The University of Jordan
Physics Department
solutions to Chapter 9
Giancoli 7th edition
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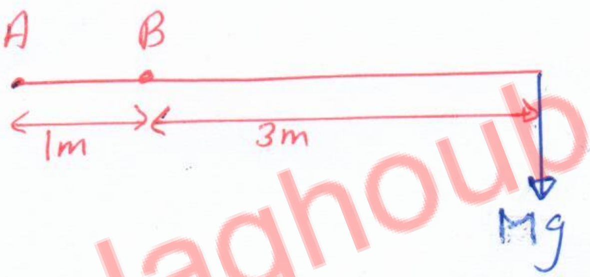
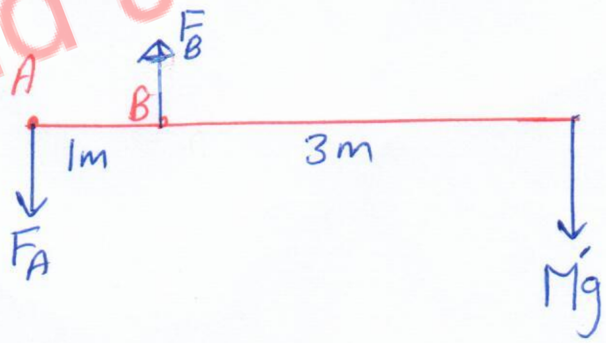
Q4] $\overset{+\circlearrowleft}{(A)}$ $\tau = -(Mg)(4) = -1800$

$\therefore M = \dfrac{1800}{4g} \approx 45.9 \text{ kg}$



Q5]

(a) ignore mass of beam.



$\overset{+\circlearrowleft}{(A)}$ $F_B(1) - Mg(4) = 0$

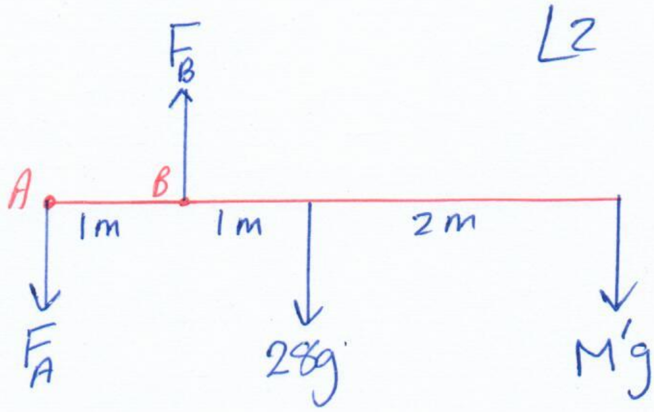
$F_B = 4Mg = 4(52)(9.8)$
$= 2038.4 \text{ N}.$

$+\uparrow$ $F_B - F_A - Mg = 0 \Rightarrow F_A = F_B - Mg$

$F_A = 1528.8 \text{ N}.$

Alternatively take torque about point B.

(b) Mass of the board $= 28 \text{ kg}$, which acts at the center of the board.



$+\circlearrowleft B$

$$\tau = F_A(1) - 28g(1) - M'g(3) = 0$$

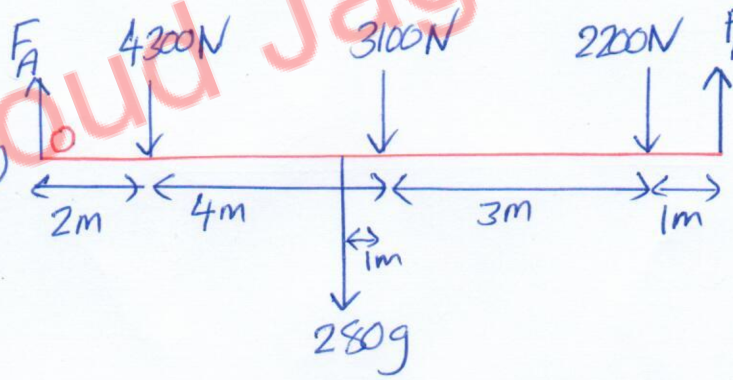
$$F_A = 28g + 52g(3) = 1803\,N$$

$+\circlearrowleft A$ $\quad F_B(1) - 28g(2) - M'g(4) = 0$

$$F_B = 2587.2\ N$$

Alternatively use $\Sigma F_y = 0$

Q16] $\Sigma F_y = 0$



$$F_A + F_B - 4300 - 3100 - 2200 - 280g = 0$$

$$F_A + F_B - 9600 - 280g = 0$$

$+\circlearrowleft O$ $\quad F_B(10) - 2200(9) - 3100(6) - 280g(5) - 4300(2) = 0$

