Name: Key

Equilibrium Provincial Exam Review Questions

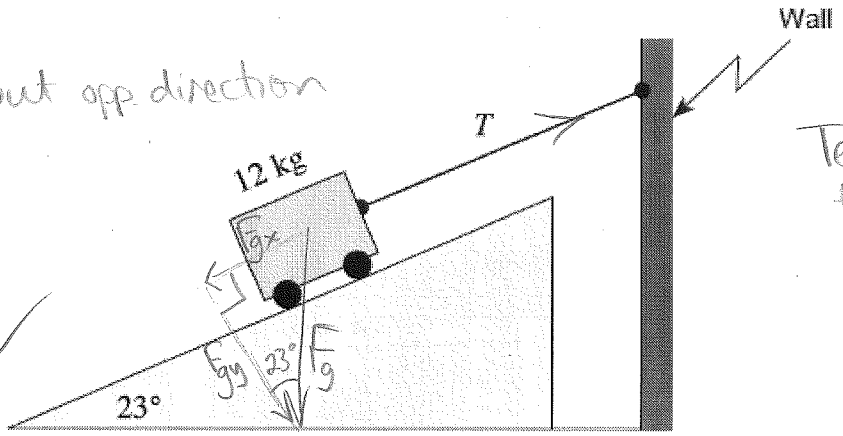
1. A 12kg cart on a 23° frictionless incline is connected to a wall as shown.

$F_{gx} = T$ but opp direction

$F_g \sin 23° =$

$12 \cdot 9.8 \times \sin 23° =$

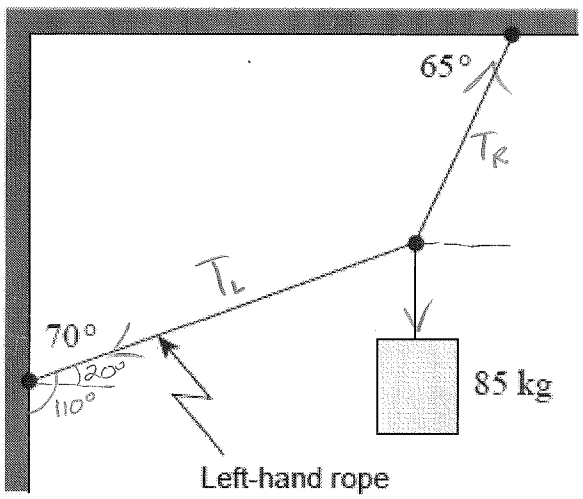
$46N = T$ ✓



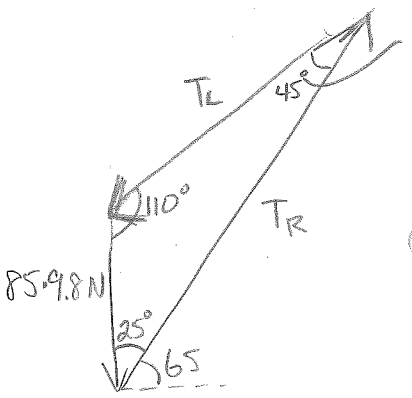
Tension is supporting the component of F_g acting down slope

What is the tension ***T*** in the cord?

2. An 85kg object is suspended from a ceiling and attached to a wall.



in equilibrium so connet all vectors in Δ



length of rope doesn't equate to size of force vectors

What is the tension in the left-hand rope?

