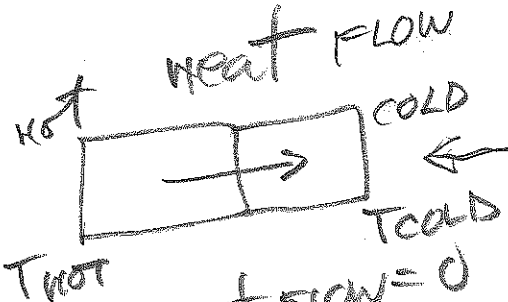
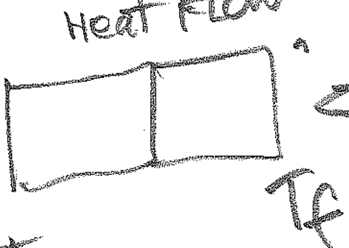
2A 11-18-13

Ch 14



← not in equilibrium



← EQUILIBRIUM at T_f = final temperature

↑ T_f

Temperature Scales

°C = celsius

K = kelvin

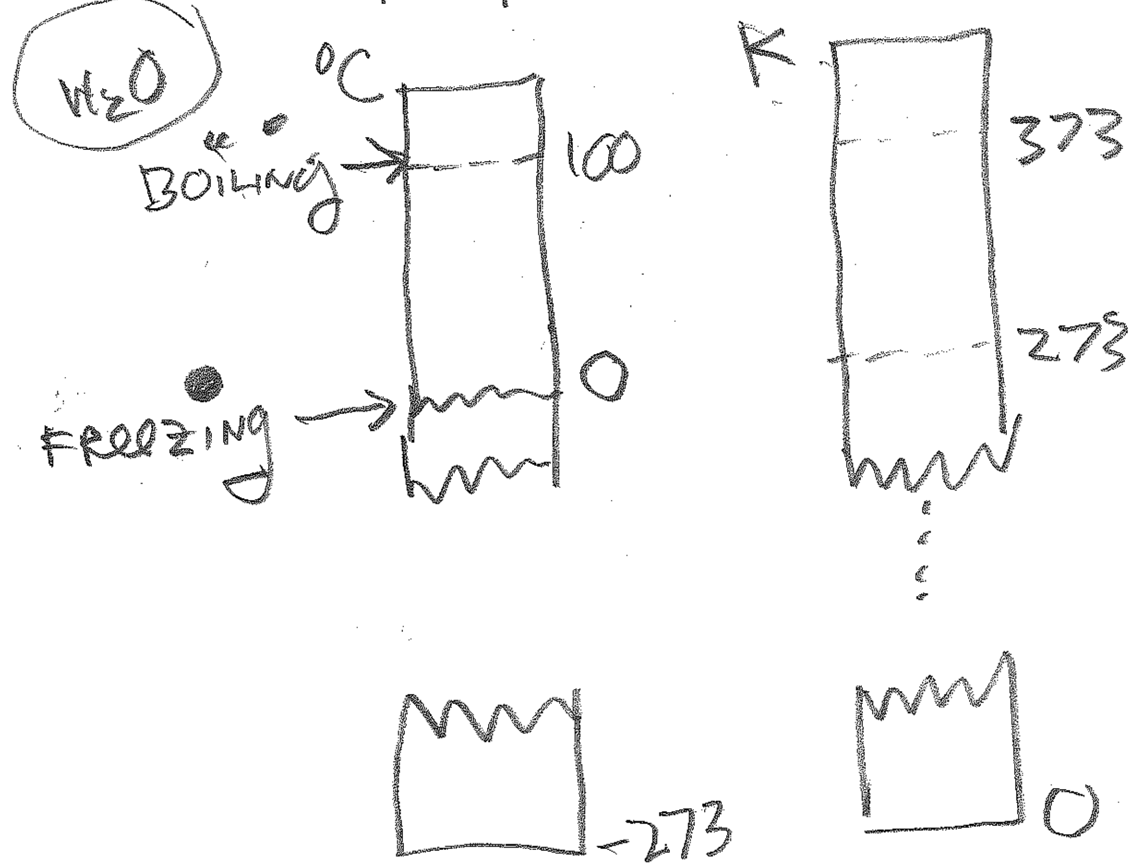
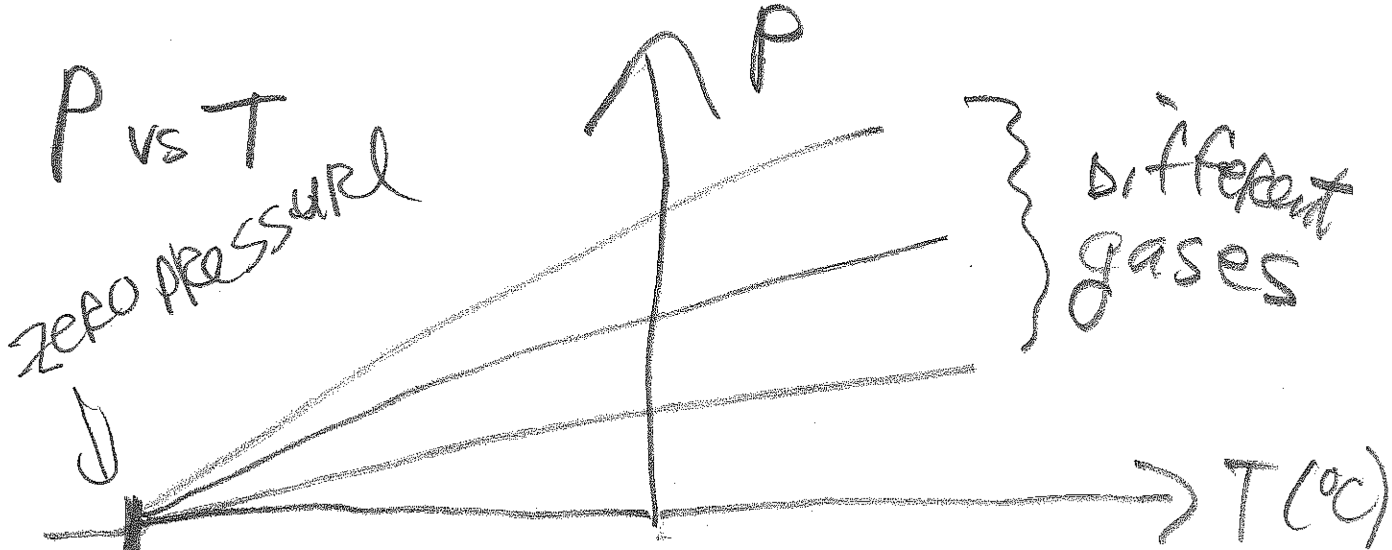


