Pressure

the force exerted per unit area

$$P = \frac{F}{A} \quad Pa \text{ (pascal)}$$

$$= \frac{N}{m^2} = Pa$$

Solids:

Solids exerts pressure on whatever it rest on, depends on its weight and the surface area of contact.

→ The solid object exert a force equal to its weight downwards on the surface it sitting on divided by the surface area of contact = P

Gases:-

Gases consist of large # of fast moving molecules, these molecules collide with the walls of the container the gas is confined to.

→ These collisions exert forces and hence pressure to the container walls

∴ then P depends on the average mag of these collision forces and on the # of collisions happening per second.

→ This average force depends on ① density ② how fast the molecules are moving on average (depends on temp)

→ for a small volume of gas, the weight force at the bottom of the ~~sa~~ sample is negligible?!

its very small compared to the pressure due to the random collisons

→ for large sample:

the change in pressure with elevation due to the additional weight of the gas is significant, and must take in consideration.

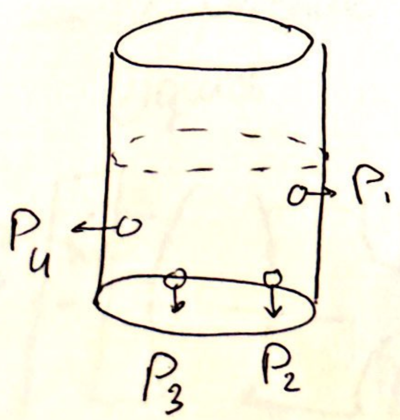
Liquid :-

like gases the molecules also moving randomly (more slowly than in a gas) and are able to slide past each other

higher density → additional pressure due to the weight of the liquid above

→ the weight of the liquid above a certain point is the dominant term in determining the pressure that the random motion (unlike gas)

→ liquid exert pressure sideways on the sides of the container



* The pressure in a non-~~liquid~~ flowing liquid varies with elevation in the liquid, but is the same at all points at the same elevation.

* **Density:**

$$\rho = \frac{m}{V}$$

→ solids and liquids have ~~[illegible]~~ distinct densites which depends only on the average length of the inter molecular bonds within the material

→ for specific temp, then is a well-defined density.

→ The inter molecular bonds in gases are weak, gases expand to fill their container So the density of a gas depends on the size of the container

Pascal's Principle:

→ States that pressure applied to an enclosed fluid is transmitted undiminished to every part of the fluid as well as the walls of the container

then go back to

start from here

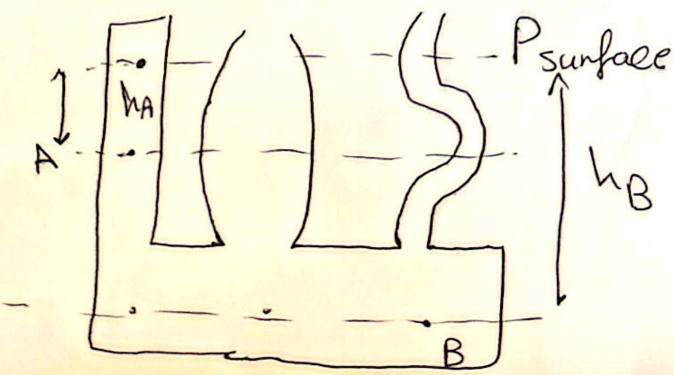
- for non-moving liquid.

$$P_{bottom} = P_{surface(atm)} + \rho g h$$

$$P_{liquid} = \frac{weight}{A} = \frac{mg}{A} = \frac{\rho V g}{A}$$

$$= \frac{\rho A h g}{A} = \rho g h$$

→ The pressure at any two arbitrary points in the liquid.



$$P_A = P_{surface} + \rho g h_A$$

$$P_B = P_{surface} + \rho g h_B$$

$$\boxed{\Delta P = \rho g \Delta h}$$

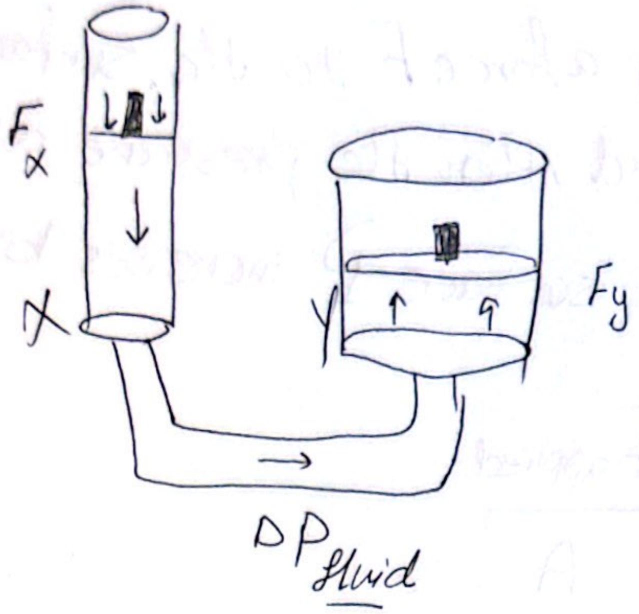
* Hydraulic Systems:

→ if we apply a force F to the surface of the Liquid, then the pressure at the liquid surface P increases by

$$\Delta P = \frac{F_{applied}}{A}$$

→ and the pressure at all other points in the liquid increases by the same amount because of the pascals principle.

