AP Physics - Thermodynamics - 4 Basic P-V Process Diagrams

Note Title 1/12/2007

PROCESS	$U\Delta = Q - W$	P-V GRAPH

Isothermal (Constant Temperature)

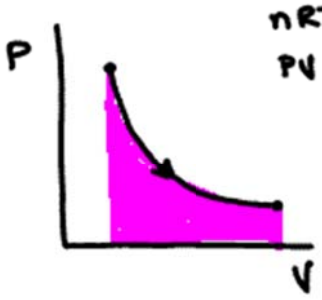
$U = \frac{3}{2}nRT$

$\Delta U = \frac{3}{2}nR\Delta T$

If $\Delta T = 0$

→ $\Delta U = 0$

→ $Q_{IN} = W_{BY}$



nRT = constant

PV = constant

$P = \frac{\text{constant}}{V}$

∴ Hyperbola

→ Happens only during slow processes → Temp has a chance to fully equalize with the surroundings

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Adiabatic (No heat transfer)

$Q = 0$

→ $\Delta U = W_{ON}$

nR = constant

$\frac{PV}{T}$ = constant

∴ Not a hyperbola!!!

→ Happens only during FAST processes → Temp doesn't have chance to equalize

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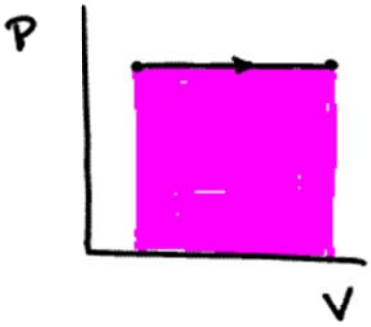
Isobaric (Constant Pressure)

$W = P\Delta V$



Isochoric a.k.a. Isovolumetric a.k.a. Constant Volume

$W = 0$

$\Delta U = Q_{IN}$

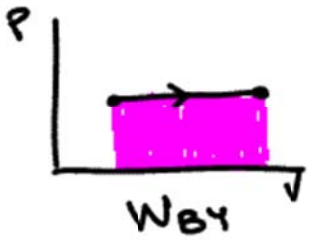
Calculating work done during a process

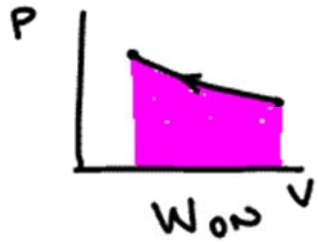
$$W = P\Delta V$$

∴ Work is equal to the area under the P-V curve! (see your friendly neighborhood calculus teacher for an explanation)

For the work done by each of the 4 processes, look at the area shaded in pink.

* If volume is increasing, ΔV is positive, therefore work is being done by the system.
* If volume is decreasing ΔV is negative therefore work is being done on the system.





Thermodynamic Cycles

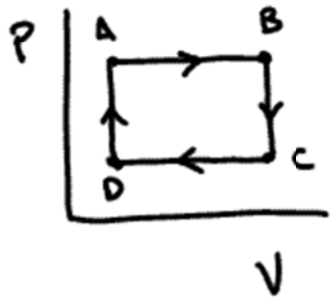
A thermodynamic cycle is a series of processes that a system undergoes such that the ending state is identical to the beginning state.

During any process within a cycle

Heat - may be transferred into or out of the system

Work - may be done on or by the system

Example



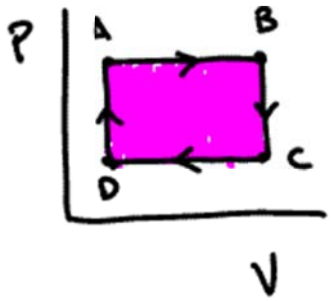
A-B: Work is done by the system at high pressure.
W_{BY} = Area under curve A-B

B-C: No work is done

C-D: Work is done on the system at low pressure.

D-A: No work is done

Net work done by the system = $W_{A\to B} - W_{C\to D}$



$\therefore W_{BY}$ = Area of rectangle ABCD!