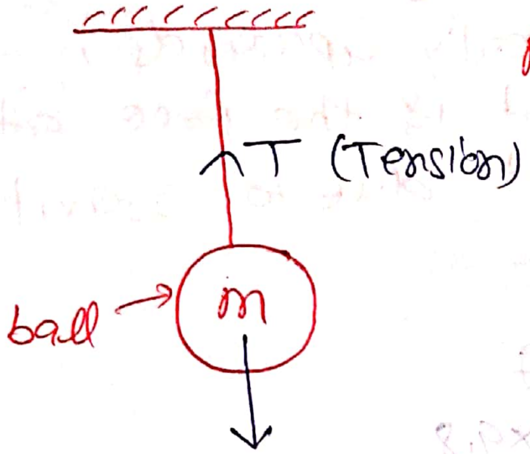
Chapter-1

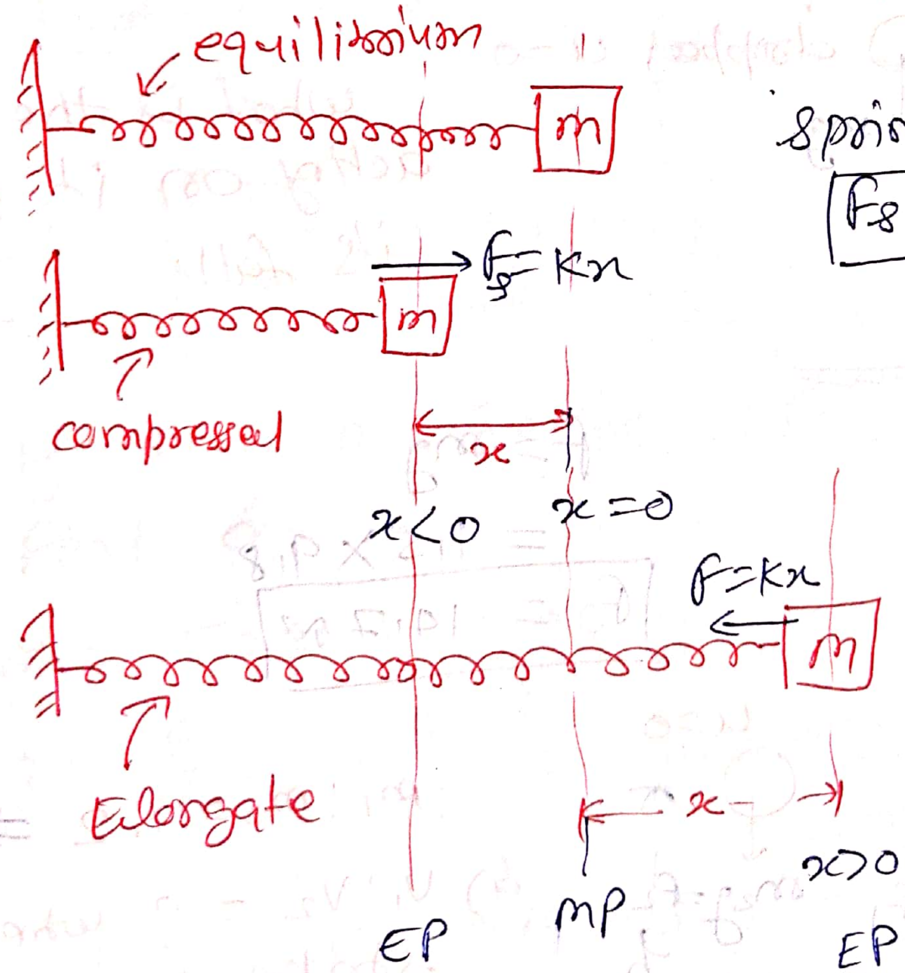
:- Force :-

Q1 A ball is hanging, draw FBD on the ball and string



$mg = w$ (weight of the ball acting downwards)

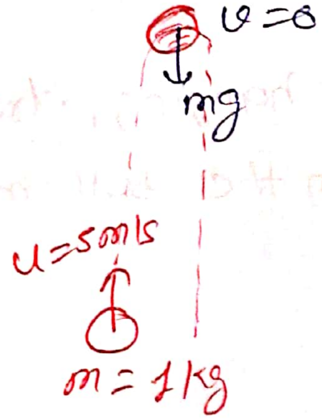
Q2



Spring force

$$F_s = -kx$$

Numericals 1.1

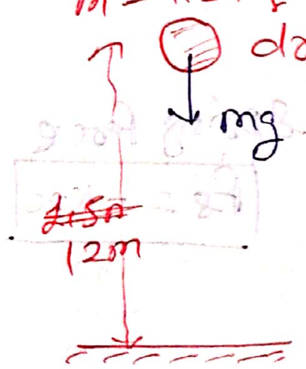
(1) 

A body of mass 1 kg throw vertically upwards, what is the force at highest point due to gravity.

$F = mg$

$= 1 \times 9.8$

$\boxed{F = 9.8\,N} = 1\,kgf$ towards.

(2) 

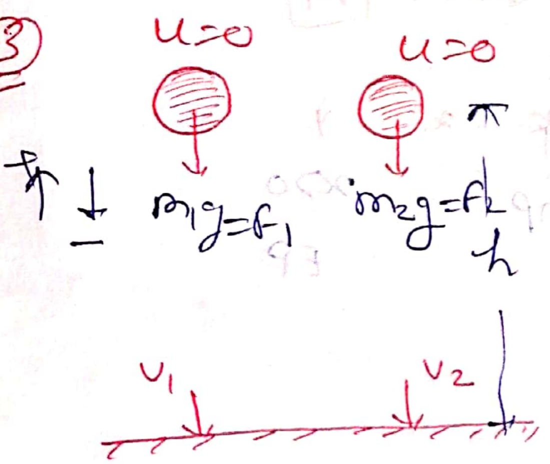
$m = 1.5\,kg$ dropped $u = 0$

what is the force acting on it during its fall.

