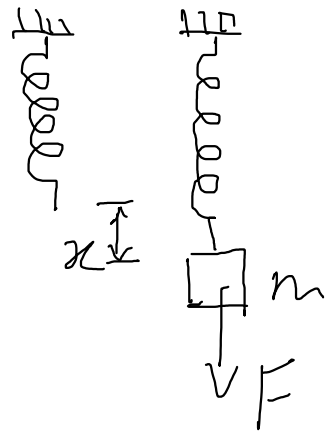
Hooke's Law

Dr K M Hock



$F = kx$

k: spring constant

e.g. Weight is 5 N, extension 5 cm.
Spring constant = ?

Hooke's law → $5\ N = k \times 0.05\ m$

$k = 100\ N\ m^{-1}$

deduce the elastic potential energy in a deformed material from the area under the force-extension graph

Elastic Potential Energy

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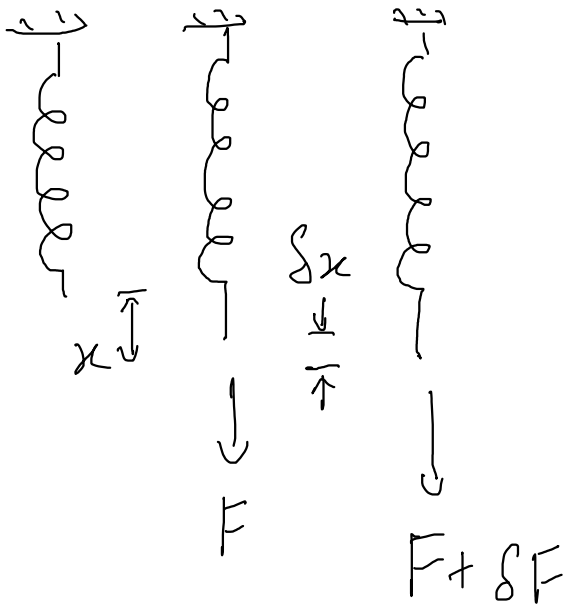
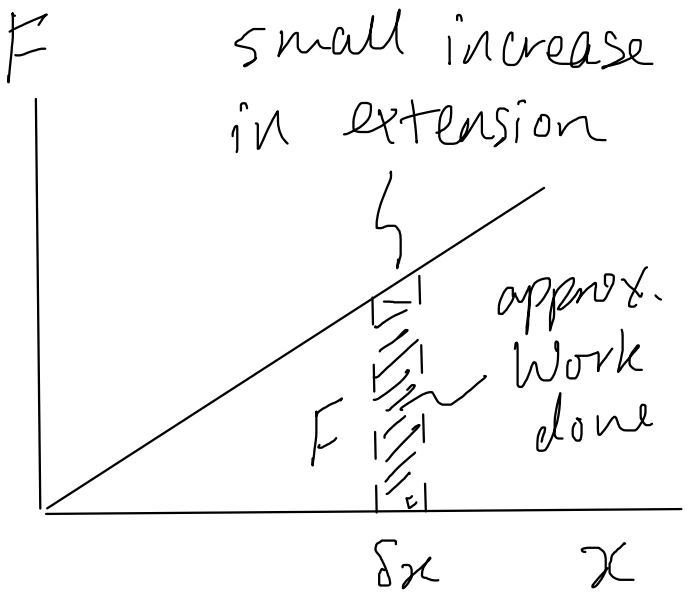
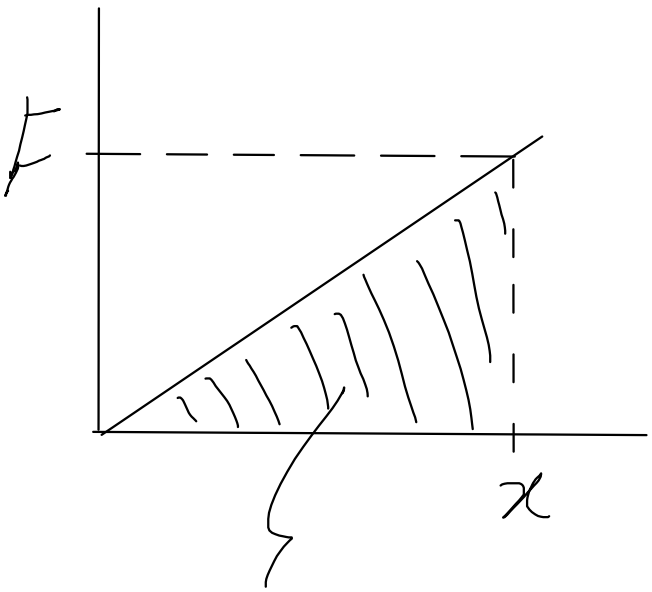


