$

No unit problems were detected.

problem 1-10*corrosion of steel plate*

$$m = 50 \text{ [g]}$$

$$n = 2$$

$$F = 96485.33 \text{ [Coulomb/mol]}$$

$$m = I \cdot t \cdot \frac{MW}{n \cdot F}$$

$$t = 3600 \cdot 24 \cdot 365 \text{ [s]}$$

$$MW = 55.845 \text{ [g/mol]}$$

SOLUTION

Unit Settings: SI C kPa kJ mass deg

$$F = 96485 \text{ [Coulomb/mol]}$$

$$m = 50 \text{ [g]}$$

$$n = 2$$

$$I = 0.005479 \text{ [A]}$$

$$MW = 55.85 \text{ [g/mol]}$$

$$t = 3.154\text{E}+07 \text{ [s]}$$

No unit problems were detected.

PROBLEM 1-11*accelerated corrosion*

$$i = 0.14 \text{ [A/m}^2\text{]}$$

$$n = 2$$

$$F = 96485.33 \text{ [Coulomb/mol]}$$

$$m = i \cdot t \cdot A \cdot \frac{\text{MW}}{n \cdot F}$$

$$t = 360000 \text{ [s]}$$

$$A = 0.01 \text{ [m}^2\text{]}$$

$$\text{MW} = 55.845 \text{ [g/mol]} \text{ } \textit{molecular weight of iron}$$

$$m_r = 0.11 \text{ [g]}$$

$$\eta = \frac{m_r}{m} \text{ } \textit{faradaic efficiency}$$

$$\text{cur} = i \cdot A$$

oxygen evolved

$$n_1 = 4$$

$$m_o = i \cdot t \cdot A \cdot \left[\frac{1 - \eta}{n_1 \cdot F} \right]$$

SOLUTION**Unit Settings: SI C kPa kJ mass deg**

$$A = 0.01 \text{ [m}^2\text{]}$$

$$\eta = 0.7542$$

$$i = 0.14 \text{ [A/m}^2\text{]}$$

$$m_o = 0.000321 \text{ [mol]}$$

$$\text{MW} = 55.85 \text{ [g/mol]}$$

$$n_1 = 4$$

$$\text{cur} = 0.0014 \text{ [A]}$$

$$F = 96485 \text{ [Coulomb/mol]}$$

$$m = 0.1459 \text{ [g]}$$

$$m_r = 0.11 \text{ [g]}$$

$$n = 2$$

$$t = 360000 \text{ [s]}$$

No unit problems were detected.

"!PROBLEM 1-12"

$$r = 1e-9 \text{ [m]}$$

$$\epsilon_0 = 8.854e-12 \text{ [farad/m]}$$

$$q = 1.602e-19 \text{ [coulomb]}$$

$$W = q^2 / (4 * \pi * \epsilon_0 * r)$$

$$\phi = W / q$$

SOLUTION

Unit Settings: SI C kPa kJ mass deg

$$\epsilon_0 = 8.854E-12 \text{ [farad/m]}$$

$$q = 1.602E-19 \text{ [coulomb]}$$

$$W = 2.307E-19 \text{ [J]}$$

$$\phi = 1.44 \text{ [V]}$$

$$r = 1.000E-09 \text{ [m]}$$

No unit problems were detected.