

Lecture 4: Thermocouple and Infrared Thermometry

0. Review

1. Thermocouple

2. Infrared Thermometer

- Reading: pdf's on website
 - ① Thermocouple
 - ② Thermal sensing
 - ③ TA Thermometry

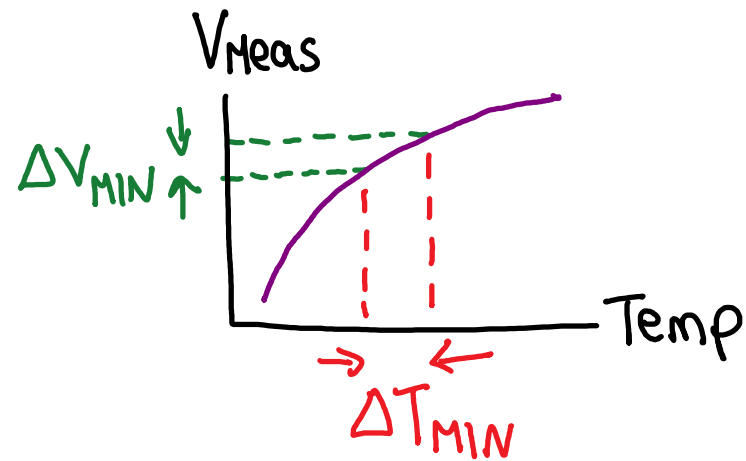
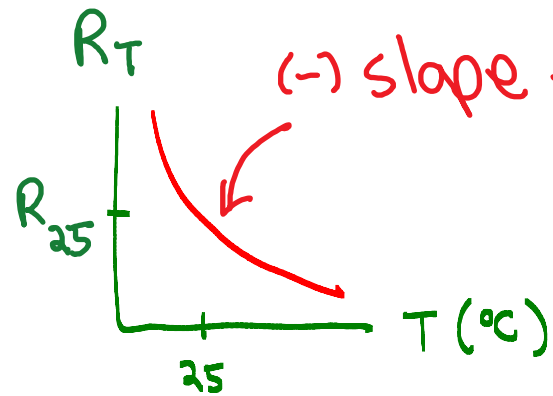
- Today: HW1 due
Quiz next Tue (1/21) ← HW1 material
- Lab1 report due next Fri (1/25)
(see course website for template)
- PreLab2 due next lab session
- HW2 due next Thu (Jan 24)

