Ch 17. Temperature & Heat

17.1-3. Temperature

A measure of how hot /cold an object is

Temperature Scale

Celsius (centigrade)	^oC
Fahrenheit	^oF
Absolute (Kelvin, Scientific work)	K

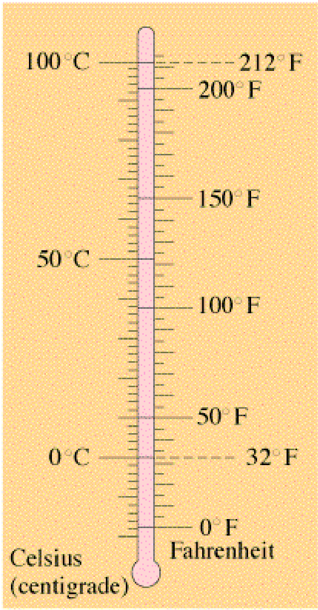
ΔT in C^o, F^o, or K

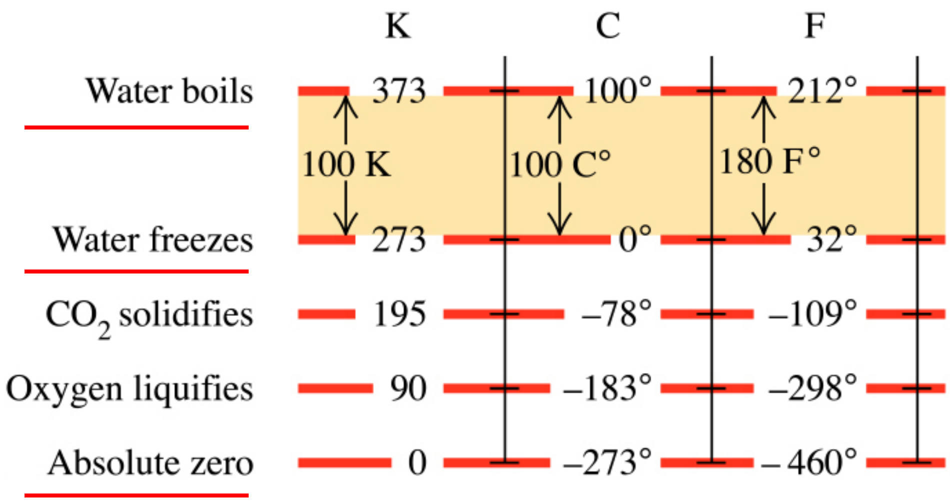
Temperature Conversion

$T_C = 5/9\ (T_F - 32^o)$

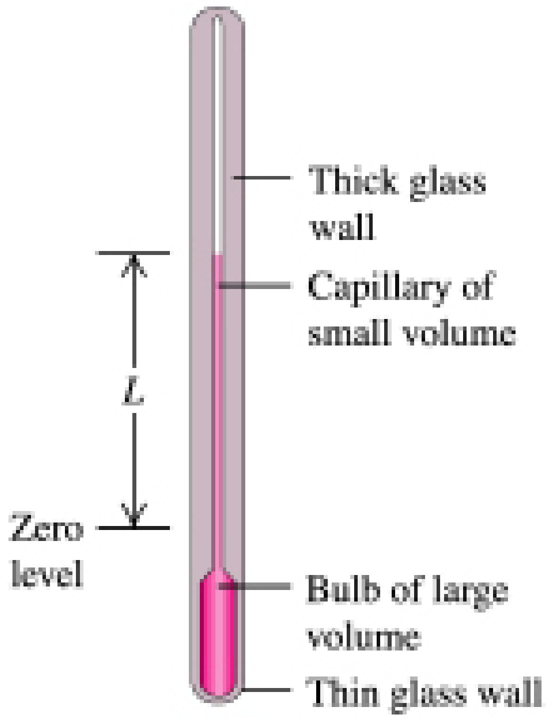
$T_F = 9\ T_C/5 + 32^o$

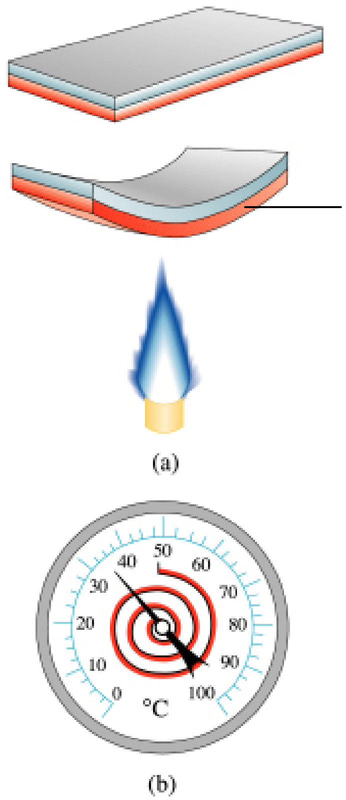