$F = mg$

$= 1.5 \times 9.8$

$\boxed{F = 14.7\,N}$

(3) 

$m_1 : m_2 = 1 : 2 \Rightarrow$

a) $v_1 : v_2 = ?$ when they strike the ground

b) force ratio during motion.

a) $v = u + at$ (u = 0)

$v_1 = -gt$

$v_2 =$

a) $v^2 = u^2 + 2gh$ (u = 0)

$-v_1^2 = -2gh$

$v_1 = +\sqrt{2gh}$

$$\frac{v_1}{v_2} = \frac{\sqrt{2gh}}{\sqrt{2gh}} = 1:1$$

(3) $\frac{m_1}{m_2} = \frac{1}{2} \Rightarrow m_1 = \frac{m_2}{2}$

or $\boxed{m_2 = 2m_1}$

$$\frac{F_1}{F_2} = \frac{m_1 g}{m_2 g} = \frac{m_1 g}{2m_1 g} = 1:2$$

(4)

P_1: [5 kg] → 20 m/s = v_1

[20 kg] → 5 m/s = v_2, P_2

} compare momentum.

$$\frac{P_1}{P_2} = \frac{20\times5}{20\times5} = 1:1$$

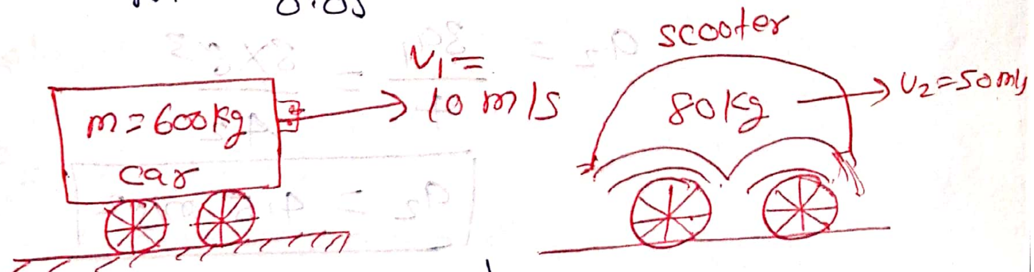
Q5 If mass m = 50 gm, F = 20 N

find a = ?

m = 50 gm = 0.05 kg

$$a = \frac{F}{m} = \frac{20}{0.05} = 400\ m/s^2$$

Q6



a) $P_1 : P_2$

$$\frac{P_1}{P_2} = \frac{600\times10}{80\times50}$$

$\boxed{P_1/P_2 = 3/2}$

b) which vehicle requi~~r~~ more force to stop

1) same interval (ii) same dist.

i) $P_1 = mv$

$= 600\times10 = 6000$

$P_2 = 80\times50 = 4000$

$\boxed{P_1 > P_2}$ car required more force.

ii) $\boxed{v_1 < v_2}$

So scooter required more force.

(7)

$$\boxed{10\ kg} \rightarrow 2\ kgf = F \qquad a = ?$$

$$F = 2 \times 9.8\ N$$

$$F = 19.6\ N$$

$$a = \frac{F}{m} = \frac{19.6}{10} = 1.96\ ms^{-2}$$

(8) $m_1 : m_2 = 3 : 4$

$\rightarrow a_1 = 6\ m/s \qquad \rightarrow a_2 = ?$

$\boxed{m_1} \rightarrow F_1 \qquad \boxed{m_2} \rightarrow F_2$

If $F_1 = F_2$ Then find $a_2 = ?$

Sol^n

$$\frac{m_1}{m_2} = \frac{3}{4} \Rightarrow \boxed{m_1 = \frac{3m_2}{4}}$$

$$\because a = \frac{F}{m}$$

$$\therefore \frac{a_1}{a_2} = \frac{F_1/m_1}{F_2/m_2} = \frac{F/3m_2/4}{F/m_2}$$

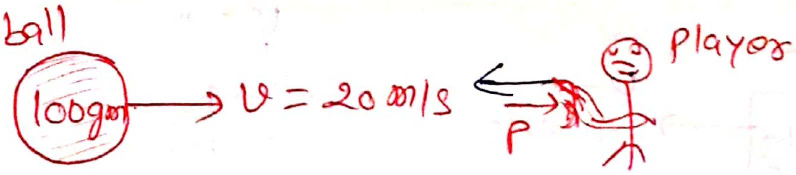
$$= \frac{4F}{3m_2} \times \frac{m_2}{F}$$

$$\frac{a_1}{a_2} = \frac{4}{3}$$

$$a_2 = \frac{3a_1}{4} = \frac{3 \times 6}{4}$$

$$\boxed{a_2 = 4.5\ m/s^2}$$

(9)



$\Delta t = 0.01$ sec.

i) ball strikes player hand and comes rest in 0.01 sec
find force applied by the ball on player hand

ii) $a_{ball} = ?$

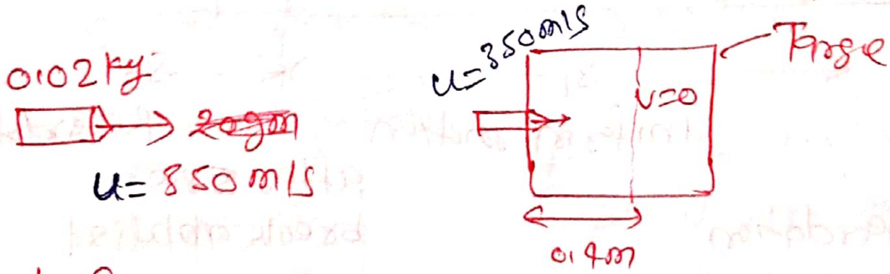
(i) $$F = \frac{\Delta P}{\Delta t} = \frac{mv}{\Delta t} = \frac{-0.1 \times 20}{0.01}$$

$$= -2 \times 10^{+2}$$

$$\boxed{F = -200 N}$$

(ii) $$a = \frac{F}{m} = \frac{-200}{0.1} = -2000\ m/s^2$$

(10)



i) Find force = ?

ii) Retardation?