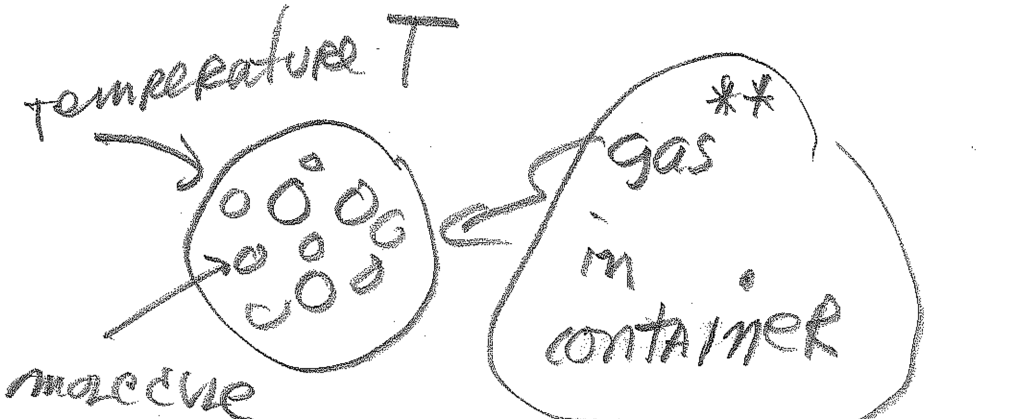
fig 14-4 <u>Lab</u> <u>this week</u>

on fig. 14.4

P vs T



-273.15
= 0K



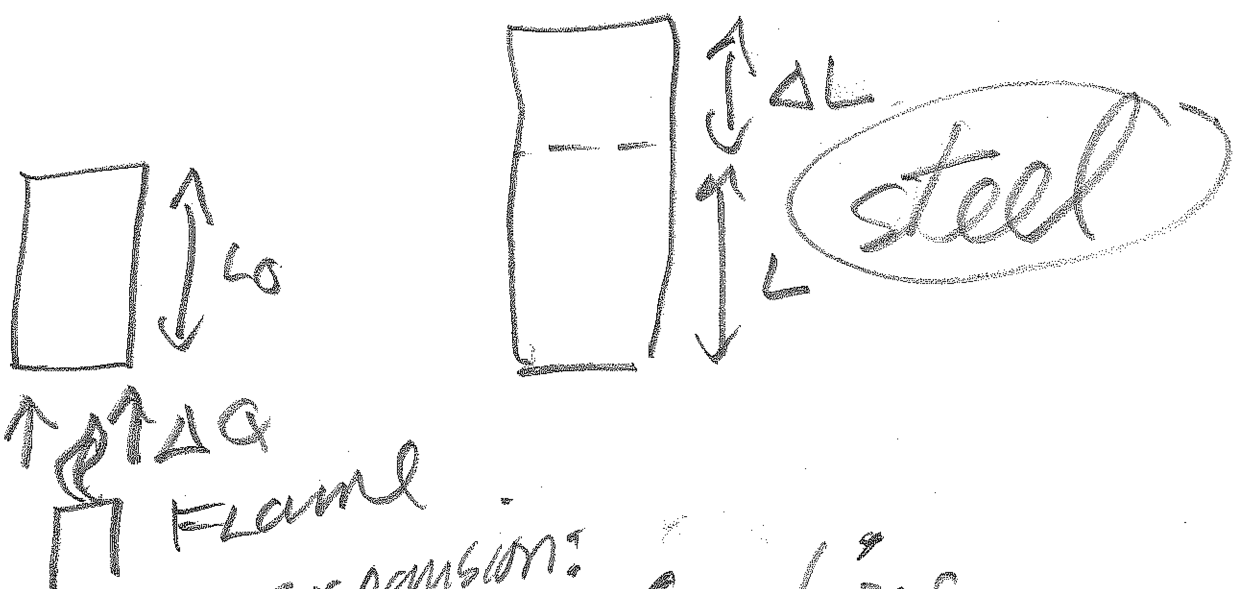
when T = 0K*, Pressure = 0*

Pressure = ** $\frac{\text{Force on inner wall}}{\text{area of wall}}$

* 0K, kinetic energy of molecule = 0 ⇒ force = 0 **

sec. 14.3

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

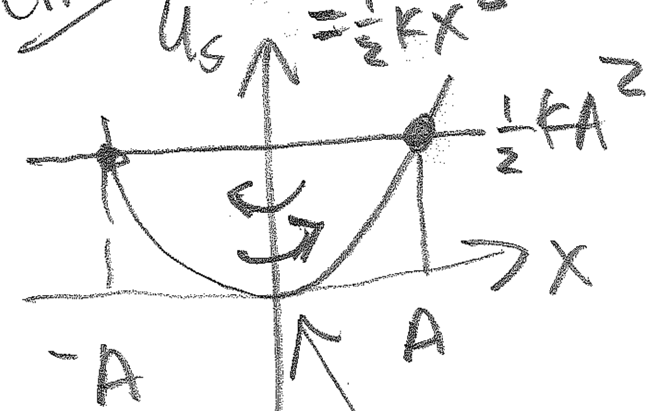


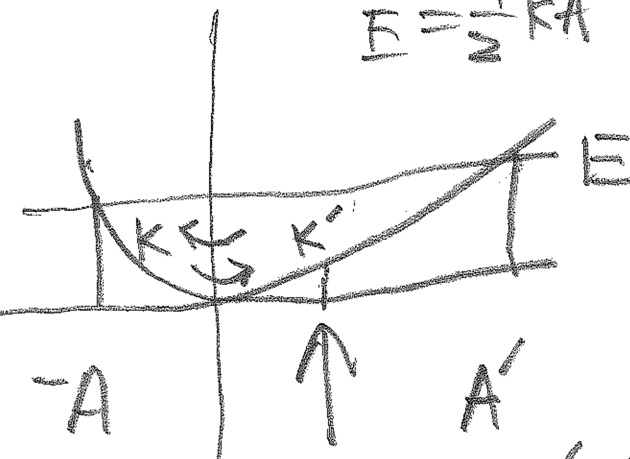
Reason for Expansion:
Asymmetric oscillations
of molecules (CH 11).

$E = \frac{1}{2} k' A'^2$

$E = \frac{1}{2} k A^2$

Chill:



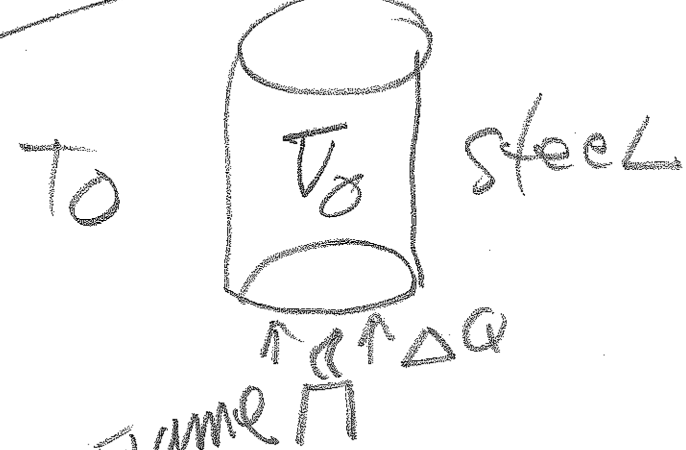


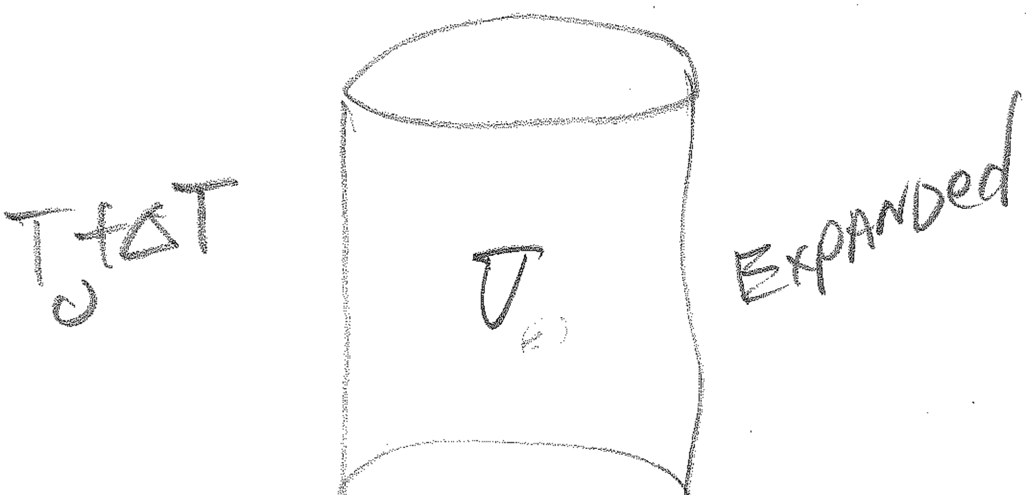
Average $x = 0$

Average $x \neq 0$

as T rises, average x grows

3D Expansion:





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

$$\beta = 3\alpha$$

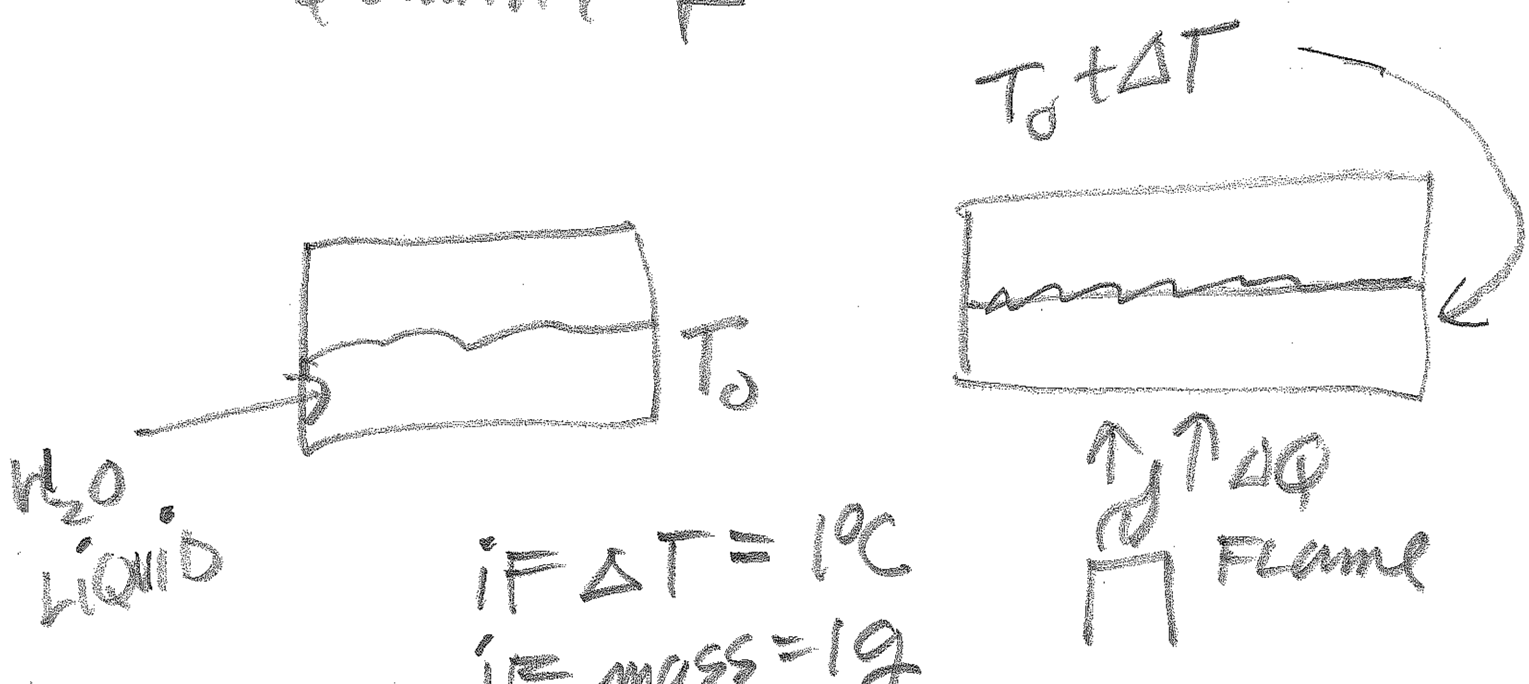
see table 14.1 Glass $\alpha_g = 0.65 \times 10^{-5} (°C)^{-1}$

steel $= \alpha_{st} = 1.2 \times 10^{-5} (°C)^{-1}$

NOTE: Steel expands more than glass.

Section 14.4

Quantity of heat



if $\Delta T = 1°C$
if mass $= 1g$

$\Delta Q = 1\ cal = 4.190\ J$

m = mass $\Longrightarrow \Delta Q = m \cdot C \cdot \Delta T$.

