Physics 101

Lecture 36 Friday. April 2, 2004

Topics: Internal Energy
Systems in Thermodynamics
1st. 2nd and third laws of Thermodynamics

Ref: 17-2, 18-1, 2, 5

- Final Exam:

  BQ200 : A – K
  BQ201 : L – Z
  } Next Thur. April 8. 12:00 – 3:00 PM.

- Relation between microscopic motion and Temperature:

$$\frac{3}{2}kT = \left(\frac{1}{2}mv^2\right)_{ave}.$$ — ideal gas

$$P = \frac{2}{3}\left(\frac{N}{V}\right)\left(\frac{1}{2}mv^2\right)_{ave}.$$ — *see 17.2 for derivation.

- Internal Energy of ideal gases:

$$U = \Sigma\left(\frac{1}{2}mv^2\right) = \frac{3}{2}NkT.$$

(Total energy of the system)

- Systems in Thermodynamics

  - Open system

    Can exchange both mass and energy with other systems.

    e.g: A class room.

    e.g: Each student.

  - Closed system

    can exchange energy, but not mass.

    e.g: Water in a bottle.

  - Isolated system.

    Neither mass nor energy can be exchanged with other systems.

    e.g: water in a thermal bottle.

- The first Law of Thermodynamics

(Energy conservation).

$$\Delta U = Q - W$$

U — internal Energy of the system

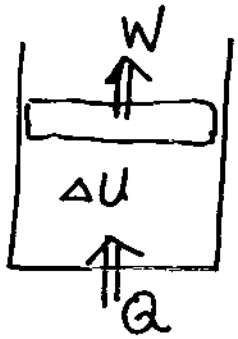
Q — Heat that flows into the system.

W — Work done by the system.

$-W$ — Work done on the system.

A typical heat engine

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



- The 2nd Law of Thermodynamics: — There are different equivalent statements:

e.g.: A Spontaneous heat flow is always from higher temperature to lower Temperature.

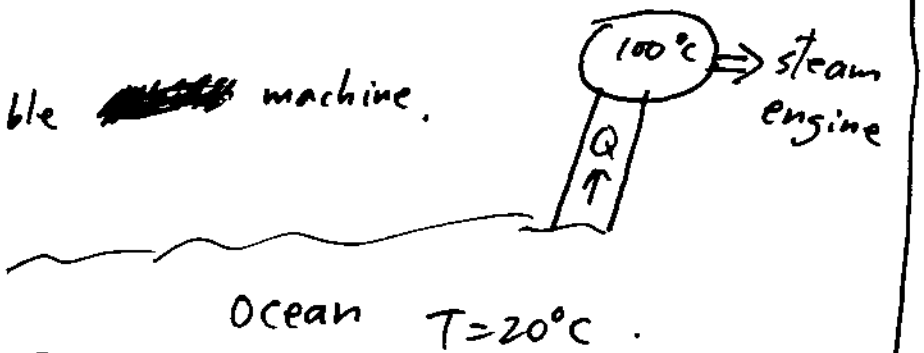
- The 2nd Law of thermodynamics

(There are different but equivalent ways of expressing it)

e.g: A spontaneous heat flow is always from higher temperature to lower temperature.

[It would be nice if the 2nd Law were wrong.

e.g: An impossible [redacted] machine.



]

- The third Law of thermodynamics.

Zero-kelvin temperature can not be reached.

∵ 0K $\xrightarrow{\text{means}}$ No thermal motion in the system.

We could get closer and closer to it, but never be able to reach it.

★ Review on Selected Topics.

1. Vectors

- What quantities are vectors ?

  e.g: position . displacement .

  velocity . acceleration .

  momentum . Force .

- Addition and subtraction of vectors .

  — Head to Tail

  — Component method .

- Components .

  — why
  a) convert vector calculations to algebraic calculations.
  b). x- and y- are independent components.

  — How to find the components .

  — How to reconstruct the vector from components.

- Dot product and work.

$$W = \vec{F} \cdot \Delta\vec{x} .$$

- Typical mistakes.
  - Can't recognise a quantity as a vector.
  - Add/subtract algebraically.
  - forget the direction

2. Kinematics.

- Definitions.

vector difference!

e.g: $\vec{v}_{av} = \frac{\Delta\vec{x}}{\Delta t}$. $\vec{a}_{av} = \frac{\Delta\vec{v}}{\Delta t}$.

- Graphical relationship:

e.g: $x \rightarrow v_x \rightarrow a_x$. (slope of curve)

e.g: $a_x \rightarrow v_x \rightarrow x$. area under curve.

- Linear vs. circular.

$v = r \cdot \omega$. (angle - rads)

$a_c = \frac{v^2}{r}$. $a_t = r \cdot \alpha$.