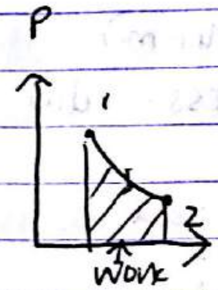
09/10/15

Chapter 19 Lecture

09/08/15 review

ISOTHERM $\rightarrow \Delta T = 0$

$PV = nRT$, $P \propto \frac{1}{V}$



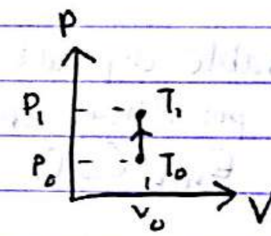
$$W = \int_{V_0}^{V_1} P\,dV = \int_{V_0}^{1} \frac{nRT}{V}\,dV = \boxed{nRT\left[\ln(V)\right]_{V_0}^{V_1}}$$

$$W = \int_0^f \vec{F}\,d\vec{l} = \int_0^f PA\,dl = \boxed{\int_{V_0}^{V_f} P\,dV}$$

$W \rightarrow$ change of volume

ISOVOLUMETRIC $\rightarrow \Delta V = 0$

$PV = nRT$ $\quad P = \frac{nR}{V} T$

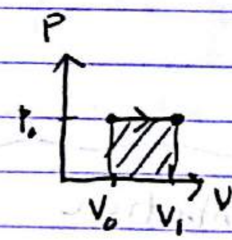


$T_0 < T_1$

$W = 0$

ISOBARIC $\rightarrow \Delta P = 0$

$PV = nRT$ $\quad V = \frac{nR}{P} T$



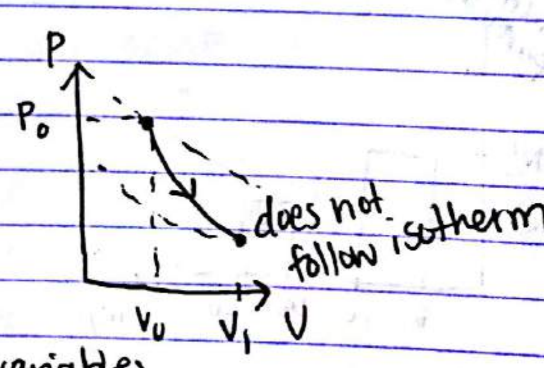
$W = P_0 \cdot (V_1 - V_0) = P_0 \Delta V$

ADIABATIC $\rightarrow Q = 0$

$PV = nRT$

$\Delta E_{int} = Q - W$

adiabatic: $\Delta E_{int} = W$



work & heat are not state variables

temp & ΔE_{int} are state variables

ISOTHERM

$W = nRT\ln\left(\frac{V_f}{V_0}\right)$

$\Delta \cancel{E}_{int} = Q - W$ (0)

$W = Q$

Problem

$Q = mc\Delta T$

$\downarrow$ c $\Delta T = 0$!! , $Q = 0$?!

this rule only applies to solids.

Gas – Volume changes (large change vs. small change T)

– Pressure changes

– Account for above in Q

volume change : $C_v = \frac{Q}{\Delta T}\Big|_{V=const}$ ← specific heat of gas

$C_p = \frac{Q}{\Delta T}\Big|_{P=const}$

$C_p > C_v$

C_p (gas does work, so $Q_p > Q_v$)

monoatomic gas

$C_v = \frac{Q}{\Delta T}\Big|_V$

$\Delta E_{int} = \frac{3}{2}nR\Delta T$

$\Delta E_{int} = Q$

$C_v = \frac{3}{2}nR$, $\frac{3}{2}R$ for $n=1$

does not depend on ideal gas type. (but does depend if it's monoatomic)

$C_p = \frac{Q}{\Delta T}\Big|_P$

$\Delta E_{int} = \frac{3}{2}nR\Delta T = nc_v\Delta T$

$Q = \Delta E_{int} + W = nc_v\Delta T + P\Delta V$

$C_p = \frac{nc_v\Delta T + P\Delta V}{\Delta T} = nc_v + \frac{P\Delta V}{\Delta T}$ ($P\Delta V = nR\Delta T$)

$= nc_v + nR$

$= c_v + R$ for $n=1$

* for an isotherm, do not use specific heat eqn for calculating heat.

ADIABATIC $Q=0$

$-W = \Delta E_{int}$

step 1 P depends V $(W = \int_{V_0}^{V_1} P\,dV)$

$P = \frac{nRT}{V}$ is invalid b/c T is not constant.

$\rightarrow P(V,T)$

$\rightarrow V(V,P)$ Bad!

$\rightarrow V(T,P)$

$PV^{\gamma} = \text{const}$, $\gamma = 1 + \frac{R}{C_v}$

step 2 Calculate work

$P\,dV = -n C_v \Delta T$

$\cancel{n}RT \frac{dV}{V} + \cancel{n}C_v\,dT = 0$

$\frac{dV}{V} + \frac{C_v}{R}\frac{dT}{T} = 0$ ← fundamental eqn for adiabatic

* if $dV < 0$, $dT > 0$

$dV > 0$, $dT < 0$

$$\int_{V_0}^{V_1} \frac{dV}{V} + \frac{C_v}{R}\int_{T_0}^{T_1} \frac{dT}{T} = 0$$

$$\ln(V_1/V_0) + \frac{C_v}{R}\ln(T_1/T_0) = 0$$

$$= \ln\left(\underbrace{\frac{V_1}{V_0}\left(\frac{T_1}{T_0}\right)^{C_v/R}}_{=1}\right) = 0$$

$$\frac{V_1}{V_0} \cdot \left(\frac{T_1}{T_0}\right)^{\frac{C_v}{R}} = 1$$

$$V_1 T_1^{C_V/R} = V_0 T_0^{C_v/R}$$

monoatomic
$C_v = 3/2 R$

monoatomic

$T^{3/2} V = \text{constant}$

$PV = nRT$

$$T = \frac{PV}{nR} \Rightarrow \left(\frac{1}{\cancel{n}R} P_1 V_1\right)^{C_V/R} V_1 = \left(\frac{1}{\cancel{n}R} P_0 V_0\right)^{C_v/R} V_0$$

$$= \left[P_1^{C_V/R} V_1^{(1+C_V/R)}\right]^{R/C_V} = \left[P_0^{C_v/R} V_0^{(1+C_v/R)}\right]^{R/C_v}$$

$$P_1 V_1^{(1+R/C_v)} = P_0 V_0^{(1+R/C_v)}$$

$$\gamma = 1 + \frac{R}{C_v} \Rightarrow PV^{\gamma} = \text{const}$$

$$W = \int_{V_1}^{V_2} P\,dV = \int_{V_1}^{V_2} \frac{\text{const.}}{V^\gamma} dV$$

$$= c\int_{V_1}^{V_2} \frac{1}{V^\gamma} dV$$

$$= c\int_{V_1}^{V_2} V^{-\gamma} dV$$

$$= c \left.\frac{V^{-\gamma+1}}{-\gamma+1}\right|_{V_1}^{V_2}$$

$$V^{-\gamma+1} = V^{-\gamma} V$$

$$W = \frac{P_1 V_1 - P_2 V_2}{\gamma - 1}$$

> 0

read about conduction