4C

11-8-13

<u>Test 3</u>

CH 34, 35, 36, CH 18 (EC)

final: CH. 20
EXAM
19
18 + 2 problems from T1, T2
36
35
34

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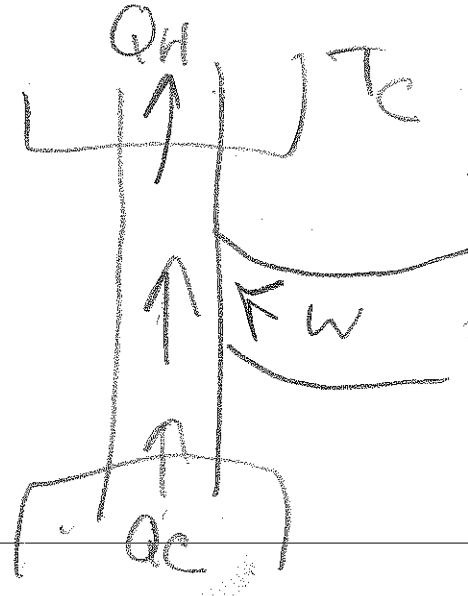
section 20.4

fridges



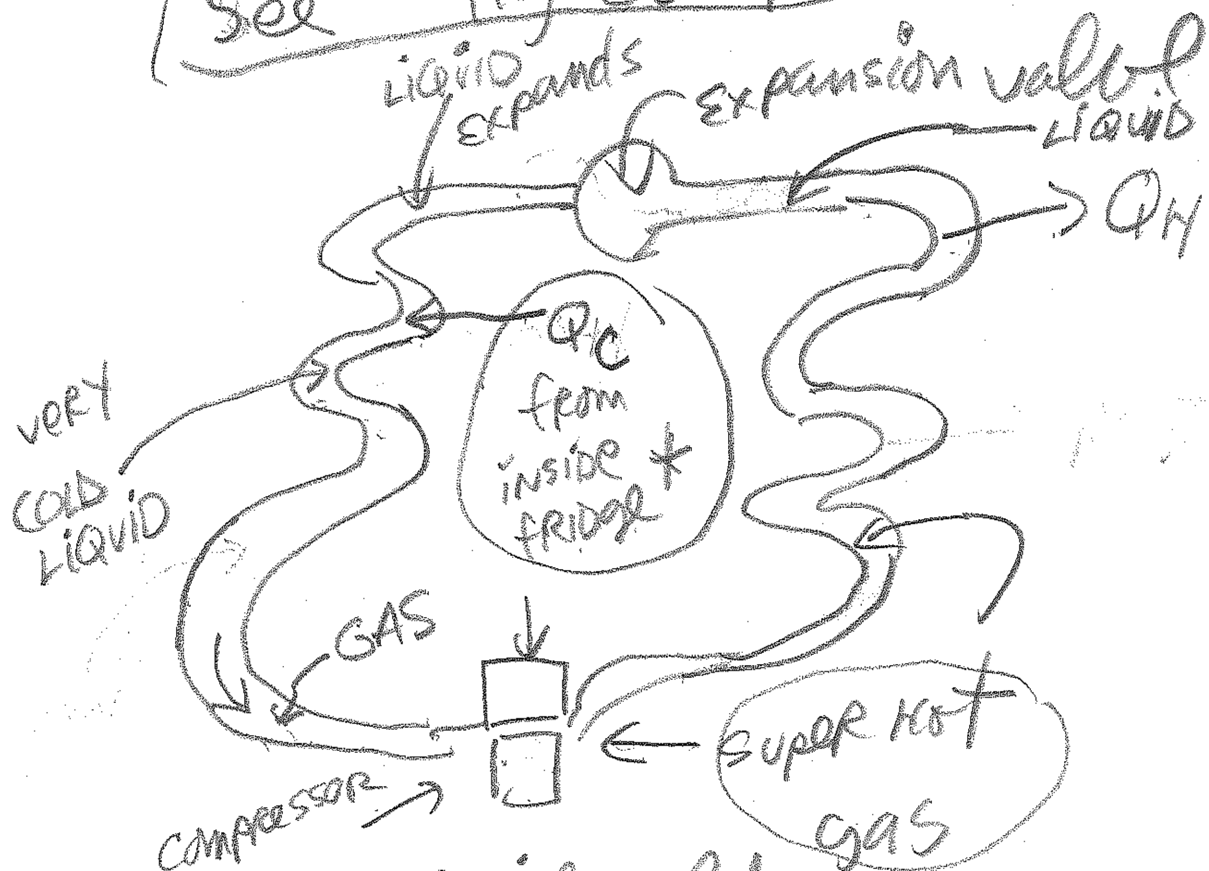
$|Q_H| = Q_C + W$

$K = \frac{|Q_C|}{W}$

$K = \frac{|Q_C|}{|Q_H| - |Q_C|}$

$K \to \infty$ when $|W| \to 0 \Leftrightarrow |Q_H| = |Q_C|$

See fig 20.9



* keeps inside cold.

