Physics 212 lecture 4 F01

Lecture 4

- HW due Friday
- HW session tonight @ 5:30
- Quiz 1 Friday
- Labs
- next week

Today: review temp., thermal expansion (water), Ideal gases, gas process, gas law

Finish chapter 18, start 19

Temperature in SI units of Kelvin

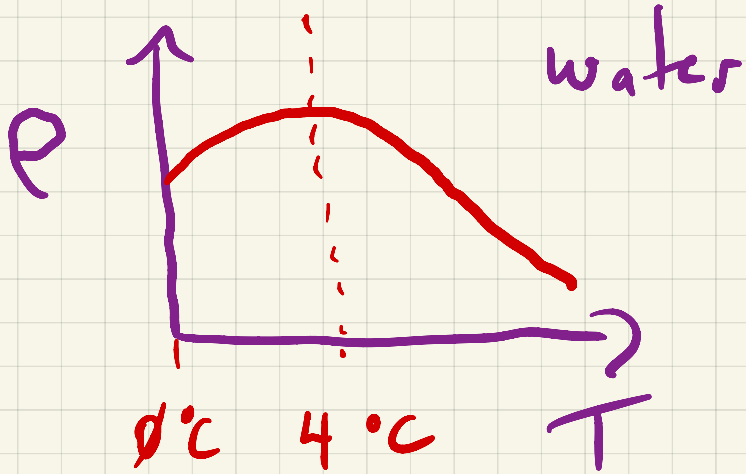
absolute temperature scale

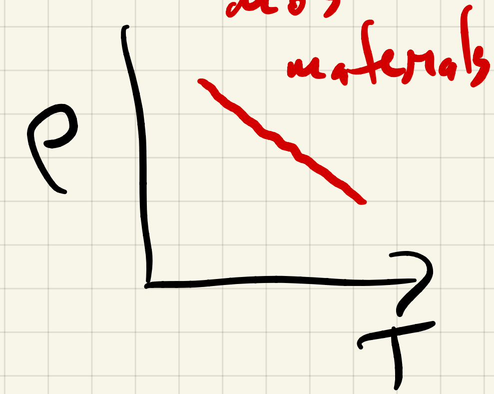
F → C → K

Thermometers ⇒ many use thermal expansion.

$$\frac{\Delta L}{L} = \alpha \Delta T \quad \text{or} \quad \frac{\Delta V}{V} = \beta \Delta T$$

$$\rho = \frac{M}{V}$$





water freezes from the top ⇒ liquid water (~4°C) sits on bottom

Ideal gases ⇒ "low" density & not near a phase transition

Equations of state ⇒ relate the state variables to each other ($P, V, T, N, M, n \ldots$) can be complicated

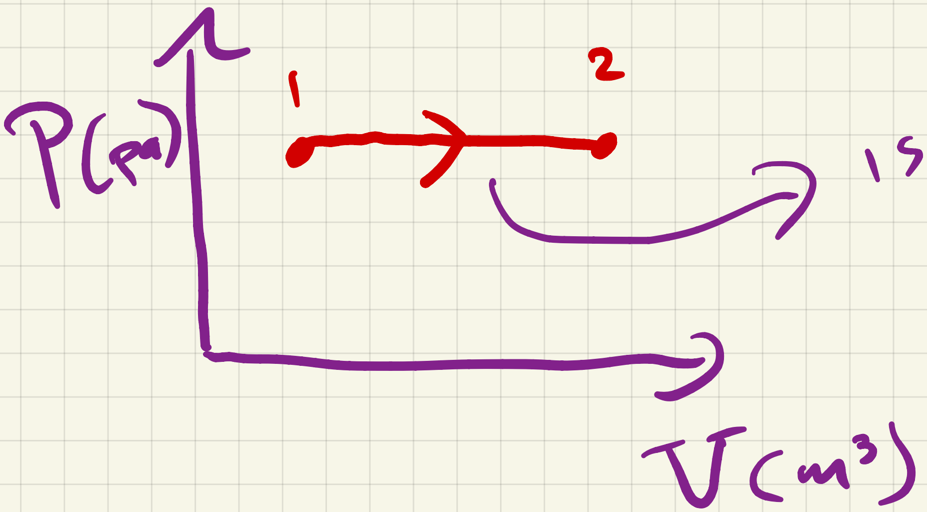
For Ideal gases the equation of state is the Ideal Gas Law

$$PV = nRT$$

- P → pressure in Pa
- V → Volume in m^3
- n → # of moles
- R → gas constant 8,31 J/mole K
- T → Temperature in Kelvin !

