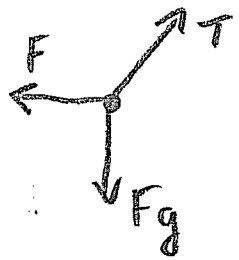
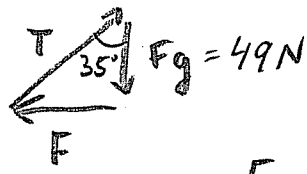
PHYSICS 12

NAME: _____

Translational Equilibrium

1. A mass of 5.0 kg is suspended from a cord as shown in the diagram below. What horizontal force F is necessary to hold the mass in the position shown?

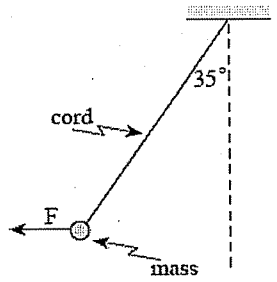




$F = 49 \tan 35^\circ$

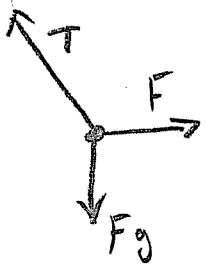
$= 34.3\,N$

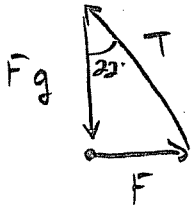
$\tan 35^\circ = \frac{F}{F_g} = \frac{F}{49N}$



34N

2. Find the tension, T, in the cord.

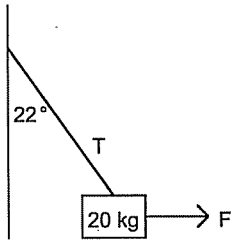




$\cos 22^\circ = \frac{F_g}{T}$

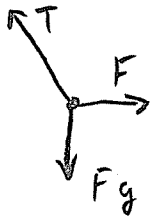
$T = \frac{F_g}{\cos 22} = \frac{196}{\cos 22}$

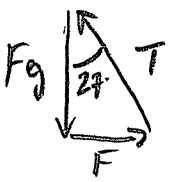
$= 211\,N$



T = 211 N

3. A 20.0 N child sitting on a playground swing is being pushed by her father. When the rope makes an angle of 27° to the vertical what is the force exerted by her father? What is the tension in the rope, T?
(F = 10.2 N, T = 22.4 N)



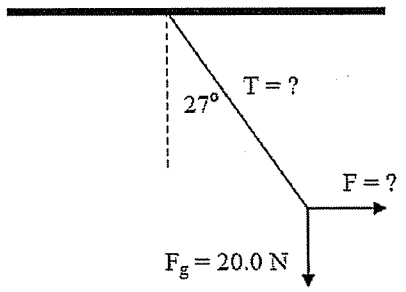


$\cos 27^\circ = \frac{F_g}{T}$, $T = \frac{20N}{\cos 27^\circ}$

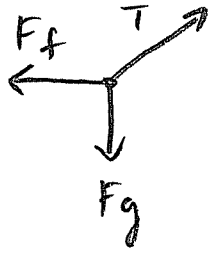
$= 22.4\,N$

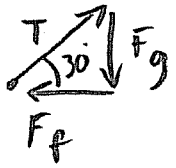
$F_g^2 + F^2 = T^2$

$F = 10.2\,N$



4. A 15 kg object rests on a table. A cord is attached to this object and also to a wall. Another object is hung from this cord as shown. If the coefficient of friction between the 15 kg object and the table is 0.27, what is the maximum mass that can be hung, without movement?





$F_f = \mu F_N$

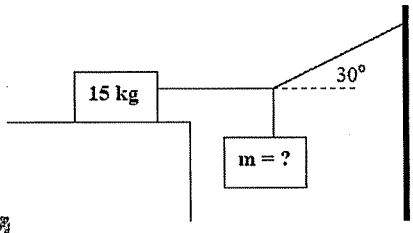
$= .27(15)(9.8)$

$= 39.7\,N$

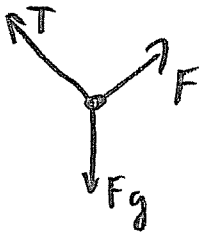
$\tan 30^\circ = \frac{F_g}{F_f} = \frac{F_g}{39.7N}$