ZND LAW

impossible

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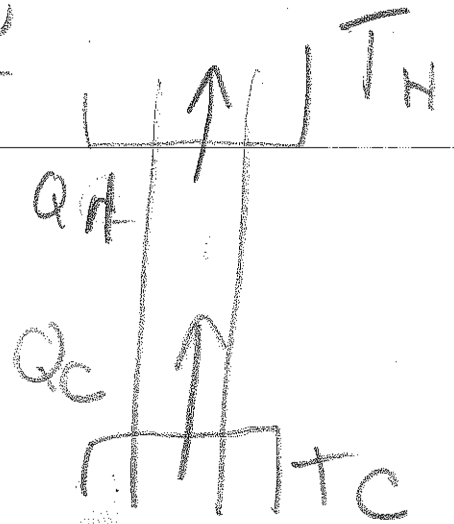


cpc 20.6

carnot cycle: MOST Efficient!

reversible: slowly,

no friction, NO TURBULence

a SPECIAL reversible

PROCESS IN 4 STEPS:

1. Isothermal expansion
2. Adiabatic expansion
3. Isothermal compression
4. ADIABATIC compression

$$\varepsilon_C = 1 - \frac{T_C}{T_H}$$ MOST Efficient

note: $\varepsilon_C < 1$ ALWAYS

Sec. 20.7 Entropy

Isothermal process

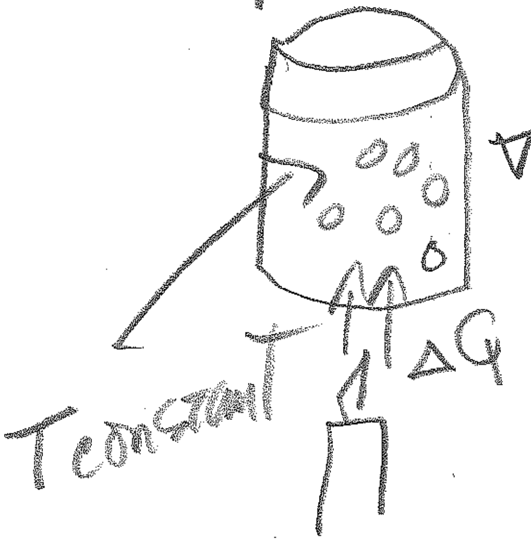
$$dQ = dW$$

$$dU = 0$$

$$U \propto T = \text{const.}$$

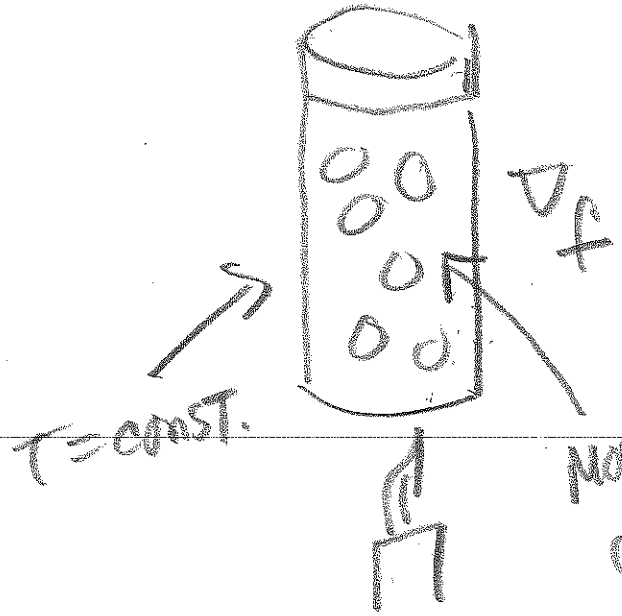
internal energy of gas

$$dU \propto dT = 0$$



Gas molecules are randomly moving over a larger volume

$\Rightarrow$ more disorder



More disorder in larger volume

Isothermal entropy:

$$dQ = dW = p\,dV \text{ since } dU = 0$$

$$p = \frac{nRT}{V} \quad (\text{CH } 18)$$

$$dQ = \frac{nRT\,dV}{V}$$

$$\rightarrow \frac{dV}{V} = \frac{dQ}{nRT}$$

fractional increase in disorder.

