

Phys 101

Lecture 33

Wed. March 26, 2003

Topics Covered.

Thermal Expansion

Mechanisms of Heat Exchange

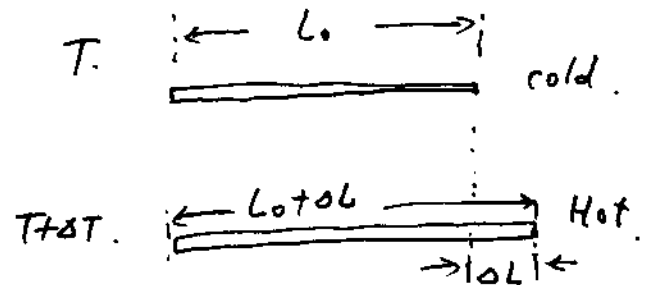
Ref : 16-3, 4, 5, 6

- Thermal expansion

— size changes with temperature.

- Linear expansion $\hookrightarrow$ Thin rod, wire etc.

$$\Delta L = \alpha \cdot L_0 \cdot \Delta T.$$



α — coefficient of Linear expansion.

L_0 — initial length.

Demo
rulers



- Area expansion.

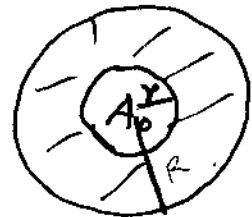
$$\Delta A = 2 \cdot \alpha \cdot A_0 \cdot \Delta T.$$

A_0 — initial area.

e.g: A washer is heated, how does the area ~~size~~ of the hole change?

final A. initial A_0 .

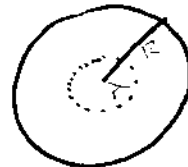
change in A: $\Delta A = A - A_0$.



Q: ~~which one~~ Does the hole become smaller? [$A < A_0$].

Idea: consider a disk.

draw an inner circle.
—/cut
~~then cut it~~.



cold.



Hot.

Since the area of the inner circle is a disk,
it expands when heated.

Therefore, the hole of washer will expand ^{just like a disk of radius r .}

$$\Delta A = 2\alpha \cdot A_0 \cdot \Delta T.$$

• Volume expansion.

$$\Delta V = 3\alpha \cdot V_0 \cdot \Delta T$$

$$\equiv \beta V_0 \cdot \Delta T.$$

$$\beta = 3\alpha.$$

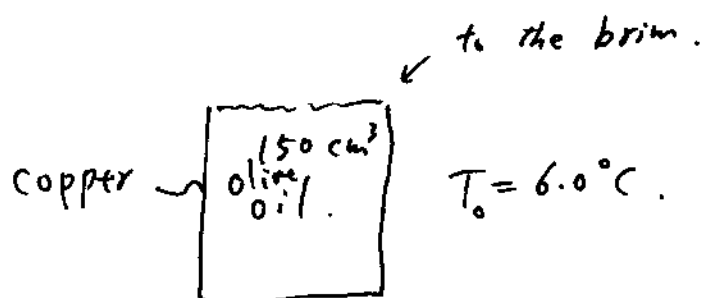
The volume of a container increases with increasing temperature. just like a 3-D object. (Demo: ball and hoop)

~~Ex:~~ Values of α and β . (p. 505. Table 1)

e.g. p. 509. e.g. 16-3.

Oil Spill.

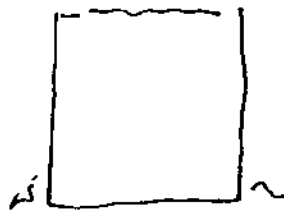
Q: How much oil spills from the flask?



$$T_0 = 6.0^\circ\text{C}.$$

$$\Delta T = \Delta T_k = \Delta T_c.$$

$$= 31^\circ - 6^\circ = 25^\circ\text{C} \\ = 25\text{ K}.$$



$$T = 31^\circ\text{C}.$$

change in volume of oil:

$$\begin{aligned}\Delta V_{oil} &= \beta \cdot V_0 \cdot \Delta T \\ &= (0.68 \times 10^{-3} \text{ K}^{-1}) \cdot (150 \text{ cm}^3) \cdot (25 \text{ K}) \\ &= 2.6 \text{ cm}^3.\end{aligned}$$

change in volume of flask.

$$\begin{aligned}\Delta V_{flask} &= 3\alpha V_0 \cdot \Delta T \\ &= 3(17 \times 10^{-6} \text{ K}^{-1}) \cdot (150 \text{ cm}^3) \cdot (25 \text{ K}) \\ &= 0.19 \text{ cm}^3.\end{aligned}$$

$$\Delta V_{oil} - \Delta V_{flask} = 2.6 - 0.19 = 2.4 \text{ cm}^3.$$

Note: Certain substance in certain Temperature range won't expand upon heating.

e.g: water. between 0° and 4°C .

it shrinks if you heat it up. in this T -range.