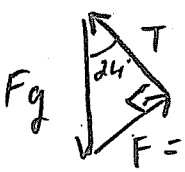
$F_g = 22.9\,N$

$m = 2.34\,kg$



5. A mass suspended by a string is held 24° from vertical by a force of 13.8 N as shown. Find the mass.



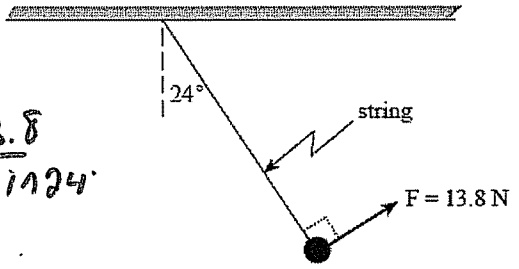


$\sin 24° = \frac{F}{F_g}$

$F_g = \frac{F}{\sin 24} = \frac{13.8}{\sin 24°}$

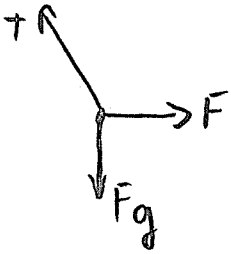
$= 33.9\,N$

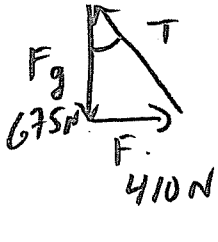
$m = 3.46\,kg$



3.5 kg

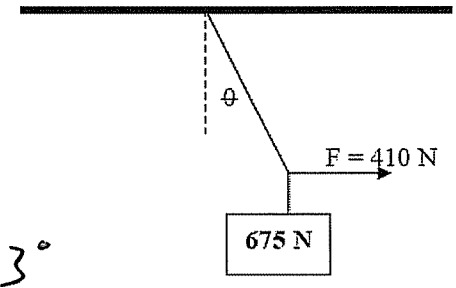
6. A 675 N object is pulled horizontally by a force of 410 N as shown. What is the angle, θ, between the rope and the vertical?



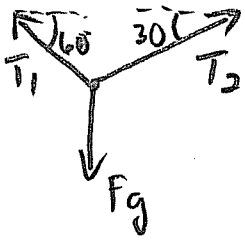


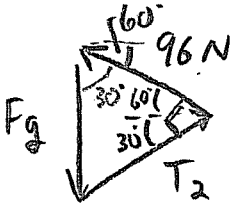
$\tan\theta = \frac{F}{F_g} = \frac{410\,N}{675\,N}$

$\tan^{-1}\left(\frac{410}{675}\right) = 31.3°$



7. Given the following diagram, find W and T2. (110 N, 55 N)



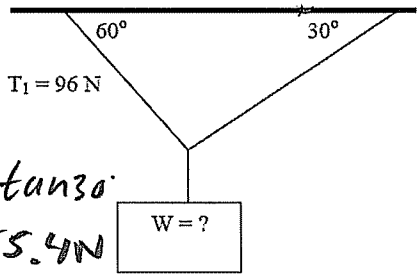


right triangle

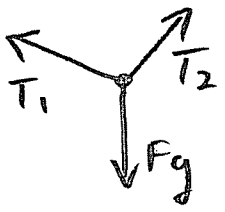
$\tan 30° = \frac{T_2}{96}$, $T_2 = 96 \tan 30°$

$= 55.4\,N$

$96^2 + 55^2 = F_g^2$, $F_g = 111\,N$



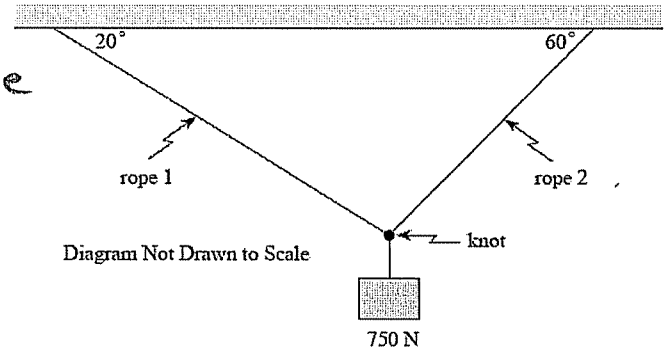
8. A 750 N weight is supported by two ropes fastened together by a knot, as shown in the diagram below.

