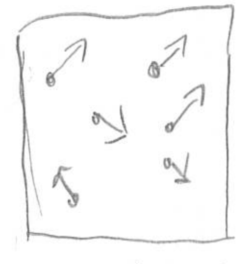
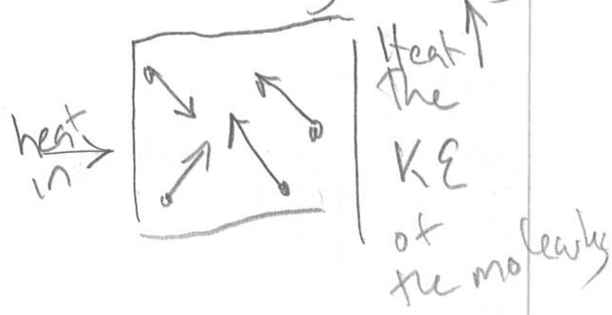
What is temperature, thermal Energy & heat?

Thermal Energy of an ideal gas is Total Kinetic Energy of the gas molecules



Molecules are colliding Elastically

Temperature is a measure of the average Kinetic energy of a substance



$$F = \frac{9}{5}(C° + 32)$$

$$C = (F - 32) \cdot \frac{5}{9}$$

$$C + 273$$

If $F° = 0$, then $C = -17.7$ & $K = 255.2$

What is absolute Zero in F?

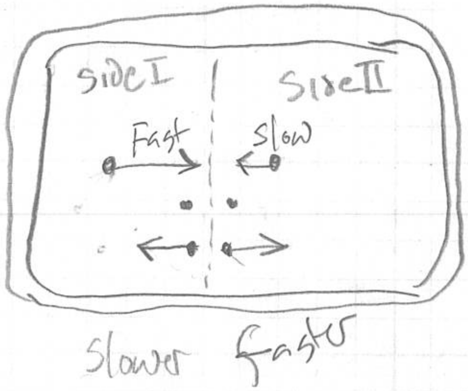
$0\,K = -273\,C$

$F = \frac{9}{5}(-273 + 32)$

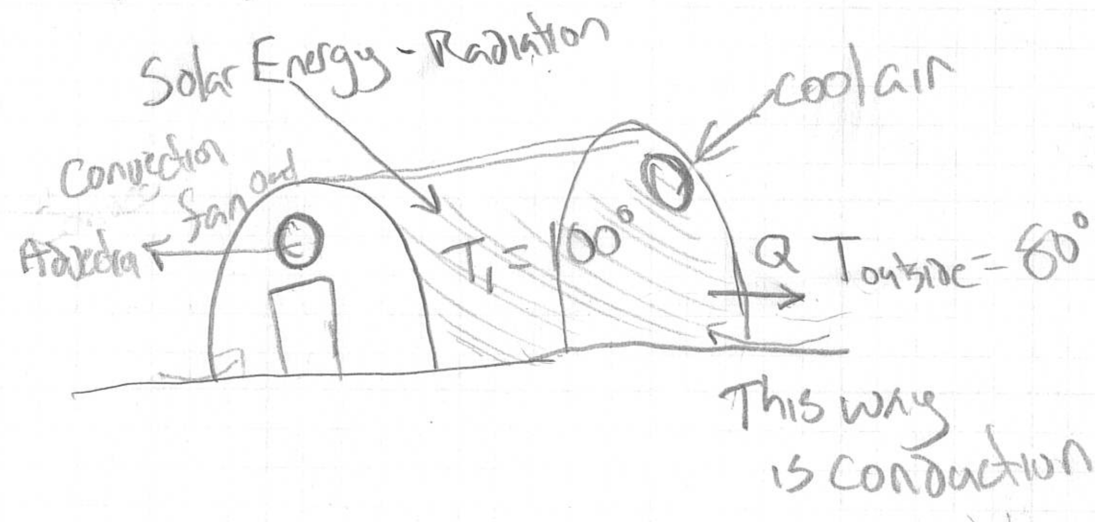
$(F = -459.4)$

Heat is the energy transferred between two objects because of differences in temperature

