PHYSICS 534

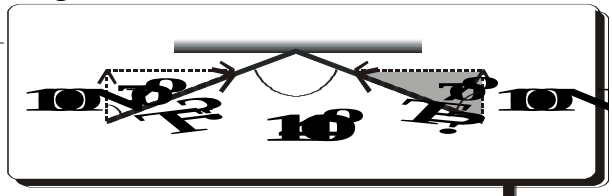
ANSWERS

EXERCISE-21 **Equilibrium Review Part-1/ 2**

PLANCK

Max Planck was awarded the Nobel prize for physics in 1918 for his work on energy quanta.

1. A 20 kg picture frame hangs on a wall by means of a cord tied to a hook. The cord makes an angle of 140 degrees. Find the tension in the cord. [292 N]



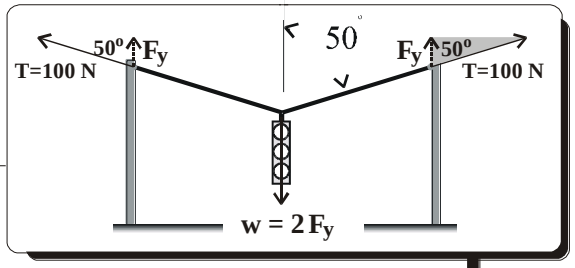
Since $F_R = 0$ $\Sigma F_X = 0$ and $\Sigma F_Y = 0$

The total forces up = the weight (down)

With reference to the shaded triangle:

$$\text{Cos } 70^o = \frac{100\text{ N}}{T} \quad \therefore\ T = \frac{100\text{ N}}{\text{Cos } 70^o} = \frac{100\text{ N}}{0.3420} = 292.3 = 292\text{ N}$$

2. A traffic light is held by 2 wires each making an angle of 50 degrees with the vertical. The wires exert a tension of 100 N. Find the mass of the traffic light. [13 kg]



With reference to the shaded triangle:

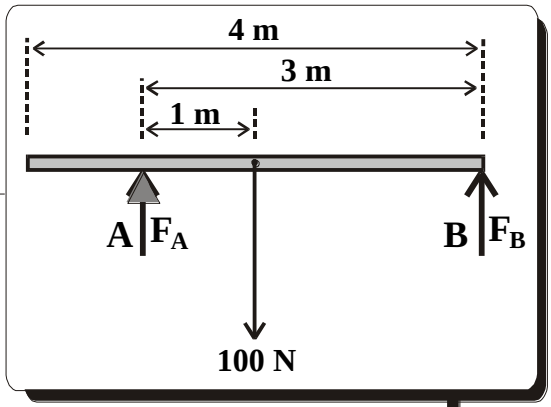
$$F_Y = (100\text{ N})(\text{Cos } 50^o)$$

$$= (100\text{ N})(0.6427) = 64.3\text{ N}$$

$$\therefore\ w = 2F_Y = 2(64.3\text{ N}) = 129\text{ N}$$

$$\text{But: } w = mg \quad \therefore\ m = \frac{w}{g} = \frac{129\text{ N}}{10\text{ m/s}^2} = 12.9 = 13\text{ kg}$$

3. Two men, A and B, carry a ***uniform*** plank 4 m long weighing 100 N between their shoulders. Calculate how much of the plank's weight each man carries if the plank extends 1 meter from man-A [66.7 N] [33.3 N]



Taking moments from point A:

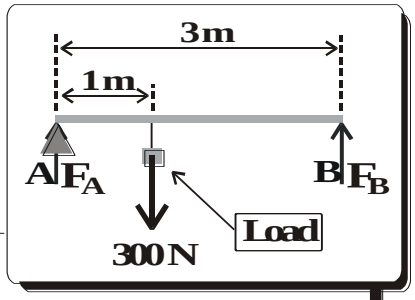
$$\Sigma \text{ cwm} = \Sigma \text{ ccwm}$$

$$(100\text{ N})(1\text{ m}) = (F_B)(3\text{ m})$$

$$\therefore\ F_B = \frac{(100\text{ N})(1\text{ m})}{3\text{ m}} = 33.3\text{ N}$$

$$F_A = 100\text{ N} - 33.3\text{ N} = 66.67 = 66.7\text{ N}$$

4. Two men, A and B, are carrying a 300 N load on a ***uniform*** plank of wood between their shoulders. If the plank is 3 m long and the load is one meter from man-A, how much of the load does each man carry? [200 N] [100 N]