$$\frac{T_L}{\sin 25°} = \frac{85 \cdot 9.8}{\sin 45°}$$

$T_L = 498\ N$

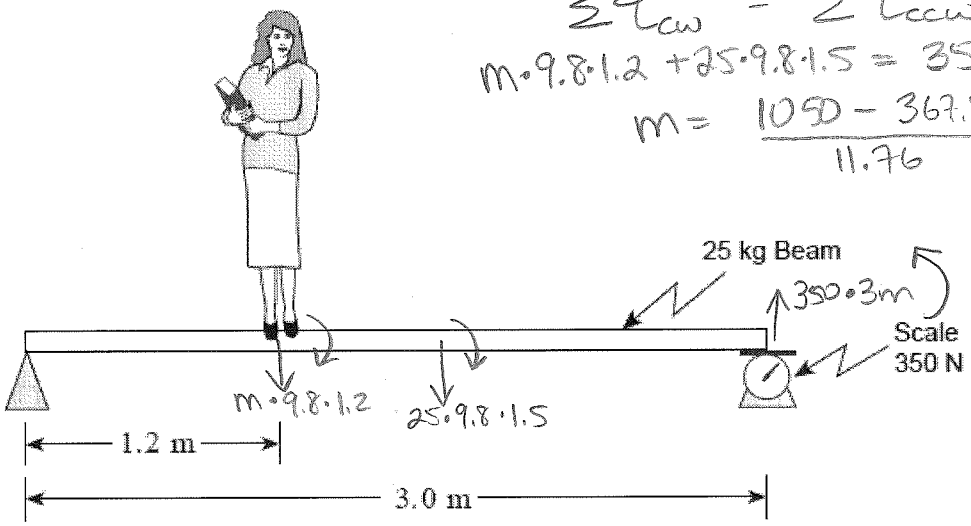
$= 5.0 \times 10^2\ N$ ✓

3. A student stands on a uniform 25kg beam. The scale on the right end reads 350N.

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

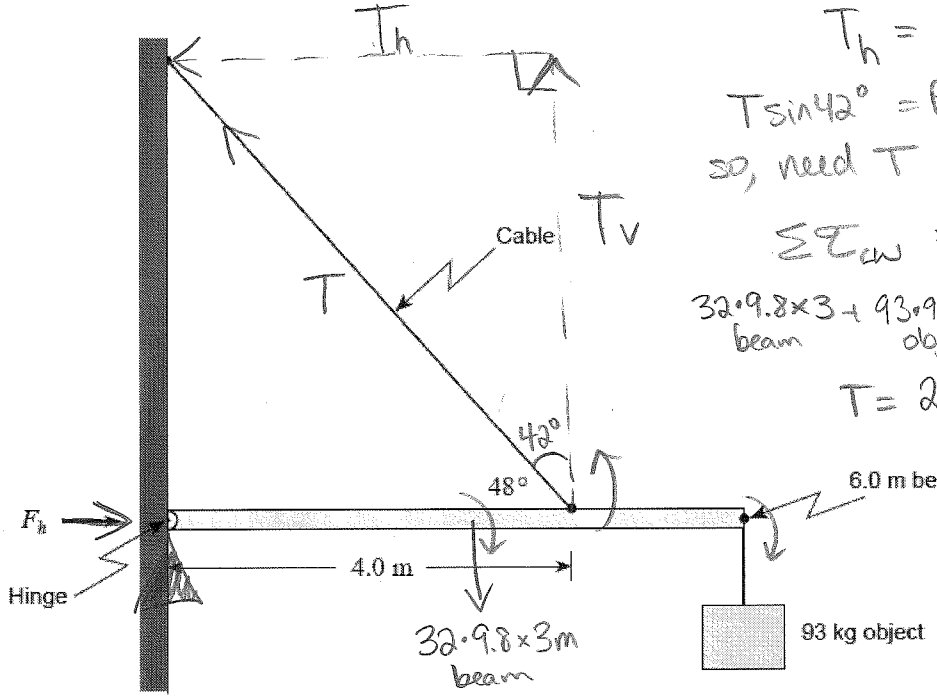
$m \cdot 9.8 \cdot 1.2 + 25 \cdot 9.8 \cdot 1.5 = 350N \cdot 3$

$m = \frac{1050 - 367.5}{11.76} = 58\,kg$ ✓



What is the mass of the student?

4. A 6.0m uniform beam of mass 32kg is suspended horizontally by a hinged end and a cable. A 93kg object is connected to one end of the beam.



$T_h = F_h$ opp directions (the only horizontal forces)

$T \sin 42° = F_h$

so, need T

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

$32 \cdot 9.8 \times 3 + 93 \cdot 9.8 \times 6 = (T \cos 42°)\, 4m$

(beam, object, T_v)

$T = 2156\,N$

so

$(2156N) \sin 42 = F_h$

$F_h = 1443\,N$

$= 1.4 \times 10^3\,N$

What is the magnitude of the horizontal force ***Fh*** that the hinge exerts on the beam? ✓

