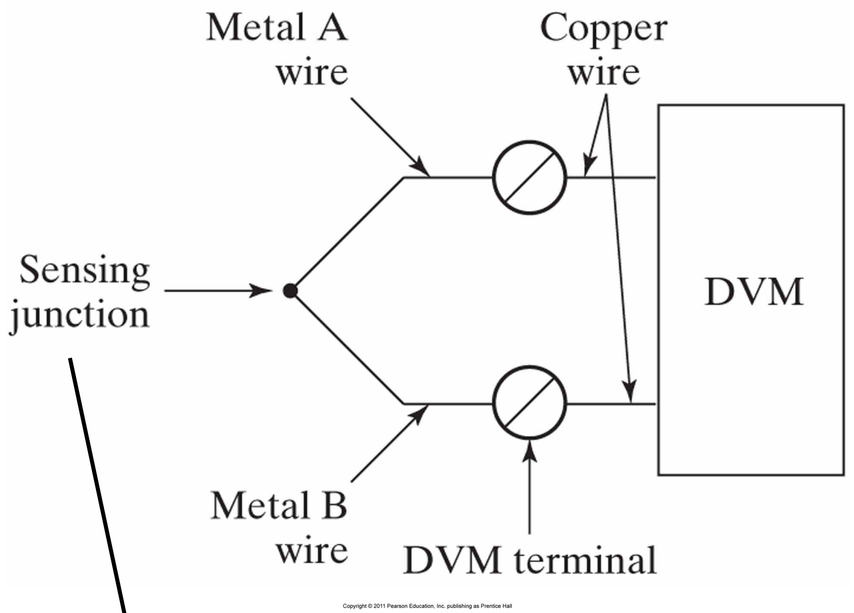
Thermocouples



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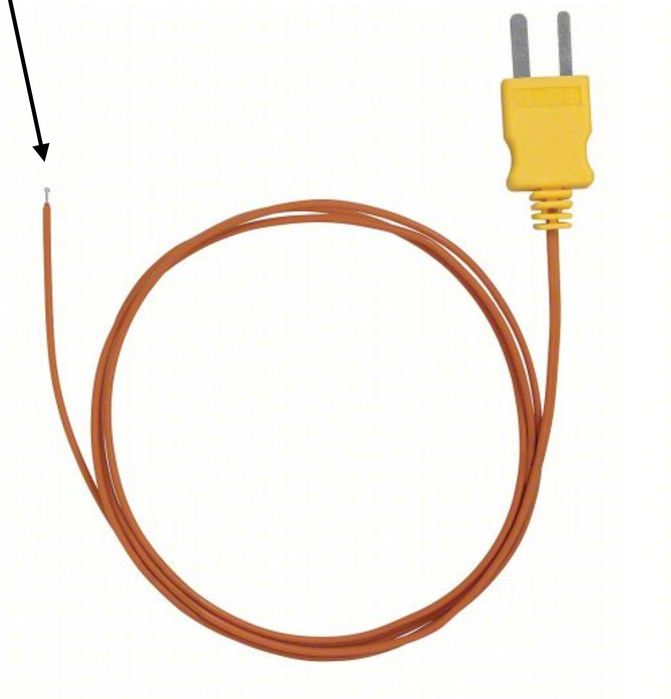
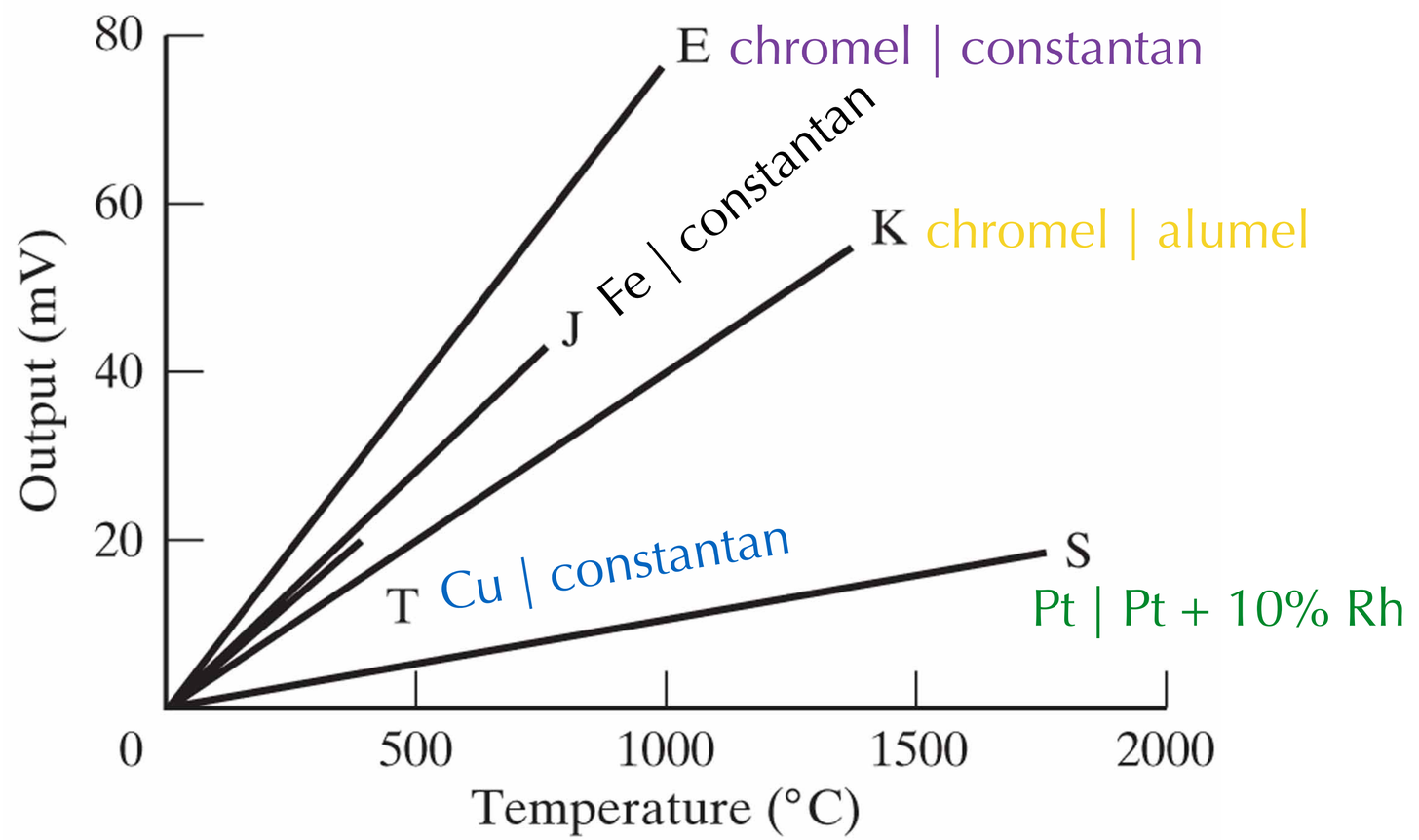


- Where two metals touch, a voltage is developed that is proportional to temperature (Peltier effect).
- Different proportionality for different metals.
- Lead wires of same (or compatible) metal



Radiation thermometers / thermal cameras

- All objects radiate always!

$$E = \epsilon\sigma T^4 = \epsilon \int_0^\infty \frac{C_1 \lambda^{-5}}{e^{\frac{C_2}{\lambda T}} - 1} d\lambda$$