0. Review

• Thermistor

$$\frac{\partial R_T}{\partial T} = \alpha R_T$$

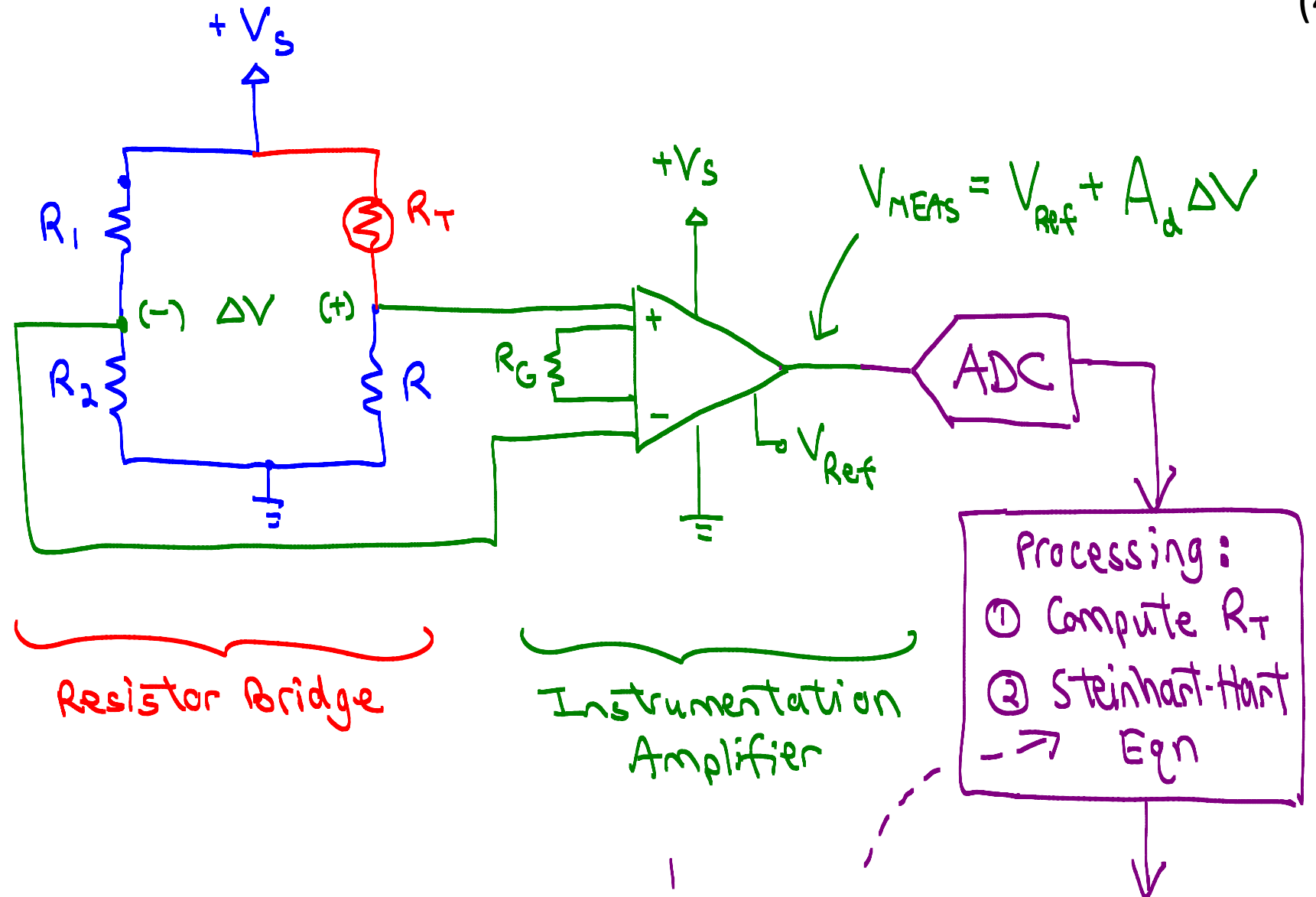
Negative Temp Co (NTC)



Sensitivity:

$$\Delta T_{\text{MIN}} = \frac{\Delta V_{\text{MIN}}}{\partial V_{\text{MEAS}} / \partial T}$$

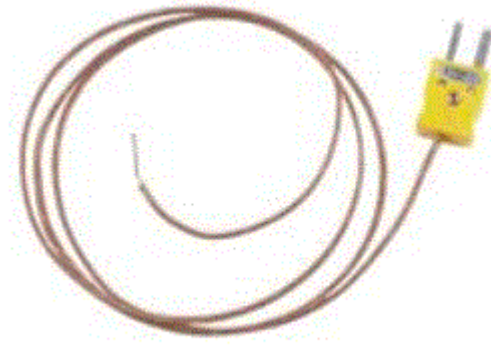
Larger of V_{noise} vs. ΔV_{ADC}



$$\text{deg K} \rightarrow T = \frac{1}{A + B \ln \frac{R_T}{R_{25}} + C \left(\ln \frac{R_T}{R_{25}} \right)^2 + D \left(\ln \frac{R_T}{R_{25}} \right)^3} \text{ Temperature}$$

1. Thermocouple

community.craftsman.com



tecpe1.com



www.fluke.com

A. Seebeck Voltage

When two ends of a metal wire are at different temp, a small voltage exists! ∇

Ex:

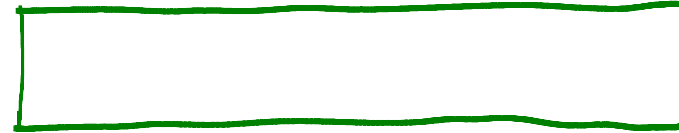
COLD

HOT



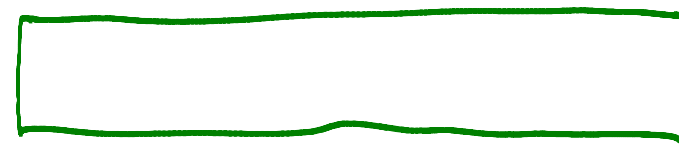
COLD

HOT



COLD

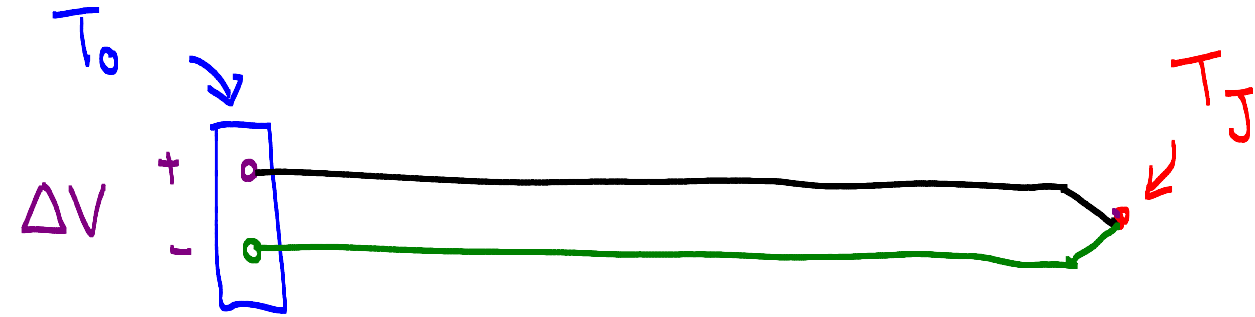
HOT



B. Thermocouple Junction

- A more useful configuration uses two wires of dissimilar metals
- Example: Iron-Constantan (Type J)

$\Delta V =$



<u>Type</u>	<u>Metal Pair</u>	<u>ΔS ($\mu V/^\circ C$)</u>
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- Example: $T_0 = 20^\circ C$, $T_J = 40^\circ C$

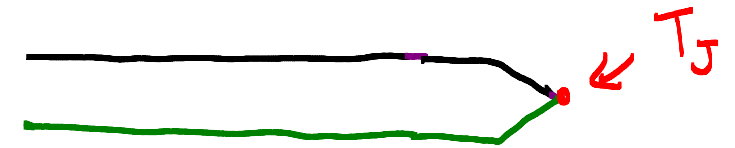
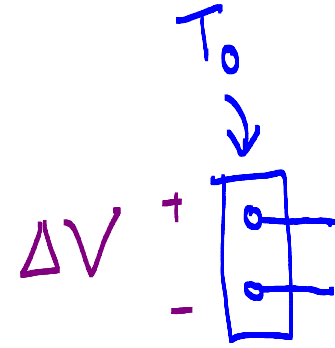
c. Ice Point Reference

How to get temperature T_J ?

$$\Delta V = \Delta$$

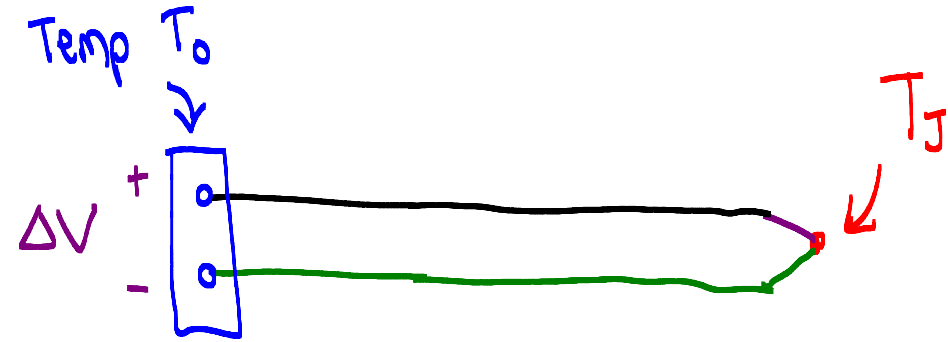
- Old fashioned solution was to include an _____