increase in disorder

$$\boxed{dS = \frac{dQ}{T}}$$

Isothermal (T = const)

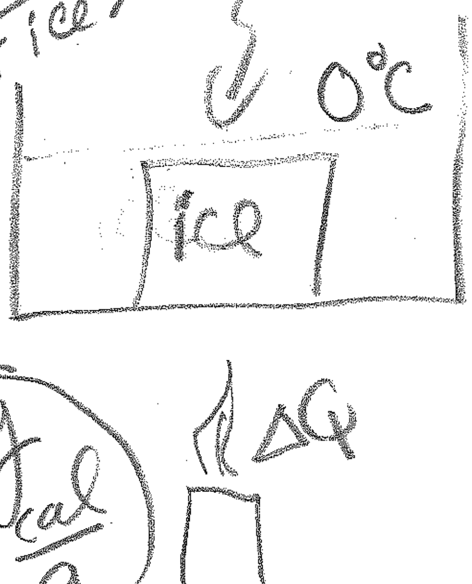
$$\left(dS \propto \frac{dV}{V}\right)$$

Isothermal process

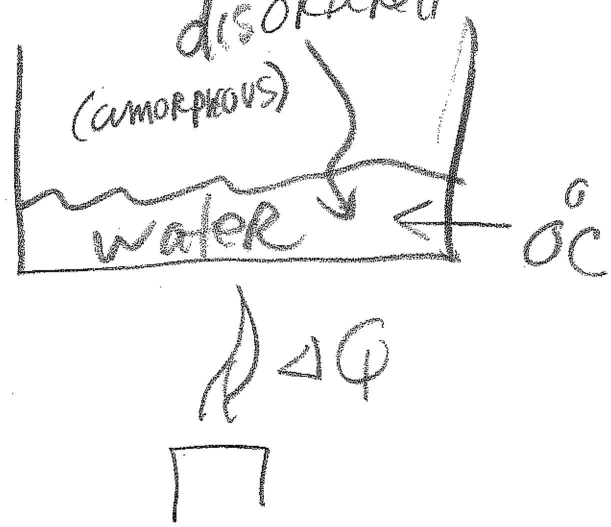
$$\Delta S = S_f - S_i = \frac{\Delta Q}{T}$$

highly ordered (crystalline)

EXAMPLE! MELT ICE.



disordered



$m = 1g$

$L_f = 80 \frac{cal}{g}$

$\Delta S = ?$ for melting ice @ 273K

$$\Delta S = \frac{\Delta Q}{T} = \frac{\Delta Q}{273K} = \frac{m_{ice} \cdot L_f}{273K}$$

$$\Delta S = \frac{(1g)\cdot(80\,cal/g)}{273K}$$

$$= \frac{80\,cal}{273K}$$

$$= 0.293\,\frac{cal}{K}$$

$$= 0.293\,\frac{cal}{K} \times \frac{4.190\,J}{cal}$$

$$= 1.23\,\frac{J}{K} = \Delta S = \text{increase in disorder}$$

Example 2: Mixing problem

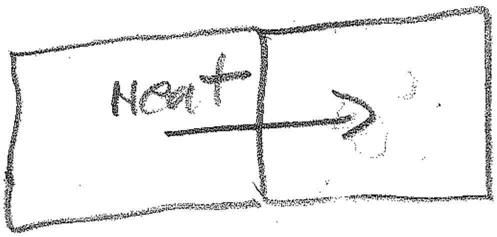
where $T \neq 0°C$ and $T \neq$ constant

1kg 1kg

$\Delta S = ?$

$\Delta S_{TOTAL} = ?$

80°C

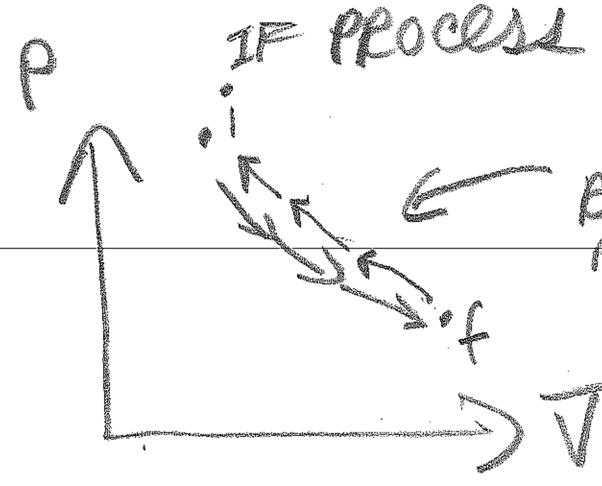


40°C

Assume bodies are insulated (closed system)