5. A body is in rotational equilibrium when

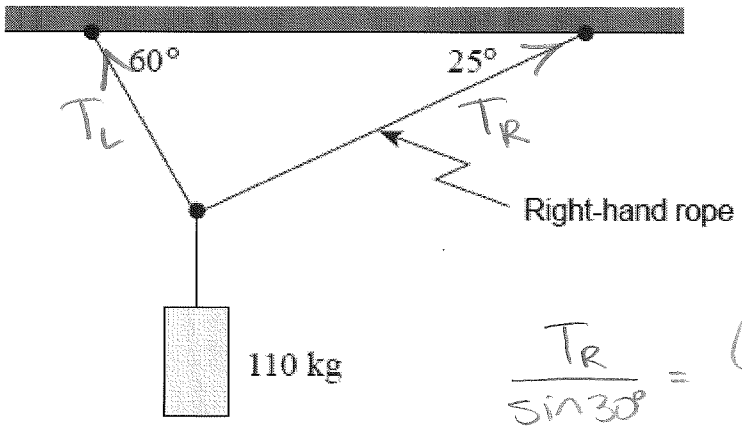
A. $\sum\tau = 0$ ✓ Torques

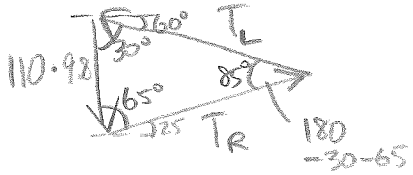
B. $\sum F = 0$

C. $\sum p = 0$

D. $\sum E_k = 0$

6. A 110kg object is supported by two ropes attached to the ceiling. equilibrium so △



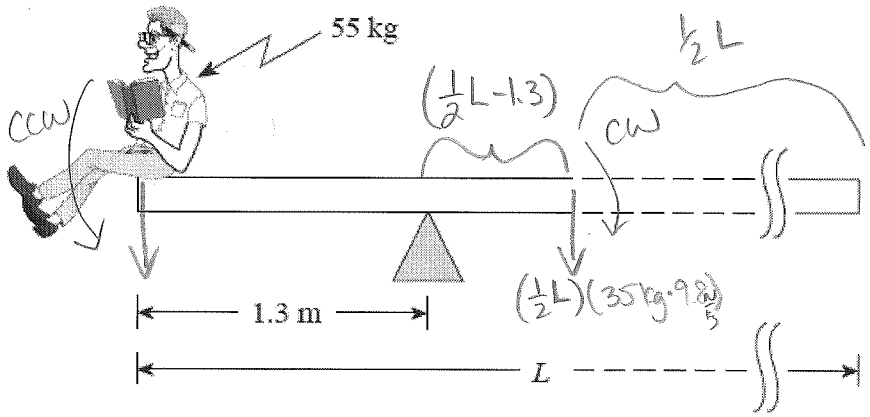


$$\frac{T_R}{\sin 30^\circ} = \frac{(110 \cdot 9.8)N}{\sin 85^\circ}$$

$$T_R = 541N = 5.4 \times 10^2 N \checkmark$$

What is the tension in the right-hand rope?

7. A 35kg uniform plank is balanced at one end by a 55kg student as shown.



What is the overall length of this plank?

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

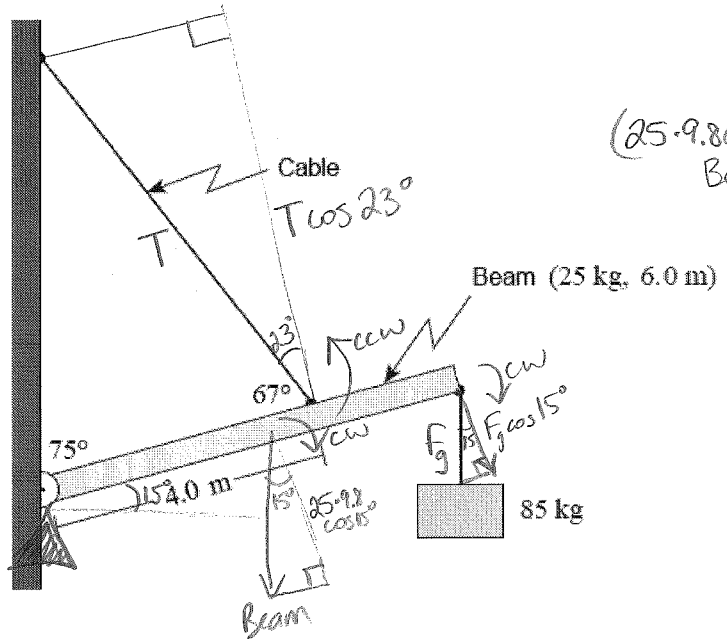
$$(1.3m)(55 \cdot 9.8N) = (\tfrac{1}{2}L - 1.3)(35 \cdot 9.8)$$

$$71.5 = 17.5L - 45.5$$

$$L = 6.7m \checkmark$$

8. A 6.0m uniform beam of mass 25kg is suspended by a cable shown. A 85 kg object hangs from one end.

Need Forces perpendicular to beam (length)



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

$(25 \cdot 9.8 \cos 15°)(3m) + (85 \cdot 9.8 \cos 15)(6m) = (T \cos 23°)(4m)$

Beam mass

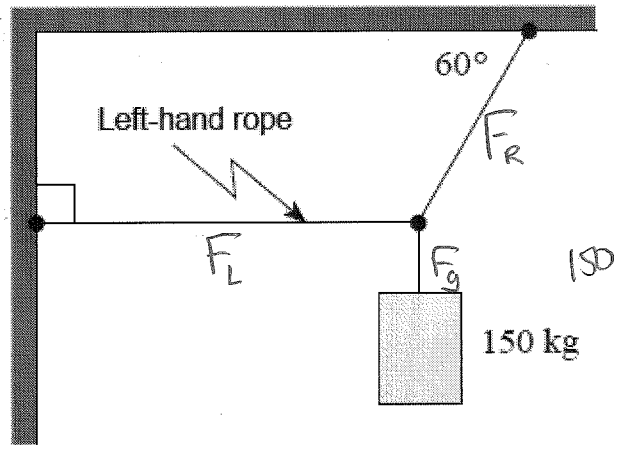
$T = 1504\ N$

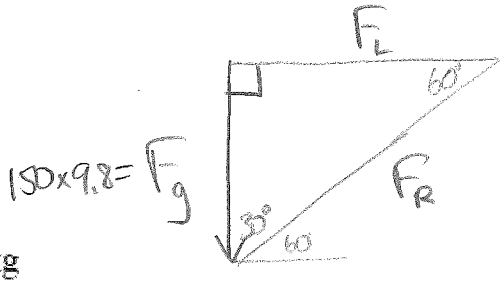
$= 1.5 \times 10^3\ N$ ✓

What is the tension in the cable?