Ideal gas process's ⇒ quasi-steady state

⇒ stays in equilibrium



⇒ isobaric (const. pressure process)

P is constant

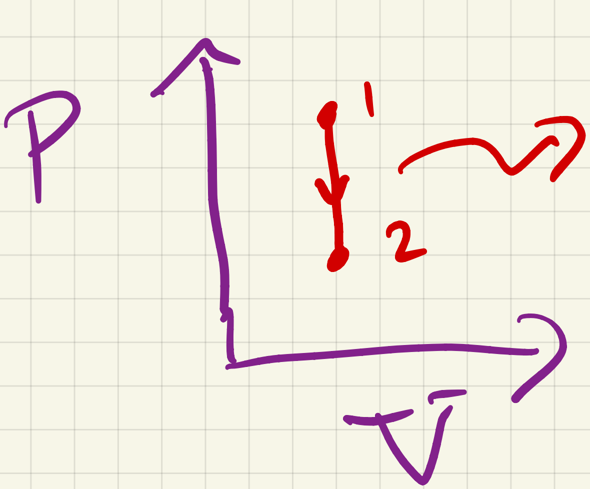
assume n is constant

$$pV = nRT$$

$$V = \underbrace{\left(\frac{nR}{P}\right)}_{\text{const}} T$$

⇒ if V ↑ then T ↑

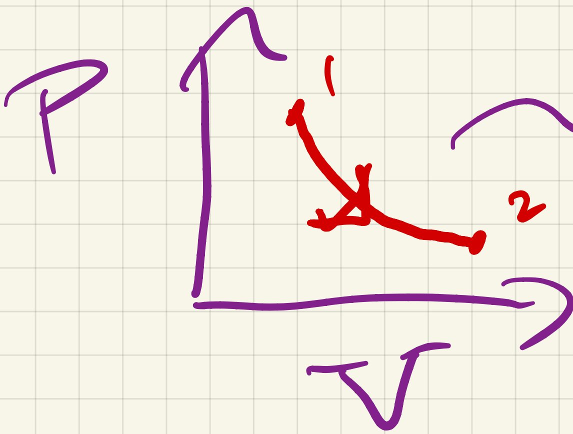
For isobaric process



isochoric (const. volume process)

$$PV = nRT \Rightarrow P = \underbrace{\left(\frac{nR}{V}\right)}_{\text{const.}} T$$

If P ↑ then T ↑ in an isochoric process



isothermal process (const. temp)

$$PV = nRT \Rightarrow P = \underbrace{(nRT)}_{\text{const.}} \frac{1}{V}$$

If P ↑ then V ↓ for isothermal process

A weather balloon @ 1 Atm & 27 °C has a volume of 6 m³. It rises to 8000 m @ 0.5 Atm & −73 °C. Find V_F.

$$PV = (nR)T \Rightarrow \frac{PV}{T} = nR$$

(nR: const)

$$\frac{P_i V_i}{T_i} = \frac{P_F V_F}{T_F}$$

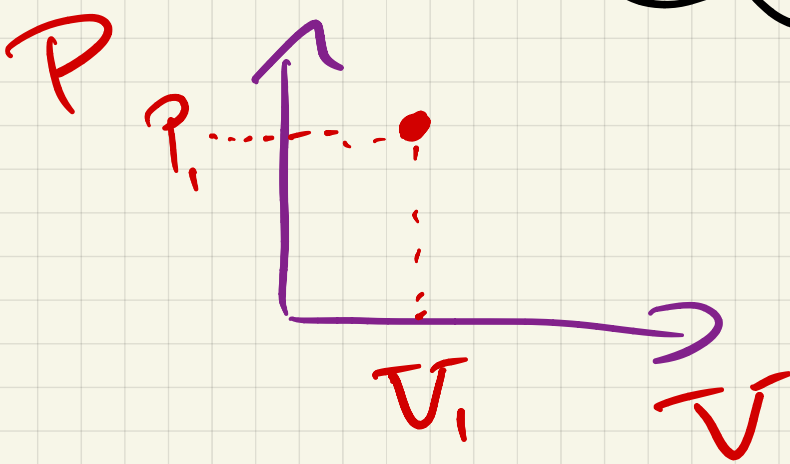
Find $V_F = \frac{P_i}{P_F} \frac{T_F}{T_i} V_i$

$T_i = 27\,^\circ C \qquad T_K = T_C + 273$

$T_i = 300\ K \qquad T_F = -73\,^\circ C \qquad T_F = 200\ K$

$$V_F = \frac{P_i}{P_f}\,\frac{T_F}{T_i}\,V_i = \frac{1\ Atm}{0.5\ Atm} \times \frac{200\ K}{300\ K} \times 6\ m^3$$

$$V_F = 2 \times \frac{2}{3} \times 6 = \underline{8\ m^3}$$



& we know n

$pV = nRT$ solve for

$T \Rightarrow T = \frac{pV}{nR}$