$T_K = T_C + 273.15$





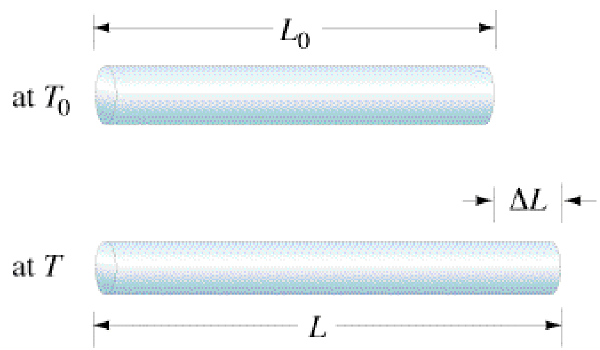
Thermometer





Larger linear thermal expansion coefficient

17-4. Thermal Expansion



Most substances:

Expand when heated

Contract when cooled

$$\frac{\Delta L}{L_0} = \alpha \Delta T \qquad L = L_0(1 + \alpha \Delta T)$$

α– Coefficient of linear expansion

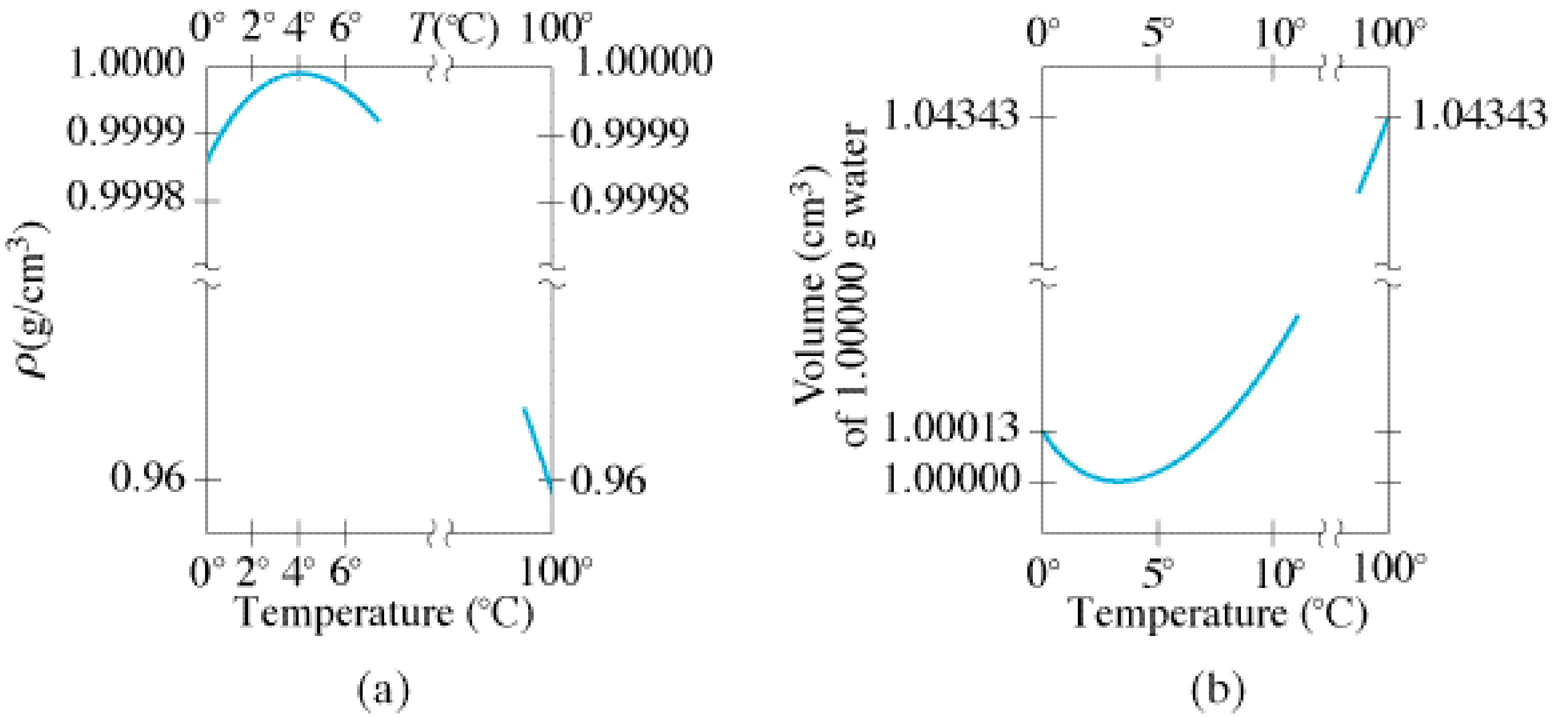
$$\frac{\Delta V}{V_0} = \beta \Delta T$$