9. A 150kg object is suspended from a ceiling and attached to a wall.

in equilibrium, use Δ





$150 \times 9.8 = F_g$

What is the tension in the left-hand rope?

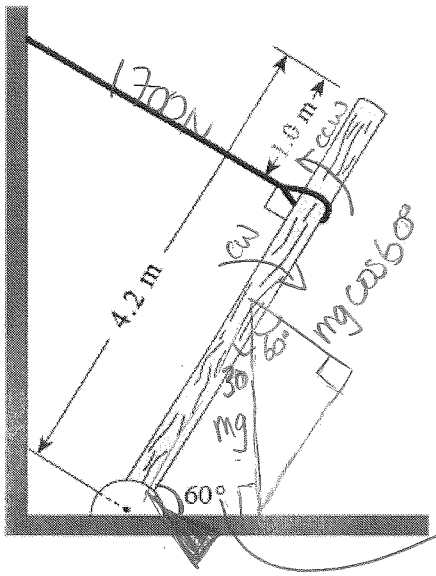
$\tan 30° = \frac{F_L}{F_g}$

$1500 \cdot 9.8 \tan 30 = F_L$

$= 848.7$

$= 8.5 \times 10^2\ N$ ✓

10. A 4.2m long uniform post is supported by a cable having a tension of 1 700 N. What is the mass of this post?



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

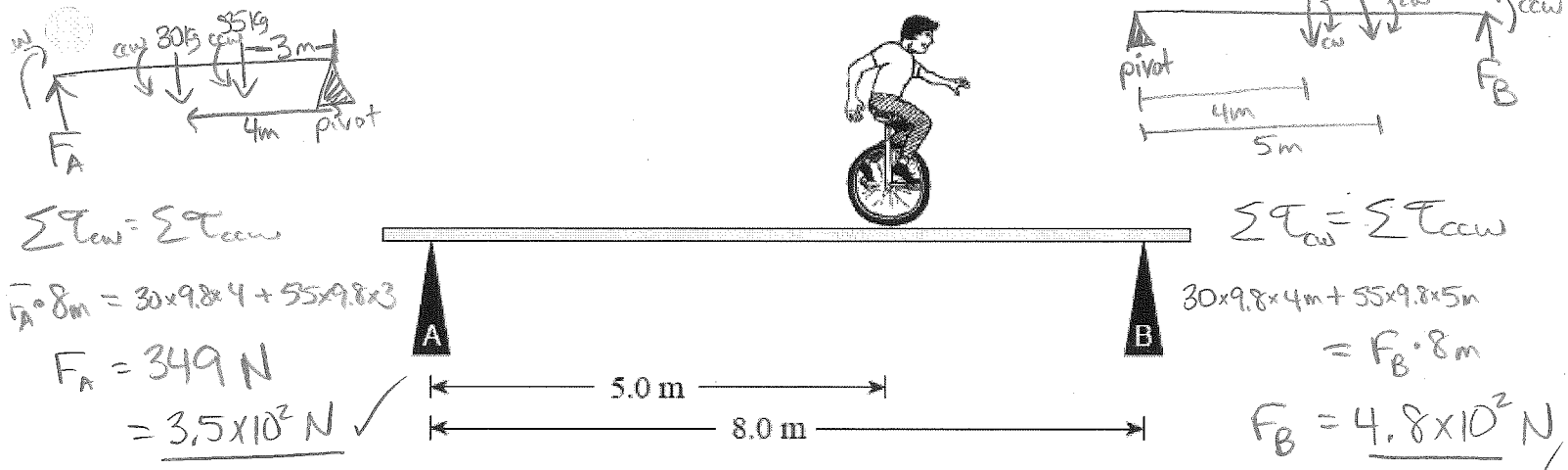
$(mg\cos 60°)(2.1m) = 1700N(3.2m)$

$m = 528.7$

$= 5.3 \times 10^2$ kg ✓

use this Δ to find top 30° angle then get 60° angle

11. A circus performer on a unicycle of total mass 55kg rides across uniform 30kg beam. The supports are placed equal distances from the ends of the beam.