Note: page 670

If process is reversible:



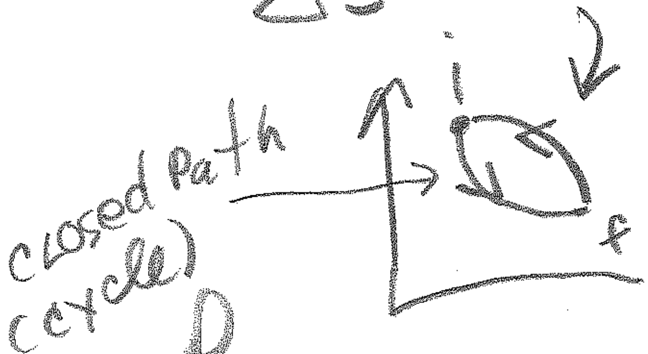
$$\Delta S = \int \frac{dQ}{T}$$

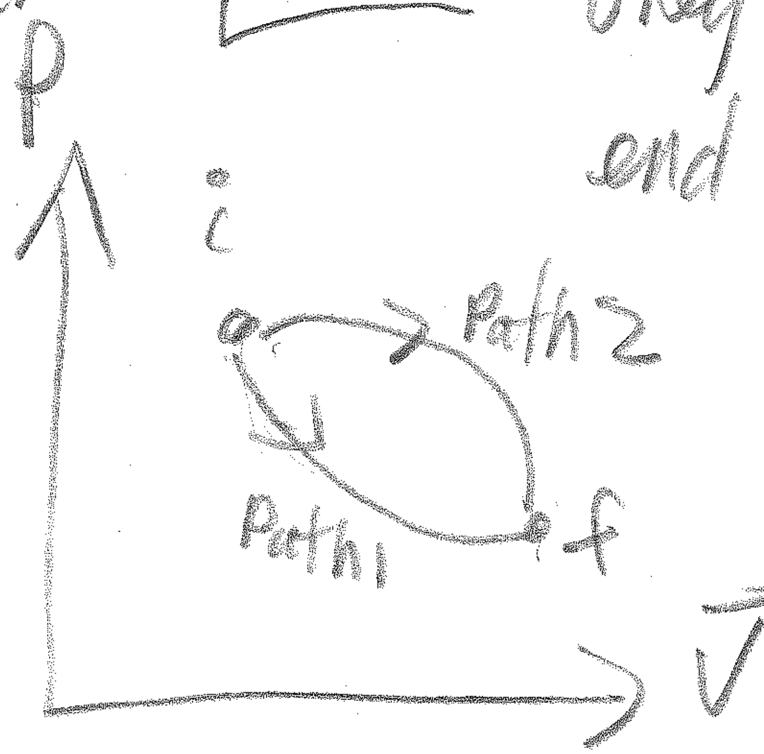
even if $T \neq$ constant

ALSO NOTE:

Since S is a "state variable";

$\Delta S = 0$ over a closed path and only depends on end points.

