

The 1st Law of Thermodynamics

Thursday, September 23, 2010
10:17 AM

Internal energy (U) is defined as the energy of an object due to its molecular motion.

If you do work on an object its internal energy will: increase

For us work + / - is defined in terms of the internal energy of the object.

If you add heat energy to an object its internal energy will: increase

For us heat + / - is defined in terms of the internal energy of the object.

1ST Law of Thermodynamics

$$\Delta U = \Delta Q + \Delta W$$

$$U = Q + W$$

Pistons:

$$PV = nRT$$



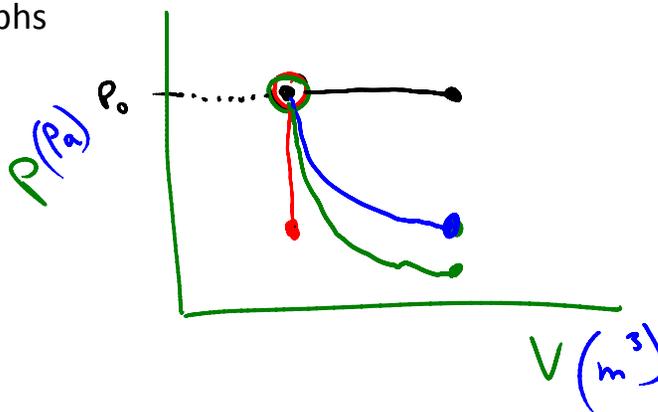
The piston moves down
Compression
Work is done ON the gas
 $\Delta U +$

If gas, does the work (piston up)
 $\Delta U -$ expansion

ΔU is proportional to ΔT

higher T objects have greater internal energy U

Pressure Vs Volume graphs



Black line represent a change in volume but pressure is constant

Constant pressure = isobaric

Red line represent a change in pressure but constant volume

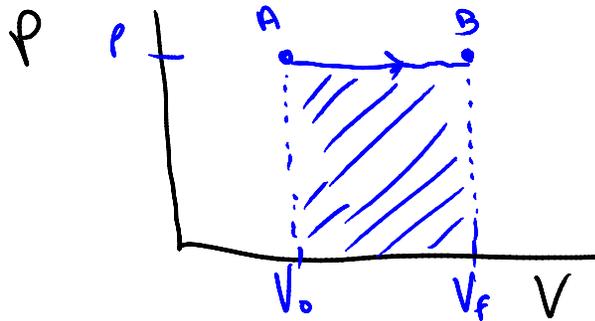
Constant volume = isochoric

Blue line represents a change in both volume and pressure but since it is an inverse curve Boyle's Law applies. Temperature is constant.

Constant temperature = isothermic =< internal energy is constant

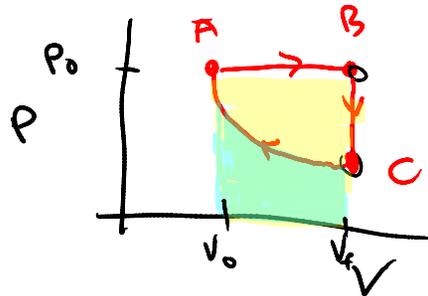
Green line represents a change in both volume and pressure that is a) so fast that no heat energy is exchanged with the environment or b) in a perfectly insulated system no heat exchanged with the environment = adiabatic =< $\Delta Q = 0$

On a P vs. V graph the area under the curve represent the work done on or by a gas.



from A \rightarrow B work = $P\Delta V$
expansion
W -

Cycles on PV diagram



$$V_f = 2V_0'$$

Describe the path AB =< isobaric

Describe the path BC =< isochoric =< what is the work? 0

If CA is isothermic what ΔU in terms of the 1st law of thermodynamics?

In all isochoric processes
 $W = 0$

$$\begin{aligned} \Delta T &= 0 \\ \Delta U &= 0 \end{aligned} \quad \Delta U = Q + W$$

$\Delta U = Q_{CA} + \text{area CA} = 0$

In process AB was work done on or by the gas (W + / -)

In process CA was work done on or by the gas (W + or -)

Which area is greater, the area under AB or under CA? So was more work done on the gas or by the gas?

$$\begin{aligned} A &\rightarrow B \rightarrow C \rightarrow A \\ \Delta U_{ABCA} &= \Delta U_{AB} + \Delta U_{BC} + \Delta U_{CA} \\ \Delta U_{AB} &= \Delta Q_{AB} + W_{AB} \\ \Delta U_{BC} &= \Delta Q_{BC} + W_{BC} \end{aligned}$$

$$\Delta U_{BC} = \Delta Q_{BC} + W_{BC}$$

$$\Delta U_{CA} = \Delta Q_{CA} + W_{CA}$$

$$\Delta U_{ABCA} = \Delta Q_{ABCA} + W_{ABCA}$$