β– Coefficient of volume expansion

Glass, $\beta \sim 10^{-5}$/C°

Mercury, $\beta \sim 10^{-4}$/ C°

Anomalous Behavior of Water Below 4ºC



Water expands as it cools from 4ºC to 0ºC, expands more upon freezing.
In a pool of water, it freezes from top.

17-5. Quantity of Heat

Common units:

calorie (cal): amount of heat necessary to raise the temperature of 1 gram of water by 1C^o

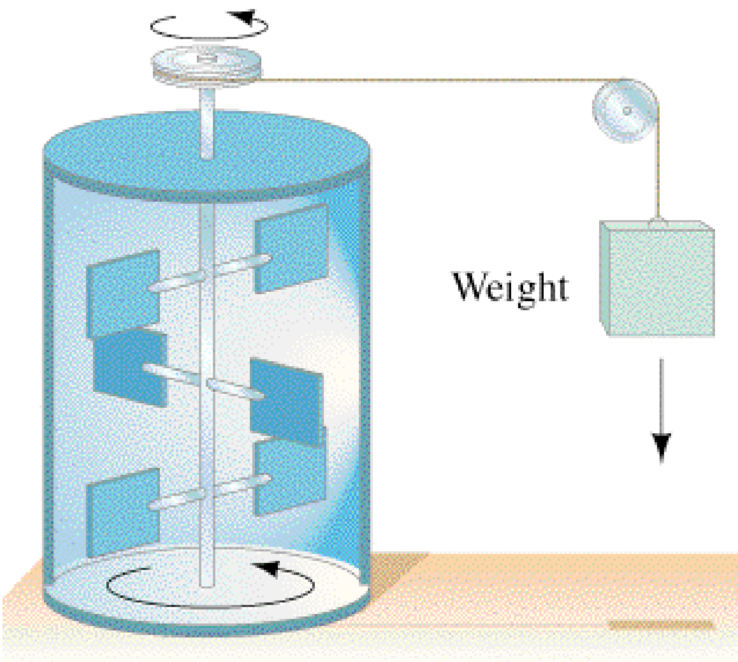
kilocalorie (kcal) 1 kcal =1000 cal

Calorie dietary usage, =1 kcal

British thermal unit (btu)
amount of heat necessary to raise the temperature of 1 lb of water by 1F^o

1btu = 252 cal

Mechanical Equivalent of Heat



4.186 J= 1 cal

Heat is energy that's transferred from one body to another because of a difference in temperature.

Like water, flows from high
to low (temperature).

Not the energy a body contains.

Specific Heat Capacity

Heat transfer $Q=mc\Delta T$

Specific heat (capacity) c: J/kg-C^o or J/kg-K

	kcal/kg -C^o	J/kg -C
Water	1	4200
Wood	0.4	1700
Aluminum	0.22	900
Iron	0.11	450
Lead	0.031	130

Molar Specific Heat

Unified atomic mass unit (u)

^{12}C atom has exactly 12u

$1u = 1.66 \times 10^{-27}$ kg

Atomic / molecular mass

H atoms	1u	H_2 molecules	2u
N_2 molecules	28u	O_2 molecules	32u
CO_2 molecules	44u		

1 mole = amount of substance that contains as many atoms or molecules as there are in 12 grams of ^{12}C.

Mole number $n = m/M$

= mass (gram)/Molecular mass (g/mol)

In molar form: $Q = mc\Delta T = nMc\Delta T = nC\Delta T$

Molar specific heat: $C = Mc$

Calorimetry

Isolated system: Energy conserved

Heat Lost = Heat Gain

Method 1: Keep heat positive

$\Sigma m_i c_i \Delta T_i = \Sigma m_j c_j \Delta T_j$

Heat Gain= $mc(T_f-T_i)$

Heat lost = $mc(T_i-T_f)$

Method 2: Keep sign consistent

$\Sigma m_k c_k \Delta (T_f-T_i)_k=0$