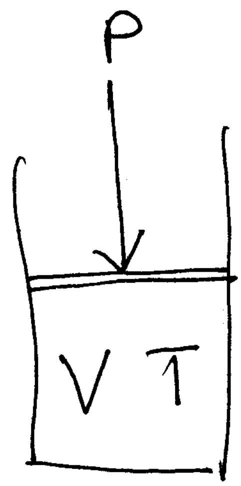
GASES



A MACROSCOPIC DESCRIPTION OF A GAS REQUIRES TO DETERMINE 3 PROPERTIES

PRESSURE
VOLUME
TEMPERATURE

VOLUME.- ONE DETERMINES THIS PROPERTY BY MEASURING THE CONTAINER'S DIMENSIONS

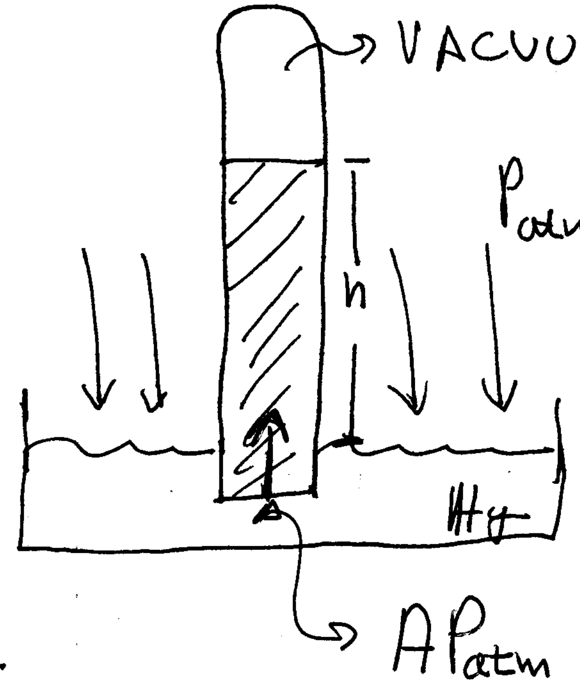
$L \rightarrow m \rightarrow$ METER.

$V \sim L^3 \rightarrow m^3$

PRESSURE.- THIS PROPERTY IS DEFINED AS FORCE PER UNIT AREA.

TO MEASURE PRESSURE WE USE MANOMETERS.

PRESSURE UNITS



$$P_{atm} A = F$$

$$= M_{Hg}\, g = V \rho_{Hg}\, g$$

$$= A h \rho_{Hg}\, g$$

$$\boxed{P_{atm} = \rho_{Hg}\, g\, h_{Hg}}$$

FOR MERCURY

$\rho_{Hg} = 13.5951\ g\, cm^{-3}$ AT $0°C$

$h_{Hg} = 0.760\ m$ AT SEA LEVEL

$$g = 9.80665\ \frac{m}{s^2}$$

AT <u>0°C</u> AND <u>SEA LEVEL</u>

$$P_{atm} = 1.35951\ \frac{Kg}{m^3}\ 9.80665\ \frac{m}{s^2}\ 0.760\ m$$

$$= 1.01 \times 10^5\ kg\frac{m}{s^2}\frac{1}{m^2}$$ Sig figs!

$$kg\frac{m}{s^2}\frac{1}{m^2} = \frac{N}{m^2} \equiv Pa = \text{Pascal}$$

$$\boxed{P_{atm} \equiv 1\,atm = 1.01 \times 10^5\ Pa}$$

EXERCISE CALCULATE THE HIGHT OF A WATER COLOUM. EXPLAIN CLEARLY ANY ASSUMPTIONS OR APPROXIMATIONS

DEF

$$bar \equiv 10^5\ Pa = 1 \times 10^5\ Pa$$

$$torr \equiv \frac{1}{760}\ atm$$

BOYLE'S LAW

1662 BOYLE

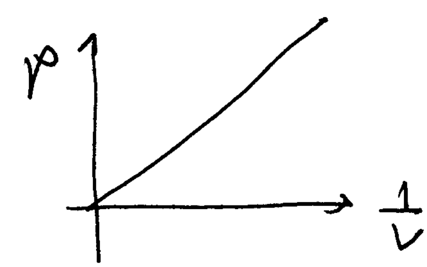
$$PV = C$$

AT CONSTANT TEMP.

