Force, density, Pressure

Force is rate of change of momentum.
There are two groups of force:
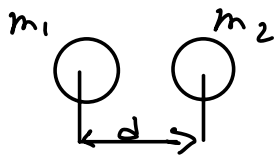1) Contact force
2) Non contact force

Effect of force

1) Change speed
2) Change direction
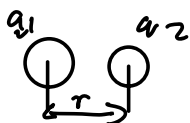3) Change shape
4) Cause a body to rotate about an axis.

Different type of Forces

1) Gravitational force → Every object attracts
other object with a force.

$$F \propto \frac{m_1 m_2}{d^2}$$

2) Electrostatic force → Force between two charged particles

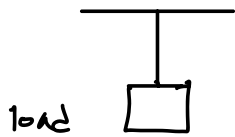$$F \propto \frac{q_1 q_2}{r^2}$$

Contact force

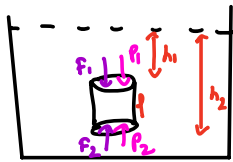1) Normal Contact Force

2) Friction

3) Tension

For load tension is upwards.
for ceiling tension is downwards.

4) Upthrust

$$P_1 = h_1 \rho g$$
$$P_2 = h_2 \rho g$$

$$P_1 = \frac{F_1}{A} \qquad P_2 = \frac{F_2}{A}$$

$$F_1 = P_1 A \qquad F_2 = P_2 A$$

$$P_2 > P_1 \qquad F_2 > F_1$$

$$F_2 - F_1 = \text{resultant force upwards}$$

$$F_2 - F_1 = \text{upthrust}$$
$$h_2 \rho g A - h_1 \rho g A = \text{upthrust}$$
$$\rho g A (h_2 - h_1) = \text{upthrust}$$
$$\rho g A l = \text{upthrust}$$
$$\rho g V_s = \text{upthrust}$$
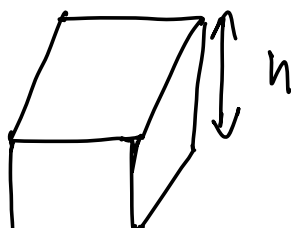$$\rho_l g V_\rho = \text{upthrust}$$

$$m_l g = \text{upthrust}$$

$$m_l g = \text{weight of the liquid} = \text{upthrust}$$
$$\text{displaced}$$

Archimedes principle which states

→ upthrust acting on a body immersed in a fluid is equal to the weight of the fluid displaced.

* Show that pressure $P = h \rho g$ *

Sol^n Consider a section of fluid in the form of a cuboid.

Volume of cuboid $V = A \times h$

If mass $m = V \times p$ (density of fluid)

$$m = Ahp$$

weight $= mg = Ahpg$

Pressure $= \dfrac{Force}{Area} = \dfrac{Ahpg}{A} = hpg$

$$P = hpg$$

* Points to remember

Solid : Liquid : gas

density ratio $\longrightarrow$ S : L : G = 1000 : 1000 : 1

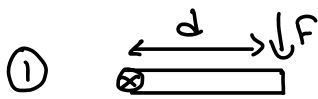Spacing ratio $\longrightarrow$ S : L : G = 1 : 1 : 10

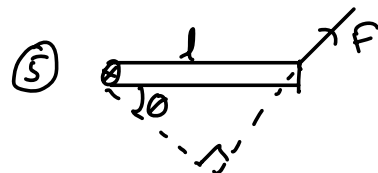spacing $x = \sqrt[3]{V}$

and

$$x \propto \sqrt[3]{\dfrac{1}{p}}$$

Moments

Moment → The turning effect of a force is
called moment

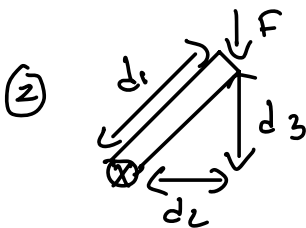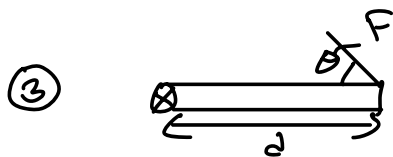Moment = Force × perpendicular distance from pivot.

SI unit = Nm

① $\qquad$ Moment = $F \times d$
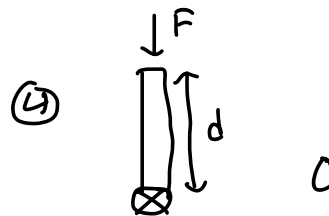
⑤ $\qquad$ $l \cos \theta \, F$
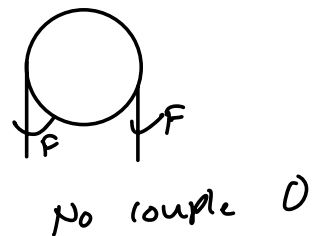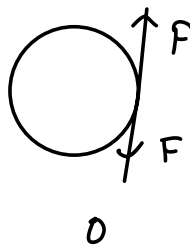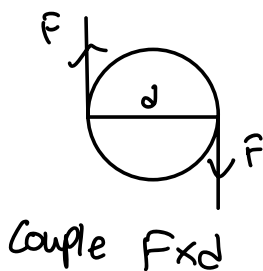
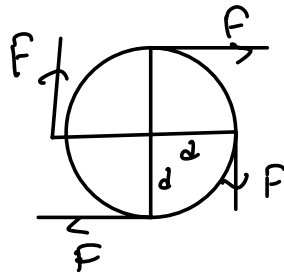② $\qquad$ $F \times d_2$

