$\Sigma\tau_{cw} = \Sigma\tau_{ccw}$

PRACTICE EXERCISES

← on pink sheets, like this only

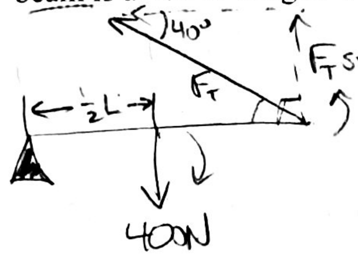
Formulas: $\tau = rF\sin\theta$ $\Sigma\tau = 0$ $\tau = F_{\perp}d$

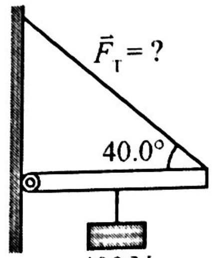
1. If the torque needed to loosen a lug nut holding the wheel of a car is 45 N·m and you are using a wheel wrench that is 35 cm long (0.35 m), what is the magnitude of the force you exert perpendicular to the end of the wrench?

$\tau = F_{\perp}d$ $F = \frac{\tau}{d} = \frac{45\ \text{N·m}}{0.35\ \text{m}} = 1.3\times10^2\ \text{N}$ ✓

2. A beam of negligible mass is attached to a wall by means of a hinge. Attached to the centre of the beam is a 400 N weight. A rope also helps to support this beam as shown below.

no c.g.





$\Sigma\tau_{cw} = \Sigma\tau_{ccw}$

technically 1 s.g. fig, but...

a) What is the magnitude of the tension in the rope?

$\Sigma\tau_{cw} = \Sigma\tau_{ccw}$

$400(\frac{1}{2}L) = F_T\sin40°(L)$

$F_T = \frac{200}{\sin 40°} = 311.1448 = 3.11\times10^2\ \text{N}$ ✓

b) What are the magnitudes of the vertical and horizontal forces that the wall exerts on the beam?

Vertical

$\Sigma F_{up} = \Sigma F_{down}$

$F_{wall\ up} + 311.14\sin40 = 400$

$F_{wall\ up} = 200\ \text{N}$ ✓

$F_{wall\ up}$ (assuming up) 400 $F_T\cos40$

horizontal

F_{wall} $F_T(\cos 40)$

$\Sigma F_{rgt} = \Sigma F_{lft}$

$F_{wall} = 311.14(\cos 40)$

$= 238\ \text{N}$

3. A 650 N student stands on a 250 N uniform beam that is supported by two supports as shown below.

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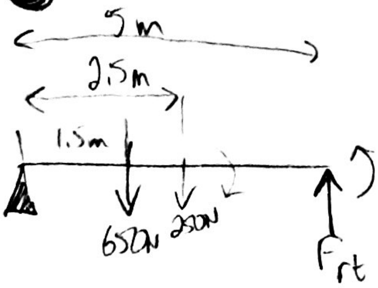
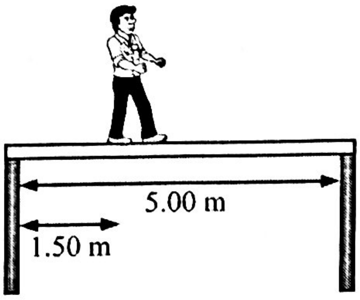




If the supports are 5.00 m apart and the student stands 1.50 m from the left support,

a) what is the magnitude of the force that the right support exerts on the beam? (put fulcrum on left)

$\Sigma\tau_{cw} = \Sigma\tau_{ccw}$

$(650\ \text{N})(1.5\ \text{m}) + (250\ \text{N})(2.5\ \text{m}) = F_{rt}(5\ \text{m})$

$F_{rt} = 320\ \text{N}$ ✓

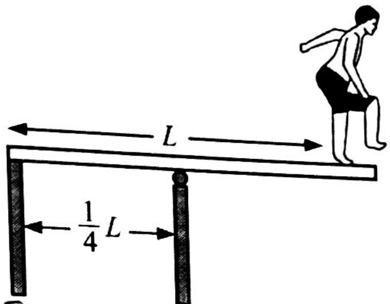
b) what is the magnitude of the force that the left support exerts on the beam? (put fulcrum on right)

$\Sigma \tau_{cw} = \Sigma \tau_{ccw}$

$F_{lf}(5\,m) = (650\,N)(3.5\,m) + (250\,N)(2.5\,m)$

$= 580\,N$ ✓

4. A uniform 400 N diving board is supported at two points as shown below.



If a 75.0 kg diver stands at the end of the board, what are the forces acting on each support?

$\Sigma \tau_{ccw} = \Sigma \tau_{cw}$

$F_{rt}(\frac{1}{4}L) = 400N(\frac{1}{2}L) + (75 \times 9.81)(L)$

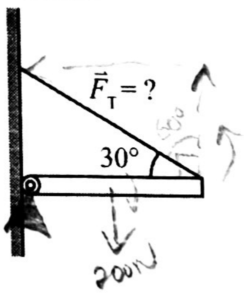
$F_{rt} = 3743 = 3.74 \times 10^3\,N$ [up] ✓

$\Sigma \tau_{ccw} = \Sigma \tau_{cw}$

$F_{lf}(\frac{1}{4}L) = (400N)(\frac{1}{4}L) + (75 \times 9.81)(\frac{3}{4}L)$

$F_{lf} = 2607 = 2.61 \times 10^3\,N$ [down] ✓

5. Find the tension in the rope supporting the 200 N hinged uniform beam shown below.



$\sin 30 = \frac{F_{Ty}}{F_T}$

$F_T \sin 30° = F_{Ty}$

$\Sigma \tau_{cw} = \Sigma \tau_{ccw}$

$200(\frac{1}{2}L) = (F_T \sin 30)(L)$

$F_T = 200\,N$ ✓

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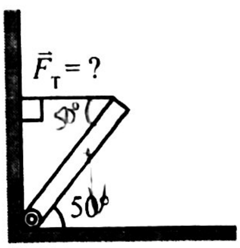
6. Find the tension in the rope supporting the 200 N hinged uniform beam shown below.



