Phy 2B 3/9

Monday, March 9, 2015 10:00 AM

Continue thermodynamics
ch. 17 and 18

Review session: Thursday Noon − 1:00 pm → 4404

Ideal gas law:

$P \propto n$ (number of moles)

$P \propto T$ temp

$P \propto \frac{1}{V}$ volume

$$P = R\frac{nT}{V}$$

$$PV = nRT$$

$R = 8.31 \frac{J}{mol\ K}$

$R = 0.0821 \frac{l\ atm}{mol\ K}$

OR

$$PV = NKT$$

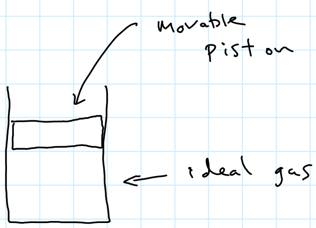
K = Boltzman Constant

$= 1.38 \times 10^{-23} \frac{J}{K}$

N = # of molecules

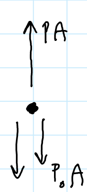
Cylinder:
- ideal gas
- room temp
- sealed
- piston free to move without friction

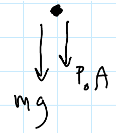
mass: M
area: A



If piston is at rest and atm Pressure = P_0

Draw a FBD for the piston:





Net force on piston is: zero

Which force is larger: $F_{gas\ inside}$ or $F_{air\ outside}$

$$F_{gas} > F_{air}$$

$$\sum \vec{F} = 0$$

$$\vec{F}_{gas} + \vec{F}_{air} + m\vec{g} = 0$$

which is at higher Pressure: gas inside or air outside

$$P_{gas} > P_0$$

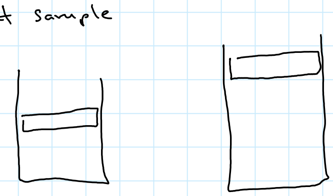
$$P_{gas} A = P_0 A + mg$$

$$P_{gas} = \frac{P_0 A + mg}{A}$$

2nd cylinder contains a different sample

Cylinders are same

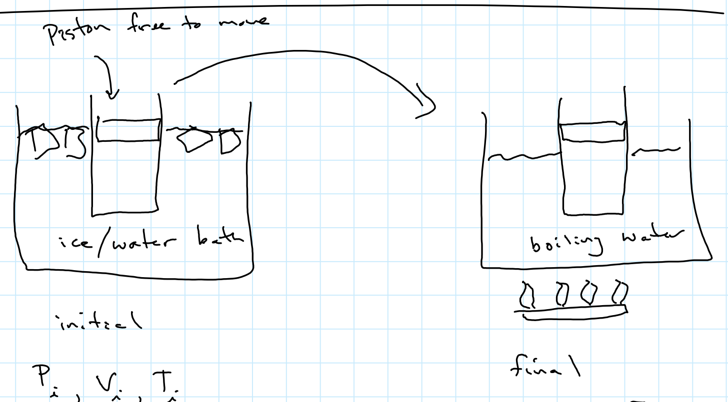
both at room temp



original Second

Is the Pressure in the 2nd cylinder greater, less, same as original?

Same



initial

P_i, V_i, T_i

final

P_f, V_f, T_f

1) Compare T to T : $T > T$

1) Compare T_f to T_i : $T_f > T_i$

2) Compare P_f to P_i : $P_f = P_i$ (after some time) (piston not moving)

3) Compare V_f to V_i : $V_f > V_i$

$$\underset{\text{same}}{\underline{P}}\, V = \underset{\text{same}}{\underline{n\,R}}\, T$$

$$V \propto T$$

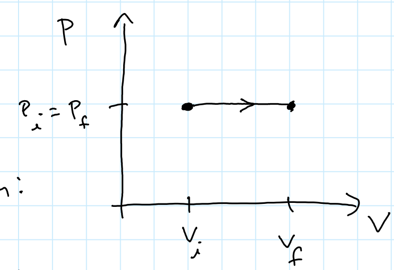
what was constant : P, n

what changed : V, T

PV diagrams

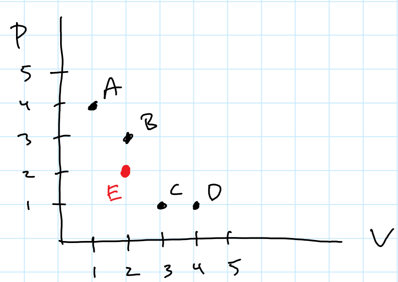
Pressure - Volume

a point represents a state of the system: P, V



Draw on the P-V diagram ↗ the process from above (P, n are constant; V, T change)

A sample of an ideal gas in a cylinder - Pressure and volume are changed and measured several times



1) Rank the temp in the 4 states :

$$PV = \underset{\text{not changing}}{\underbrace{nR}}T$$

$$T \propto PV$$

State	P	V	PV
A	4	1	4
B	3	2	6
C	1	3	3
D	1	4	4

$$T_B > T_A = T_D > T_C$$

2) Is there a state with the volume of B

and the temp of A ?
If so, mark it on the PV diagram. (call it E)

