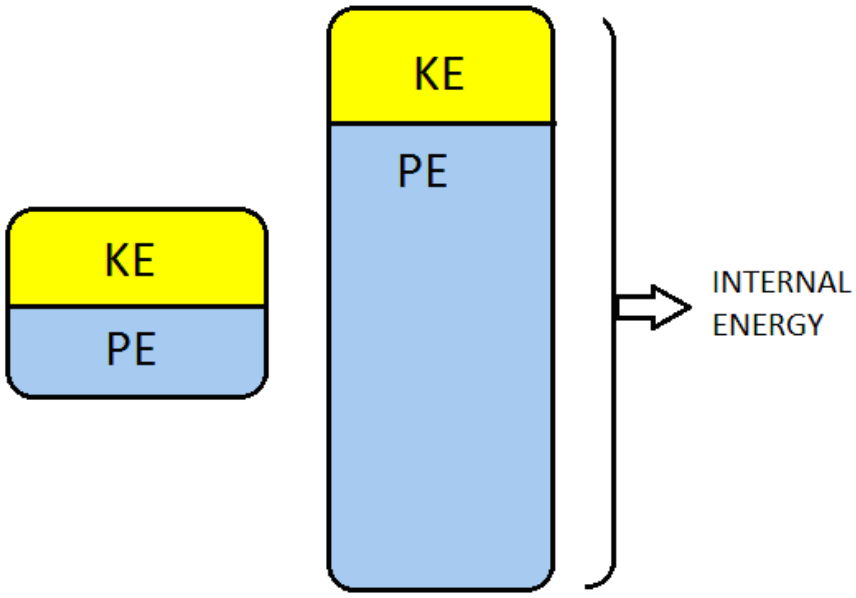
(Chapter 2)
Temperature and its measurement

Temperature: - Temperature is a degree of hotness or coldness the can be measured using a thermometer. It's also a measure of how fast the atoms and molecules of a substance are moving. The flow of heat is from a high temp region toward a lower temp region
Temperature is measured in degrees on the Fahrenheit, Celsius, and Kelvin scales.

- The degree of hotness or coldness of a body or environment.
- The degree of heat in the body of a living organism, usually about 37.0°C (98.6°F) in humans.
- An abnormally high condition of body heat caused by illness; a fever.

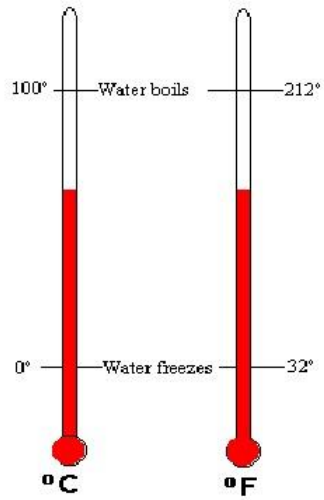
.Note:- Temp. is not directly proportional to internal energy, since temp measure only the kinetic energy part of the internal energy, so two objects with the same temp do not in general have the same internal energy.



Temperature scales

1- **Celsius's temp scale: -** is a scale and unit of measurement for temperature, also called centigrade temperature scale, scale based on 0° for the **freezing point** of water and 100° for the **boiling point** of water. Invented in **1742** by the **Swedish astronomer Anders Celsius**

0°C: - The temperature at which a mixture of ice and water is in equilibrium at a pressure of 1 atmosphere.
It is 0° on the Celsius scale and 32° on the Fahrenheit scale.
Steam point: - The temperature at which the maximum vapor pressure of water is equal to
one atmosphere (1.01325 × 105 N/m2).

