general physics
Lecture 8

Heat and Cold in Medicine

Prof.Dr. Zina A. Al Shadidi

Temperature

- **The energy transferred from the flame to the material causing temperature rise is called heat.**
- **Adding heat to substance increase its molecular kinetic energy, which increase its temperature, the reverse process is also true, heat can be removed from a substance to lower the temperature, (absolute zero,-273.15°c).**

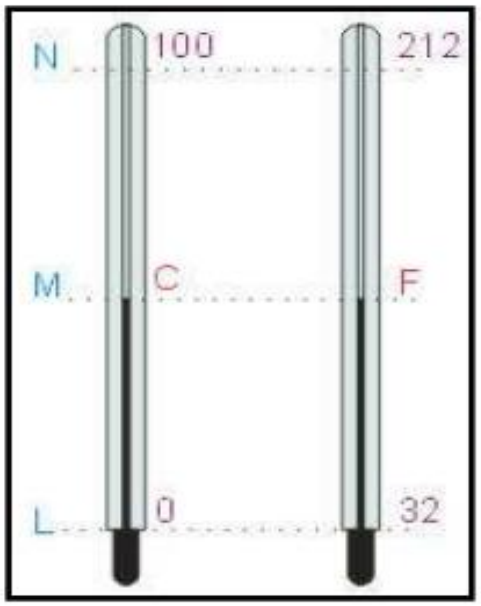
Scales of Temperature

- **Temperature is a measure of the energy carried by the body. It is difficult to measure temperature directly, so we usually measure it indirectly by comparing the energy of the body with that of another body.**

- **1-Fahrenheit scale(°F):in this scale the freezing temperature for water is 32°F and boiling point is 212°F , the normal body temperature is about 98.6°F .**

2-The Celsius(°C):the freezing point is 0°C and the boiling point is 100°C ,in between is divided into 100 division.

3-The Kalvin scale(°K):or the absolute scale this scale has the same divisions as the Celsius but takes the 0° K at the absolute zero which is (-273.15°C).



$$\frac{ML}{NL} = \frac{C-0}{100-0} = \frac{F-32}{212-32}$$

$$\therefore \frac{C}{100} = \frac{F-32}{180}$$

$$F = \frac{9}{5}C + 32$$

To change °C to °F

[°C= (°F-32) 5/9] or [°F=°C (9/5)+32]

Also °C=°K-273 or °K=°C+273

Example

change °C to °F

[°C= (°F-32) 5/9] or [°F=°C (9/5)+32]

Also °C=°K-273 or °K=°C+273

Types of thermometers

1- Glass-liquid thermometer

This thermometer composed of glass capillary tube ends with a bulb a store for liquid, the liquid can be mercury or alcohol for low temperature measurement. When the thermometer is heated the liquid inside will expand causing the liquid to rise in the capillary, for mercury it expand 1.8% from (0-100°C).

It has a thin capillary less than 0.1mm in diameter.

Types of thermometers

2- Thermistor

A **thermistor** (or **thermal resistor**) is defined as a type of resistor whose electrical resistance varies with changes in temperature. Although all resistors' resistance will fluctuate slightly with temperature, a thermistor is particularly sensitive to temperature changes.

There are two types of thermistors:

- Negative Temperature Coefficient (NTC) Thermistor
- Positive Temperature Coefficient (PTC) Thermistor

NTC Thermistor

- In an NTC thermistor, when the temperature increases, resistance decreases. And when temperature decreases, resistance increases. Hence in an NTC thermistor temperature and resistance are inversely proportional. These are the most common type of thermistor.

- **PTC Thermistor**
- A PTC thermistor has the reverse relationship between temperature and resistance. When temperature increases, the resistance increases. And when temperature decreases, resistance decreases. Hence in a PTC thermistor temperature and resistance are inversely proportional.
- Although PTC thermistors are not as common as NTC thermistors, they are frequently used as a form of circuit protection. Similar to the function of fuses, PTC thermistors can act as current-limiting device.
- When current passes through a device it will cause a small amount of resistive heating. If the current is large enough to generate more heat than the device can lose to its surroundings then the device heats up.