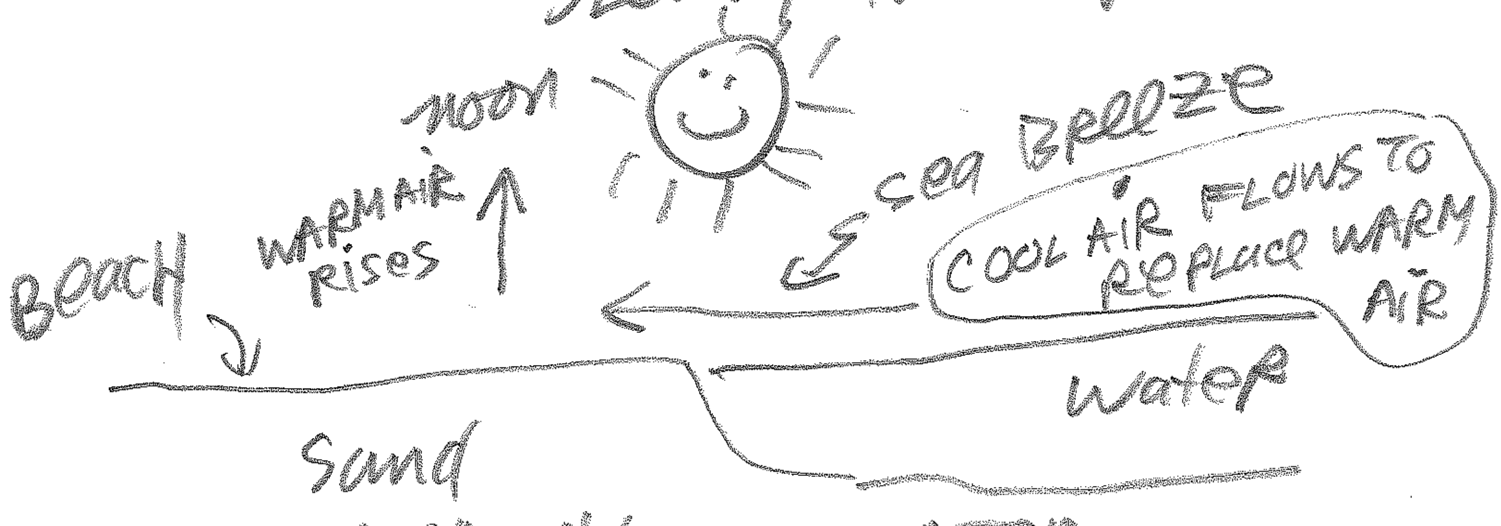
C = specific heat

table 14.3

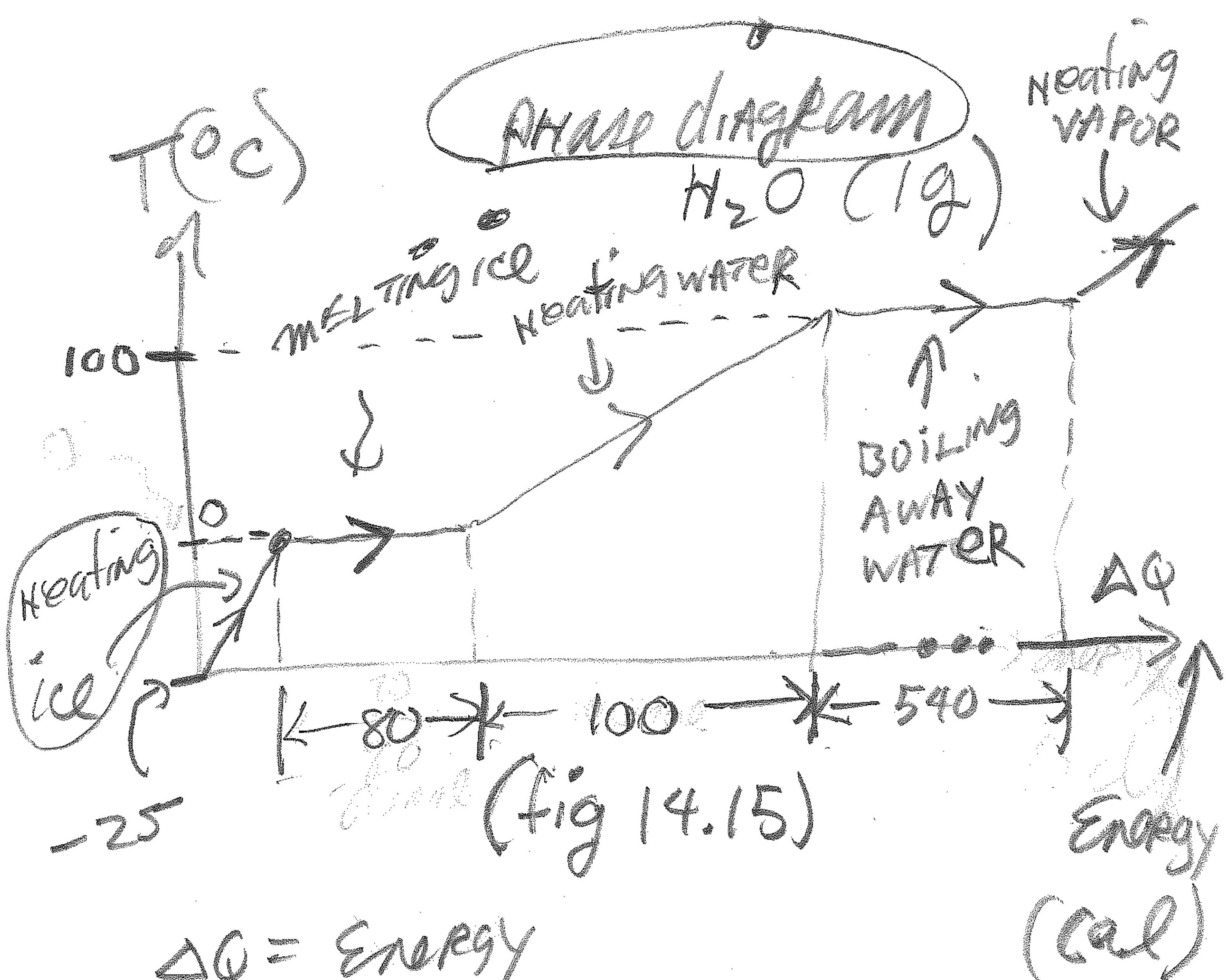
water $4.19\times10^{3}\,\frac{J}{kg\,^{\circ}C} = C_w$

