Quiz 4/26/11 (5.3)

You put an ice cube in a bowl on a table.

The ice cube is melting.

Entropy inside the bowl is:

A) increasing

B) decreasing

C) not changing

S = entropy

$$dS = \frac{dQ}{T} \quad \begin{matrix}\text{(heat)} \\ \text{(temp.)}\end{matrix}$$

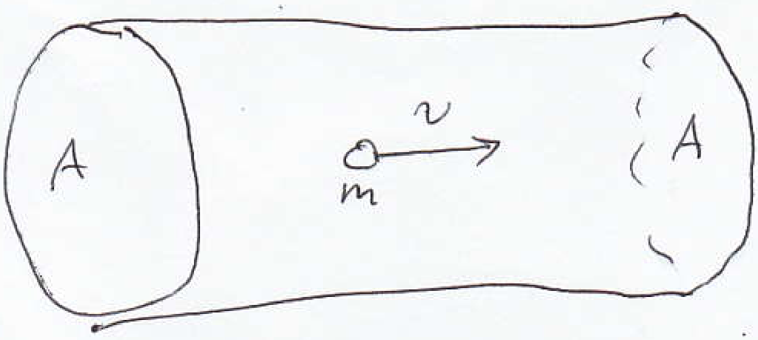
$T = 0°C = 273°K$

$dQ > 0$

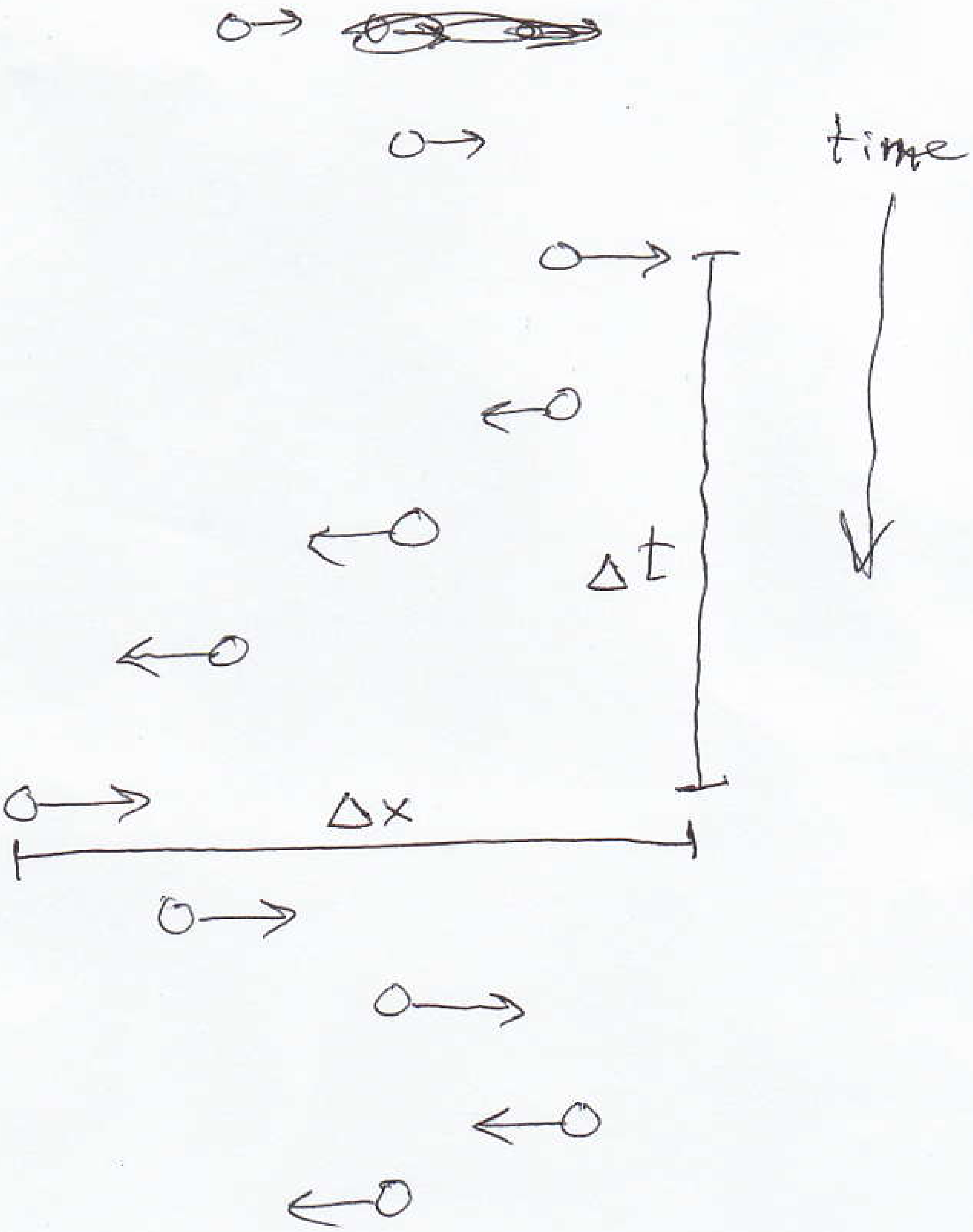
$$dS = \frac{dQ}{T} > 0$$

S increasing

1-particle "gas"



ping-pong ball (no gravity)

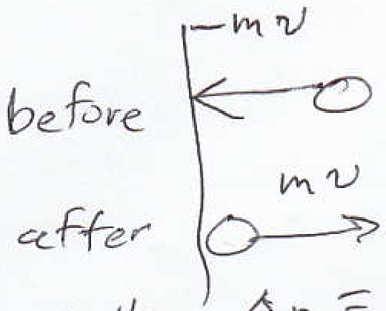


Given m, Δx, Δt, $K = ?$

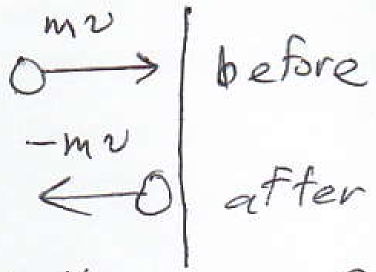
$$K = \frac{1}{2} m v^2 = \frac{1}{2} m \left(\frac{\Delta x}{\Delta t}\right)^2$$

