

# Thermodynamics Notes

## Definitions

### System

- Definite quantity of matter enclosed by real or imaginary boundaries.

### Thermal Isolation

- no heat transferred to or from a system.

\* work may be transferred.

- Force can act on the system

### Heat Reservoir

- large system from which heat can be drawn or ~~draw~~ to which heat can be deposited without a significant temp. change.

### State Equation

$$* PV = nRT$$

### State Variables

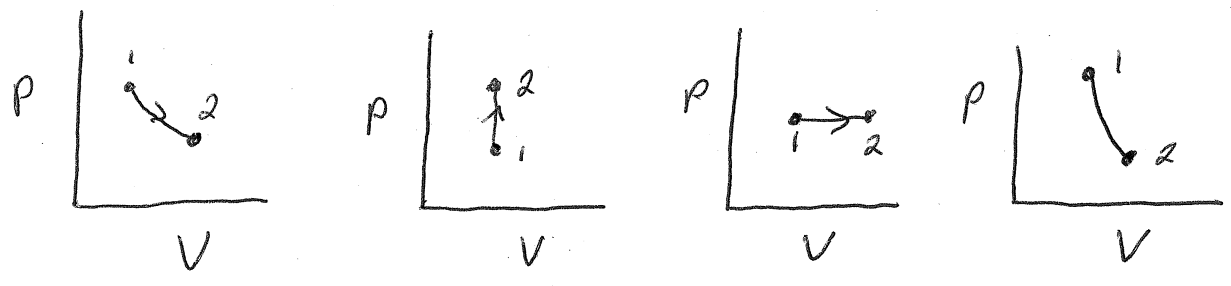
P - Pressure (Pa)

V - Volume ( $m^3$ )

T - Temp. (K)

# Process

- any change in the value of state variables
- \* characterized by a move on the P vs V graph



# Reversible Process

- A process where known states are traversed from beginning to end.
- A process that can be run backward to obtain the original state of the system and environment

# Irreversible Process

- Process that is not reversible,
- All real-life processes
  - Any process with friction is technically irreversible.

# 1st Law of Thermodynamics

$$\Delta U = Q + W$$

$\Delta U =$  internal energy change (J)

$Q =$  heat (J)

$W =$  work (J)

\* In this form:

Heat in is positive

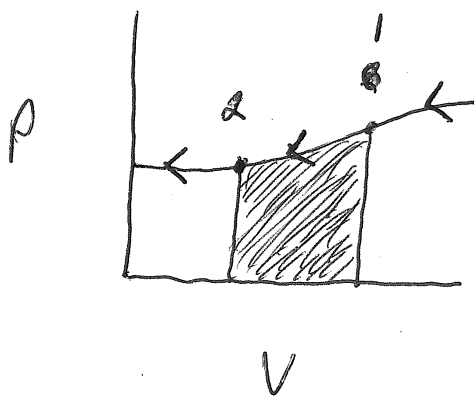
Heat out is negative

Work in is positive

Work out is negative

## Work

- Area under curve P vs. V graph.



The 1st law of thermodynamics refers to a concept discussed in mechanics:

Conservation of Energy.

The only difference between conservation of energy ~~and~~ as applied to mechanics and the first law of thermodynamics is the ~~no~~ energy storage mechanisms used.

Mechanics:

$$\Delta E = \Delta E_k + \Delta E_{el} + \Delta E_g + \Delta E_{diss} + \Delta E_{chem}$$

Change in total energy

$\Delta E_k$  - change in kinetic energy

$\Delta E_{el}$  - change in elastic potential energy

$\Delta E_g$  - change in gravitational potential energy

$\Delta E_{diss}$  - energy dissipated due to friction

$\Delta E_{chem}$  - energy stored in a battery

# Thermodynamics:

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

$\Delta U$  - change in internal energy

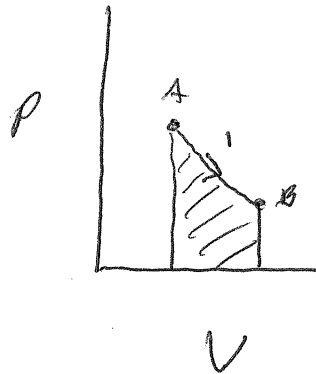
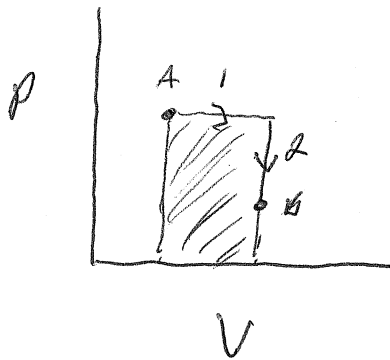
$Q$  or  $\Delta Q$  - change in heat energy  
(heat added or taken away)

$W$  or  $\Delta W$  - work done by the system or to the system

Work is not a state variable

- Recall that work is path dependent
- Depends on how a process occurs

ex: Same change in state, A to B, different work.



Internal Energy is independent of path and is a unique measure of the state of a system.