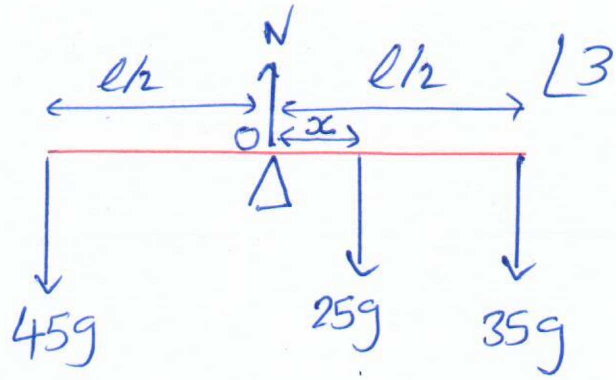
$$\therefore F_B \approx 6072\ N$$

$$\Rightarrow F_A = 6272\ N.$$

Q17]

+↺ O

$$45g\left(\frac{l}{2}\right)-25g(x)-35g(l/2)=0$$



ignore mass of board.

$$25x = 10l$$

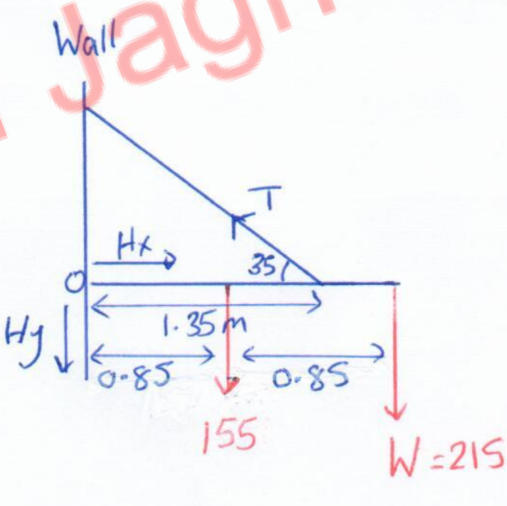
$$x = \frac{5}{25}l = \frac{1}{5}l$$

$$x = \frac{1}{5}(3.2) = 0.64\ m$$

to the right of the pivot, closer to the lighter mass.

Q18] static equilibrium ⇒

$$\sum \vec{\tau} = 0 \quad \text{and} \quad \sum \vec{F} = 0$$



+↺ O

$$(T\sin 35)(1.35) - 155(0.85) - 215(1.7) = 0$$

$$T = 642\ N.$$

<u>Guess</u> the directions of H_x and H_y.

$$\sum F_x = 0 \Rightarrow H_x - T\cos 35 = 0$$

$$\therefore H_x \sim 526\ N.$$

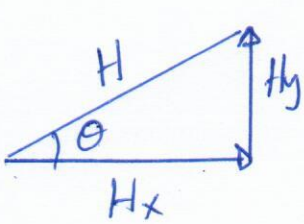
$$\sum F_y = 0 \Rightarrow T\sin 35 - 155 - 215 - H_y = 0$$

$$\therefore H_y = -1.8$$ (minus sign means H_y acts upwards NOT downwards but magnitude is correct)

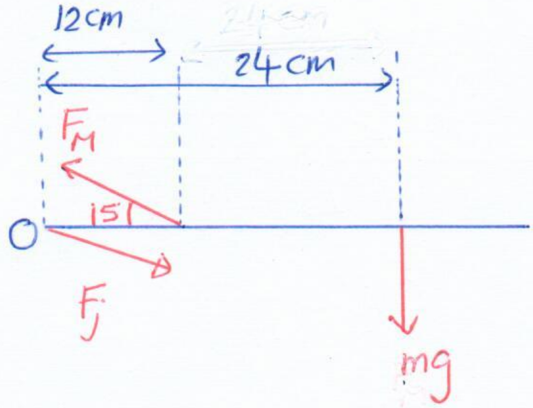
$$H = \sqrt{H_x^2 + H_y^2} \simeq 526\ N$$

$$\tan\theta = \left|\frac{H_y}{H_x}\right| \Rightarrow \theta \sim 0.19^\circ$$

i.e H lies in first quadrant



32] $m = 3.3\,kg$



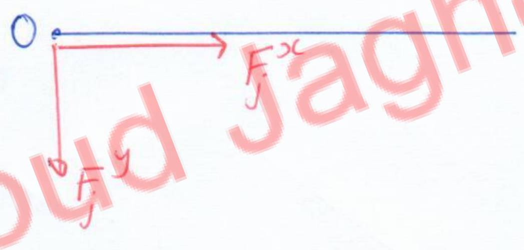
static equilibrium $\Rightarrow$

$\sum \vec{\tau} = 0$ and $\sum \vec{F} = 0$

$+\circlearrowleft$ $(F_M \sin 15)(0.12) - mg(0.24) = 0$

$\therefore F_M \approx 250\ N$.