MARBLE $0.88\times10^{3}\,\frac{J}{kg\,^{\circ}C} = C_{glass}$

$C_w > C_g$ water heats up more SLOWLY than glass (sand)



WARMER than WATER



ΔQ = ENERGY

<u>QUESTION</u> / HOW MUCH HEAT (ΔQ) is REQUIRED to melt 1g ice at 0°C INTO 1g of WATER at 50°C?

ANSWER: $\Delta Q_{melting} + \Delta Q_{heating}$

$m_w = m_{ice}$

$$m_w L_f + m_w c_w (50 - 0)^\circ C$$

L_f = heat of fusion of H_2O

$= 80 \frac{cal}{g}$; $c_w = 1 \frac{cal}{g^\circ C}$

$$= (1g)\left(80\frac{cal}{g}\right) + (1g)\left(1\frac{cal}{g^\circ C}\right)50^\circ C$$

$$= 80 \text{ cal} + 50 \text{ cal}$$

$$= 130 \text{ cal}$$

Mixing problem: QUESTION 2

Mix 1kg of H_2O (liquid) @ 80°C) with 1kg of H_2O (liquid) @ 20°C. What is T_f = ?

answer: 50°C

WORK

$$|\text{Heat lost}| = |\text{Heat gained}|$$

$$|m_w c_w (T_f - 80)_{°C}| = |m_w c_w (T_f - 20)_{°C}|$$

$$80 - T_f = T_f - 20$$

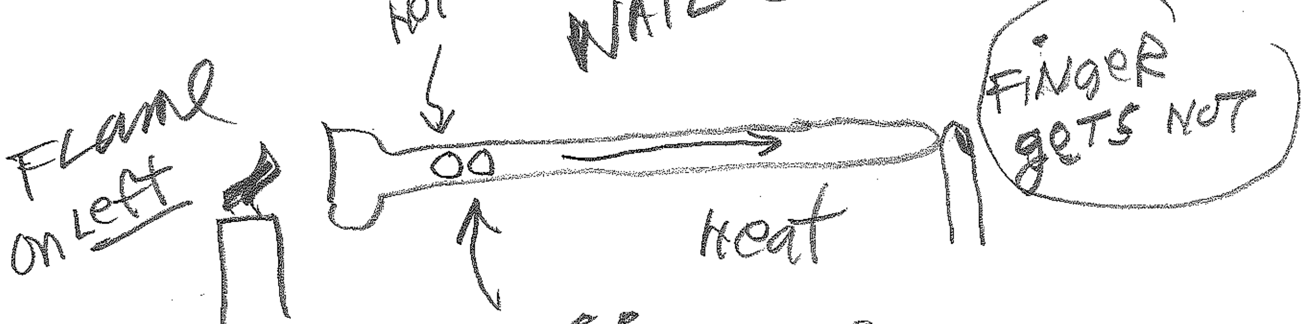
$$100°C = 2T_f$$

$$50°C = T_f$$

Survey of 3 mechanisms of heat transfer:

(1.) Conduction

Hot molecule collides w/ cool molecule



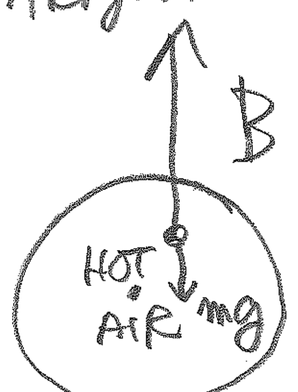
Collision of hot molecules on left w/ cool molecules on right.

$$\frac{\Delta Q}{\Delta t} = H = \frac{K \cdot A (T_H - T_C)}{L}$$

Rod length = L.
A = Rod area.