As they move towards thermal equilibrium



$T_f = T_{1f} = T_{2f}$



First Law of Thermodynamics

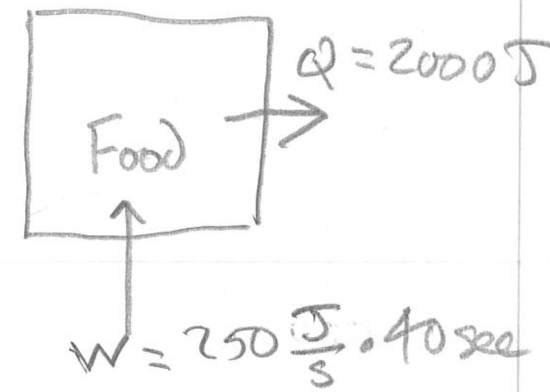
$\Delta K + \Delta U + \Delta E_{th} + \Delta E_{chem} + \ldots = W + Q$

For systems in which only thermal energy changes; $\Delta E_{thermal}$ is equal to energy in or out as work, heat or both

$\Delta E_{th} = W + Q$

Exmple 11.9

Blender @ 250 W for 40 sec transfers heat to food. The food transfers heat to the cooler container

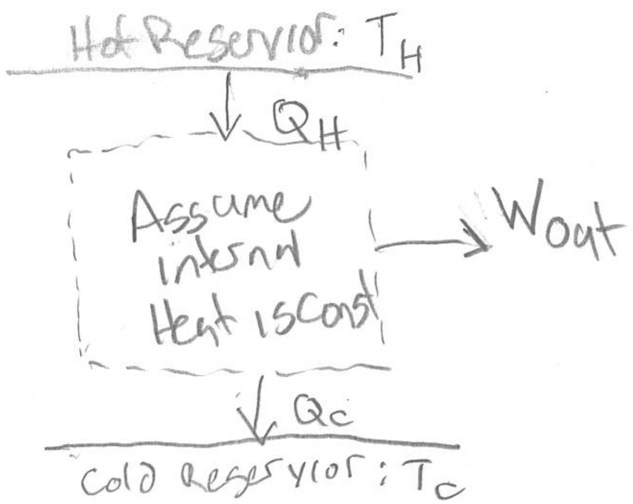


How much was the E_{th} increase?

Soln: $\Delta E_{th} = W + Q = 250\frac{J}{s} \cdot 40s - 2000J$

$$\Delta E_{th} = 8{,}000\ J$$

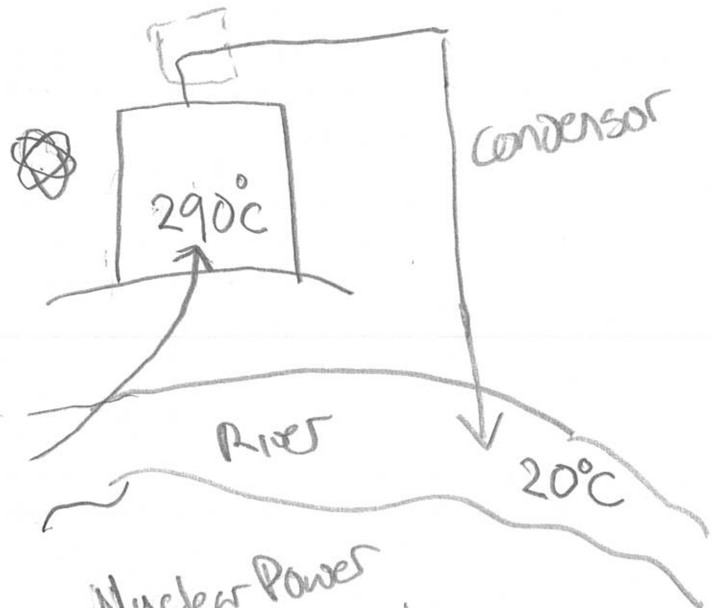
Heat Engines: Electricity from Turbines, mechanical Energy in Car Engines