$$v^2 = u^2 + 2as \quad (v \to 0)$$

$$0 = (850)^2 + 2a \times 0.4$$

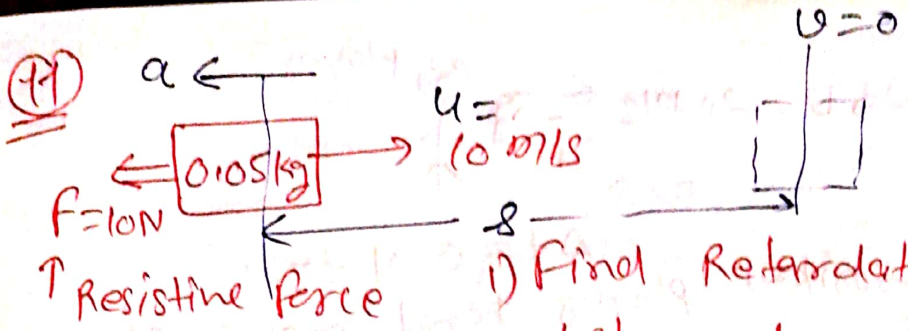
$$a = -\frac{850 \times 850}{2 \times 4 \times 10^{-1}} = -1.53 \times 10^5\ m/s^2$$

ii) Force applied by the bullete $F = ma$

$$F = 0.02 \times 1.53 \times 10^5$$

$$\boxed{F = 3062.5 N}$$

(11)



i) Find Retardation?

ii) distance travelled by the body?

$F = -ma$

$10 = -0.05 \times a$

$a = \frac{-10^2}{5 \times 10^{-2}}$

$\boxed{a = -200\ m/s^2}$

$v^2 = u^2 + 2as$ ($v \to 0$)

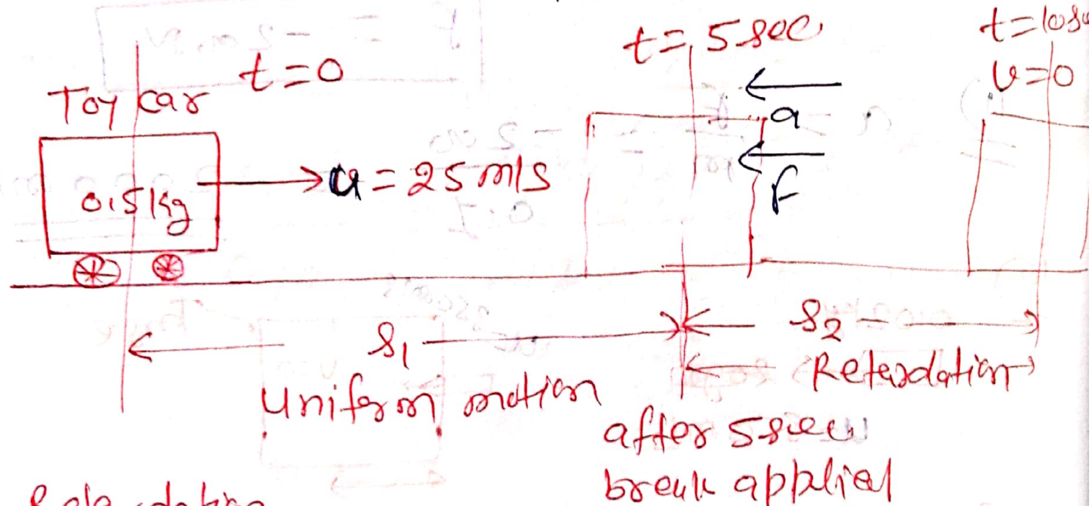
$0 = 10^2 - 2 \times 200 \times s$

$100 = 2 \times 200 \times s$

$s = 0.25\ m$

$\boxed{s = 25\ cm}$

(12)



a) Retardation

b) $s_2 = ?$ (distance after brakes)

c) Force exerted by the brakes?

(a) $v = u + at$ ($v \to 0$)

$0 = 25 + a \times 10$

$\boxed{a = -2.5\ ms^{-2}}$

(b) $v^2 = u^2 + 2as$ ($v \to 0$)

$0 = (25)^2 - 2 \times 2.5 \times s_2$

$-625 = -5 s_2$

$\boxed{s_2 = 125\ m}$

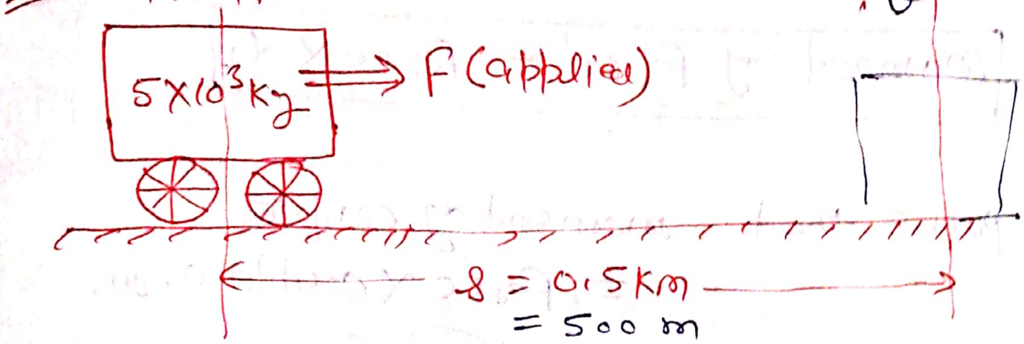
(c) $F = ma$

$F = 0.5 \times (-2.5)$

$\boxed{F = -1.25\ N}$

(13) Rest

Truck $u = 0$ $t = 10\,sec$



A force f is applied and truck travel 0.5 km in 10 sec

find $a = ?$ & $f = ?$

Soln $s = \cancel{ut}^{\,0} + \frac{1}{2}at^2$

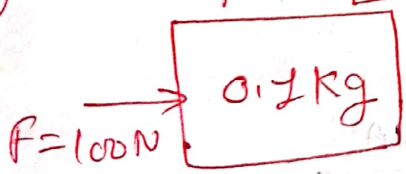
$0.5\times10^3 = \frac{1}{2}\,a \times 100$ (50)

