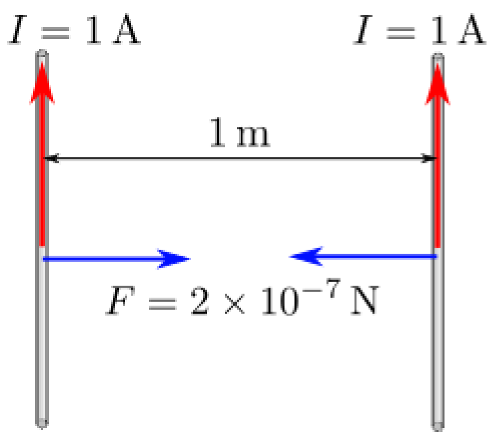
1.1 The original "International Ampere" was defined electrochemically as the current required to deposit 1.118 mg of silver per second from a solution of silver nitrate. Using this definition, how does the international ampere compare to the SI version? (Note that the SI version is based on the Ampere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

$$\frac{1.118\times10^{-3}\text{g Ag}}{\text{s}}\left|\frac{\text{mol Ag}}{107.8682\text{ g Ag}}\right|\frac{96485.33\text{ C}}{\text{equivalent}}\left|\frac{1\text{ equivalent}}{\text{mol Ag}}\right.=1.00022\text{ A}$$

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

MW = 95.94 [g/mol]

F = 96485 [coulomb/mol]

m = 12.85 [g]

I = 7 [coulomb/s]

t = 3600 [s]

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

z=1.95

SOLUTION

Unit Settings: SI C kPa kJ mass deg

F = 96485 [coulomb/mol]
I = 7 [coulomb/s]
m = 12.85 [g]
MW = 95.94 [g/mol]
t = 3600 [s]
z = 1.95

No unit problems were detected.

Chapter 1, problem 3

amount of hydrogen needed to run fuel cell

F = 96485 [coulomb/mol]

Power = 50000 [W]

V = 0.7 [V] *cell voltage*

Power = I · V

t = 3600 · 3 · 1 [s]

MW = 0.002 [kg/mol] *molecular weight of hydrogen*

n = 2

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

SOLUTION

Unit Settings: SI C kPa kJ mass deg

F = 96485 [coulomb/mol]
I = 71429 [coulomb/s]
m = 7.995 [kg]
MW = 0.002 [kg/mol]
n = 2
Power = 50000 [W]
t = 10800 [s]
V = 0.7 [V]

No unit problems were detected.

Chapter 1, problem 4

Al production from Electrolysis

$MW = 26.982$ [g/mol]

$F = 96485$ [coulomb/mol]

$I = 200000$ [coulomb/s]

$t = 24 \cdot 3600$ [s]

$\eta = 0.95$

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

$z = 3$

$cf1 = 1000$ [g/kg]

$$prod_{rate} = \frac{m}{cf1}$$

SOLUTION

Unit Settings: SI C kPa kJ mass deg

$cf1 = 1000$ [g/kg]	$\eta = 0.95$
$F = 96485$ [coulomb/mol]	$I = 200000$ [coulomb/s]
$m = 1.530E+06$ [g]	$MW = 26.98$ [g/mol]
$prod_{rate} = 1530$ [kg]	$t = 86400$ [s]
$z = 3$	

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=prod_rate/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[g/mol]

F=96485 [coulomb/mol]

m=50 [g]

I=25 [coulomb/s]

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

z=3

"calculate the volume of chlorine gas"
MWg=70.9052 [g/mol]
R=8.314 [J/mol-K]
Tk=273 [K]
p=1e5 [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 [coulomb/mol]
m = 50 [g]
MWg = 70.91 [g/mol]
p = 100000 [N/m^2]
t = 10366 [s]
V = 0.03048 [m^3]

I = 25 [coulomb/s]
MW = 55.85 [g/mol]
n = 1.343 [mol]
R = 8.314 [J/mol-K]
Tk = 273 [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]	η = 0.89
F = 96485 [coulomb/mol]	I = 150000 [coulomb/s]
m = 1.075E+06 [g]	MW = 26.98 [g/mol]
$prod_{rate}$ = 1075 [kg]	t = 86400 [s]
z = 3	

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 deg

A = 1 [m^2]
cd = 1750 [A/m^2]
d = 0.0001366 [m]
F = 96485 [coulomb/mol]
loading = 1.22 [kg/m^2]
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/m^3]
t = 2228 [s]

No unit problems were detected.

Chapter 1, problem 9

amount of lithium in battery

MW = 6.941 [g/mol] *molecular weight of Li*

Cap = 1.32 [A-h]

cf1 = 3600 [coulomb/A-h]

F = 96485 [coulomb/mol]

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

z = 1

SOLUTION

Unit Settings: SI C kPa kJ mass deg

Cap = 1.32 [A-h]
cf1 = 3600 [coulomb/A-h]
F = 96485 [coulomb/mol]
m = 0.3419 [g]
MW = 6.941 [g/mol]
z = 1

No unit problems were detected.

problem 1-10

corrosion of steel plate

$m = 50$ [g]

$n = 2$

$F = 96485.33$ [Coulomb/mol]

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

$t = 3600 \cdot 24 \cdot 365$ [s]

$MW = 55.845$ [g/mol]

SOLUTION

Unit Settings: SI C kPa kJ mass deg

F = 96485 [Coulomb/mol]	I = 0.005479 [A]
m = 50 [g]	MW = 55.85 [g/mol]
n = 2	t = 3.154E+07 [s]

No unit problems were detected.

PROBLEM 1-11

accelerated corrosion

$i = 0.14$ [A/m^2]

$n = 2$

$F = 96485.33$ [Coulomb/mol]

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

$t = 360000$ [s]

$A = 0.01$ [m^2]

$MW = 55.845$ [g/mol] *molecular weight of iron*

$mr = 0.11$ [g]

$$\eta = \frac{mr}{m}$$ *faradaic efficiency*

$cur = i \cdot A$

oxygen evolved

$n1 = 4$

$$mo = i \cdot t \cdot A \cdot \left[\frac{1 - \eta}{n1 \cdot F}\right]$$

SOLUTION

Unit Settings: SI C kPa kJ mass deg

A = 0.01 [m^2]
η = 0.7542
i = 0.14 [A/m^2]
mo = 0.000321 [mol]
MW = 55.85 [g/mol]
n1 = 4
cur = 0.0014 [A]
F = 96485 [Coulomb/mol]
m = 0.1459 [g]
mr = 0.11 [g]
n = 2
t = 360000 [s]

No unit problems were detected.

"!PROBLEM 1-12"

r= 1e-9 [m]

eo=8.854e-12 [farad/m]

q=1.602e-19 [coulomb]

W=q*q/(4*pi*eo*r)

phi=W/q

SOLUTION

Unit Settings: SI C kPa kJ mass deg

eo = 8.854E-12 [farad/m]
q = 1.602E-19 [coulomb]
W = 2.307E-19 [J]
ϕ = 1.44 [V]
r = 1.000E-09 [m]

No unit problems were detected.