Resolve F_j into horizontal F_j^x and vertical F_j^y components



$\sum F_x = 0 \Rightarrow$

$\xrightarrow{+}$ $F_j^x - F_M \cos 15 = 0$

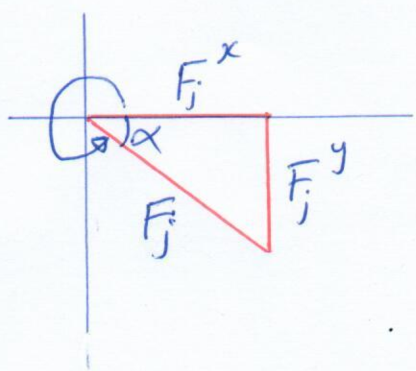
$F_j^x = 241.5\ N$

$\sum F_y = 0 \Rightarrow \overset{+}{\uparrow}$ $F_M \sin 15 - F_j^y - mg = 0$

$\therefore F_j^y = 32.4\ N$.

$F_j = \sqrt{(F_j^x)^2 + (F_j^y)^2} \simeq 243.7\ N$.

$\tan\alpha = \left| \frac{F_j^y}{F_j^x} \right| \Rightarrow \alpha \sim 7.6^\circ$



$\theta = 360 - \alpha = 352.4^\circ$.

Q38] $A = 1.4\ m^2$, $m = 25000\ kg$

$$\text{stress} = \frac{F}{A} = \frac{mg}{A} = 175{,}000\ N/m^2$$

$$\text{strain} = \frac{\text{stress}}{E} = \frac{175{,}000}{50\times10^9} = 3.5\times10^{-6}$$

E ← Young's modulus

$$\text{strain} = \frac{\Delta l}{l_0}$$ has NO units.

Q39] $l_0 = 8.6\ m$

$$\text{strain} = \frac{\Delta l}{l_0} = 3.5\times10^{-6} \Rightarrow \Delta l = 3.01\times10^{-5}\ m$$

∴ Column of marble shortens by $3.01\times10^{-5}\ m$

$= 3.01\times10^{-3}\ mm$

$\approx 0.003\ mm$

Q43] $l_0 = 15\ cm = 0.15\ m$, $\Delta l = 3.7\ mm = 3.7\times10^{-3}\ m$

$F = 13.4\ N$, $D = 8.5\ mm = 8.5\times10^{-3}\ m \Rightarrow r = \frac{D}{2} = 4.25\times10^{-3}\ m$

Young's modulus $E = \frac{\text{stress}}{\text{strain}}$

$$\therefore E = \frac{(13.4/\pi r^2)}{(\Delta l/l_0)} \approx 9.6\times10^6\ N/m^2$$

Q46] minimum cross sectional area $A = 3\ cm^2 = 3\times10^{-4}\ m^2$.

compressive strength $= F/A$

$$stress = \frac{F_{max}}{A} \Rightarrow F_{max} = A \times stress$$

$$F_{max} = (3\times10^{-4}) \times (\underbrace{170\times10^{6}}_{\text{from tables}}) = 51000\ N$$

Q50] $$\text{shear strength} = \frac{F}{A}$$

a safety factor of 7 $\Rightarrow$

shear strength $\longrightarrow \dfrac{\text{shear strength}}{7}$ for safety reasons to avoid damge

$$\therefore \frac{\text{shear strength}}{7} = \frac{F}{A} \Rightarrow A = 7\left(\frac{F}{\text{shear strength}}\right)$$

$$\therefore A = \underset{\substack{\uparrow \\ \text{safety factor}}}{7}\left(\frac{3300}{170\times10^{6}}\right) \simeq 7(19.4\times10^{-6})\ m^2$$

$$\simeq 1.36\times10^{-4}\ m^2$$

100%

Note: safety factor of 7 increased the area by a factor of 7 so that the iron bolt can withstand the force easily.

$$A = \pi r^2 = \pi \left(\frac{D}{2}\right)^2$$

$$\therefore \quad D = \sqrt{\frac{4}{\pi} A} \sim 0.013 \text{ m}$$

$$\therefore \quad D \sim 1.3 \text{ cm} .$$