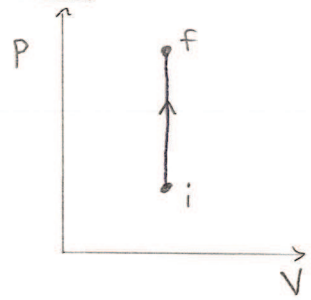
IDEAL GAS CYCLES

- TYPES OF PROCESSES

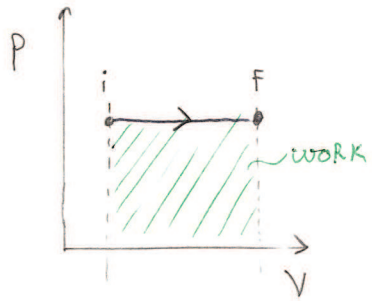
1) ISOCHORIC – CONSTANT VOLUME



- $V_i = V_f$ THUS $\frac{P}{T}$ = CONSTANT
- AREA = 0 THUS NO WORK ($W=0$)
- WITH $\Delta E_{TH} = Q + \cancel{W}^{\,0}$

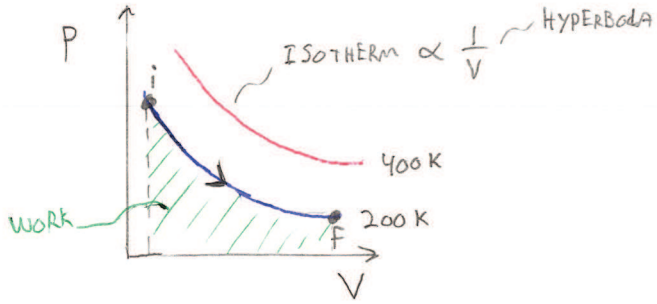
$$\Delta E_{TH} = Q$$

2) ISOBARIC – CONSTANT PRESSURE



- $P_i = P_f$ THUS $\frac{NK_BT}{V}$ = CONSTANT
- $W = -P\Delta V$
- $\Delta E_{TH} = Q + W$

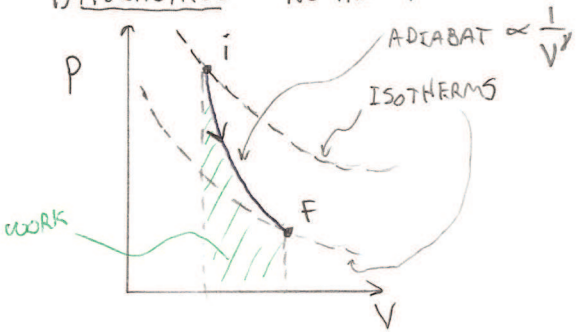
3) ISOTHERMAL – CONSTANT TEMPERATURE



- $T_i = T_f$ THUS PV = CONSTANT
- $W = -NK_BT\ln\left(\frac{V_f}{V_i}\right)$
- WITH $\Delta E_{TH} = Q + W$ ($\Delta E_{TH} \to 0$)

$$Q = -W$$

4) ADIABATIC – NO HEAT TRANSFER



- STEEPER THAN ISOTHERMS $\to PV^\gamma$ = CONSTANT

$\gamma = \frac{5}{3}$ FOR MONATOMIC GAS

- W = ... MESSY....
- WITH $\Delta E_{TH} = \cancel{Q}^{\,0} + W$

$$\Delta E_{TH} = W$$

PROCESSES SUMMARY

MONATOMIC	ISOCHORIC	ISOBARIC	ISOTHERMAL	ADIABATIC
ΔE_{TH}	$\frac{3}{2}NK_B\Delta T$	$\frac{3}{2}NK_B\Delta T$	0	$\frac{3}{2}NK_B\Delta T$
Q	$\frac{3}{2}NK_B\Delta T$	$\frac{3}{2}NK_BT + P\Delta V$	$NK_BT\ln\left(\frac{V_f}{V_i}\right)$	0
W	0	$-P\Delta V$	$-NK_BT\ln\left(\frac{V_f}{V_i}\right)$	$\frac{3}{2}NK_B\Delta T$

THERMO CYCLE EFFICIENCY

$$e = \frac{GET}{PAY} = \frac{|\Sigma W|}{|\Sigma Q_{IN}|}$$

$|\Sigma W|$ ← SUM BOTH + AND – WORK

$|\Sigma Q_{IN}|$ ← SUM ONLY + HEAT

RECALL: STATE OF THERMODYNAMIC SYSTEM IS CHARACTERIZED BY A SET OF MACROSCOPIC VARIABLES (STATE VARIABLES) SUCH AS:

$$P, V, T, N$$

THUS THE STATE OF A SYSTEM IN EQUILIBRIUM IS REPRESENTED BY A POINT ON A P-V DIAGRAM.

- A THERMODYNAMIC SYSTEM CAN CHANGE ITS STATE (INITIAL → FINAL) THROUGH A PROCESS WHICH IS REPRESENTED BY A CURVE/PATH IN A P-V DIAGRAM.
- STATES CAN ONLY BE SPECIFIED IF THE SYSTEM IS IN EQUILIBRIUM
- QUASISTATIC PROCESS – EACH INSTANT IN A PROCESS IS VERY CLOSE TO EQUILIBRIUM (i.e. "SLOW")