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

$F_A \cdot 8m = 30 \times 9.8 \times 4 + 55 \times 9.8 \times 3$

$F_A = 349$ N

$= 3.5 \times 10^2$ N ✓

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

$30 \times 9.8 \times 4m + 55 \times 9.8 \times 5m = F_B \cdot 8m$

$F_B = 4.8 \times 10^2$ N ✓

a) When he is in the position shown, determine the forces exerted by the supports on the beam

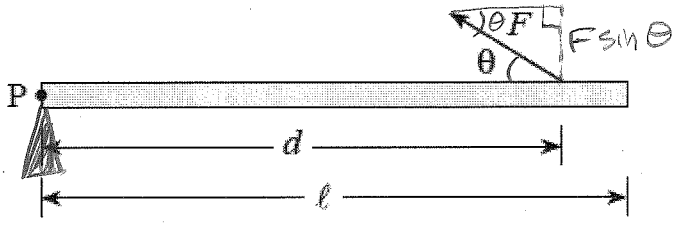
b) As the performer moves towards the right, the force exerted by support B will

- ☐ Remain the same
- ☒ Increase ✓
- ☐ Decrease

c) Using principles of physics, explain your answer to b).

As bike move toward B, the clockwise τ increases so B must exert more counterclockwise to counteract. ✓

12. A force F is applied to a uniform horizontal beam as shown in the diagram below.

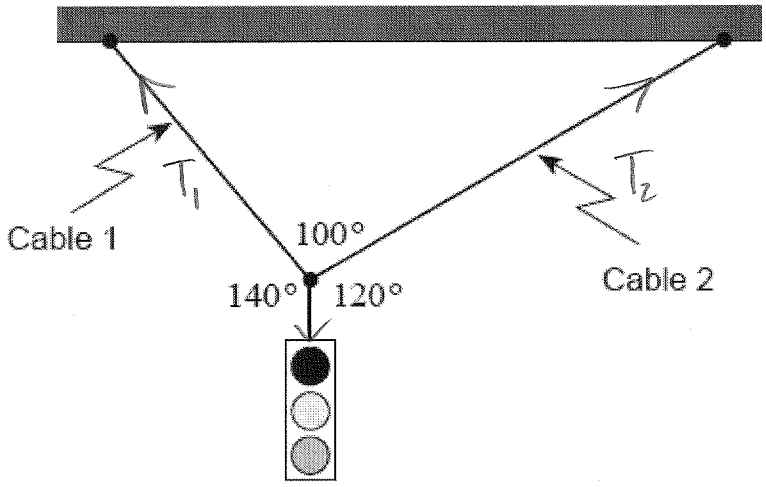


* ignoring mass of beam

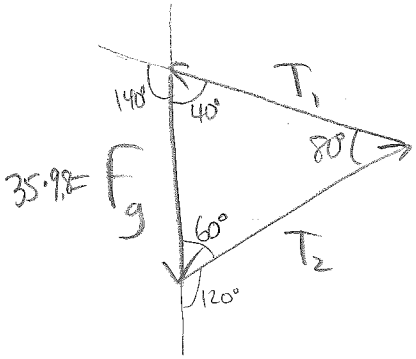
Which of the following is a correct expression for the torque on the beam about pivot point P due to this force?

(A) $F \sin\theta \cdot d$ ✓
B. $F \sin\theta \cdot d/\ell$
C. $F \cos\theta \cdot d$
D. $F \cos\theta \cdot d/\ell$

13. A 35kg traffic light is suspended from two cables as shown in the diagram.



in equilibrium



What is the tension in each of these cables?

$$\frac{T_1}{\sin 60} = \frac{35.98}{\sin 80^\circ}$$

$$T_1 = 302\ N$$

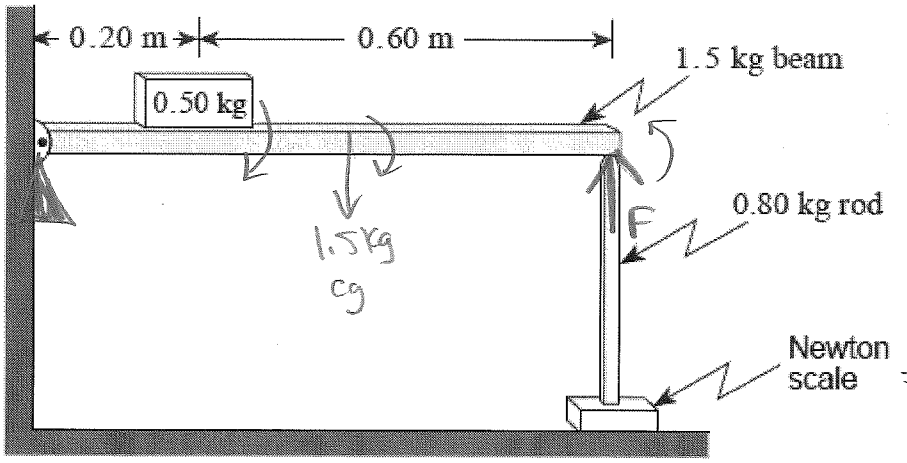
$$= 3.0 \times 10^2\ N$$

$$\frac{T_2}{\sin 40^\circ} = \frac{35.98}{\sin 80^\circ}$$

$$T_2 = 224\ N$$

$$= 2.2 \times 10^2\ N$$

14. A uniform 1.5kg beam hinged at one end supports a ~~5.0kg~~ 0.5kg ✓ block. The beam is held level by a vertical 0.80kg rod resting on a Newton scale at the other end.



rod supporting
$= 0.8kg \cdot 9.8 + F$

What is the reading on the scale?

