Ch.10
Temperature and the Behavior of Gases

- Temperature: is directly related to the average kinetic energy of the atoms and molecules composing the object.

- Calibration of thermometer:
  To calibrate the thermometer we use the freezing point and the boiling point of water at normal atmospheric pressure as our reference and divide the interval between them into 100 equal steps.

- Temperature Scales

Scale	Freezing Point	Boiling Point	Division
Celsius C°	$0\ C^\circ$	$100\ C^\circ$	100
Fahrenheit F°	$32\ F^\circ$	$212\ F^\circ$	180
Kelvin K°	$273.15\ K^\circ$	$373.15\ K^\circ$	100

- The relationship between the scales

$$T_F = \frac{9}{5} T_C + 32$$

$$T_K = T_C + 273.15$$

Example: the human body (normal) temperature is $98.6\ F^\circ$. Find it in C°

$$T_C = \frac{5}{9}(T_F - 32) = \frac{5}{9}(98.6 - 32) = 37\ C^\circ$$

Example: convert $20\ C^\circ$ to $F^\circ \Rightarrow T_F = \frac{9}{5}(20) + 32 = 68\ F^\circ$

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Pressure:

The average pressure $\bar{P}$ is the sum of the magnitudes of the normal forces divided by the surface area

$$\bar{P} = \frac{F}{A}$$ on a molecule

the pressure of the gas is $P = \frac{F}{A}$
where F is the Force exerted by the gas on the piston (plate) and is normal to area at any point.

unit of pressure is pascal (Pa) where

$$1\ Pa = 1\ N/m^2$$

other units: atmosphere (atm)

where
$$1\ atm = 1.013 \times 10^5\ Pa = 1.013\ bars$$ } meteorology الأرصاد الجوية
$$= 760\ torr = 760\ mm\ Hg$$ } medicine الطب

Example:
A gas at $P = 10$ atm is in a cubical container of side 0.1 m. If the pressure outside is atmospheric pressure, what is the net Force on one wall of the container?

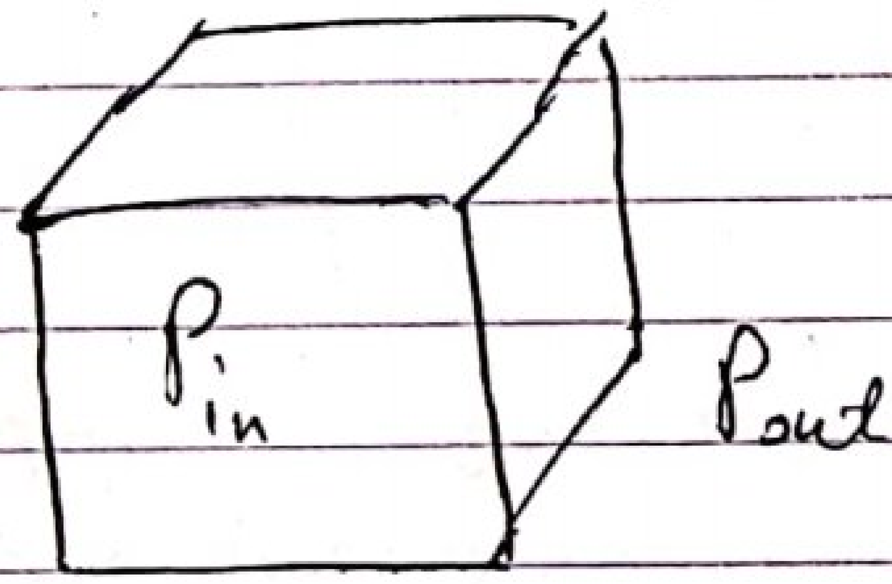
the Force of the gas inside
$$F_{in} = P_i A = (10\ atm)(1.013 \times 10^5)(0.1)^2 = 1.013 \times 10^4\ N$$

the Force outside

$F_{out} = P_{out} A = (1)(1.013 \times 10^5)(0.1)^2 = 0.1013 \times 10^4 \ N$

the net force is

$F_{net} = F_{in} - F_{out} = (1.013 - 0.1013) \times 10^4 = 0.912 \times 10^4 \ N$



- Gauge Pressure

the difference $P_{in} - P_{out}$ is called the gauge pressure

مثل قياس الضغط في عجلات السيارة

chapter 12
Thermal properties of matter

▣ Thermal Expansion:

When a substance is heated, its volume increases due to the increase of its kinetic energy, so each molecule collides with its neighbors and push them away and the material expand.