- 3 Mechanisms of Heat exchange.
↑
Thermal energy
{

 conduction
 convection
 radiation

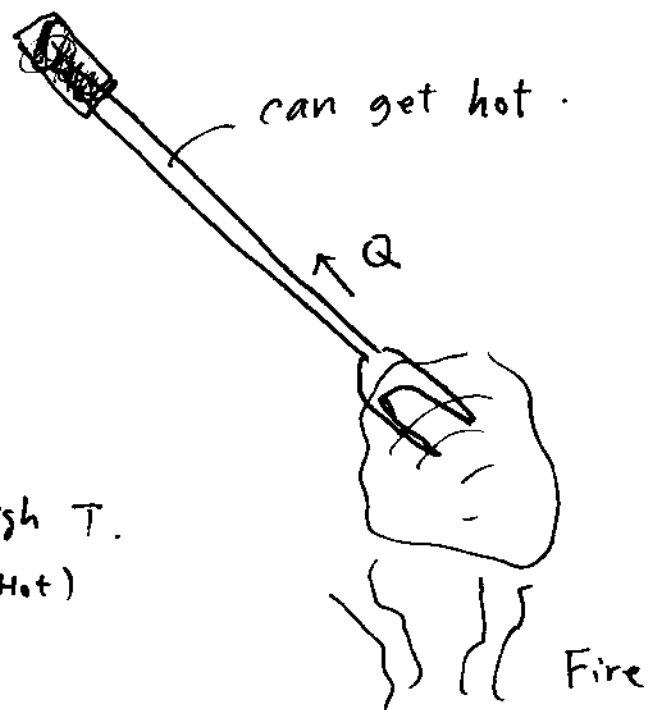
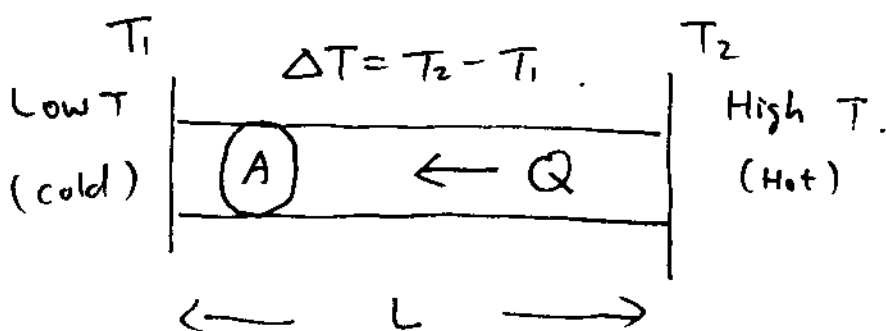
- conduction

- by interactions among atoms and molecules,
 but there is no transport of the atoms and
 molecules themselves.

e.g. BBQ

Heat flow by conduction:

$$Q = k \cdot A \cdot \left(\frac{\Delta T}{L} \right) \star$$



k — Thermal conductivity

steel: $k = 67 \text{ W/m}\cdot\text{K}$

wood: $k = 0.1 \text{ W/m}\cdot\text{K}$

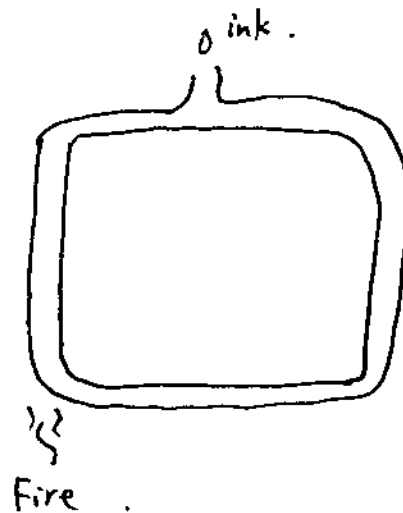
- Convection

— There is a transport of atoms and molecules.

e.g.: Warming a house by forced hot air.

How to increase the efficiency — blow !

Demo:



- Radiation .

— by electromagnetic radiation .

With the speed of light .

No physical contact !

Demo