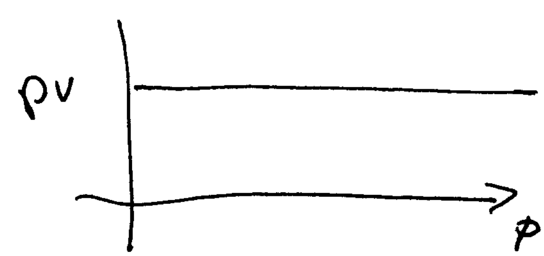
Plot

P vs V

P vs $\frac{1}{V}$



PV vs P



$P_1V_1 = P_2V_2$ CONST T AND n

- TEMPERATURE IS NOT A MECHANICAL PROPERTY BUT THERE ARE MECHANICAL PROPERTIES THAT DEPEND ON TEMPERATURE

WE LOOK FOR ONE OF THOSE MECHANICAL PROPERTIES THAT DEPEND LINEARLY ON TEMPERATURE.

THE THERMAL EXPANSION OF Hg IS ALMOST LINEAR IN TEMP.

- USING THIS NEARLY LINEAR PROPERTY, WE DESIGN A THERMOMETER

ARBITRARY		FREEZING	BOILING
	°C	0	100
	F	32	212

FOR LIQUID AND SOLIDS MOST OF THE PROPERTIES THAT DEPEND ON TEMP.

- DO NOT DEPEND LINEARLY ON Temp.

FOR ACCURATE MEASUREMENTS OF TEMP. WE DESIGN A GAS THERMOMETER, WHICH IS INDEPENDENT OF THE GAS!

