Temperature

Thermometer

Length =

Quantity of State

Gas in a Container:

Quantity of State = pressure

These are systems

Put 2 systems in Contact

If one is "hotter" than other ⇒

Quantities of State will Change.

Separate these systems with insulating Wall = **Adiabatic** wall (styrofoam)

Qty's of State Change slowly or not at all

Separate systems with a Conducting Wall = **Diathermic**

Qty's of State will Change quickly

Copper

If Qty's of State do not Change ⇒ Systems in Thermal Equilibrium

A and C are in Thermal Eq + B and C are in Therm Equilibrium

A isolated from B

↳ A and B put in Contact ⇒ Qty's of State don't change ⇒ A + B are in Thermal Equilibrium

If A in therm Eq w/C
and B in therm Eq w/C
⇒ A and B in therm Eq.
Zeroeth Law of
Thermodynamics
⇒ 2 systems in therm.
Eq. have same Temperature
⇒ define temperature

Define temperature scale ⇒
Need duplicatable temp.

Substances have 3 phases
Solid, Liquid, gas.
2 phases coexist w/o
changing amounts ⇒
Phases are in equilibrium
Solid/Liquid ⇒ Melting Pt
= Freezing Point
Liquid/Gas ⇒ Boiling Pt
⇒ Condensation point.
Solid/Gas ⇒ Sublimation
point

For a specific Temp + Press
for water. Solid, Liquid, gas
coexist = Triple Point
at .01°C = 273.16 K
Sets scale, ratio
of 2 temps be ratio
of their qty's of state
T(X) temperature at value
Qty of state X
T(X') " " " " " " X'

$\frac{T(X)}{T(X')} = \frac{X}{X'}$ Let X_3 be Value at Triple pt

$T(X) = (273.16\,k)\left(\frac{X}{X_3}\right)$

Column of Hg reads 5.0 cm at Triple pt, what does it read at boiling pt of H_2O?

$\frac{T(h)}{T(h_3)} = \frac{h}{h_3} \Rightarrow h = h_3 \frac{T(h)}{T(h_3)}$

$h = (5\,cm)\left(\frac{373\,k}{273.16\,k}\right) = 6.83\,cm$

Celsius (t_c), Kelvin (T) and Farenheit (t_F)

$t_c = T - 273.15\,k$

Boiling Pt = 373.15 k = 100°C

$t_F = \frac{9}{5}t_c + 32°F$

Define Coefficient of Linear expansion α s.t.

$\Delta L = \alpha L_0 \Delta T$

$\alpha = \frac{1}{L}\frac{\Delta L}{\Delta T}$ at some temp.

Thermal Expansion

Rod of Length L_0 at initial temp. T_0 Change by ΔT → Length changes ΔL

Steel surveyor's tape Correct at 20°C, gr. outside at 35°C measure 86.57 ft apart: what is correct distance?

$\alpha(\text{Steel}) = 1,2 \times 10^{-5}/°C$

$\Delta L = L_0 \Delta T \Rightarrow L = L_0 + \Delta L$

$= L_0(1+\alpha\Delta T) =$

$86.57\,ft\,(1+(1.2\times10^{-5}/{}^\circ C)(15^\circ C))$

$= 86.59\,ft$

Volume changes with Temp: Define Volume Coefficient β s.t.

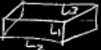
$\Delta V = \beta V_0 \Delta T$

Points:

① Hole expands like Solid of same material

② Relation btw. Volume and Linear expansion

Parallelopiped sides L_1, L_2, L_3



$V_0 = L_1 L_2 L_3$

$V = V_0 + \Delta V = L_1 L_2 L_3 (1+\alpha\Delta T)^3$

$= V_0(1+\alpha\Delta T)^3 =$

$V_0(1+3\alpha\Delta T+3\alpha^2(\Delta T)^2+\alpha^3(\Delta T)^3)$

For small ΔT, ignore ΔT^2, ΔT^3 terms

$V_0+\Delta V = V_0(1+3\alpha\Delta T$

$V_0+\Delta V = V_0(1+\beta\Delta T)$

$\Rightarrow \Delta V = 3\alpha V_0 \Delta T$

$= \beta V_0 \Delta T$

$\Rightarrow \boxed{\beta = 3\alpha}$

Equations of State

Relation between
Qty's of State of system.
Volume V, Pressure P,
Temperature T, mass m.

$$V = f(p, T, m)$$

f = some function
Equation of State
= Equilibrium States

Equation of State of
Ideal Gas. measure
gas in moles, if
$\mathcal{M}$ = Molecular mass
= mass per mole
Avogadro's #.

$$N_A = 6.02 \times 10^{23} \frac{\text{molecules}}{\text{mole}}$$

n moles, mass m

$$n = \frac{m}{\mathcal{M}}$$

$$pV = nRT$$

Eq. of State of Ideal
Gas. n = # moles
R = Universal Gas Cons

$$R = 8.314 \left(\frac{N}{m^2}\right) \cdot m^3 \, mo$$

$$R = 8.314 \, J \, mol^{-1} \, K^{-1}$$

Pressure can be defin
in terms of atmospheres =