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

$0.5 \cdot 9.8 \cdot 0.2m + 1.5 \times 9.8 \times 0.4 = F(0.8m)$

$F = 8.58$

scale $0.8 \times 9.8 + 8.58 = \underline{16.4\ N}$

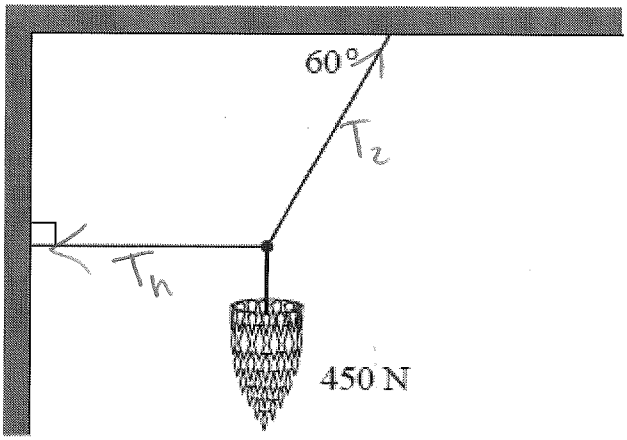
A. 8.6N

B. 9.1N

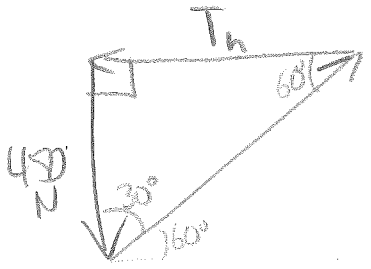
C. 16N ✓

D. 27N

15. A 450N chandelier is supported by three cables as shown in the diagram.



in equilibrium, use Δ



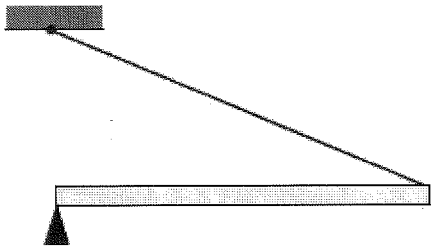
What is the tension in the horizontal cable?

$T_h = 450 \tan 30°$

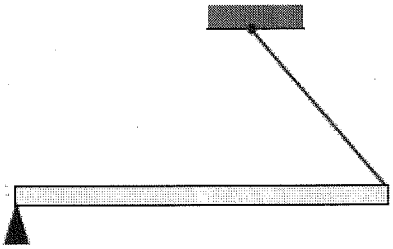
$= 2.6 \times 10^2\ N$ ✓

16. A beam is to be kept horizontal by a cord. In which of four situations below would the tension in the cord be the least?

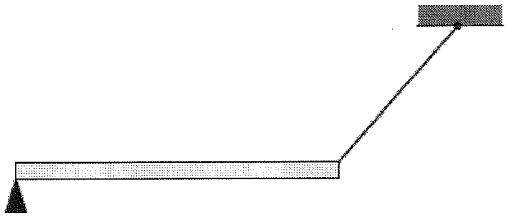
A.



B.



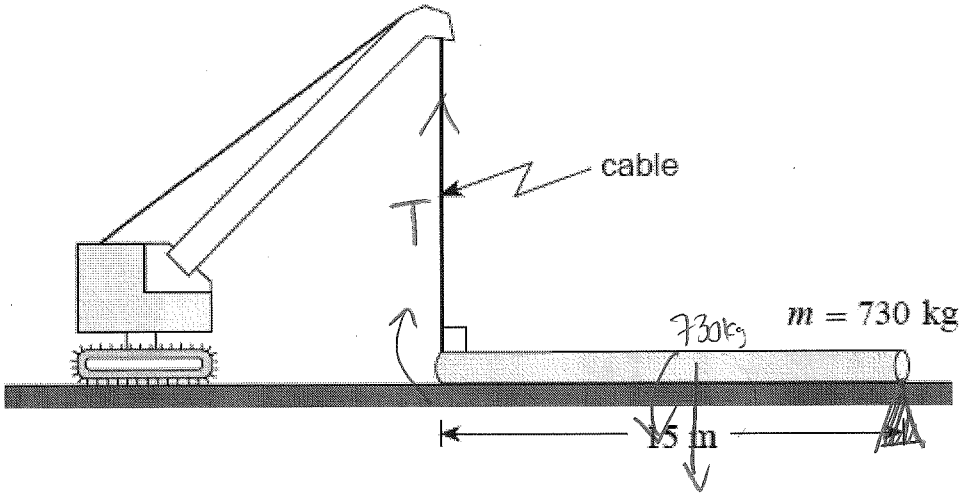
C.