$$\Rightarrow \Delta V =$$

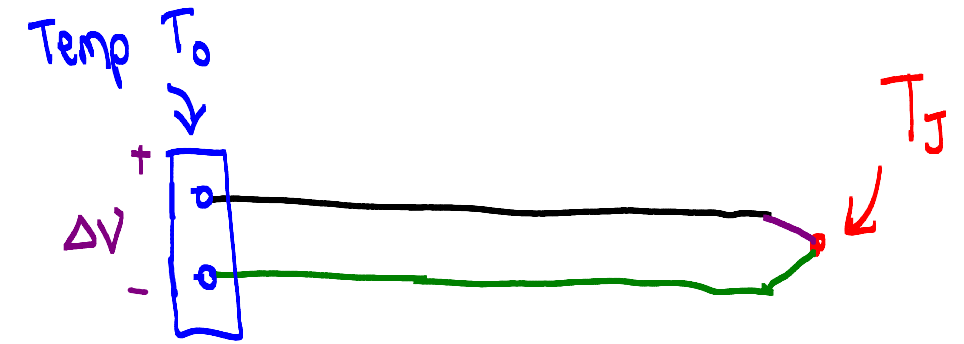


D. Cold Junction Compensation (CJC)

Q: How to replace the ice bath with a circuit?



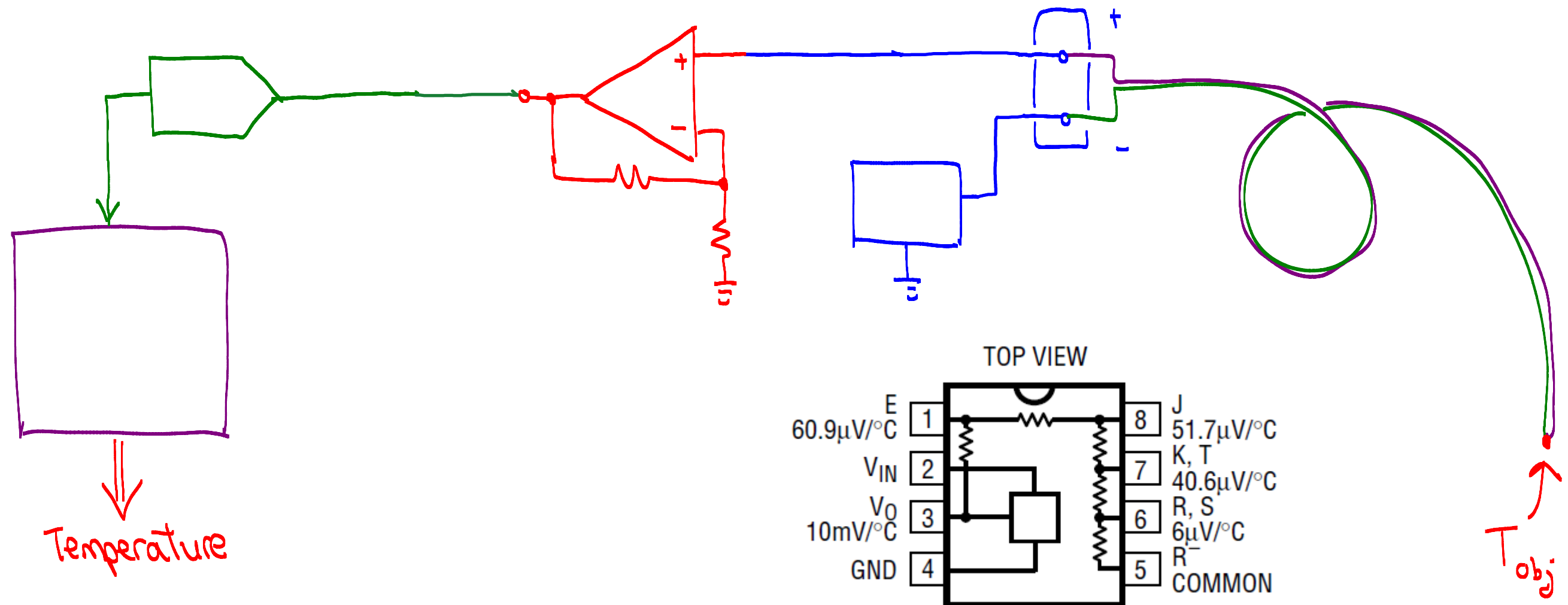
VS.



