PROCESSES

STATE - specific set of measurable parameters
$P, V, T \ldots$

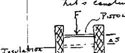
$PV = N k_B T$ is the EQUATION OF STATE of an IDEAL GAS

Processes alter the state of a system - four basic modes

ISOTHERMAL	$T = \text{const}$
ISOBARIC	$P = \text{const}$ (think of BAROMETER)
ADIABATIC	$Q = 0 \quad \Delta U = -W$
ISOCHORIC	$V = \text{const}$ (Book calls it ISOVOLUMIC (?)) $W = 0$ $\Delta U = Q$

HEAT + WORK

Let's construct a system



Gas expands "quasi-statically"

$$dW = \vec{F} \cdot \vec{ds}$$

System does work against piston

How? Remember $P = F/A$

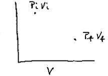
$$dW = PA\,ds$$
$$= P(A\,ds)$$
$$= P\,dV$$
$$W = \int dW = \int_{V_i}^{V_f} P\,dV$$

If $P = \text{const}$ (ISOBARIC) then

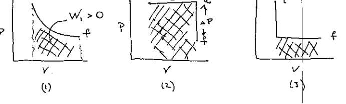
$$W = P\Delta V$$

A useful way of analyzing the work done by a system is a P-V DIAGRAM (PRESSURE-VOLUME). Consider two states:

$P_{initial}$ $V_{initial}$ ($T_{initial}$) $\quad$ P_{final} V_{final} (T_{final})



In general there will be a variety of paths that can be taken. Since $W = \int P dV$, the work for a path will be the area under the curve



(1) $\quad$ (2) $\quad$ (3)

The work, as shown above will depend upon the path. Consider how you might produce diagram (2) via track i-a-f in an Ideal Gas

$i \to a$ $\quad P = \text{const}$ $\qquad PV = N k_B T$

V increases ΔV $\qquad \Delta T = \frac{P}{N k_B} \Delta V$

$\Delta V = V_f - V_i$

$W = P\Delta V$ $\qquad Q = C_P \Delta T$ will be positive

$a \to f$ $V = $ const $\Delta T = \frac{V}{N k_B} \Delta P$

P decreases

$W = 0$ T must decrease; heat will be lost

The work getting from $i \to f$ depends upon the path — the manner in which the material goes from initial to final state.

W is <u>not</u> a <u>state</u> variable

The internal energy, however depends only on initial + final states ΔQ is independent of path

U is a <u>state</u> variable