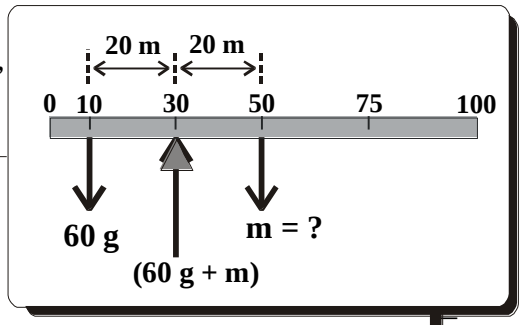
Taking moments about point A :

Σ cwm $= \Sigma$ ccwm

$(300\text{ N})(1\text{ m}) = (F_B)(3\text{ m})$

$$\mathbf{F_B = \frac{(300\text{ N})(1\text{ m})}{(3\text{ m})} = 100\text{ N}} \qquad \textbf{and} \quad \mathbf{F_A = 300\text{ N} - 100\text{ N} = 200\text{ N}}$$

5. A ***uniform*** meter stick balances at its mid-point. When a 60 g mass is suspended at the 10 cm mark, the system balances at the 30 cm mark. Find the mass of the meter stick (in grams). [60 g]



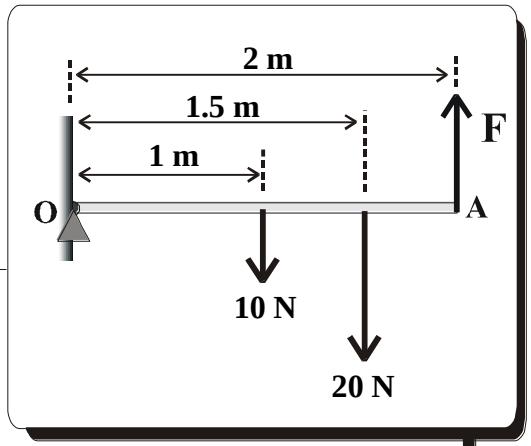
Taking moments from the 30 cm point and treating the grams as forces.

$\because$ Σ cwm $= \Sigma$ ccwm

$\therefore$ $(m)(20\text{ cm}) = (60\text{ g})(20\text{ cm})$

$$m = \frac{(60\text{ g})(20\text{ cm})}{20\text{ cm}} = 60\text{ g}$$

6. OA is a ***uniform*** bar 2 m long weighing 10 N which is hinged at O. A 20 N weight is suspended 1.5 m from end O. Find the value of force F required at end-A to keep the bar horizontal. [20 N]



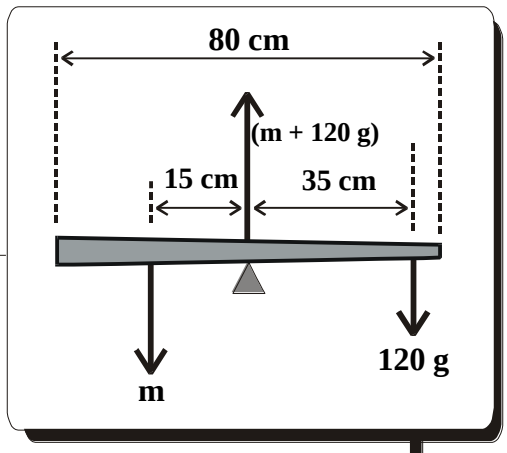
Taking moments about point O :

Σ cwm $= \Sigma$ ccwm

$(10\text{ N})(1\text{ m}) + (20\text{ N})(1.5\text{ m}) = (F)(2\text{ m})$

$$F = \frac{(10\text{ N})(1\text{ m}) + (20\text{ N})(1.5\text{ m})}{(2\text{ m})} = \frac{40\text{ N}\cdot\text{m}}{2\text{ m}} = 20\text{ N}$$