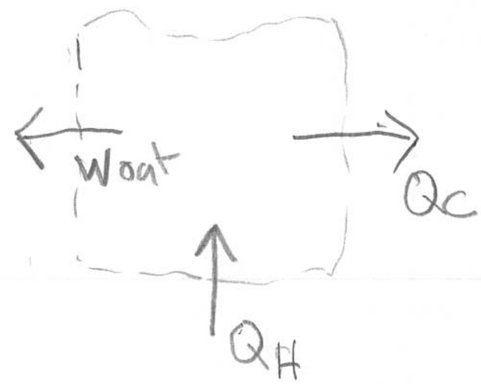
$$e = \frac{\text{What you Get}}{\text{What you pay}} = \frac{W_{out}}{Q_H} = \frac{Q_H - Q_C}{Q_H}$$

$$e_{max} = 1 - \frac{T_C}{T_H}$$

* 2nd Law of thermo *



Draw Heat Engine



Nuclear Power creates electricity by boiling water and removing useful work by turning a turbine

what is the max efficiency of this plant set up

Do the work in K

$T_H = 290 + 273 = 563K$

$T_c = 20 + 270° = 293K$

$$e = 1 - \frac{T_c}{T_H} = 1 - \frac{293}{563}$$

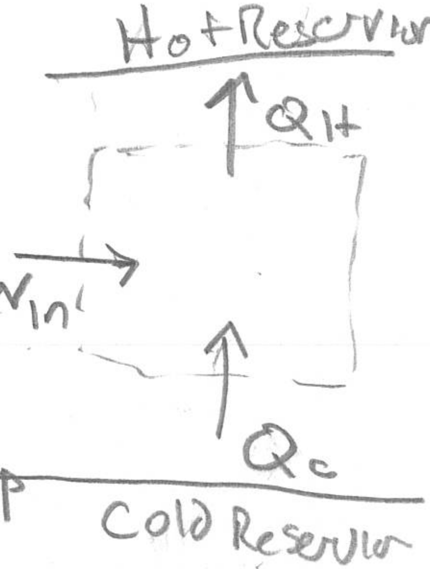
$= 1 - 0.52$

$= 0.48$

So 48% Efficent

Heat Pumps

$$Q_H = Q_C + W_{in}$$



We calculate
Efficiency of a heat pump
differently using
Coefficient of Performance (COP)

Cooling $\quad COP_{max} = \dfrac{T_C}{T_H - T_C} = \dfrac{Q_C}{W_{in}}$

Heating $\quad COP_{max} = \dfrac{T_H}{T_H - T_C} = \dfrac{Q_H}{W_{in}}$

Example 11.2

Refrig $= 0°$

$T_{Kitchen} = 20°C$

What is maximum COP

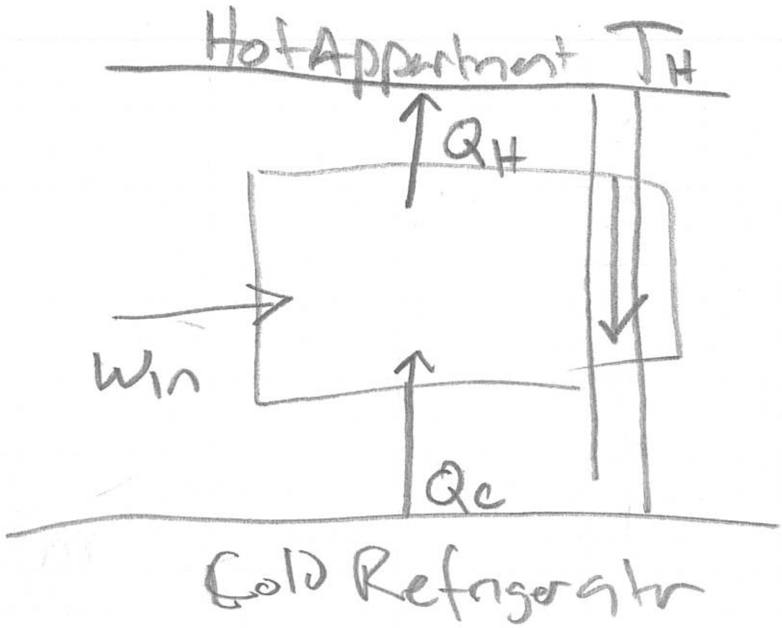
$$COP_{max} = \frac{T_C}{T_H - T_C} = \frac{273K}{293 - 273K}$$