$p = \pm m v$ When the ball hits the wall, what is Δp?

$$\Delta p = \pm 2 m v$$



ball: $\Delta p = 2mv$



ball: $\Delta p = -2mv$

After 100 collisions on the left wall and 100 collisions on the right wall,

$$\Delta t_{100} = 200 \Delta t = 200 \Delta x \cdot \frac{\Delta t}{\Delta x}$$

$$\Delta t_{100} = 200 \frac{\Delta x}{v} \qquad \frac{\Delta t}{\Delta x} = \frac{1}{v}$$

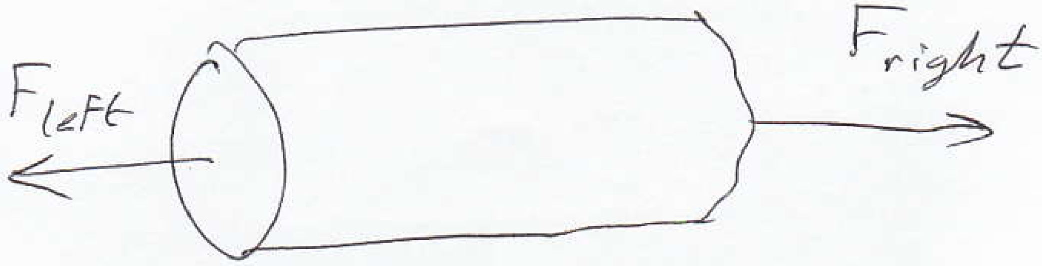
Total Δp_{100}^{left} on left wall:

$$\Delta p_{100}^{left\ wall} = 100(-2mv) = -200 mv$$

$$\Delta p_{100}^{\text{right wall}} = 100(2mv) = 200mv$$

$$\Delta p_{100}^{\text{can}} = \Delta p_{100}^{\text{right wall}} + \Delta p_{100}^{\text{left wall}} = 0$$