④ $\qquad$ 0

③ $\qquad$ $F \sin \theta \, d$

Couple: A couple is a pair of forces equal in
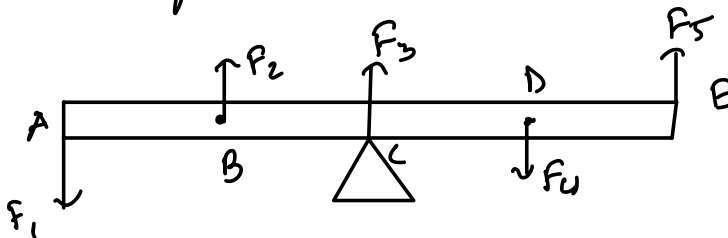magnitude, opposite in direction and are
not in the same line of action.

Couple $F \times d$ $\qquad$ 0 $\qquad$ No couple 0

Torque : The total moment produced by a couple is called torque

$$\text{Torque} = Fd + Fd$$
$$2Fd$$

The Principal of moment

For an object to be in equilibrium the sum of clockwise moment is equal to te sum of anti clock wise about the same point.
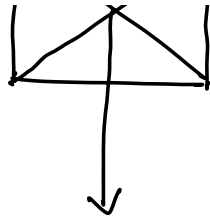

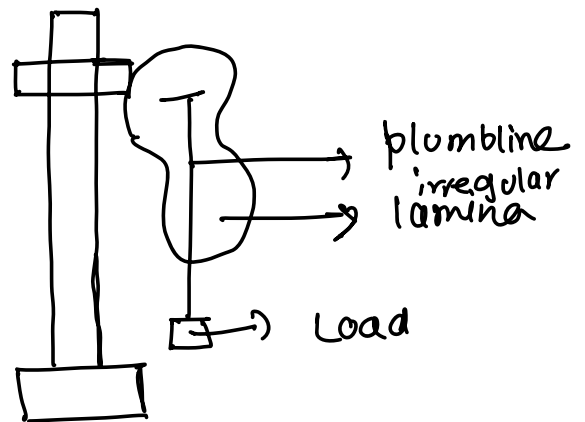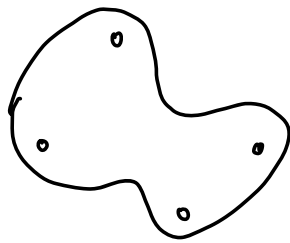**About C**   sum of CWM = Sum of ACWM

$$(F_4 \times CD) + (F_2 \times BC) = (F_1 \, AC) + (F_5 \, CE)$$

Centre of gravity → It is the point on the body where all it's weight seems to act.

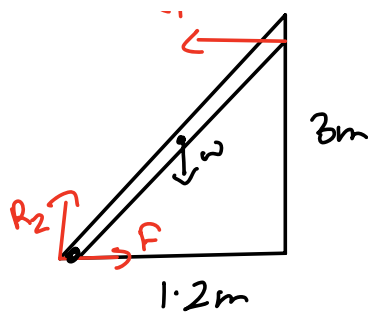Finding centre of gravity of irregular lamina (Plumbline method)

→ plumbline
→ irregular lamina
→ Load

Equilibrium → For an object to be in equilibrium

1) The sum of forces in any direction must be zero.

2) the sum of the moments of the forces about any point must be zero.

Figure shows a ladder leaned against the wall at rest.

$w = 50$

3m

R_2

F

1.2m

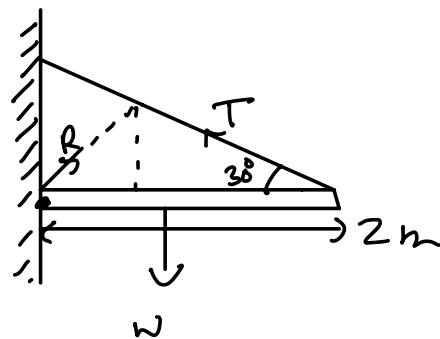Resultant force = 0   upward force = downward force

$$R_2 = w$$
$$F = R_1$$

Comparing moments

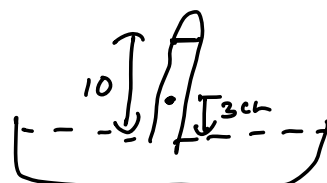$$w \times 0.6 = R_1 \times 3$$
$$50 \times 0.6 = R_1 \times 3$$
$$R_1 = 10 N$$

T

30°

2m

W

$$W \times 1 = T_{\sin} 30 \times 2$$

(the line of forces will have to intersect at one point if the object is in equilibrium)

Barometer → It measures atmospheric pressure

h

10

3cm

Atmospheric pressure $= h\rho g$

(760mm of Hg)

If pressure for 10cm is P

Pressure at $X = \frac{7}{6} P$