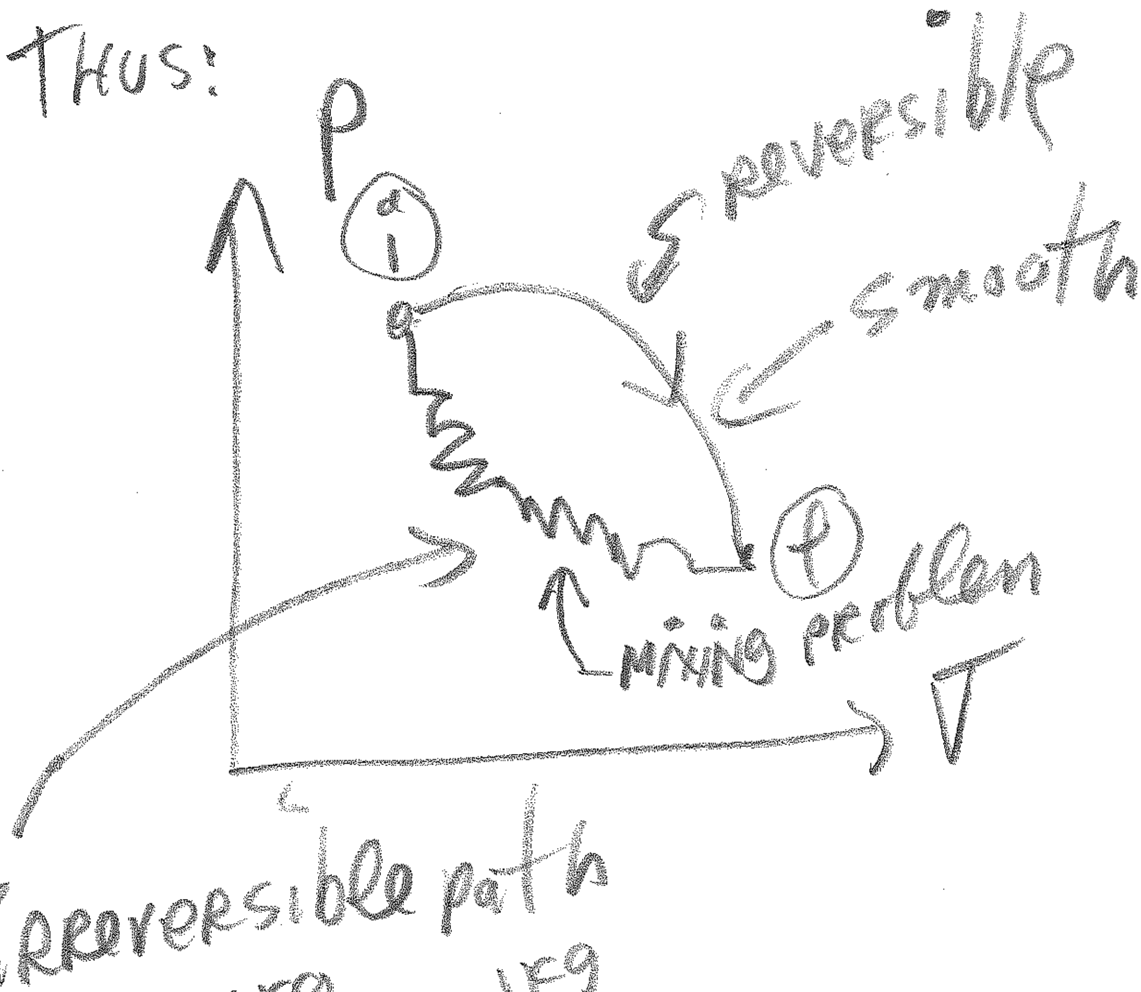


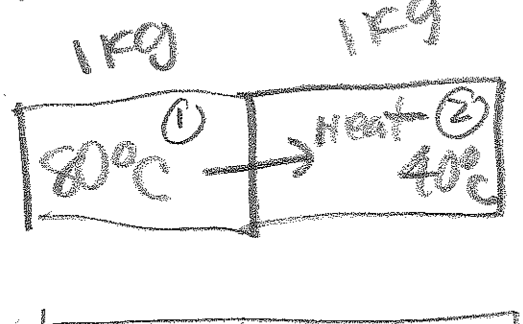


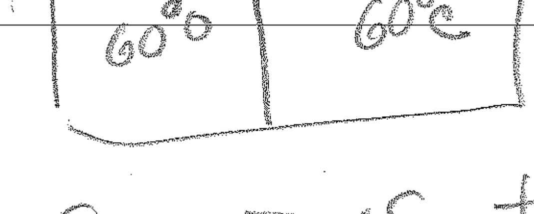
$$\Delta S_{path_1} = \Delta S_{path\,2}$$

$$\Delta S_{path_1} - \Delta S_{path\,2} = 0$$

THUS:







$\Delta S = ?$

$$\Delta S_{TOTAL} = \Delta S_1 + \Delta S_2$$

Assume water $C_w = \frac{1\,cal}{g^\circ C}$

use a reversible path!

$$\Delta S_1 = \int \frac{dQ}{T} = m\int \frac{c\,dT}{T} = mc\ln\frac{T_f}{T_i}$$

$$dQ = mc_w dT = (1000g)\,c_w\,dT$$

$$\Delta S_1 = mc\ln\frac{333K}{353K}$$

$$\Delta S_2 = mc\ln\frac{333K}{313K}$$

$$\Delta S_1 + \Delta S_2 = mc\left[\ln\left\{\frac{333^2}{353\cdot 313}\right\}\right] > 0$$

$$333^2 > 353\cdot 313$$