$a = \frac{5\times10^{-1}}{500\ (100)} \Rightarrow \boxed{a = 10\ ms^{-2}}$

(b) $F = ma$

$= 5\times10^3 \times 10 = 5\times10^4\ N$

(14) Rest $\boxed{u=0}$



for. 0.1

A force 100 N is applied on the body for 0.1 sec.

a) $P = ?$

b) distance travelled in 0.1 sec. Take $g = 10\,m/s^2$

i) $F = \frac{\Delta P}{\Delta t}$

$\Delta P = F\,\Delta t$

$= 100 \times 0.1$

$\boxed{\Delta P = 10\ N\text{-}s}$

ii) $F = ma$

$a = \frac{100}{0.1} = 1000\ m/s^2$

$s = \cancel{ut}^{\,0} + \frac{1}{2}at^2$

$= 0 + \frac{1}{2}\times1000\times(10^{-1})^2$

$\boxed{s = 5\,m}$ Ans.

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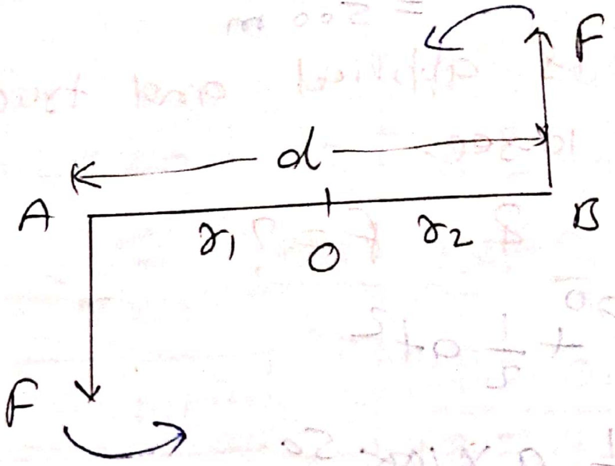
Exercise 1(B)

(1) moment of force = force × $d_{\perp}$

(2) prove that moment of couple = force × couple arm.



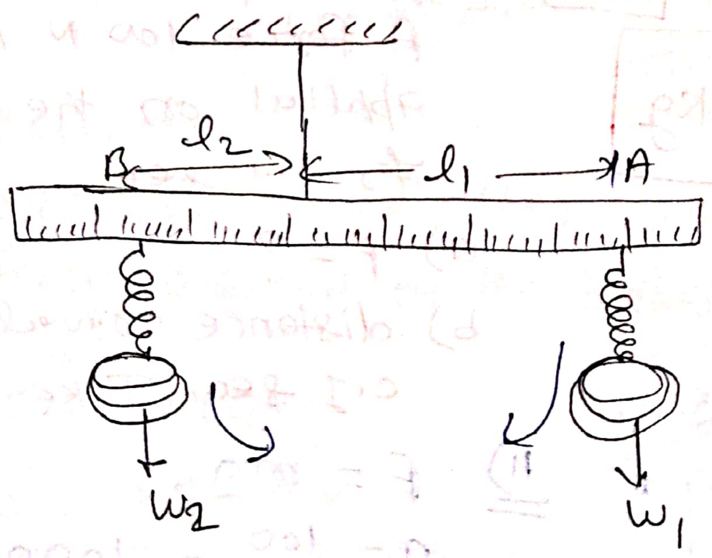
moment of couple (τ) $= F \times r_1 + F \times r_2$

$= F(r_1 + r_2)$

$= Fd$

(Fd: F = force, d = couple arm)

(3)

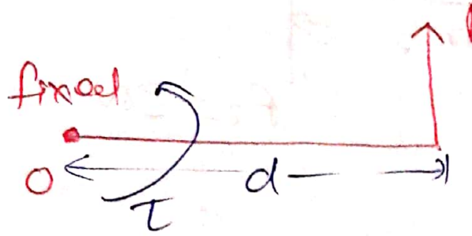


For equilibrium,

$w_1 l_1 = w_2 l_2$ principle of moments.

Numerikals 12

①

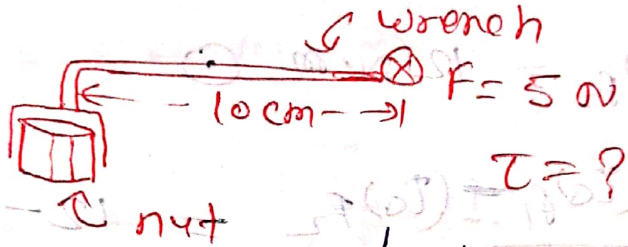


$$\tau = F \cdot d$$

$$5 = F \cdot d$$

$$d = \frac{5}{10_2} = 0.5\,m$$

Q2



$\tau = ?$

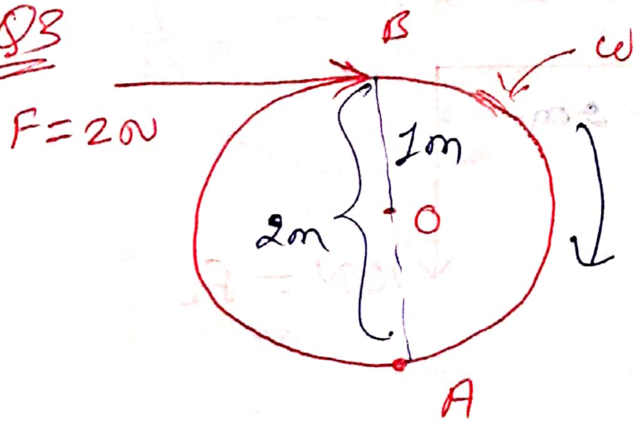
$d = 10\,cm = 0.1\,m$

$$\tau = F \cdot d$$

$$= 5 \times 0.1$$

$$\boxed{\tau = 0.5\,Nm}$$

Q3



moment of force.