(2.) Convection:

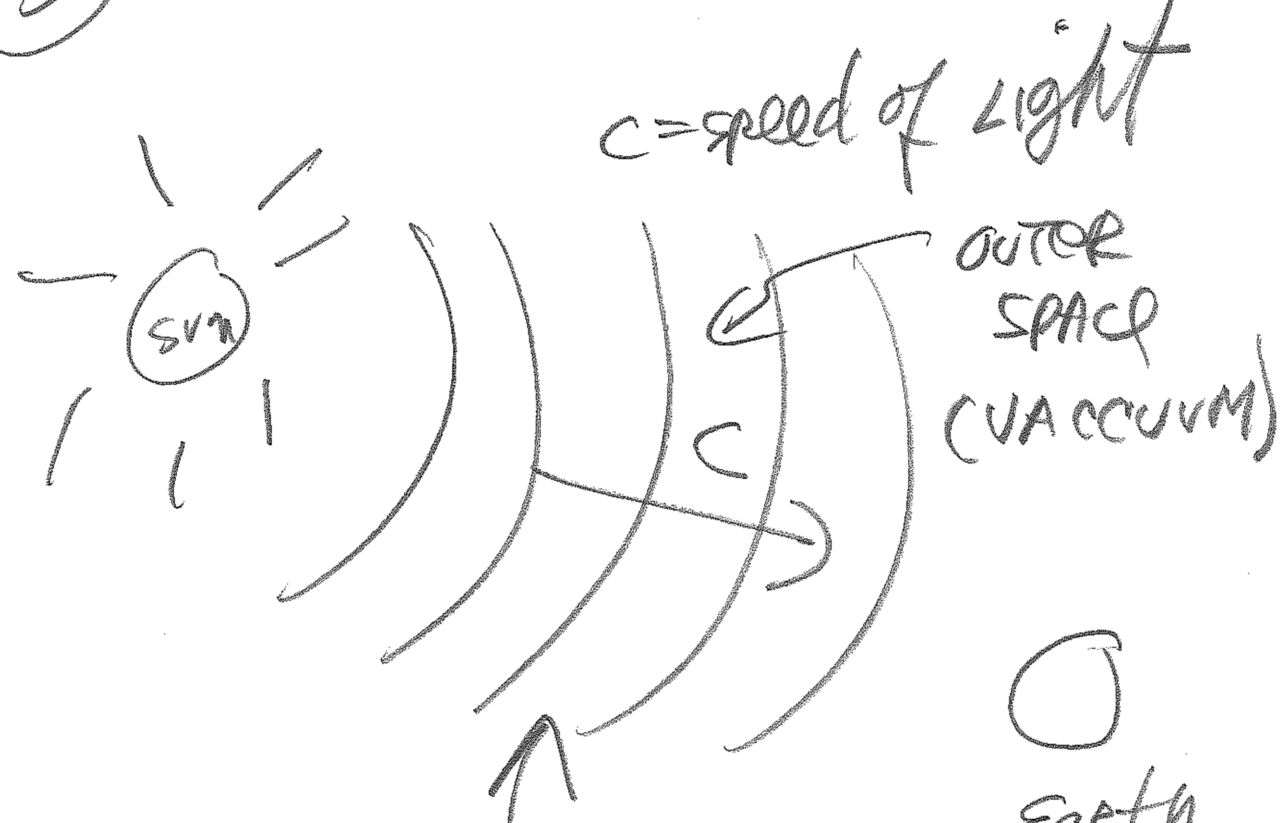
Hot air surrounded by cool air



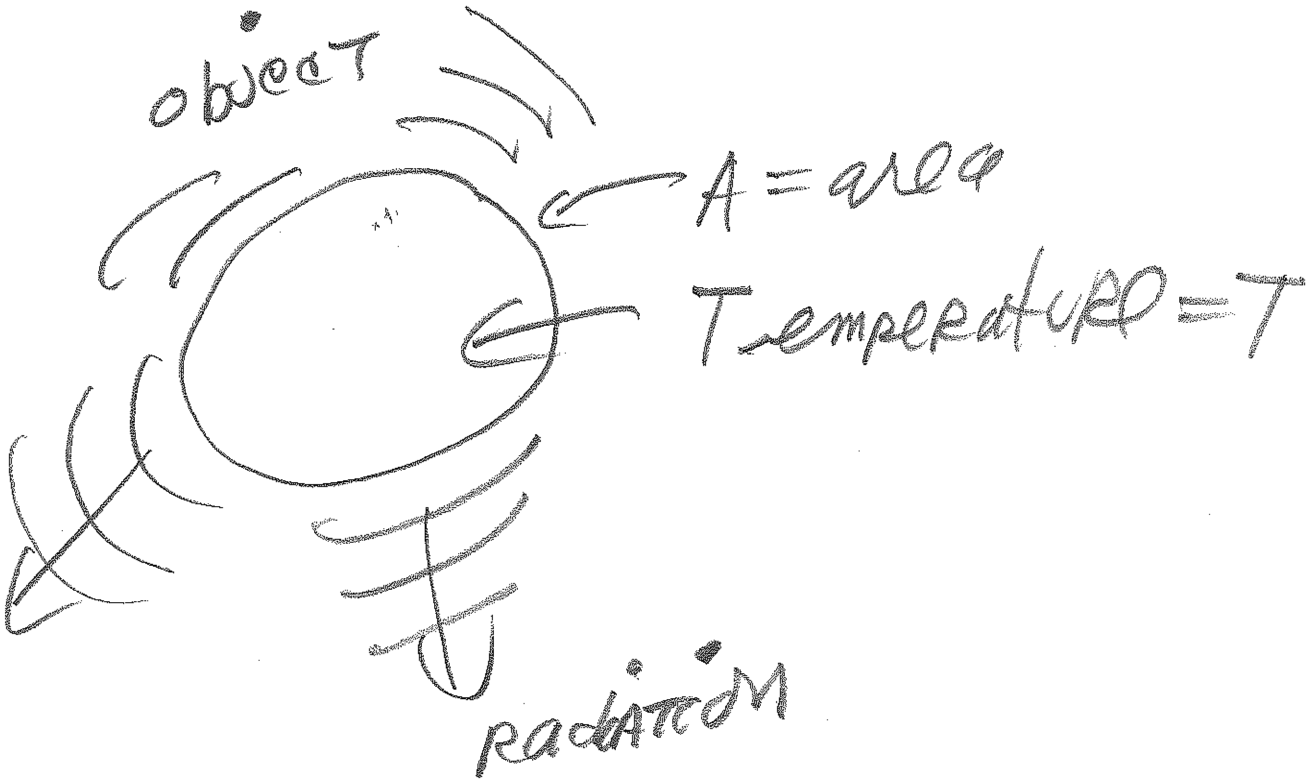
B = weight of cool air displaced (Ch 13)

cool air density > hot air density

(3) RADIATION



No medium is required for transmission (vaccuum)

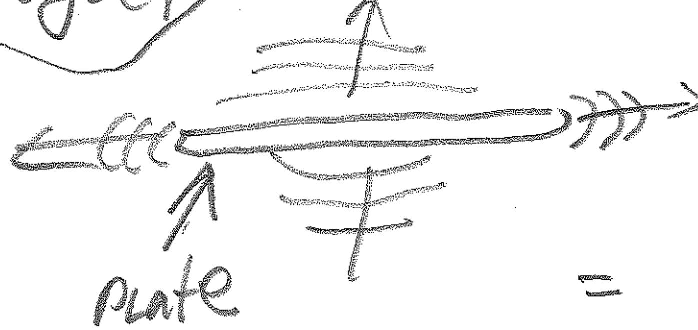


$$H = \frac{\Delta Q}{\Delta t} = A e \sigma T^4$$