Same temp as A: $PV = 4$

Same V as B: $V = 2$

So, $P = 2$

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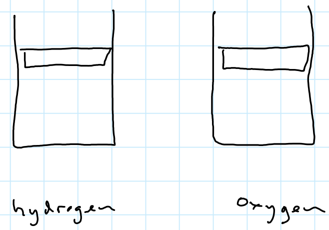
2 identical cylinders
- same temp
- pistons at same height



1) Compare volumes: same

2) Compare temp : same

3) Compare Pressure: same

4) Compare number of moles : same

since: $PV = nRT$

H_2 : 2 grams per mol

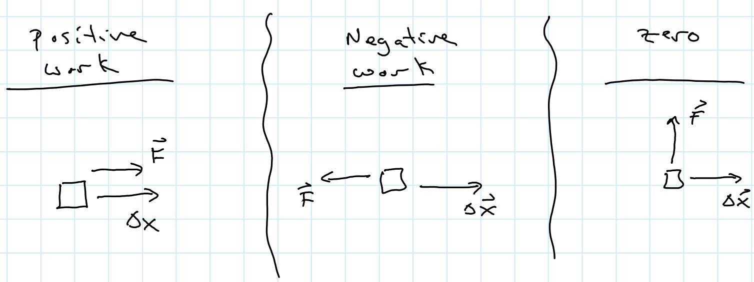
O_2 : 32 grams per mol

$M_{O_2} > M_{H_2}$

Work Review:

A) Define work: $W = Fd$ if F is constant and in direction of displacement

$W = \vec{F} \cdot \Delta\vec{x}$ if F is constant



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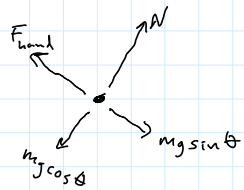
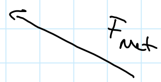
block moves up incline with increasing speed

1) FBD for block:



2) direction of Net force:



3)

Force	Work done on block
F_{hand}	Positive
F_g	Negative
N	Zero

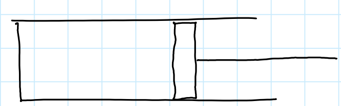
4) Work done on your hand by the block:

Negative

$$W_{\text{on hand by block}} = -W_{\text{on block by hand}}$$

$$W_{Net} = \underbrace{\Delta K}_{\text{change in Kinetic Energy}}$$

Ideal gas in cylinder
free to move w/o friction



1) Direction of force piston exerts on gas: ←

Does it depend on the motion of the piston: NO

2) How can it move to do

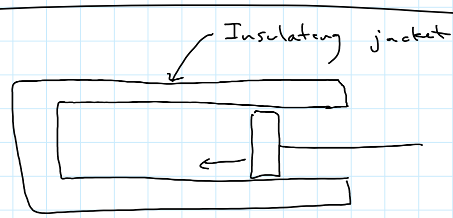
Positive work on gas : to the left

Negative " " " : to the Right

Does it depend on your coordinate system? NO

$W_{AB} = -W_{BA}$

Cylinder thermally isolated



Press inward on piston
call this step:
Compression 1

In compression 1: Is work done on the gas by the piston +/-/0 : positive

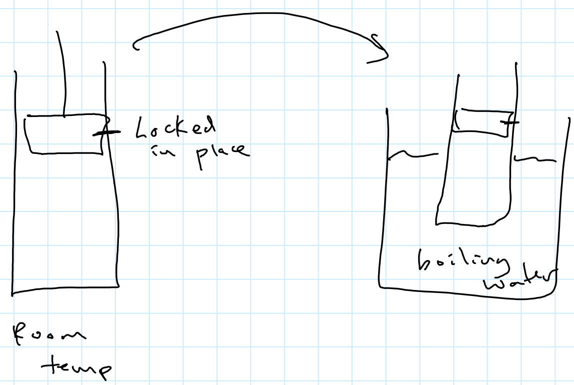
Internal energy: E_{int}

Can change E_{int} by +/- heat
or by doing +/- work on system

For our process above, how does E_{int} change:
increases

Does the temp of the gas change:
increases

Process 2:



In process 2: how do the following change:

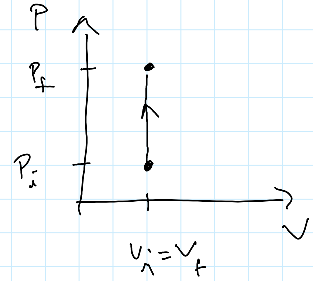
Temp: increases

E_{int}: increases

Pressure: increases

Volume: same

Sketch on a PV diagram:



Work done on the gas in Process 2 : $W = 0$

Q is heat transferred to the gas { into gas is + / out to environment −

1^{st} Law of Thermodynamics : Conservation of energy

$$\Delta E_{int} = Q + W_{on\ system}$$

OR

$$\Delta E_{int} = Q - W_{by\ system}$$