E. Typical Thermocouple System

← SIGNAL CONDITIONING →

(4.6)



2. Infrared Thermometry

- Thermistors and thermocouples require physical contact with the object
- Non-contact methods detect from the object

Examples:

①

②

③

Google Images

①



②



www.exergen.com

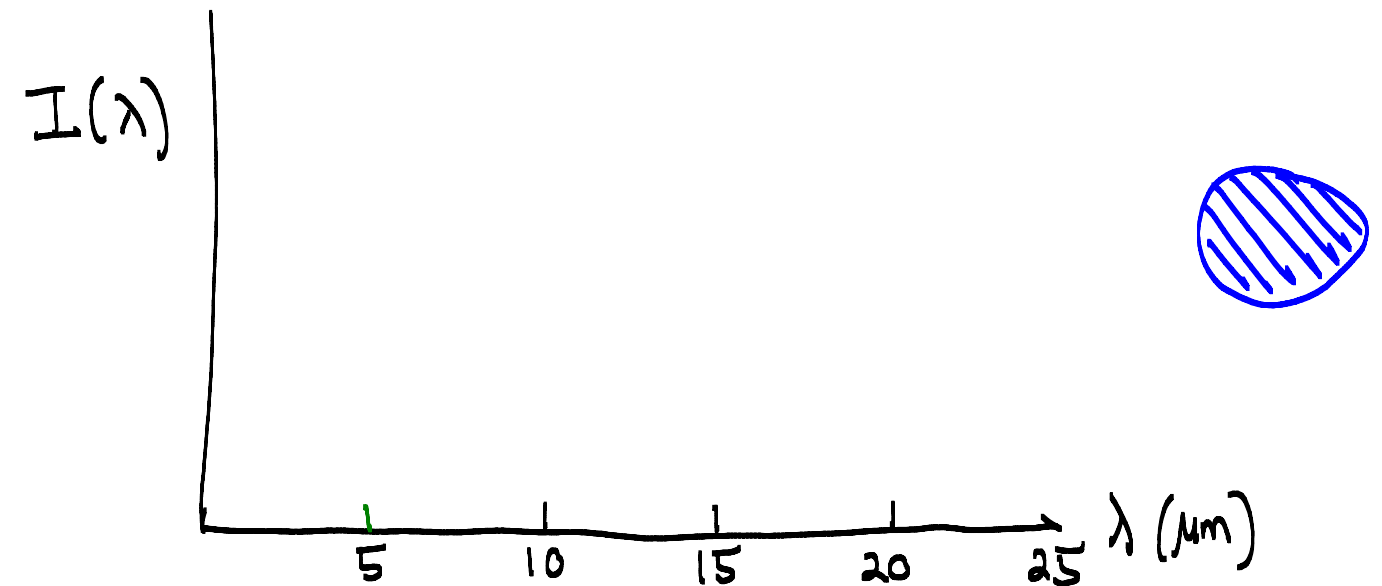
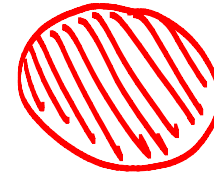
③



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A. Infrared Basics

- Wavelength: Broadly speaking, IR can have
- Blackbody Radiation
→ An object at _____ radiates energy.