Work done

$\approx F \times \delta x$





Total work done

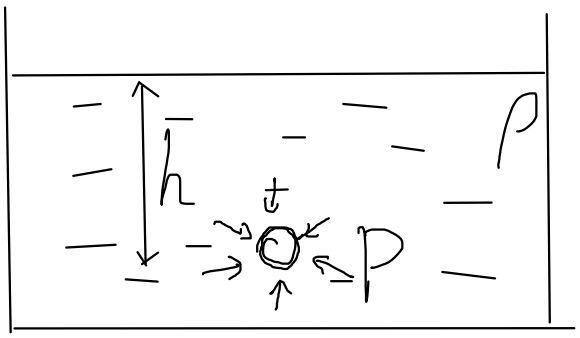
Define as:

elastic potential energy $= \frac{1}{2} F x$

solve problems using the equation p = ρgh

Liquid Pressure

Dr. K. M. Hock



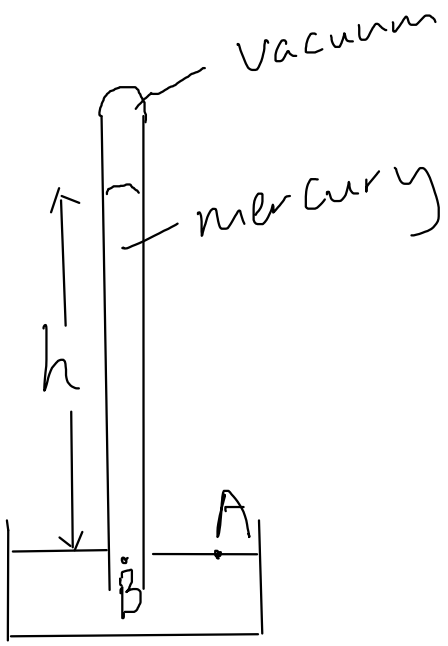
ρ density

h depth

g $9.81\ m/s^2$

Pressure $P = \rho g h$

e.g.



$\rho = 13.6\ g/cm^3$

air pressure $= 10^5\ Pa$

Find h.

Pressure at B = pressure at A

$\rho g h$ = air pressure

$13600\ kg/m^3$ | $9.81\ m/s^2$ | ? | $10^5\ Pa$

h = ____

Upthrust

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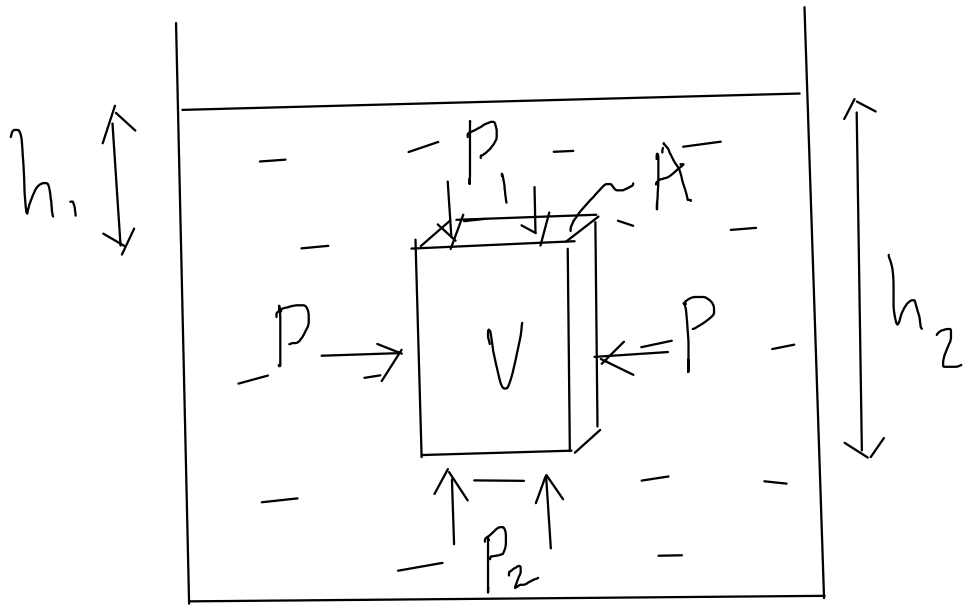
You feel lighter in a swimming pool.