.

Radial leaded

Axial leaded

Glass

Probe

Threaded

Different Types of Thermistor

3- Thermocouple

Thermocouple Consist of two junctions of two different metals. If the two junctions are at different temperature , a voltage is produced that Heat radiation power can be measured by:

$$W = e\,\sigma T^4$$

Where T: is the absolute temperature of the body

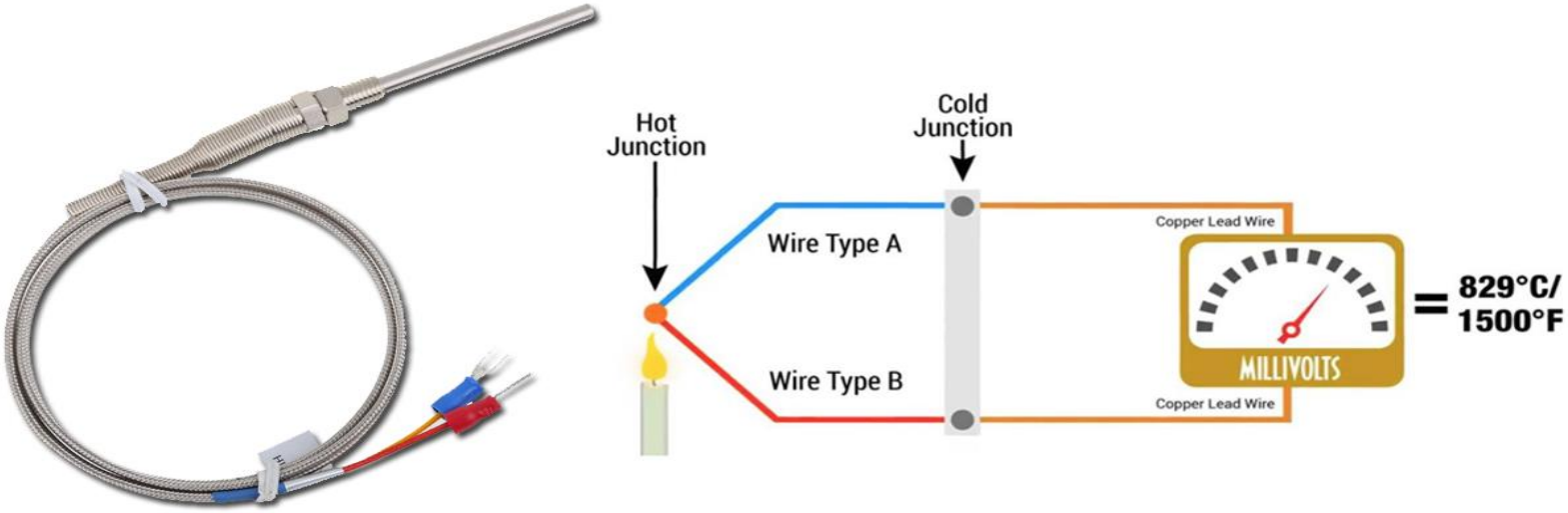
e: is the emissivity depends upon the emitter material and its temperature for radiation from body e is almost 1.

σ: is the Stefan –Boltzmann $constant = 5.7 \times 10^{-12}\ {}^{W}/_{cm^2}.{}^{\circ}K^4$

Q.1: What is the power radiated per square centimeters from skin at a temperature of 306°K.?

$W = e\,\sigma T^4$ = (5.7×10-12)$(306)^4$= $0.05 W/cm^2$

Thermocouple How it Works



- A thermocouple is made up of two dissimilar metals, joined together at one end, that produce a voltage (expressed in millivolts) with a change in temperature. The junction of the two metals, called the sensing junction, is connected to extension wires. Any two dissimilar metals may be used to make a thermocouple.

- It was found that the most breast cancers has 1°C higher than that the other side(healthy)(since the tumor often increase the blood flow) and it was thought that this will be good procedure for early breast cancer detection. It was found that one third of thousands women, have abnormal thermogram of the breast and less than 1% has shown cancer.