Actually in real world
$COP \approx 5.0$ $\quad$ * Use Kelvin * $\quad = \dfrac{273}{20}$

≈ 13.6

Example 11.B

Should you leave the fridge open
to cool an apartment



We say that moving
from hot → cold
is a spontanious
process? Why?

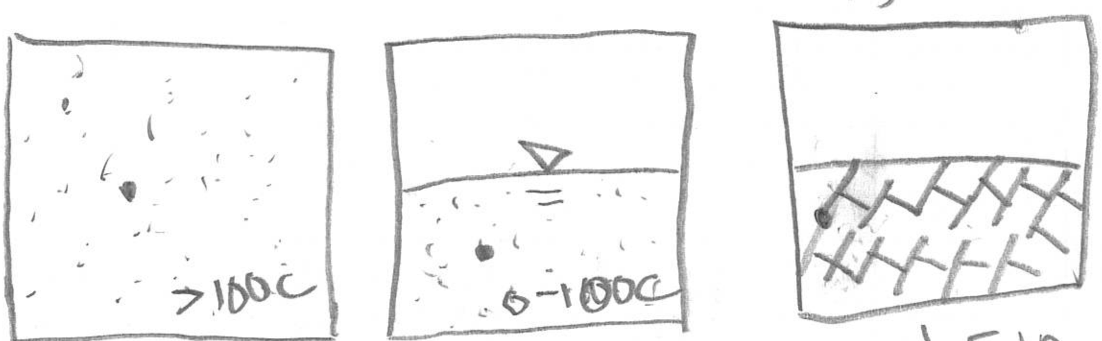
We can use a heat pump
to counteract the tendency
for a system to reach
thermal Equlibrium so,
First Law of thermodynamics
doesn't cause Irreverversibily
in something moving from
hot to cold

What causes spontaneous & irreversable
reactions is the second Law of
thermodynamics
The entropy of an isolated system
never decreases. Entropy either increase
towards Equlibrium or it begins in equlibrum

Entropy is a measure of disorder, randomness or uncertainty

Gas liquid Solid

Increasing Entropy (uncertainty)

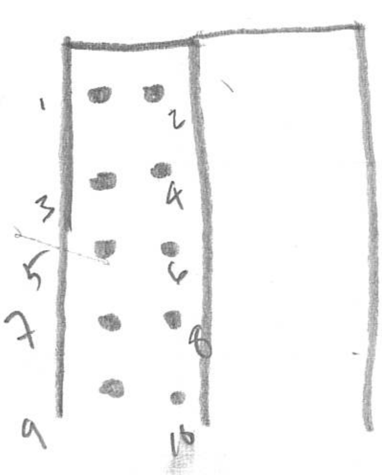


water in gassious state in a closed container

water in liquid state in a closed container

water in solid state in closed container

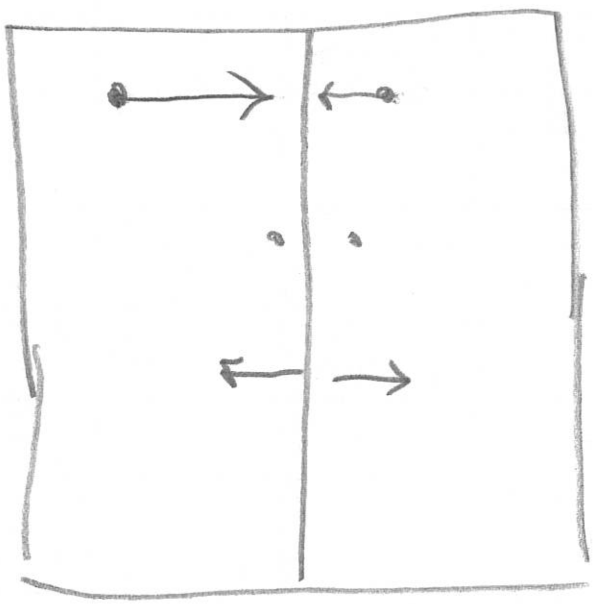
Law of Large numbers is why heatflow reactions are irreversable