Because pressure on your legs is higher than pressure on your head.

Resultant upward force = Upthrust.

Force at bottom $= p_2 A$

Force at top $= p_1 A$

Upthrust, $U = p_2 A - p_1 A$.

state that an upthrust is provided by the fluid displaced by a submerged or floating object

Fluid Displaced

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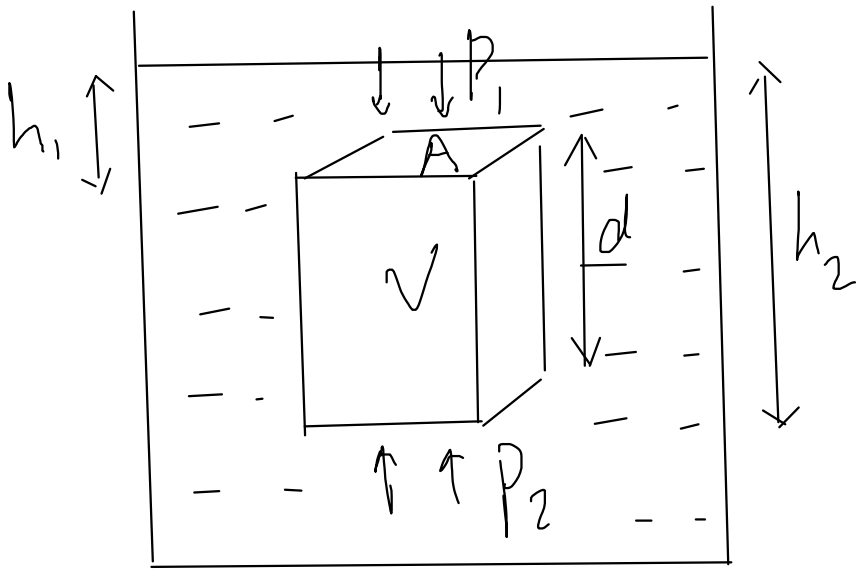

Upthrust $= p_2A - p_1A$

$= \rho g h_2 A - \rho g h_1 A$

$= \rho g (h_2 - h_1) A$

$= \rho g dA$

$= \rho g V$

weight of displaced liquid

V = volume of body

= volume of displaced liquid

ρ = density " " "

$\therefore \rho V$ = mass " " " = m

state that an upthrust is provided by the fluid displaced by a submerged or floating object