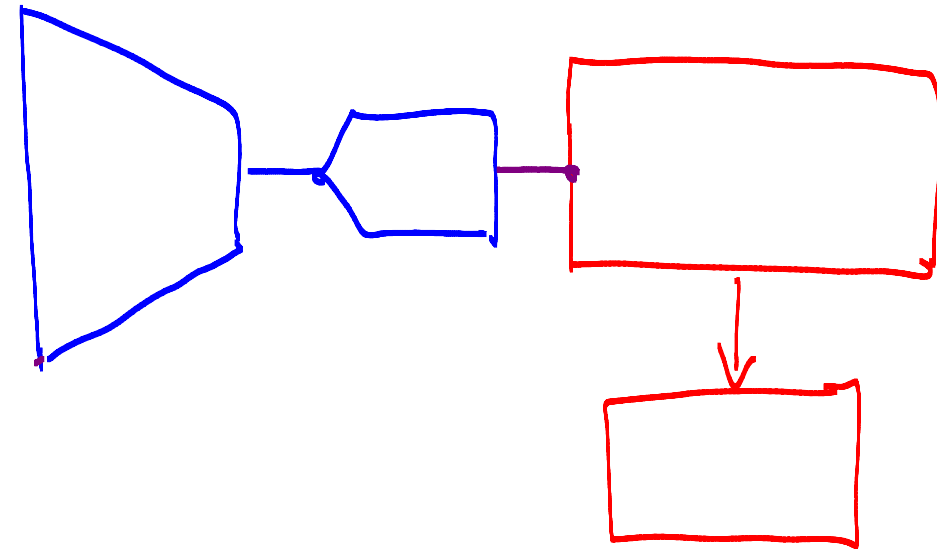
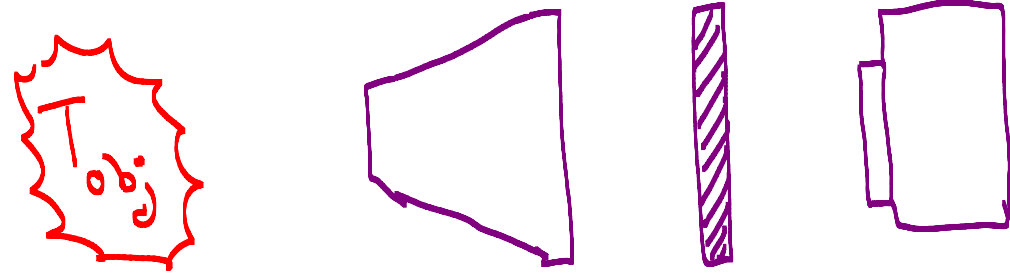