Imagine you start with 10 particles on left hand side & 1 particle moves each step across the barrier

What happens after many steps?

The most probable state is the state at which the least information is known, the most random



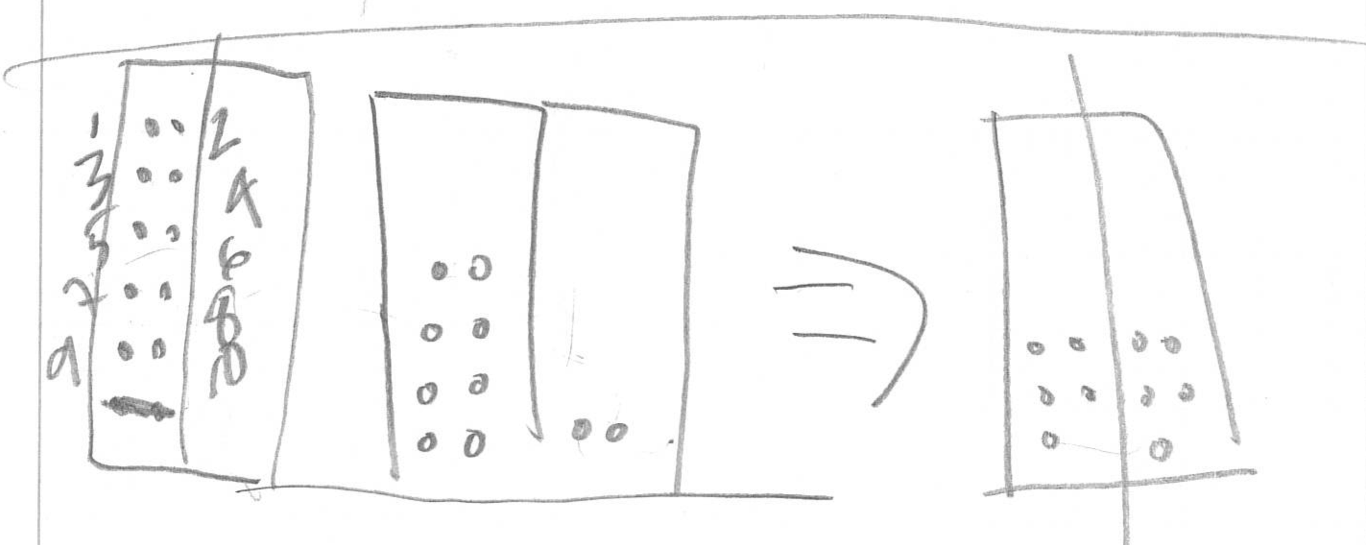
1 mol of gas has 6.2×10^{23} particles

T

for one mole of gas distributed equally @ hot side & cold side @ $t = \phi$

The most probable state is thermal equilibrium

Object	State Init	State @ 50 moves	
1	R	R L R L R L	L
2	L	R L R L R L	L
3	L	R L R L R L R	R
4	L	R L R L	L
5	L	R L R L R L	L
6	L	R L R L	L
7	L	R L R L	L
8	L	R L R L R	R
9	L	R L R L	L
10	L	R L R L	L



