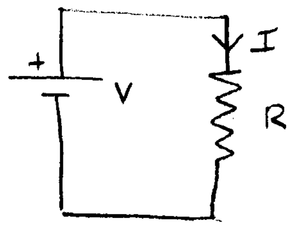
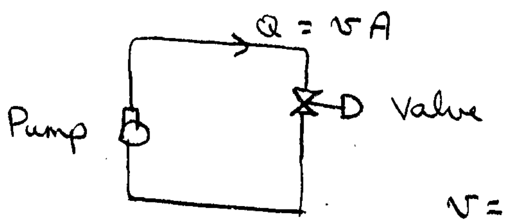
1. [Serway Chapter 27 Question 8, pg 790]
In the water analogy of an electric circuit, what corresponds to the power supply, resistor, charge, and potential difference?



I = flow
R = resistance
V = potential rise (drop)

$$V = RI$$

In hydraulic loops:



$$\Delta P_{pump} = \frac{fL}{D}\frac{v^2}{2g}$$

v = velocity
A = area
L = length
D = diameter
g = grav. const.
ΔP = pressure diff.

f = friction factor
Q = volumetric flow

In laminar flow, $f = \frac{64}{Re}$ ← Reynold's #

$\propto \frac{1}{v}$

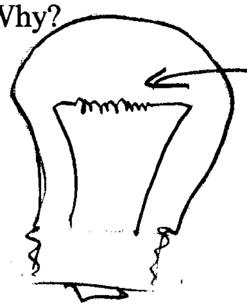
$\therefore \Delta P_{pump} = k\,v$
↑ same factor α to resistance.

$\therefore$ $\Delta P \Leftrightarrow V$

k or $f \Leftrightarrow R$

$Q \Leftrightarrow I$

2. [Serway Chapter 27 Question 18, pg 791]
When incandensecent lamps burn out, they usually do so just after they are switched on. Why?



When a lamp is turned on, current flows through the resistor, heating it up to a "white hot" temperature.

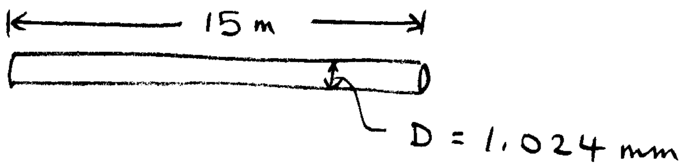
Since $R = R_0[1 + \alpha(T - T_0)]$ + $\alpha > 0$, the resistance is higher at higher temperatures.

The cycling of temperature as the lamp is switched on + off, on + off, etc., fatigues the metal, making it more susceptable to damage and breakage as time goes on.

The current is higest when the resistance is lowest – ie at the lowest temperature – ie the instant the lamp is turned on.

Thus a weakened filament (perhaps full of microscopic cracks and in a brittle state) is shocked more as it is turned on than after it is warmed up. Hence that is when it is more likely to break.

3. [Serway Chapter 27 Problem 16, pg 792]
Eighteen-gauge wire has a diameter of 1.024 mm. Calculate the resistance of 15.0 m of 18-gauge copper wire at 20.0 °C.



$T = 20.0°C$

$$R = \rho \frac{l}{A} = 1.7 \times 10^{-8}\ \Omega \cdot m \times \frac{15}{\left[\pi \left(\frac{1.024 \times 10^{-3}}{2}\right)^2\right]}\ \Omega$$

$$= \underline{0.31\ \Omega}$$

(ρ from Serway Table 27.1)

4. [Serway Chapter 27 Problem 17, pg 792]

While traveling through Death Valley on a day when the temperature is 58 °C, Bill Hiker finds that a certain voltage applied to a copper wire produces a current of 1.000 A. Bill then travels to Antarctica and applies the same voltage to the same wire. What current does he register if the temperature is -88 °C? Assume no change in the wire's shape and size.

$$V = RI = \frac{\rho l}{A} I$$

Condition 1 : Death Valley 58 °C

" 2 : Antartica −88 °C

$$V_1 = \frac{\rho_1 l_1}{A_1} I_1 = V_2 = \rho_2 \frac{l_1}{A_2} I_2$$

We are given $l_1 = l_2$, $A_1 = A_2$, $V_1 = V_2$

$$\therefore \frac{V_2}{V_1} = 1 = \frac{\rho_2 I_2}{\rho_1 I_1} \Rightarrow I_2 = \frac{\rho_1 I_1}{\rho_2}$$

$$\therefore I_2 = \frac{\rho_0 [1 + \alpha(T_1 - T_0)] I_1}{\rho_0 [1 + \alpha(T_2 - T_0)]}$$

$$= \frac{[1 + 3.9 \times 10^{-3}(58 - 20)] \times 1\ A}{1 + 3.9 \times 10^{-3}(-88 - 20)]}$$

$$= \frac{1.1482}{0.5788} = \underline{\underline{1.984\ A}}$$

5. [Serway Chapter 27 Problem 49, pg 794]
Suppose you want to install a heating coil that will convert electric energy to heat at a rate of 300 W for a current of 1.5 A.
(a) Determine the resistance of the coil.
(b) The resistivity of the coil wire is 1.0 x 10^{-6} Ω·m, and the diameter is 0.30 mm. Determine its length.

a) $P = I^2 R \Rightarrow R = \frac{300\,W}{(1.5A)^2} = 133\,\Omega$

b) $R = \frac{\rho l}{A} \Rightarrow l = \frac{RA}{\rho}$

$\therefore l = \frac{133\,\Omega \times \pi \left(\frac{0.30 \times 10^{-3}\,m}{2}\right)^2}{1.0 \times 10^{-6}\,\Omega \cdot m}$

$\therefore l = 9.4\,m$

6. [Serway Chapter 27 Problem 54, pg 794]
It requires about 10.0 W of power per square foot to heat a room having ceilings 7.5 ft high. At a cost of ~~$0.80~~ $0.08 /kWh, how much does it cost per day to use electric heat to a room 10.0 ft x 15.0 ft?

$\$/\text{day-room} = \frac{W}{ft^2} \times \frac{kW}{W} \times \frac{ft^2}{room} \times \$/kWh \times \frac{h}{day}$

$= 10 \times .001 \times (10 \times 15) \times \$0.08 \times 24$

$= \$2.88$ /day per room