7. A ***tapered*** stick is 80 cm long. It balances at a point 25 cm from the thicker end. When a 120 g mass is suspended 5 cm from the thinner end, the stick balances at its midpoint. Find the mass of the stick. [280 g]



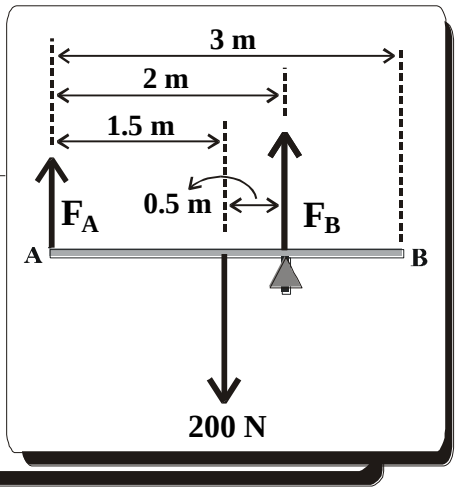
Taking moments at the middle and treating the grams as forces we have :

$\because$ Σ cwm = Σ ccwm

$\therefore$ (120 g)(35 cm) = (m)(15 cm)

$$m = \frac{(120\text{ g})(35\text{ cm})}{15\text{ cm}} = 280\text{ g}$$

8. A ***uniform*** wooden plank, AB, 3 m long and 200 N in weight, is supported at a point 1.0 m from end B. What force must be applied at end A in order to keep the plank in equilibrium horizontally? [50 N]



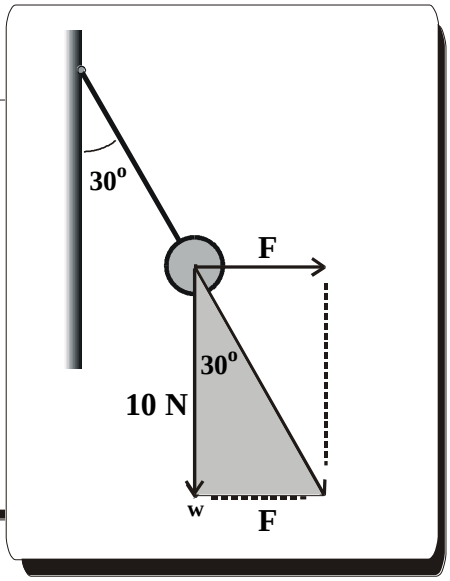
Taking moments at its support

$\because$ Σ cwm = Σ ccwm

$\therefore$ $(F_A)(2\text{ m}) = (200\text{N})(0.5\text{ m})$

$$F_A = \frac{(200\text{ N})(0.5\text{ m})}{2\text{ m}} = 50\text{ N}$$

9. A mass of 1.0 kg is suspended by a thread 1 m long. Find the horizontal force F required to hold it 30^o away from the vertical. [5.8 N]



With reference to the shaded triangle :

$$\text{Tan } 30^o = \frac{F}{10\text{ N}}$$

$\therefore$ $F = (\text{Tan } 30^o)(10\text{ N})$

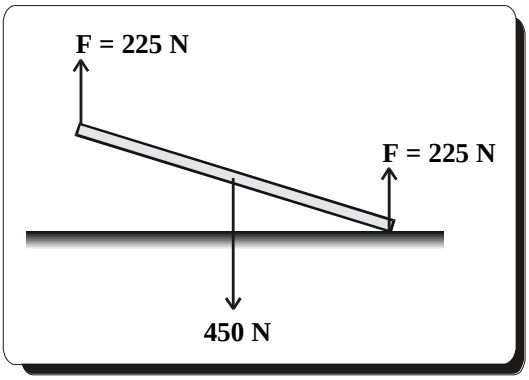
$= (0.5773)(10\text{ N}) = 5.77 = 5.8\text{ N}$

10. A man lifts one end of a uniform 45 kg slab of cement and holds it motionless. What weight does the man hold?

Since $F_R = 0 \quad \therefore \Sigma F_Y = 0$

Thus, the man holds half the weight.

Or $F = \dfrac{450\ \text{N}}{2} = 225\ \text{N}$



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