$\tau_0 = ?$

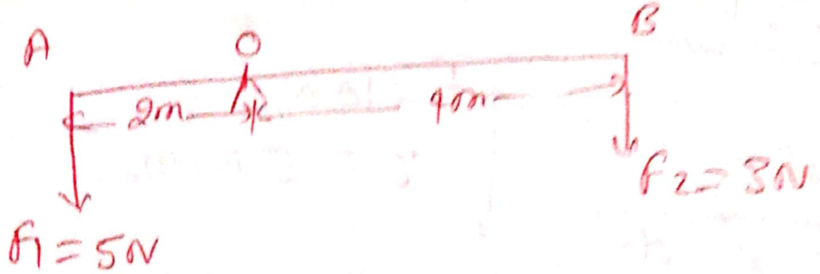
$\tau_A = ?$

$$\tau_0 = 2 \times 1 = 2\,N\text{-}m$$

$$\tau_A = F \times AB = 2 \times 2$$

$$\boxed{\tau_A = 4\,N\text{-}m}$$

Q.4



a) moment of force F_1 about O

b) — — F_2 — —

c) Total moment = ?

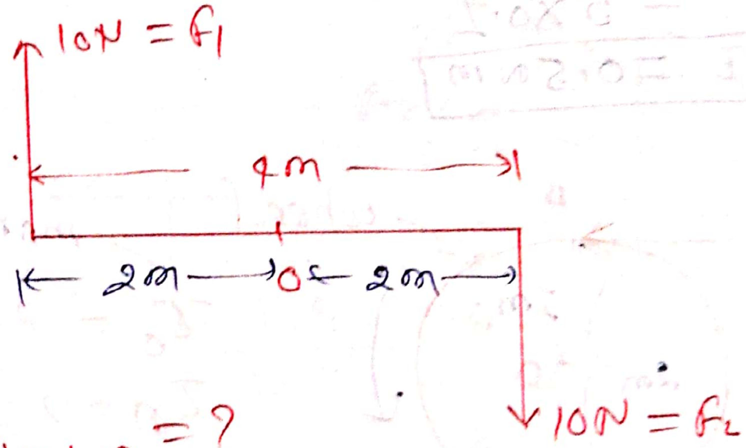
F1 $(\tau_O)_{F_1} = 10$ N-m ⊗

F2 $(\tau_O)_{F_2} = 12$ N·m ⊙

$\tau = (\tau_O)_{F_1} + (\tau_O)_{F_2} = 12 - 10$

~~$\tau = 22$ N-m~~ $= 2$ N-m ⊙

Q5



$(\tau_{net})_{about\ O} = ?$

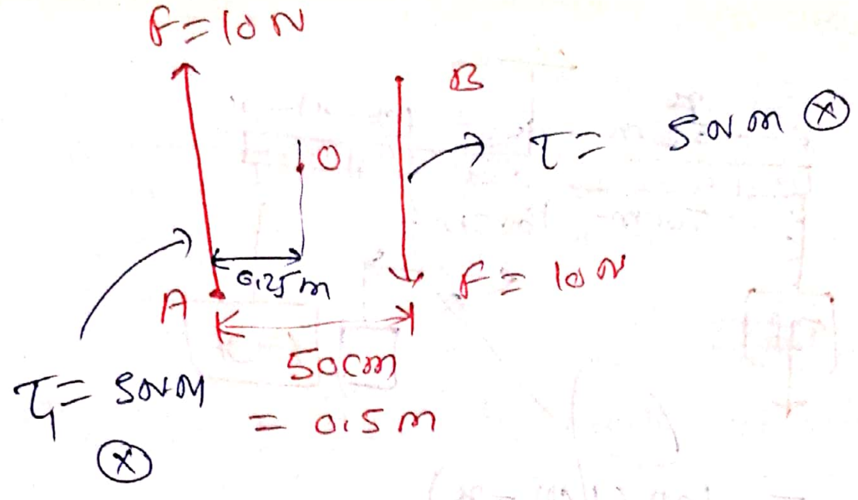
$(\tau_O)_{F_1} = 10 \times 2 = 20$ N-m ⊗

$(\tau_O)_{F_2} = 20$ NM ⊗

$\tau_{net} = 20 + 20$

$= 40$ NM ⊗

Q6

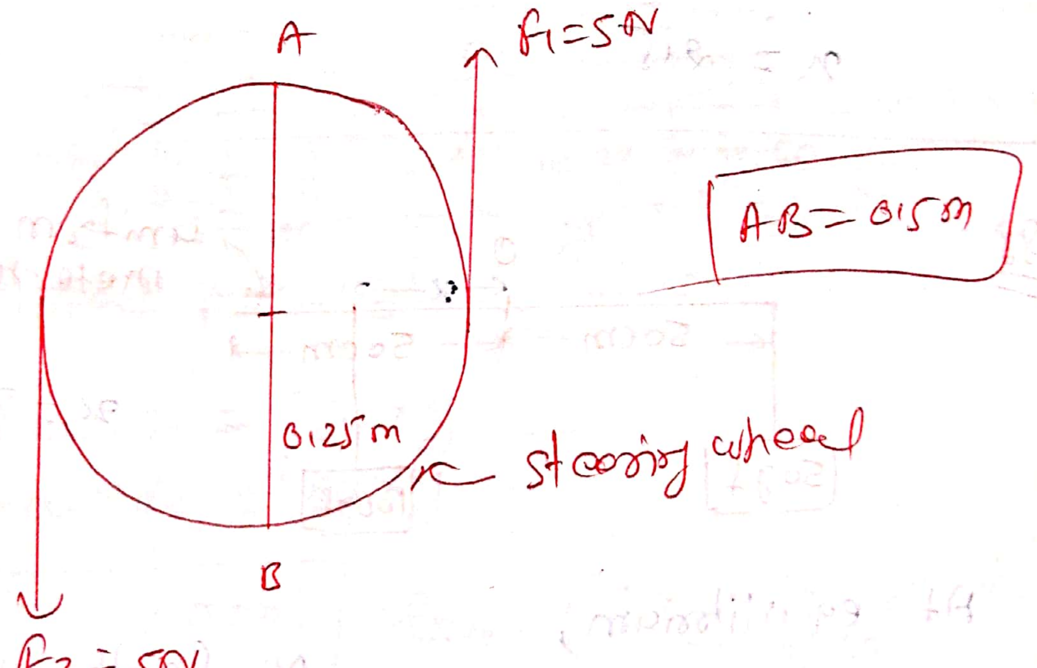


$$(\tau_{net})_O = 10 \times 0.25 + 10 \times 0.25$$
(⊗) (⊗)