calculate the upthrust in terms of the weight of the displaced fluid

Archimedes Principle

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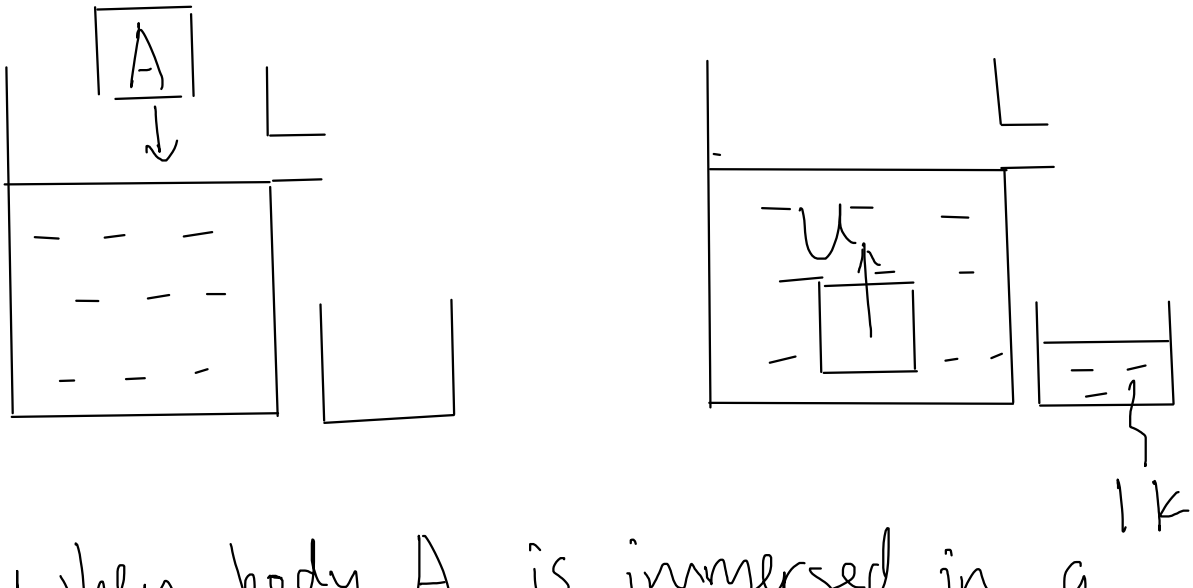
Upthrust in a fluid = weight of fluid displaced



e.g. when body A is immersed in a liquid, the liquid overflowed. This displaced liquid has a weight of 9.81 N. Find the upthrust on A.

Answer:

upthrust = weight of displaced fluid

= 9.81 N.

recall and apply the principle that, for an object floating in equilibrium, the upthrust is equal to the weight of the object to new situations or to solve related problems

Floating Object

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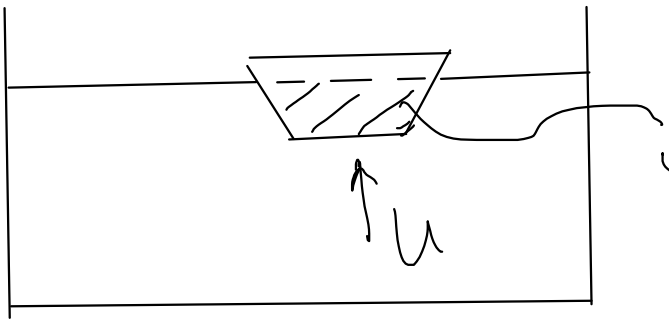
Law of flotation: Weight of a floating object = weight of liquid displaced.



Reason: Weight = upthrust = weight of liquid displaced

e.g. a block of wood has a weight of 100 N.

When it floats on sea water, what is the weight of the sea water displaced?

weight of sea water displaced = weight of the wood = 100 N.

show a qualitative understanding of frictional forces and viscous forces including air resistance.

Friction and viscosity

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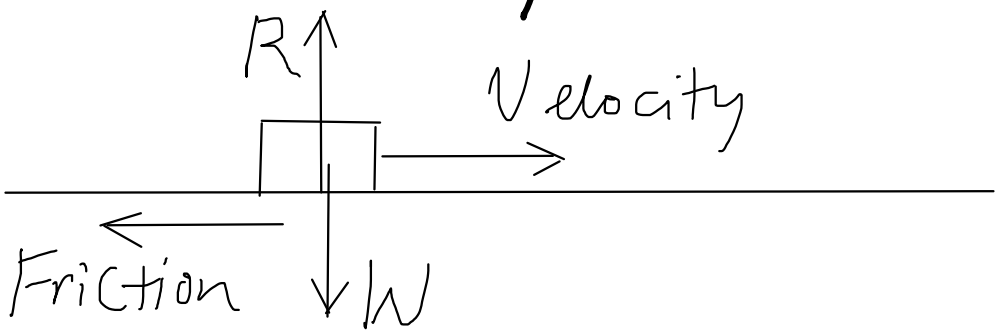
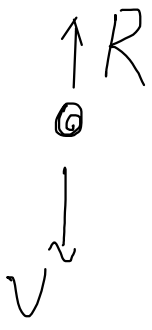
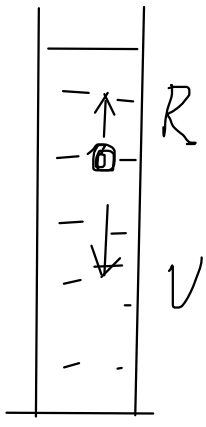