rate of heat leaving object

Emissivity

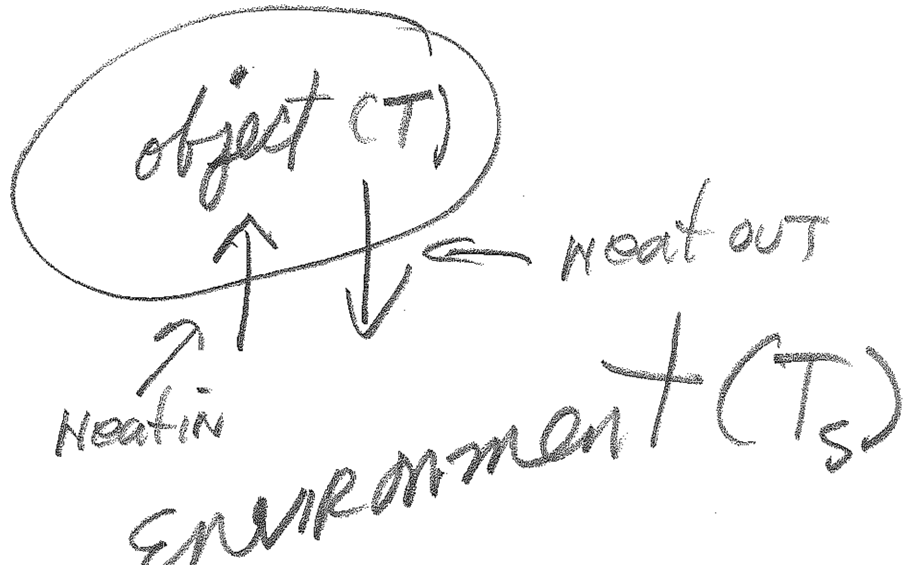
see example 14.13



$$H = (0.02)(0.60)(5.67\times10^{-8}) \times (1073K)^4$$

$$= 900\,W\ \left(\frac{J}{s}\right)$$

NOTE: Environment (T_s)



Heat in: Environment

Heat out: object

$$H_{NET} = Ae\sigma(T^4 - T_s^4)$$

NOTE: GOOD EMITTERS ARE ALSO GOOD ABSORBERS: BLACK EMITS EFFICIENTLY.