→ this system used for amyriad of the applications such as car lifts, densists chair....



$$\Delta P_{fluid} = \frac{F_x}{A_x}$$

$$F_y = \Delta P_{fluid} A_y$$

$$= \frac{A_y}{A_x} F_x$$

$$\boxed{\therefore \frac{F_y}{F_x} = \frac{A_y}{A_x}}$$

→ As work done equals force times distance $W = F \times d$ ∴ this equivalent to saying that the work done by piston X is the work done on poiston Y

$$V = A_x d_x = A_y d_y$$

$$\therefore d_y = \frac{A_x}{A_y} d_x$$

- Note that the poistons will move through diffrent distances, as for an incompressible liquid the volume of liquid that is displaced by piston X is the same as the volume of liquid that poiston Y displaces

The pressure at a point in a liquid is the same in all directions, this means that small, flat plate placed at particular height within aliquid will experience the same force per unit area regardless of it's orientation, the forc is always exerted perpendicular to the area, the pressure must be the same in all direction.

see Page 115

* Measurement of pressure :

- There are many kinds of devices in use today that rely on a wide variety of pressure-sensitive phenomena to do so.

- Diaphragm pressure meter : rely on measuring the expansion / contraction of a fixed mass of gas in a sealed compartment.

1. The manometer
2. The Barometer

(HW)

Gauge Pressure VS the absolute pressure:

Gage: → The pressure relative to the local atmospheric pressure.

→ the pressure due the fluide only

the absolute: the pressure due to the gauge pressure pluse the atm pressure

- **Gauge pressure**

1. Can be positive or negative

positive: means that the pressure being measured is higher than the refrence pressure

negative: means that the Pressure being measured is lower than the refrence pressure

$$\text{gauge } P = \text{absolute } P - \underbrace{P_{atm}}_{\text{reference point}}$$

- **absolute pressure**

- Can't be negative

absolute pressure $= \text{gauge } P + P_{atm}$

→ So the gauge pressure measures the value pressure at the place of interest of how mush higher or lower it is than the atmosp...

* when the atmospheric pressure is the the refrene point then it's Called Gauge pressure $\boxed{P = \rho g h}$

* Units

$$1\,Pa = \frac{N}{m^2}$$

$$P_{atm} = 10^5\,Pa = 1\,bar$$

$1\,bar = 100\,kPa$

$\boxed{1\,hecto = 10^2}$ used in maps

$1\,m\,bar = 1\,hecto\,Pa$

$$\therefore 10^5\,Pa = 1000\,hecto\,Pa = 100\,k\,Pa = 0.1\,MPa = 1\,bar$$

$$100\,Pa = 1\,hecto\,Pa = 0.1\,kPa = 1\,m\,Bar$$

other units of pressure still commonly found in use, Psi (pounds per square inch)
~~torr~~ mmHg (millimeter of mercury)
atm (atmosphere)
torr

Blood-pressure readings are still given in ~~units~~ units of $\boxed{mmHg}$, and this is unlikely to change as the old-fashioned mercury blood pressure meter dont go out of calibration, and are used to check the calibration of other types.

1 mmHg : is the pressure exerted at the base ~~of the~~ of a column of fluid exactly 1mm hight, when the density of the fluid ρ = is 13.5951 $g.cm^{-3}$ and $g = 9.80665 ms^{-2}$
this ρ = density of mercury Hg at $0 C^{\circ}$

1 mmHg very close to one torr

pressure and the Human Body:-

. Blood pressure

→ blood Pressure is routinely measured in medical practice, one method of measurment would be to connect a manometer directly to an artery, but this clearly too ~~...~~ invasive.

→ The standard method uses a sphygmomanometer

procedure:

1. Use the blood pressure cuff at the correct size (should be at least equal to 80% of the circumference of the upper arm)

2. Wrap the cuff around the upper arm with cuff's lower edge one inch above the antecubital fossa

3. Lightly press the stethoscope's bell over the brachial artery just below the cuff's edge

4. Rapidly inflate ~~the~~ the Cuff to 180 m... release air from the Cuff at a modera... rate (3 mm/sec)

5. Listen with the stethoscope and simultaneously observe the dial or mercury gauge, The first Knocking sound is the subject's systolic pressure, when the knocking sound disappears that is the diastolic pressure.

6. a blood pressure of 180/120 mmHg or more Requires immediate attention.

inflatable cuff is used to apply pressure
outside of the artery.

→ The blood pressure in the artery varies with time throughout the cardiac cycle, and it's maximum just after the left ventricle of the heart contracts sending a surge of the blood into the arteries

→ Now, the external pressure applied to the artery is beyond the expected maximum blood pressure

→ at this point, the artery collapses, The applied pressure is slowly reduced as the physician listen.

→ when sounds (known as korotkoff sounds) are first heard it's indicate that the applied pressure has dropped below the maximum pressure in the artery

→ when the pressure in the artery is maximum the artery opens breifly allowing a spurt of blood through, and the sound results from the brief turbulent flow of blood through the artery

→ The pressure at which sounds are first heard is known as the systolic pressure, it's the max pressure in the artery at the location of measurment

→ This ranges from 95 to 140 mmHg for a norm adult, with average being 120 mmHg, when the the pressure is measured level with the heart, as is customary.

→ as the external pressure on the artery is reduced further, the artery remains open for longer fractions of the cardial cycle.

→ when the pressure is reduced to a level where no further sounds are heard, the artery remain open throughout the cardiac cycle, This is known as the diastolic pressure, and is the lowest pressure in the artery at the location of measurment.

r a normal adult, this # is in the range from
,0 to 85 mmHg

* The blood pressures reported as 2 numbers
the first # is the systolic pressure
the second # is the diastolic pressure
(Both in mmHg)

and these pressures are gauge pressure = the pressure
in the artery relative to atmospheric pressure

* Reading will be diffrenet depending on whether
the patient is lying or sitting and how the arm
is held relative to thier heart

* Measurements are taken with the patient sitting
with thier arm by thier side, so the point of
measurments is level with thier heart.