FOR GASES A LOW CONCENTRATION AND FIXED PRESSURE THEIR VOLUMES DEPEND LINEARLY ON TEMPERATURE

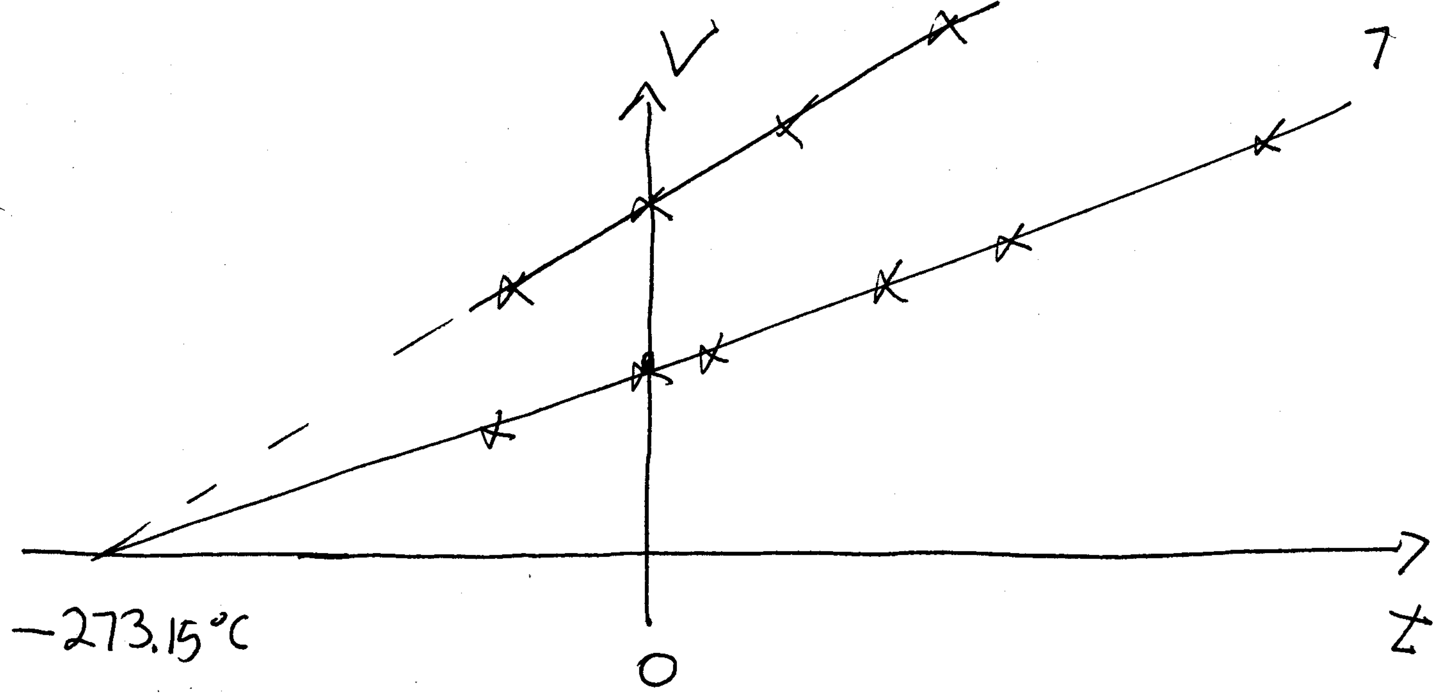
$$t = c\left(\frac{V}{V_0} - 1\right)$$

WHERE V_0 IS THE VOLUME AT 0°C.
THE VALUE OF "C" IS INDEPENDENT OF THE GAS USED.

IN 1802 GAY LUSSAC FOUND A VALUE OF 267 °C, BUT MODERN MEASUREMENTS GIVE

$$C = 273.15\ °C$$

FOR ALL GASES AT CONSTANT LOW PRESSURE.



FOR A GAS THERMOMETER

$$t(°C) = 273.15\,°C\left(\frac{V}{V_0} - 1\right)$$

OR

$$\frac{V}{V_0} = \frac{273.15°C + t(°C)}{273.15°}$$

$$T_0 \equiv 273.15\ K \Leftrightarrow 0\,°C$$

ABSOLUTE TEMPERATURE

$$T(K) = 273.15\,K + t°(°C)$$

$$\frac{V}{V_0} = \frac{T}{T_0}$$

WE CANNOT GO BELOW −273.15°C OR 0K

FOR 40.00 °C → GAS THERMO.

40.11 °C → Hg THERMO

a) CONST. T and n

$P_1V_1 = P_2V_2 = \text{CONST}$ $PV = C$

b) CONST. P and n

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} = \text{CONST}$$

c) CONST. P and T

$$V \sim n$$

THEREFORE

$$PV \sim nT$$

$$PV = nRT$$

OR

$$\frac{PV}{nT} = R = \text{UNIVERSAL GAS CONSTANT}$$

$$R = 8.3145 \text{ J mol}^{-1} \text{K}^{-1} = 0.082058 \text{ L atm mol}^{-1} \text{K}^{-1}$$

Kinetic Theory of Gases

Rudolf Clausius

James Clerk Maxwell

Ludwig Boltzmann

Assumptions

1.- Gas consists of a large number of molecules

2.- Distribution of speeds

3.- No interactions between collisions

4.- Wall collisions elastic (energy is conserved)

$\underset{\sim}{v}$ Velocity is a vectorial quantity (direction)

u Speed is the magnitud of the velocity $\in \mathbb{R}^+$

$\underset{\sim}{v} = (v_x, v_y, v_z)$

$$u^2 = v_x^2 + v_y^2 + v_z^2$$