radiation power

emissivity

temperature

wavelength

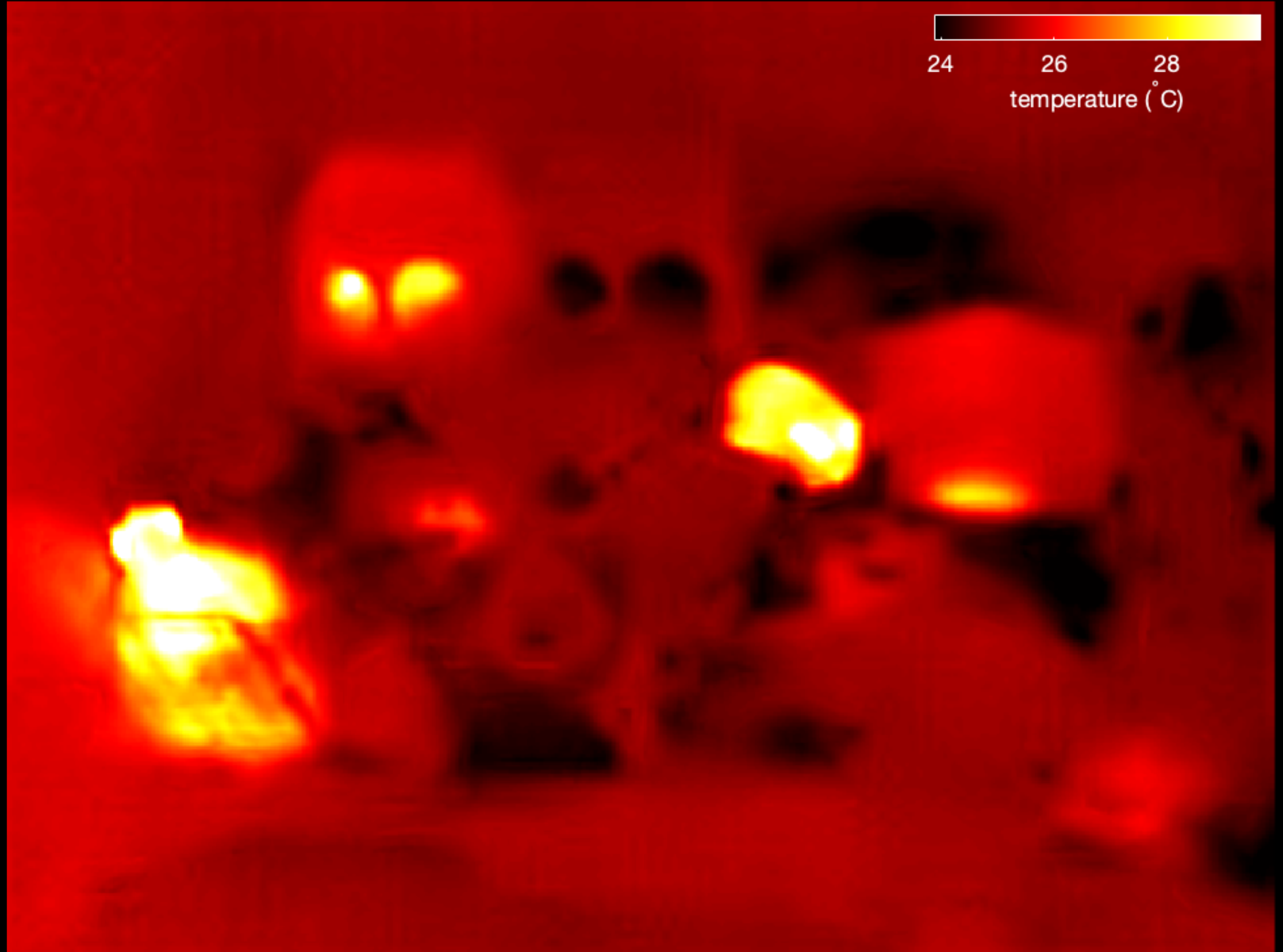
Stefan-Boltzmann constant

$\sigma = 5.669 \times 10^{-8}\,\mathrm{W m^{-2} K^{-4}}$

$C_1 = 3.743 \times 10^8\,\mathrm{W} \cdot \mu\mathrm{m}^4/\mathrm{m}^2$

$C_2 = 1.4387 \times 10^4 \mu\mathrm{m} \cdot K$

- $\epsilon = 1$ for ideal black body, $\epsilon = 0.018$ for shiny metals
- Common to measure E at two or more wavelengths, estimate T from ratio.


24
26
28
temperature (°C)