Friction - when two solid bodies slide against each other
- usually bigger if pressed harder together
- stays roughly same if velocity increases



Viscosity - in liquid
- resistance ↑ for higher velocity



Three forces in equilibrium

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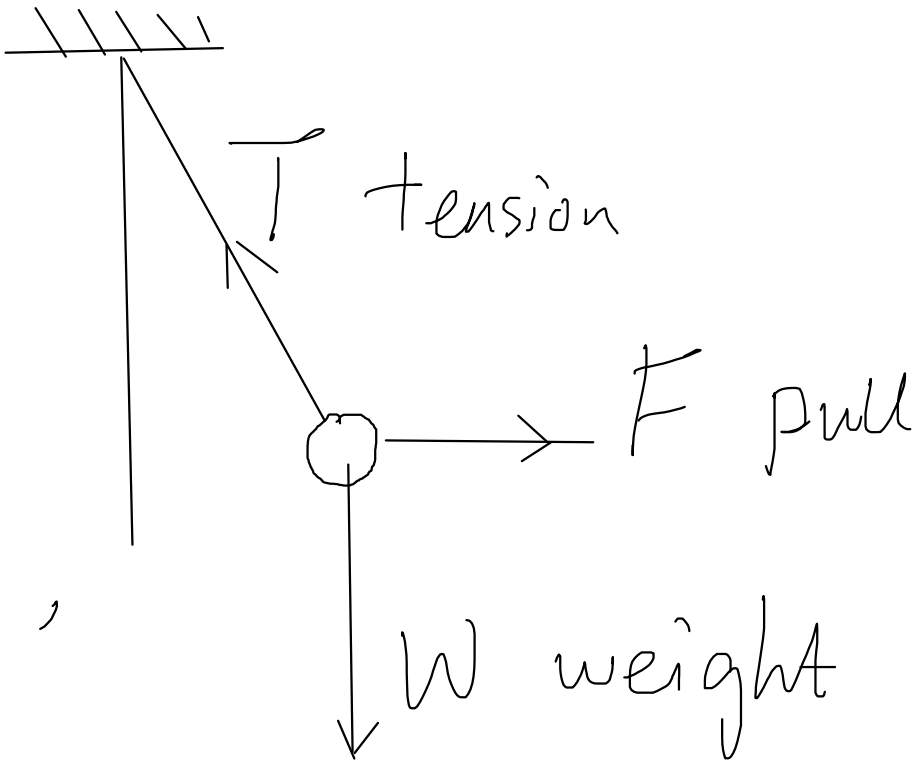
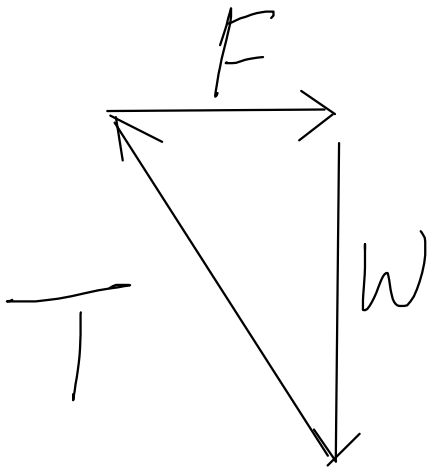
e.g. if 3 forces are balanced, their vectors must form a triangle:





if you try joining them head to tail.

show an understanding that the weight of a body may be taken as acting at a single point known as its centre of gravity

Centre of Gravity

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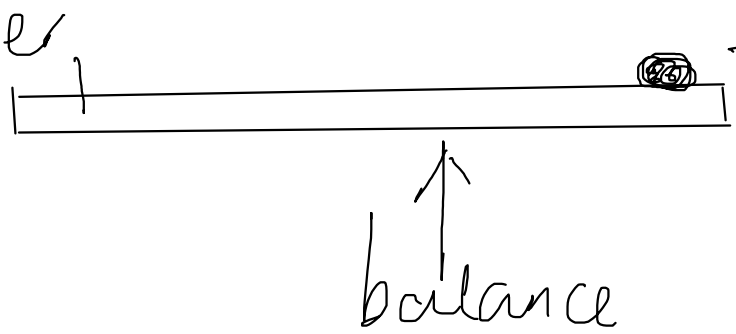
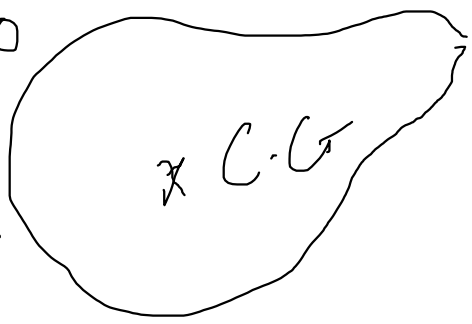
e.g.



