

## The Wiedemann-Franz Law

The transport of heat and electricity is dominated by free electrons in most metals and their alloys.

As the temperature is average velocity of free electrons increases the thermal conductivity increases whilst the electrical conduction decreases.

The ratio of the thermal to electrical conductivity depends on the square of the average velocity.

With a full Quantum mechanical treatment we find:

$$\frac{\kappa}{\sigma T} = 24.5 \times 10^{-9} \frac{W \times ohm}{K^2}$$

Thus, for normal state metals, we find that to reduce thermal conductivity we always pay the price of increased electrical resistance.

In cryogenic systems it is generally better to have high impedance devices in circuit involving resistance wiring to avoid significant voltage drops across the wiring linking room temperature to the cold circuits.