50 moves

500 moves

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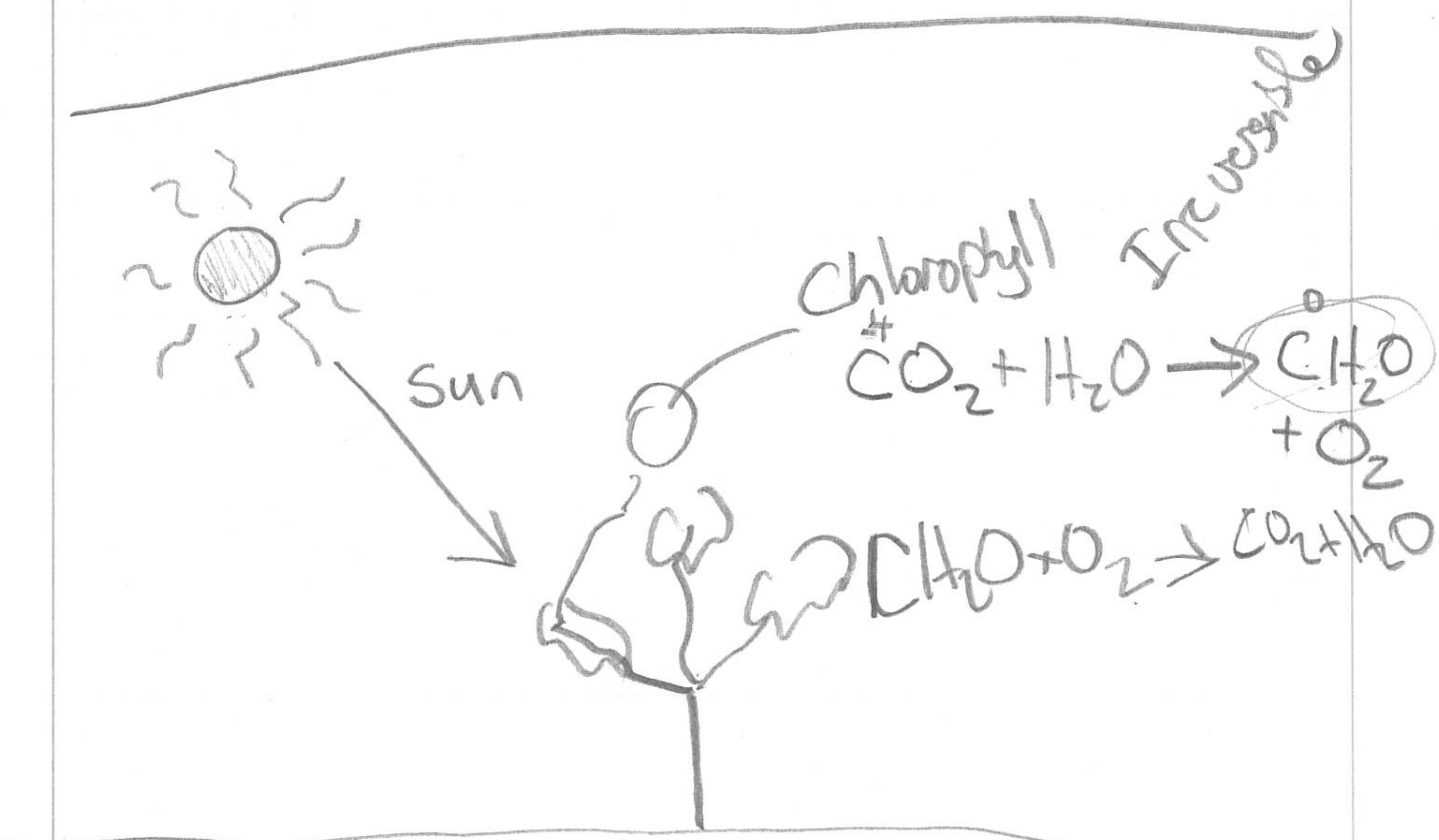
Second Law of Thermo says
Order turns towards
disorder & Randomness
Information is lost not gained
The system runs down as other
Energy forms are turned to
Thermal Energy

$$\Delta S = K_B \Omega$$

Ω = number of states



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William	Liked Examples, Enjoy	Nothing	Fix Camera ~~Nothing~~
Troy	Life & thermodynamics	Nothing	Nothing