$$= 2.5 + 2.5$$

$$= 5\ N\text{-}m \ \otimes$$

Q7



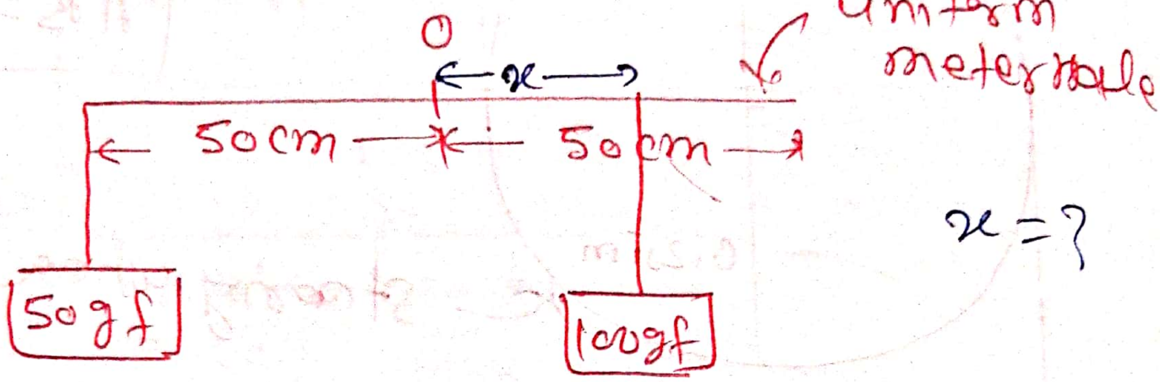
moment of couple = either. force × couple arm

" ?

$$= 5 \times 0.5$$

$$= 2.5\ Nm$$

Q8



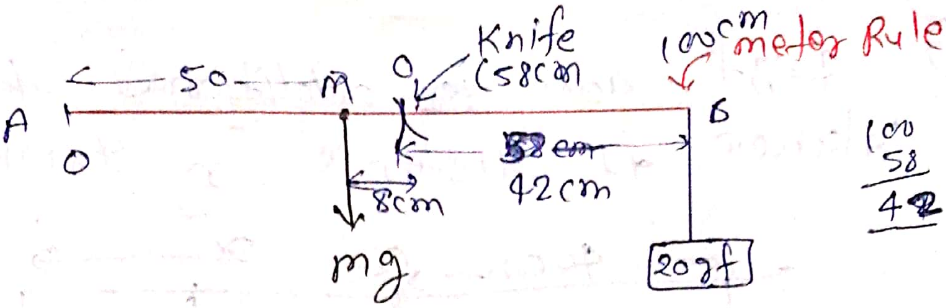
At equilibrium,

$50 \times 50 = 100 \times x$

$x = 25 \text{ cm}$

N: length of meter rule = 100 cm

Q9



mg of meter scale work at its mid point.

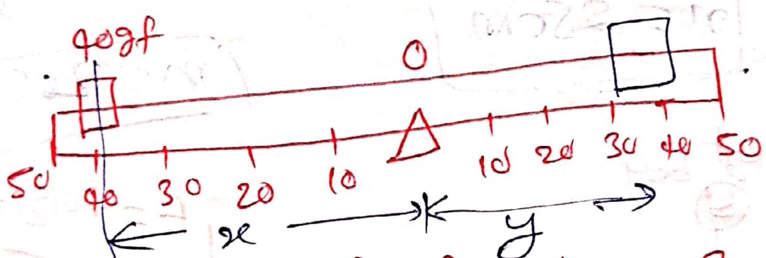
$mg \times 8 = 20 \times 42$

$mg = W$

$W = \frac{\overset{5}{\cancel{20}} \times \cancel{42}^{21}}{\cancel{8}\,4}$

$\boxed{W = 105\ gf}$

Q10



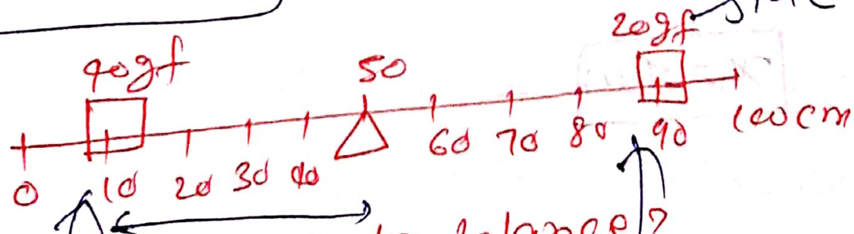
where put 80gf for balance?

$40 \times x = 80 \times y$

$20\ \cancel{40} \times \cancel{40} = \overset{2}{\cancel{80}} \times y$

$\boxed{y = 20cm}$ from poin o to right side

Q11



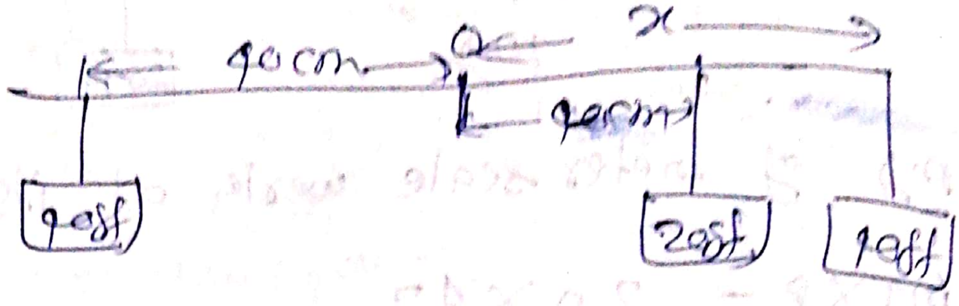
Is meter scale balance?