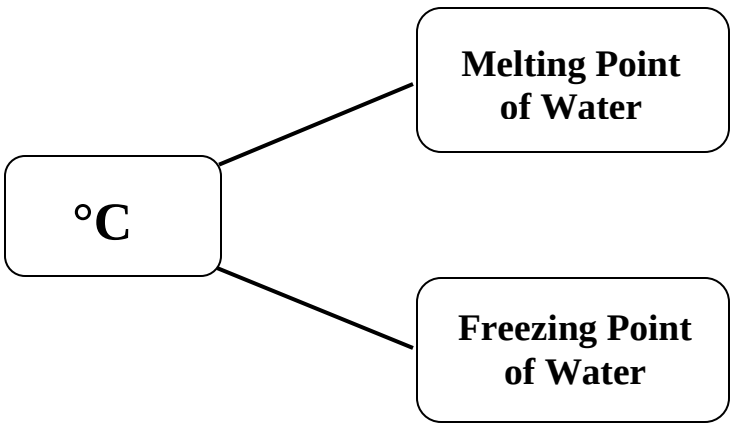


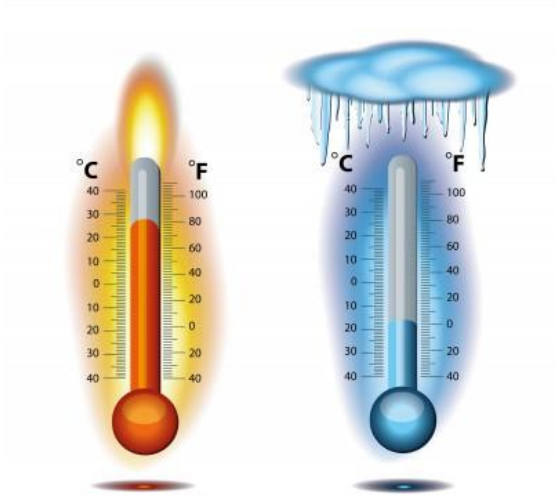
What's a different between C° and °C

What is Thermometer?

A thermometer is a device that measures the temperature
The name is made up of two smaller words: " Thermo″ means Heat and " meter″ means to measure.

A thermometer measures temperature through the regular variation of some physical property of the material inside the thermometer.





Thermometer

Thermometric substance

Since solid, liquid and gas expand on heating, any of the three can be used to construct a thermometer.
In case of solids it should be heated to a high temp, thus the expansion of solid is used to measure ***high temperature***.
While liquids expand moderately on heating, then liquid as thermometric substance are used to measure ***moderate temp.***
In case of gases expansion is very large even for a small change in temp. As a result thermometer using gas is used to measure ***small change in temp.***

2- Fahrenheit scale*: - *(symbol °F) A temperature scale that defines the freezing point of water as 32 degrees and the boiling point of water as 212 degrees, the difference between ice and steam is 180.

***3- Kelvin scale*:-** The Kelvin is a unit of measurement for temperature. It is one of the seven base units in the International System of Units (SI) and is assigned the unit symbol (K).

A thermodynamic temperature scale based upon the efficiencies of ideal heat engines. The zero of the scale is absolute zero. Originally the degree was equal to that on the Celsius scale but it is now defined so that the triple point of water is exactly 273.16 Kelvin's. The International Practical Temperature Scale (1968, revised 1990) realizes the Kelvin scale over a wide range of temperatures

Zero Kelvin (0K): is set at Absolute Zero, the temperature at which all particle motion stops.

1- Freezing point of water is (**273K**)
2- Boiling point of water is (**373K**)

If this reduction in volume were to continue with decreasing temp and if the gas did not liquefy the volume would become zero at -273.15C a temp called absolute temp.

***4- Rankin scale*:-** The symbol for degrees Rankine is (°R), In which the **freezing point** of water is **491.69°** and the **boiling point** of water is **671.69**°R

Thermodynamic scale is defined in terms two fixed points:-

- ***Absolute zero***:- which is the lowest possible temp is given in the value (0) for its temp.
- ***The triple point;-*** is given the value of 273.16k for it is temp and 0.01C in cent-grid scale

Boiling point	100C	212F	373K	672R
Ice point Absolute zero	0C -273C	32F -459F	273K 0K	492R 0R