▣ Length Expansion

if we consider a rod of length l_0 greater than its surface area then the increase in length (Δl) due to expansion is

$$\boxed{\Delta l = \alpha l_0 \Delta T}$$

$\Delta l = l - l_0$

$\Delta T = T - T_0$

where

α: is the coefficient of linear expansion which is property of each material, its unit is K^{-1}

l_0: the initial length at temperature T_0 ($T_0 = 20^\circ C$)

l: the final " " " T

Example:

A rod of length 1.28 m at temperature $-12\,c^\circ$, it is heated to $38\,c^\circ$. Find the increase in its length ($\alpha = 1.27 \times 10^{-5}\ K^{-1}$)

$$\Delta l = \alpha l_0 \Delta T = (1.27 \times 10^{-5})(1.28)(38 + 12) = 8.1 \times 10^{-4}\ m$$

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□ Area Expansion

When an object of area A is heated all of its dimensions increas, the increase in area is

$$\Delta A = (l+\Delta l)^2 - l^2 \qquad \text{(case of a square)}$$
$$= l^2 + \Delta l^2 + 2l\Delta l - l^2$$
$$= \Delta l^2 + 2l\Delta l$$
$$\simeq 2l\Delta l \quad , \quad (\Delta l)^2 \simeq 0$$
$$\Delta A \simeq 2l\alpha l\Delta T$$
$$= 2l^2\alpha\Delta T$$
$$= 2\alpha A\Delta T$$

$$\boxed{\Delta A = 2\alpha A\Delta T}$$

□ Volume Expansion

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

or $\Delta V = \beta V\Delta T$, $\beta = 3\alpha$ is the coefficient of volume expansion

Example:
A circular steal disk has a circular hole through its center. If it heated from 10 c° to 100 c°, what is the fraction increase in the area of the hole?

$$\text{Fractional increase} \equiv \frac{\Delta A}{A} = \frac{2\alpha A\Delta T}{A} = 2\alpha\Delta T$$
$$= 2(1.27\times10^{-5})(100-10) = 2.29\times10^{-3}$$

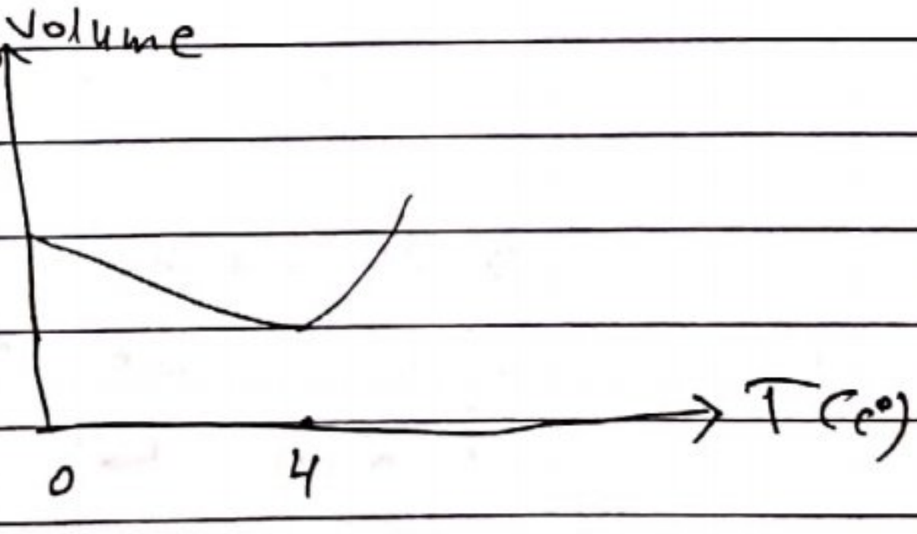
□ Thermostate: It has two metal strips with different coefficient of linear expansion attached to each other, when they are heated the unequal expansion cause them to bend from each other and open the electrical circuit.

□ Water anormaly characteristic

it has negative thermal coefficient of volume expansion in the interval [0, 4 c°].

As T rises from 0 c° to 4 c° water contracts up (يقل)

at 4 → 100 it expand



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Water anormaly characteristic