$\tau_1 = 40 \times 40$
$= 1600\ Nm$

$\tau_2 = 40 \times 20$
$= 800\ N$

$\boxed{\tau_1 \neq \tau_2}$

(11) 40gf add for additional for balance, at distance x from fulcrum.



$40 \times 40 = 20 \times 40 + 40 \times x$

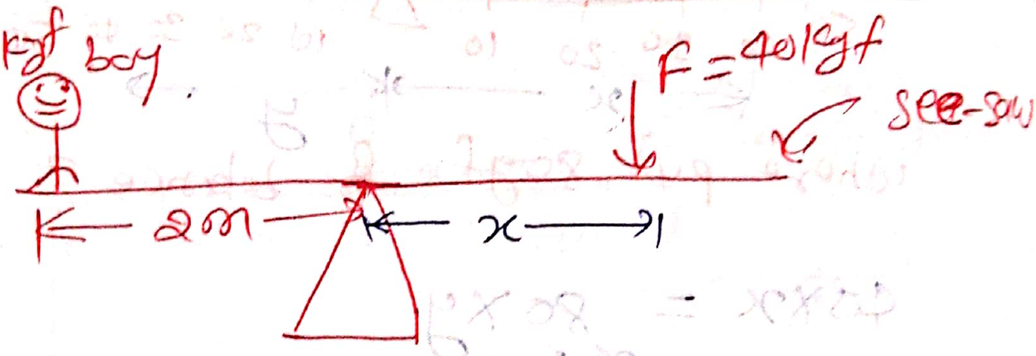
$1600 = 800 + 40x$

~~$40x = 1600$~~ , ~~$x = 25\,cm$~~

$x = \frac{800}{40}$

$x = 20\,cm$

Q12

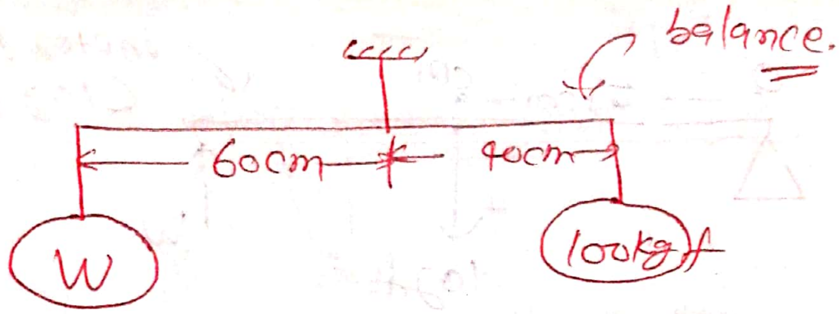


for balancing condition,

$20 \times 2 = x \times 40$

$x = 1\,m$

Q13

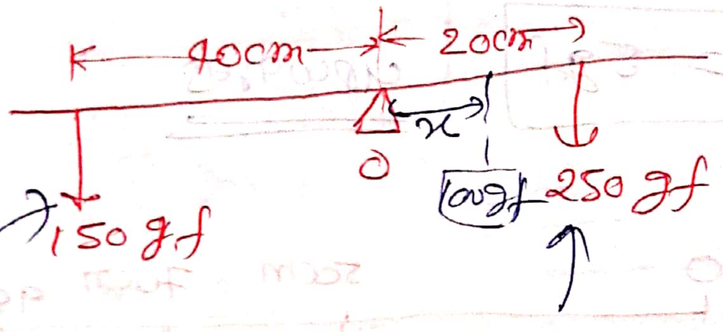


$$W \times 60 = 40 \times 100$$

$$W = \frac{400}{6} \; 200 / 3$$

$$\boxed{W = 66.66 \text{ kgf}}$$

Q14



⊗ clock

⊙ anti

$\tau_1 = 150 \times 40$ $\quad$ $\tau_2 = 250 \times 20$

$\tau_1 = 6000$ Nm $\quad$ $\tau_2 = 5000$ Nm

⊙ anti $\quad$ ⊗ clockwise

$$\tau_1 - \tau_2 = 6000 - 5000 = 1000$$ ⊙ Anticlockwise

* Let 100gf placed at distance x,

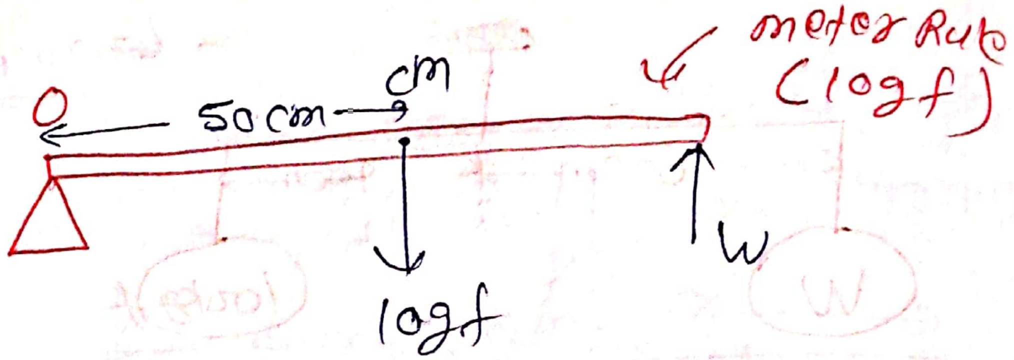
Then $150 \times 40 = 100 \times x + 250 \times 20$