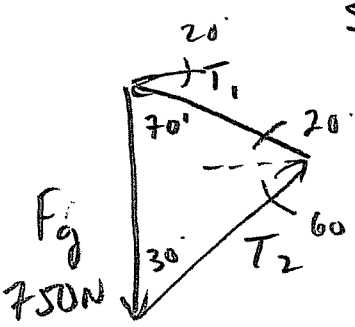


Not in right triangle

use sin law

$\frac{F_g}{\sin 80} = \frac{T_1}{\sin 30}$



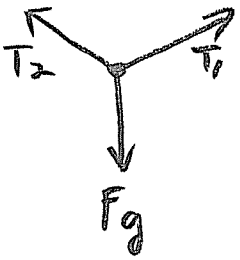


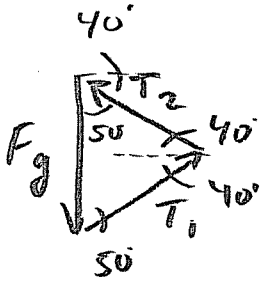
$T_1 = \frac{750(\sin 30°)}{\sin 80°} = 381\,N$

$\frac{F_g}{\sin 80} = \frac{T_2}{\sin 70°}$, $T_2 = 716\,N$

381N

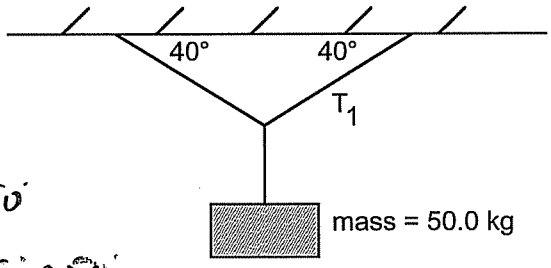
9. Find the tension, T_1.





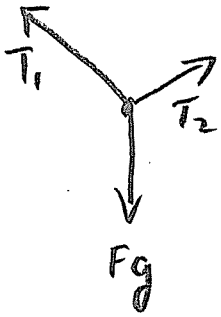
$$\frac{F_g}{\sin 80^\circ} = \frac{T_1}{\sin 50^\circ}$$

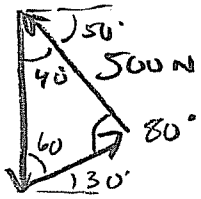
$$T_1 = \frac{(50)(9.8)\sin 50^\circ}{\sin 80^\circ}$$



$T_1 = 381$ N

10. Find the mass, m.

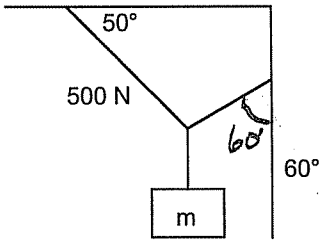




$$\frac{500\text{N}}{\sin 60^\circ} = \frac{F_g}{\sin 80^\circ}$$

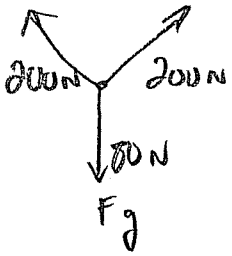
$$F_g = 569\text{N}$$

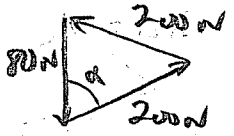
$$m = 58\text{kg}$$



m = 58.0 kg

11. What will the angle ø be when the pulley system below is at static equilibrium? Hint: The rope connecting the two 200 N weights has the same tension throughout: 200 N





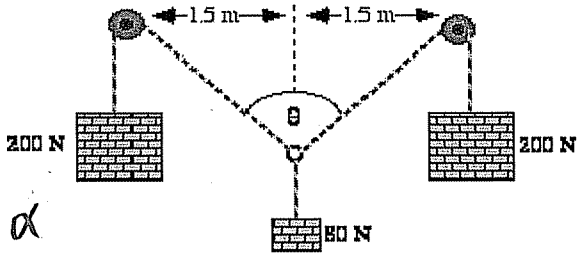
find α using Cos law

$$a^2 = b^2 + c^2 - 2bc\cos A$$

$$200^2 = 200^2 + 80^2 - 2(200)(80)\cos\alpha$$

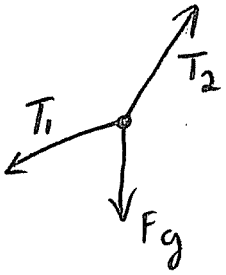
$$\cos\alpha = .2$$

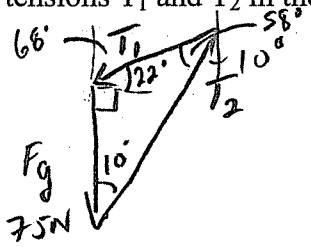
$$\alpha = 78.5^\circ \qquad \theta = 2\alpha = 157^\circ$$