- Each part of the ruler + gum has weight
- Can find 1 point that balances
- Can pretend that whole weight act on this point

Centre of gravity.

Can extend idea to complex shapes.



show an understanding that a couple is a pair of forces which tends to produce rotation only

Couple

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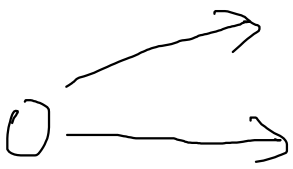
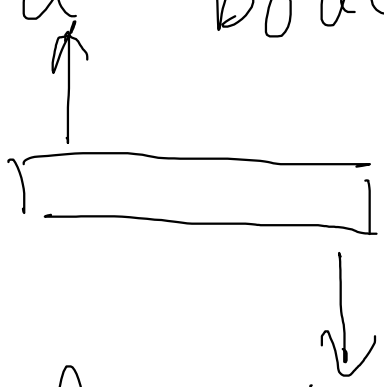
What can 2 forces do?

- Cancel each other:

- Accelerate an object



- Rotate a body



Couple - 2 forces that produces rotation only

- must be equal, opposite, & not along same line.

Moment and Torque

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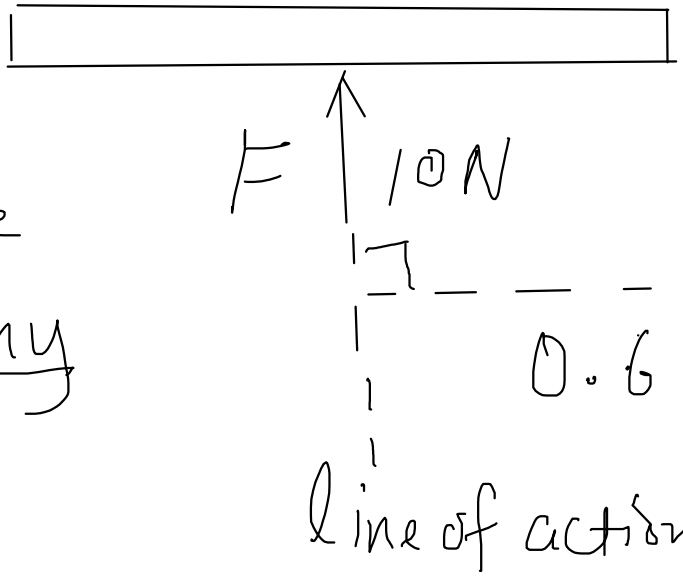
Moment

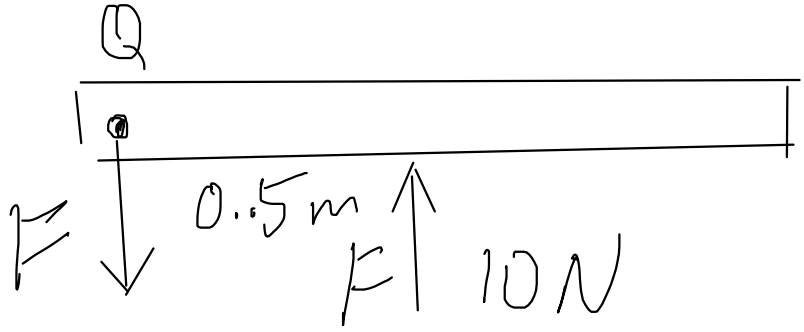


Can take about <u>any</u> point

e.g. moment of F about P = 10 x 0.6
= 6 N m.

