Phys 344

Lecture 3. Heat and Work

Ref: 1.4, 1.5.

- What's the main difference between energy and work?

Energy — A quantity of state
(inherent property of an object).

Work — A quantity of process
(spacial cummulative effect of a force)

$$W = \vec{F} \cdot \Delta \vec{r}$$

e.g. When you push an object.
from A to B.

e.g. position, velocity, etc.

If we know the <u>state of motion</u> of the object at A and B,
we know the energy of the object at A and B:

$$E_A = mgy_A + \frac{1}{2}mv_A^2 . \quad E_B = mgy_B + \frac{1}{2}mv_B^2 .$$

However, we can't say how much work the object has at A and B.

- What we can say is, when you push the object from A to B, you do work:

$$W_{AB} = \int_A^B \vec{F} \cdot d\vec{r}$$

energy transfer

This is a quantity describes something during the change of state from A to B. It's not a quantity about a state, but a quantity about a process.

└ The procedure of changing from one state to another, through a specific way (path)

e.g. when there is friction, W_{AB} depends on the path.

└ (in general. meaning there is heat involved.)

In general, even if you know the initial and final states of a system, you do not necessarily know the amount of work involved.

- Relationship between work and energy.

Energy can be transfered from one object to another by doing work.

(you convert the chemical energy in your body to the mechanical energy of the object)

- Heat — another process quantity (like work).

It's the amount of energy transfered spotaneously from one object to another due to difference in temperature.

(OR, energy transfered other than work).

i.e. There are 2 ways to transfer energy

① — work W

② — Heat Q.

- Conservation of Energy requires: (1st Law of Thermodynamics)

$$\Delta U = W + Q$$ — For any system.

U — Internal energy (Total energy in the system).

W — work done on the system

Q — Heat flow into the system.

spotaneous transfer of thermal energy.

$W > 0$. Work done on the system.

$W < 0$ work done by the system.

$Q > 0$. Heat flow into the system

$Q < 0$ Heat flow out of the system

- In an infinitesmal process.

$$dU = đW + đQ$$

$đW$, $đQ$ — small amount.

but not a differential

because W and Q are NOT state functions.

- Unit of Q: Joules, calories, Calories = kc.

$$1 \text{ cal} = 4.186 \text{ J}.$$

- state variables of an ideal gas:

$P, V, T, N.$ (at equilibrium).

- For a closed system, $N = \text{const}$. (No exchange of materials with the environment)

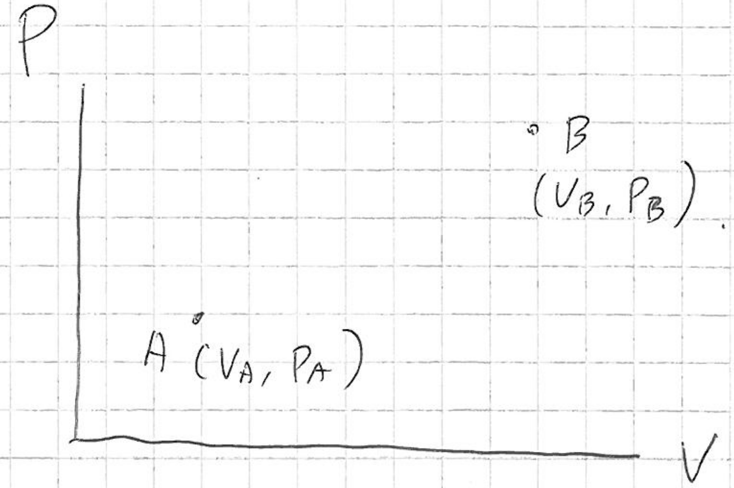
∴ We ~~need~~ have 3 variables. P, V, T.

But since we have $PV = NkT$.

We only need 2 variables to describe an ideal gas. e.g, P, V.

- A state can be represented by a point in P-V space.

A system can change its state from A to B.



- Quasistatic process. — each step is in equilibrium.
  - continuous.

It's an idealised concept. — meaning a slow process — compare to the relaxation time.

- In P–V space, a continuous line represents a quasistatic process.

However, if the process is not quasistatic, we can't have a line, because the intermediate states are not equilibrium states. We can't even define P and T.