B. System Diagram

① Detect IR

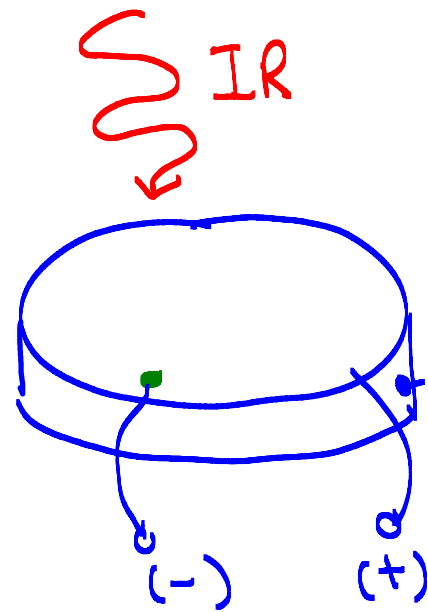
② Measure

③ $T_{obj} =$

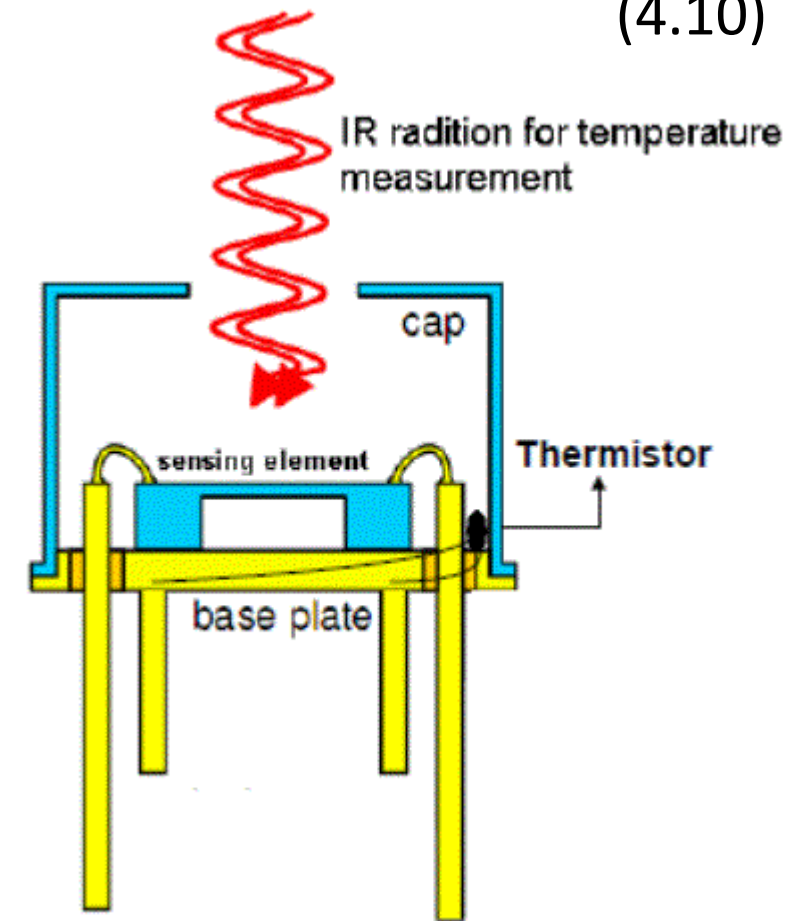


C. Thermopile Detector

- Bunch of tiny thermocouples connected in series.



(4.10)



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D. Temporal Artery (TA) Thermometry

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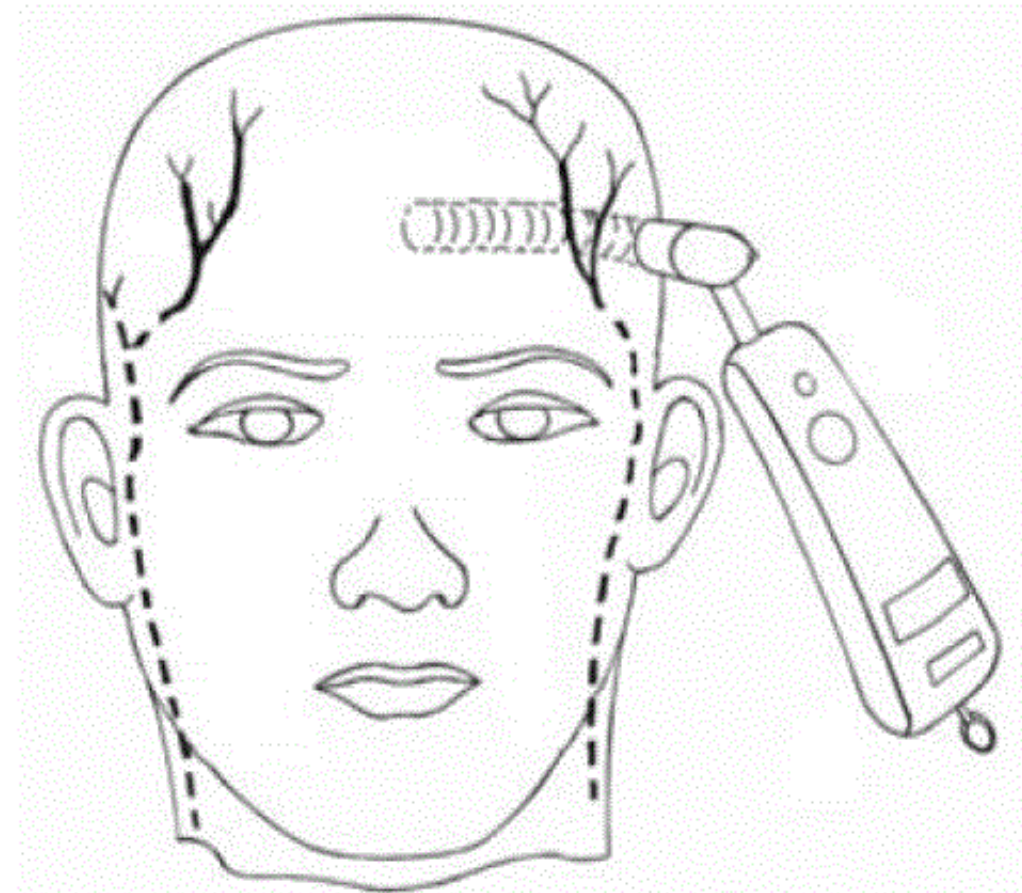
① Brush

② IR Thermometer

- Measures
- Determines

③ Computes

www.exergen.com



TA thermometer scanning across the superficial temporal artery