$$60 = x + 50$$

$$x = 60 - 50$$

$$\boxed{x = 10 \text{ cm}}$$

Q15



$\tau = 10 \times 50$

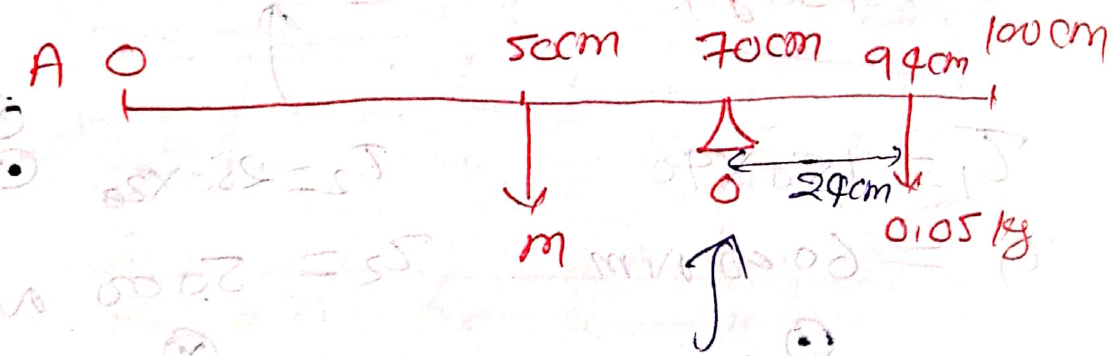
$\tau = 500\,gf\,cm$

for equilibrium,

$10 \times 50 = W \times 100$

$W = 5gf$ upwards

Q16



∴ by equilibrium condition,

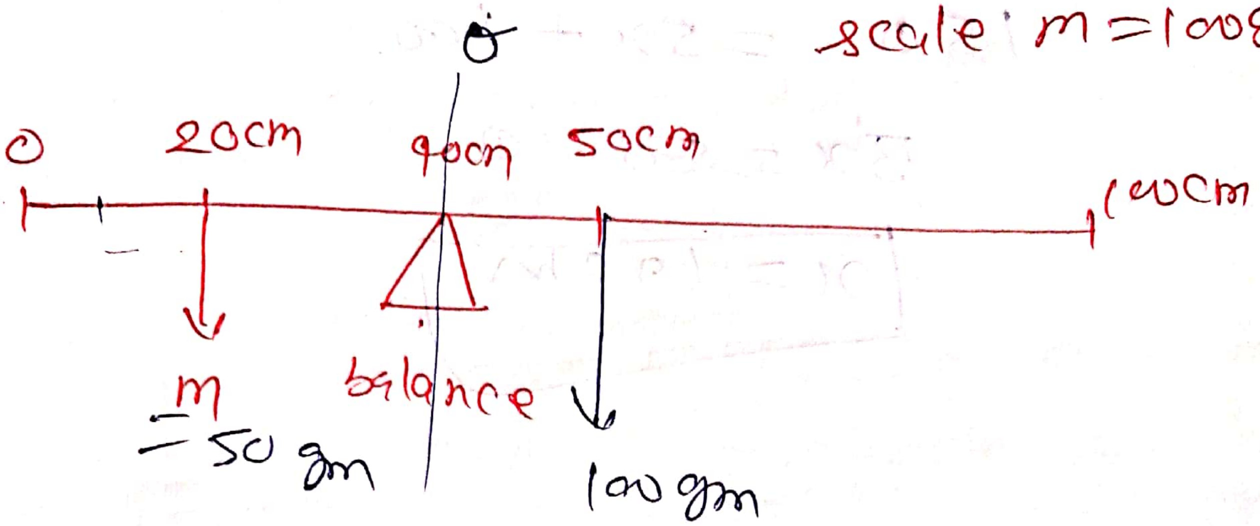
$m \times 20 = 0.05 \times 24$

$m = \frac{0.05 \times 24}{20}$

$m = 0.06\,kg$

Q17

scale : m = 100gm



moment about O,

$m \times 20 = 100 \times 10$

$m = 50gm$

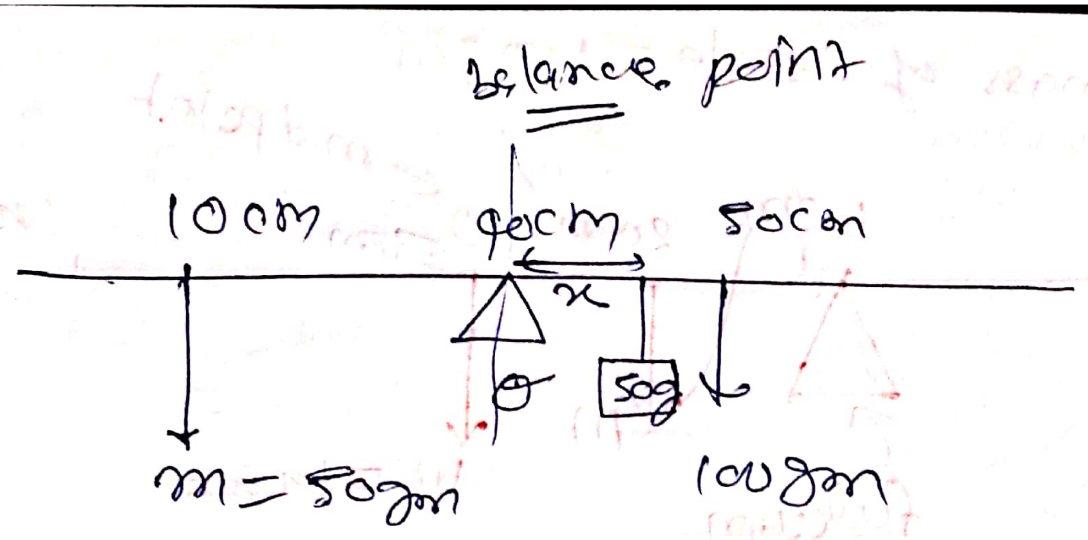
* when m moved to 10cm mark.

$\tau_{net} = 100 \times 10 + 50 \times 30$

$\otimes \qquad \odot$

$= -1000 + ~~1000~~ 1500$

$\tau_{net} = 500 \, gcm$



$$50 \times 30 = 50 \times x + 100 \times 10$$

$$150 = 5x + 100$$

$$5x = 50 \quad 10$$

$$\boxed{x = 10\,cm}$$