$F_T = \frac{100}{\tan 50°}$

$\tan 50 = \frac{100}{F_T}$ opp/adj

$\Sigma \tau_{cw} = \Sigma \tau_{ccw}$

$(200 \cos 50°)(\frac{1}{2}L) = (F_T \sin 50°)(L)$

$F_T = 84\,N$ ✓

49/50

PRACTICE TEST

1. A box with the mass *m* is sliding at a constant velocity down an incline as shown.

if have "μ"

if no "μ"

$F_{net} = 0 = F_{app} - F_{ag}$

$0 = F_{gx} - F_f$

Write an expression for the magnitude of the force of friction on this box.

$F_f = \mu F_N$

$= \mu F_g \cos\theta$

$F_f = \mu mg\cos\theta$ ← key ✓

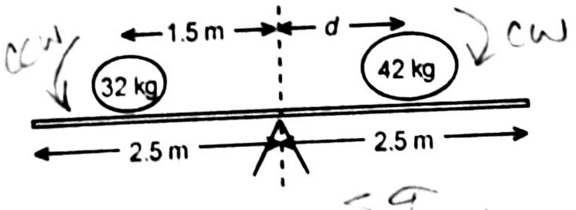
OR

$F_f = F_{gx}$

$= F_g \sin\theta$

$F_f = mg\sin\theta$

2. A 5.0 m long uniform beam with a mass of 8.0 kg is placed on a pivot as shown in the illustration. If a 32 kg mass is placed 1.5 m from the pivot, where should a 42 kg mass be placed on the beam to keep the beam in static equilibrium?



$\Sigma\tau_{ccw} = \Sigma\tau_{cw}$

$Fl = Fl$

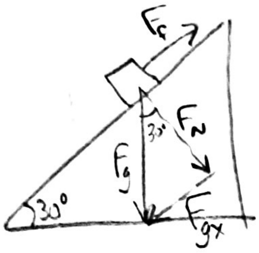
$32(9.81)(1.5) = 42(9.81)d$

$d = 1.1$ m

3. Which properties of a beam are balanced if a wooden beam has no rotational motion?

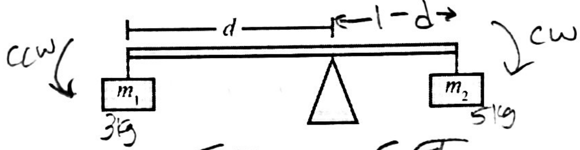
the torques are balanced ✓

4. A 2.55 kg box slides down a 30.0° incline at a constant velocity. What is the force of friction between the block and the incline?



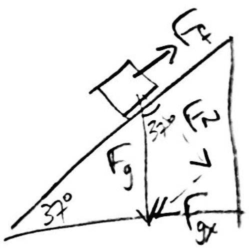
$F_f = F_{gx}$
$= F_g \sin\theta$
$= mg\sin\theta$
$= (2.55)(9.81)(\sin 30°) = \underline{12.5\ N}$

5. Two masses (m_1 = 3.00 kg, m_2 = 5.00 kg) hang from the ends of a metre stick as shown in the diagram. If the mass of the metre stick is negligible, at what distance from the left of the metre stick should a pivot be placed so that the system will be balanced?



$\Sigma\tau_{ccw} = \Sigma\tau_{cw}$
$g(3\,kg)(d) = g(5\,kg)(1-d)$
$3d = 5 - 5d$
$8d = 5$
$d = \frac{5}{8} = \underline{0.625\ m}$ from left end of meter stick ✓

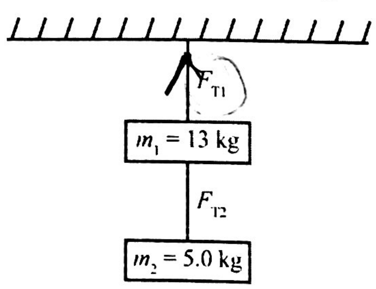
6. A 3.0 kg block slides down a 37° incline at a constant velocity. What is the coefficient of friction between the block and the incline?



$F_{net} = F_{app} - F_{ag}$
$0 = F_{gx} - F_f$
$F_{gx} = F_f$

$F_{gx} = F_f$
$mg\sin\theta = \mu F_N$
$mg\sin\theta = \mu\, mg\cos\theta$
$\mu = \frac{\sin\theta}{\cos\theta} = \frac{\sin 37°}{\cos 37°} = \tan 37°$
$\mu = \underline{0.75}$

7. In the static arrangement shown in the illustration, what is F_{T1}?



$F_{T1} = m_T g$
$= (18\,kg)(9.81\,\frac{N}{kg})$
$= \underline{1.8 \times 10^2\ N}$ ✓