average force on wall



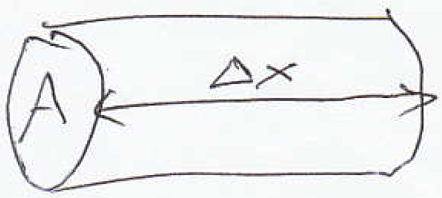
$$F = ma = m\frac{dv}{dt} = \frac{d(mv)}{dt} = \frac{dp}{dt}$$

$$\text{average force} = \frac{\Delta p}{\Delta t}$$

$$F_{left} = \frac{\Delta p_{100}^{\text{left wall}}}{\Delta t_{100}} = \frac{-200mv}{200\,\Delta x/v}$$

$$F_{left} = -mv^2/\Delta x$$

$$P_{left} = \frac{|F_{left}|}{\text{area}} = \frac{mv^2/\Delta x}{A} = \frac{mv^2}{A\Delta x}$$



$$A\Delta x = \text{volume} = V$$

$$P_{left} = \frac{mv^2}{V} = \frac{2K}{V} \Rightarrow P_{left}V = 2K$$

(Also: $P_{right}V = 2K$)

Definition of temperature

$$PV = nkT$$

$n = 1$ (just 1 ball)

$$kT = 2K \Rightarrow T = \frac{2K}{k}$$

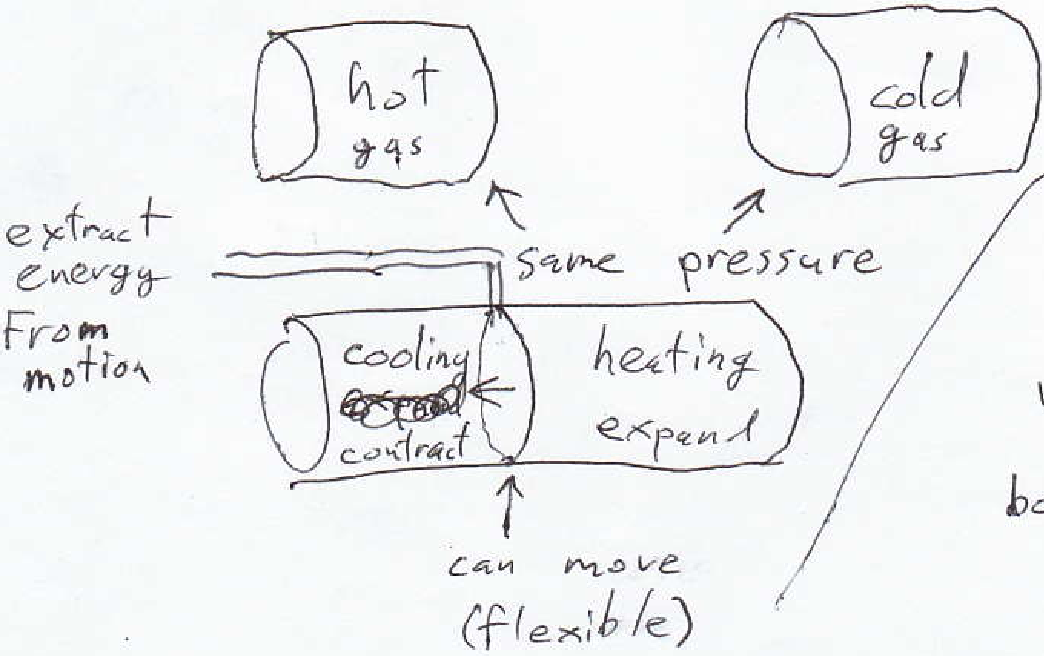
T ← in Kelvins

k ← Boltzmann constant

(ideal) (mono atomic) 3D gas: $T = \dfrac{2K_{average}}{3k}$

where $K_{average}$ = average K of many particles

Put hot & cold together:



Get faster change in volume with boiling.