(need not cause rotation)

Couple



<u>Must</u> cause rotation.

e.g. if nail at Q, Couple = 10 x 0.5 Nm

show an understanding that, when there is no resultant force and no resultant torque, a system is in equilibrium

Equilibrium

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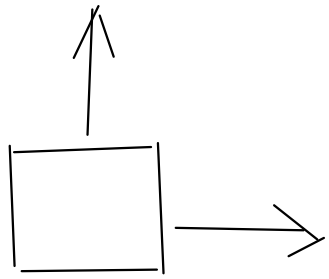
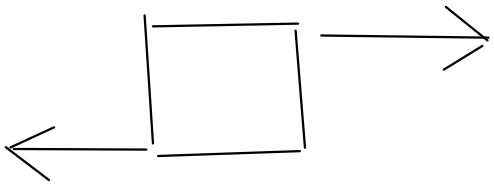
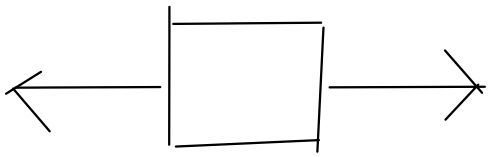
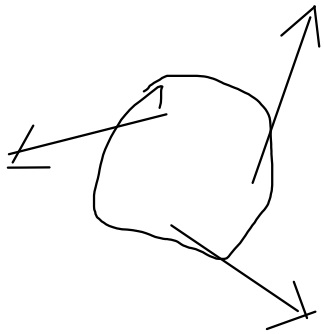
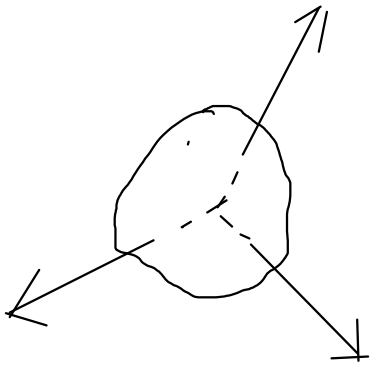
		Resultant Force	Resultant Torque
No		✓	X
No		X	✓
Yes		X	X
No		X	✓
Yes		X	X

apply the principle of moments to new situations or to solve related problems.

Moments Problems

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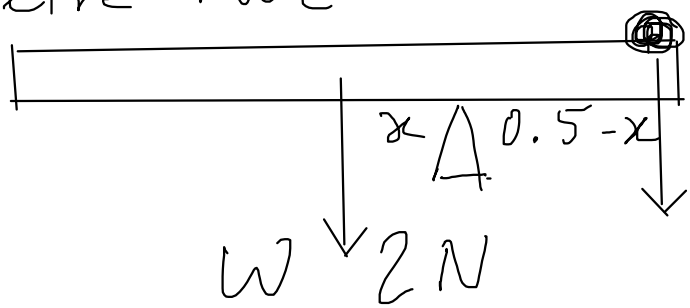
e.g. Metre rule



C.G.?

Must balance on 1 point at C.G.

moments: $2x = 1 \times (0.5 - x)$

$3x = 0.5$

$x = \frac{0.5}{3}$ m.

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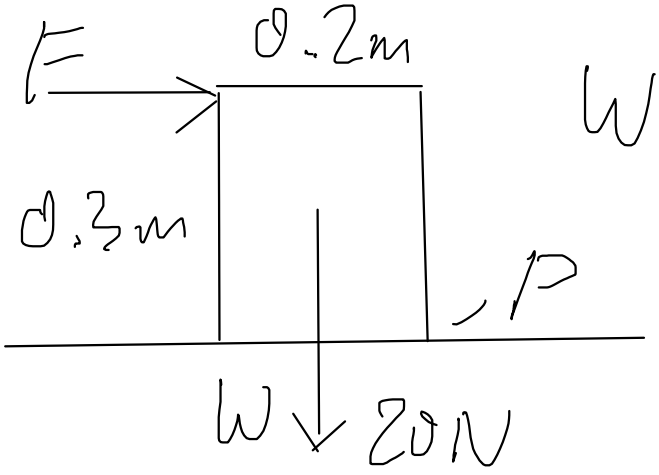
e.g.



What force F to tip?

Tip about P.

Clockwise Anticlockwise

moments: $F \times 0.3 = 20 \times 0.1$