ø = 157°

12. Find the tensions T_1 and T_2 in the ropes shown in the diagram.



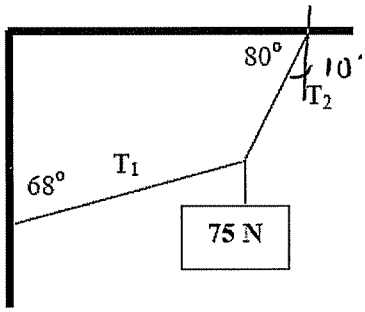


$$\frac{F_g}{\sin 58^\circ} = \frac{T_1}{\sin 10^\circ}$$

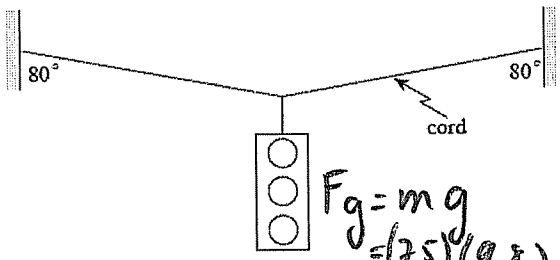
$$T_1 = 15.4\text{N}$$

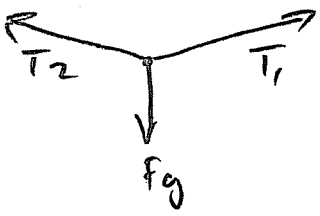
$$\frac{F_g}{\sin 58} = \frac{T_2}{\sin 112^\circ}$$

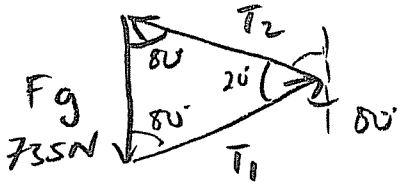
$$T_2 = 82.\text{N}$$



13. A 75 kg traffic light is held stationary midway between two supports, as shown in the diagram below. What is the tension in the cord?







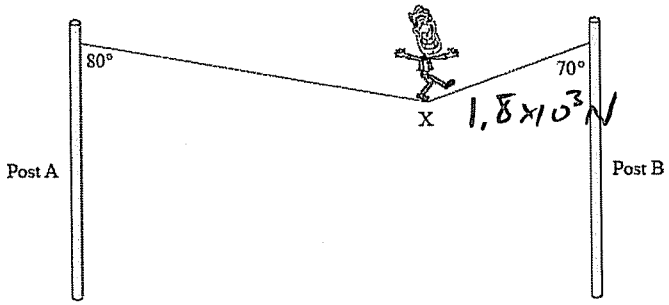
$F_g = mg$
$= (75)(9.8)$
$= 735N$

$\frac{F_g}{\sin 20} = \frac{T_1}{\sin 80}$

$T_1 = 2116\ N$

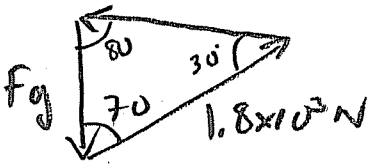
2.1×10^3N

14. A circus performer walks across a wire stretched between two vertical posts. When the performer stands at position **X** as shown below, the tension in the short length of wire attached to post **B** is 1.8 □103 N .



$1.8 \times 10^3 N$

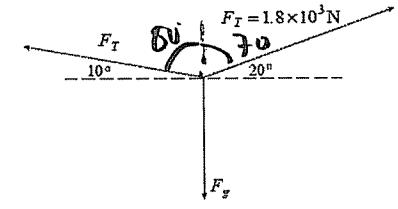
Draw and label a free body diagram showing the forces acting at position **X**.
What is the mass of the circus performer?



$\frac{F_g}{\sin 30} = \frac{1.8 \times 10^3}{\sin 80}$

$F_g = 914 kg$

$m = 93.3 kg$



93 kg