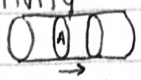
Current and Conductivity

Flow = $\frac{\Delta V}{\Delta t}$ m^3/s



Volume of water passing through a surface per unit of time

Current $I = \frac{\Delta Q}{\Delta t}$ $C/s = A$ Direction is the direction of positive charge

Flow = vA Current density $J = \frac{I}{A}$ A/m^2

Ohm's Law $J = \sigma E$ for some materials

↑ Conductivity

Drift speed $v_{drift} \approx 10^{-4}$ m/s $I = q n v_d A$ ← charge density $J = q n v_d$ $v_d = a\tau = \frac{q}{m}\tau E$ ← collisional time $J = \frac{q^2}{m} n \tau E$ $\sigma = \frac{q^2 n \tau}{m}$

Example #1

$\tau = 2.5 \times 10^{-14}$ s

$n = 8.5 \times 10^{28}$ m^{-3}

$\phi = 2\ mm \times 10^{-3}$ m

$E = 0.01$ N/C

$I = ?$

$J = \frac{q^2 n \tau}{m} E$ $I = \frac{q^2 n \tau}{m} EA = \frac{(1.6\times10^{-19})^2 8.5\times10^{28}(2.5\times10^{-14})}{9.1\times10^{-31}}(0.01)(\pi(10^{-3})^2) = \boxed{1.88\ A}$

$A = \pi(\frac{\phi}{2})^2 = \pi(10^{-3})^2$

Example #2

$\phi = 2\ mm \times 10^{-3}$ m

$v_d = 10^{-4}$ m/s

$n = 8.5 \times 10^{28}$ m^{-3}

$I = ?$

$I = q n v_d A = 1.6\times10^{-19}(8.5\times10^{28})(10^{-4})(3.14\times10^{-6}) = \boxed{4.27\ A}$

$A = \pi(\frac{d}{2})^2 = \pi(10^{-3})^2 = 3.14 \times 10^{-6}$