Converting Temperatures

1- Fahrenheit to Celsius: $T_C = \frac{5}{9} \times (T_F - 32)$

2- Celsius to Fahrenheit $T_F = \left(\frac{9}{5} \times T_C\right) + 32$

3- Celsius to Kelvin: $T_K = T_C + 273$

4- Kelvin to Celsius $T_C = T_K - 273$

5- Kelvin to Rankin: $K = \frac{5}{9} \times R$

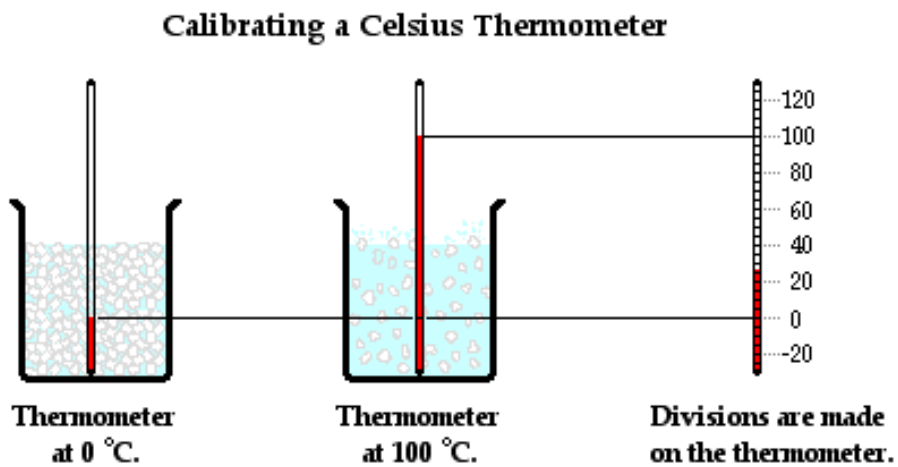
6- Rankin to Kelvin $R = \frac{9}{5} \times K$

7- Fahrenheit to Rankin: $R = F + 459.6$

Calibrate a thermometer on the centigrade scale:-

To calibrate a thermometer on the centigrade scale, its thermometer property is measured when the thermometer is at ice point and when it is at steam point

The temp on a centigrade scale given by:-



Where x_{100} and x_0 are the

$$\theta = \left(\frac{x - x_0}{x_{100} - x_0} \right) \times 100 \qquad \ldots\ldots\ldots\ldots..(1)$$

values of thermometric property at steam and ice point, if the thermometric property at same unknown temp has a value x, then unknown temp is given by eq (1).

Comparison and relation amongst the different temperature scales

$$\frac{C-0}{100-0} = \frac{F-32}{212-32} = \frac{R-492}{672-492} = \frac{K-273}{373-273}$$

$$\frac{C}{100} = \frac{F-32}{180}, relation - connecting - c\,\text{int}\,egrade - and - fahranahit$$

$$\frac{C}{100} = \frac{K-273}{100}, relation, centegrade, and, kelvin$$

Thermometry

The essential requisites of a thermometer are: -

- **Construction.**
- **Calibration.**
- **Sensitiveness.**

Body Temperature

It is a marker of endocrine, metabolic, or muscle activity; the response of the body to heat or cold in the environment: or the presence of infection or inflammation, among other illnesses, it is one of the vital signs.

Normal body temperature

Body temperature is usually measured by a thermometer placed in the mouth, the rectum, or the auditory canal (for tympanic membrane temperature)

The normal oral temperature is (37 °C --- 98.6 ^{O}F); rectally, it's (37.3 °C --- 99.20 ^{O}F)

The tympanic membrane temperature is a direct reflection of the body's core

TEMPERATURE REGULATION

Body temperature is regulated by thermoregulatory centers in the hypothalamus that balances heat production and heat loss. 85% of body heat loss is through skin (radiation, conduction, sweating) and the remainder through the lungs and fecal and urinary excretions. Muscular work (including shivering) is a mechanism for raising body temperature.