D. ✓

no horizontal component to add in.

17. A crane is used to lift one end of a uniform 15m long pipe with a mass of 730kg as shown in the diagram below.



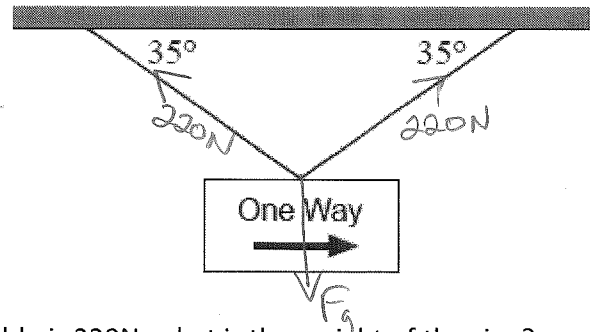
What is the minimum force of tension in the crane cable to just lift the end of the pipe off of the ground?

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

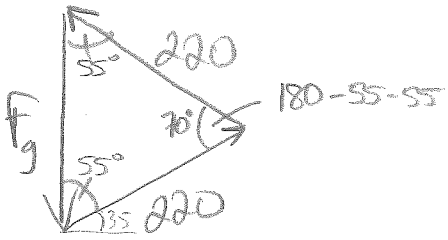
$T \times 15m = (730 \times 9.8N)(7.5m)$

$T = 3.6 \times 10^3 N$ ✓

18. A traffic sign hangs from two cables as shown.



in equilibrium



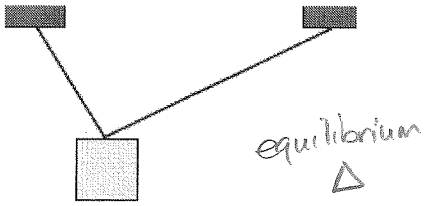
$$\frac{F_g}{\sin 70^\circ} = \frac{220}{\sin 55^\circ}$$

$$F_g = 2.5 \times 10^2 \text{ N}$$ ✓

If the tension in each cable is 220N, what is the weight of the sign?

19. Which of the four problems shown requires the application of torque?

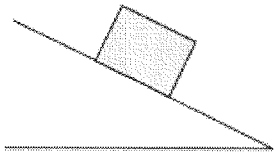
A.



equilibrium △

What is the tension in the supporting cables?

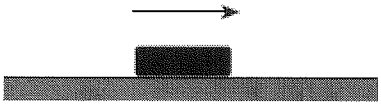
B.



$F_f = \mu F_N$

What is the friction force acting on the block?

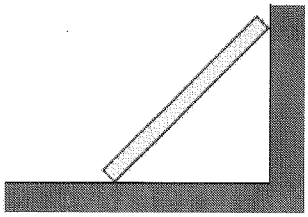
C.



What is the acceleration of the puck?

Kinematics

D. ✓

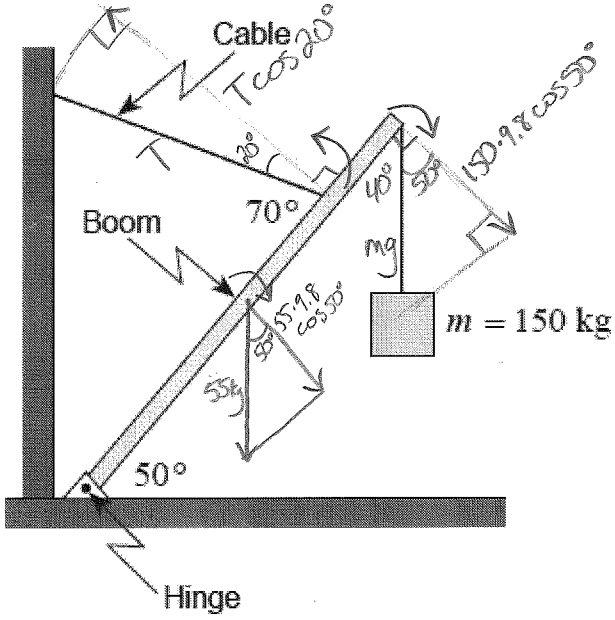


make a pivot at one end...

What force does the wall exert on the board?

20. A uniform 6.0m-long boom has a mass of 55kg. It is kept in position by a restraining cable attached three-quarters of the way along the boom.

need all F ⊥ to boom



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

$(55 \cdot 9.8 \cos 50)(3m) + (150 \cdot 9.8 \cdot \cos 50)(6m)$

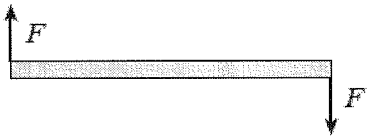
$= (T \cos 20°)(\frac{3}{4} \cdot 6m)$

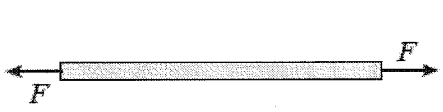
$T = 1586.5$

$= 1.6 \times 10^3 N$ ✓

What is the tension in this cable when the boom when the boom supports a 150kg mass as shown?