Elevation of temperature above normal is called fever (pyrexia), and subnormal temperature is hypothermia

Other factors that can influence body temperature are: -

Age: Infants and children have a wider range of body temperature than adults, and elderly have a lower body temperature than others.

Menstruation cycle in women: The temperature rises in the ovulatory mid-cycle and remains high until menstruation period.

Exercise: Temperature rises with moderate to vigorous muscular activity.

TEMPERATURE MEASUREMENT

Oral Temperature Oral temperature:

is measured by placing the clinical thermometer under the tongue with mouth closed for a period of one minute. Prior to measurement no oral feeds for 15 minutes, wash the thermometer with antiseptic siolution mercury in the thermometer is gently shaken down

Axillary Temperature:

The temperature obtained by placing a thermometer in the apex of the axilla with arm pressed closely to the side of the body for time recorded by the manufacturer of the thermometer. The temperature obtained by this method is usually 0.5° to 1.5°F lower than oral

Rectal Temperature:

The temperature obtained by inserting a thermometer into the anal canal to a depth of at least 3.8 cm and holding it in place for 3 to 5 minutes. A rectal temperature is more accurate than either oral or axillary temperatures It averages about 1°F higher than the oral temperature and approx. 1.5°F higher than the Axillary Temperature:

Tympanic Temperature:

The temperature obtained by placing an electronic probe in the ear canal. Such a reading measures the temperature in the capillary bed of the tympanic membrane and is generally reflective of the core temperature.

Core Temperature:

The temperature of structures deep within the body, as opposed to peripheral temperature such as that of the skin

Inverse Temperature:

A condition in which the body temperature is higher in the morning than in the evening

HYPOTHERMIA

- Hypothermia exist when the body's normal thermal regulatory mechanisms are unable to maintain heat in a cold environment and core temperature falls below 350C. › Infants are susceptible to hypothermia because of their poor thermos regulation and high body surface area to weight ratio
- More rarely hypothermia is secondary to glucocorticoid insufficiency, stroke, hepatic failure or hypoglycemia
- Hypothermia also occurs in healthy individuals whose thermoregulatory mechanisms are intact but insufficient to cope with intensity of the thermal stress

Examples:

1. Immersion in cold water - when core temperature may fall rapidly (acute hypothermia)

2. Exposure to extreme climate such as during hill walking (sub-acute hypothermia)

3. Slow onset hyperthermia as develops in an immobilized older individual (sub chronic hypothermia)

COLD INJURY:

Freezing cold injury (Frost bite) This represents the direct freezing of body tissues and usually affects the extremities: In particular, the fingers, toes, ears and face. Risk factors include smoking, peripheral vascular disease, dehydration and alcohol consumption.

Frost bitten tissue is initially pale and doughy to the touch and insensitive to the pain. Once frozen, the tissue is hard

Non-freezing cold injury (Trench / Immersion foot) This results from prolonged exposure to cold, damp conditions. The limb (usually the foot) appears cold, ischemic and numb, but there is no freezing of the tissue

CHILBLAINS:

Chilblains are tender, red or purplish skin lesions that occur in the cold and wet. They are often seen in horse riders, cyclists and swimmers, and are more common in women than men. They are short lived, and although painful, not usually serious.

Homework:-

1-

Suppose you place water in a freezer.

A. The water particles move

1) faster 2) slower 3) the same

B. The water will get

1) hotter 2) colder 3) stay the same

C. The temperature of the water will be

1) higher 2) lower 3) the same

2-

A. Temperature of freezing water

1) 0°F 2) 0°C 3) 0 K

B. Temperature of boiling water

1) 100°F 2) 32°F 3) 373K

C. Number of Celsius units between the boiling and freezing points of water

1) 100 2) 180 3) 273

3- The normal temperature of a chickadee is 105.8°F. What is that temperature in °C?

1) 73.8 °C 2) 58.8 °C 3) 41.0 °C

4- Pizza is baked at 455°F. What is that temperature in °C?

1) **437 °C** **2) 235°C** **3) 221°C**