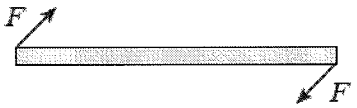
21. A metre stick, as seen from above, is sitting on a table and is then subjected to two forces of equal magnitude as shown. In which case would the metre stick be in rotational equilibrium? (not rotating)

A. 

B. 

✓

C. 

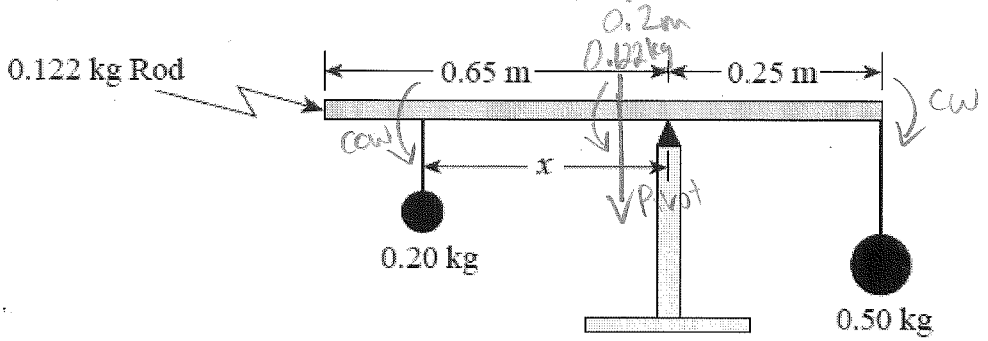
D. 

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

$(0.2 \cdot 9.8)(x) + (0.122 \cdot 9.8)(0.2\text{m}) = (0.5 \cdot 9.8)(0.25\text{m})$

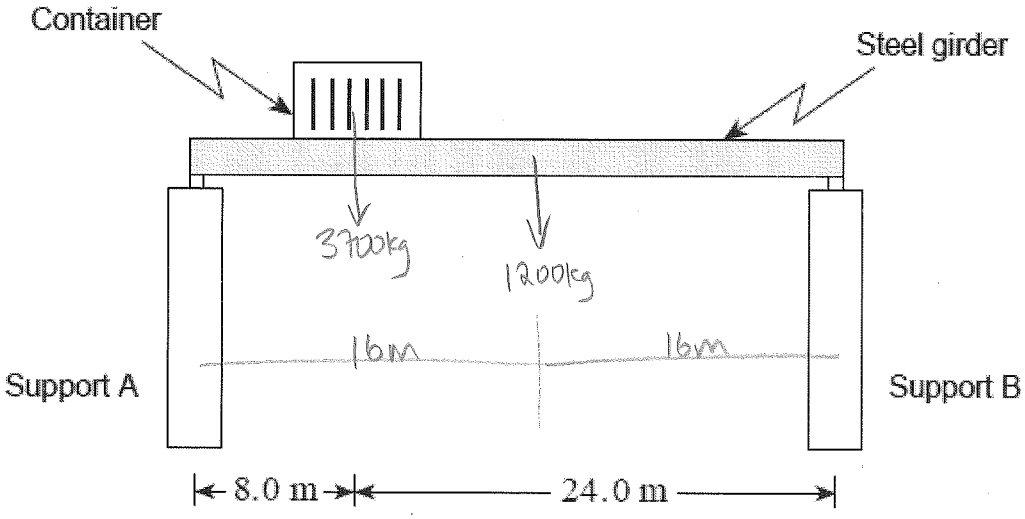
$x = 0.50\text{m}$ ✓

22. A uniform 0.122kg rod of 0.90m length is used to suspend two masses as shown below.



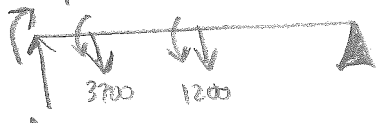
At what distance ***x*** should the 0.20kg mass be placed to achieve static equilibrium?

23. A uniform 1200kg steel girder is supported horizontally at its endpoints as shown in the diagram.



What are the upward forces at the girder end points when it is bearing a 3700kg shipping container 8.0m from support A?

at Support A, pivot at B:



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

$F_A(32\text{m}) = (3700 \cdot 9.8 \cdot 24\text{m}) + (1200 \cdot 9.8 \cdot 16\text{m})$

$F_A = 33075\text{N} = 3.3 \times 10^4\text{N}$ ✓

at Support B, pivot at A

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

$(3700 \cdot 9.8 \cdot 8\text{m}) + (1200 \cdot 9.8 \cdot 16\text{m}) = F_B \cdot 32\text{m}$

$F_B = 14945\text{N} = 1.5 \times 10^4\text{N}$ ✓