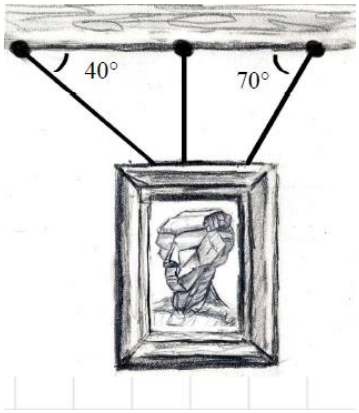
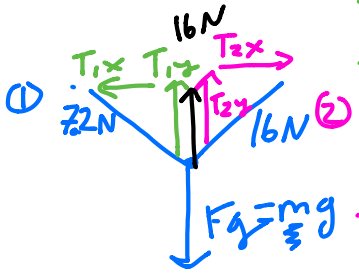
Worksheet 3.4

Forces at an angle



1. Find the mass m of the painting. The tension in the leftmost rope is 7.2 N, in the middle rope it is 16 N, and in the rightmost rope it is 16 N.



$T_{1y} = 7.2\sin 40 = 4.62\,N$

$T_{1x} = 7.2\cos 40 = 5.52\,N$

$T_{2y} = 16\sin 70 = 15\,N$

$T_{2x} = 16\cos 70 = 5.5\,N$

$\sin 40 = \frac{T_{1y}}{7.2}$

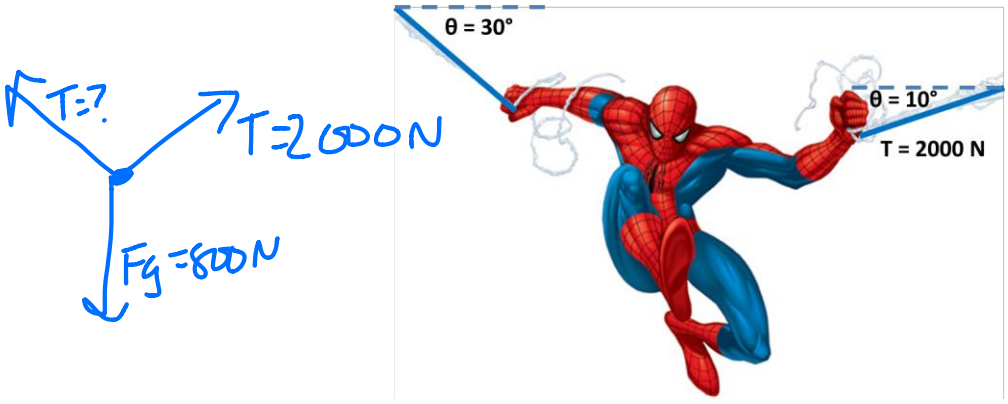
$\cos 40 = \frac{T_{1x}}{7.2}$

$T_{1y} + T_{2y} + 16N$

$4.62N + 15N + 16N = m(10\,m/s^2)$

$35.5N = m(10\,m/s^2)$

$3.55kg = m$



2. Spiderman hangs at rest from two strings of web as shown in the picture above. The right hand string has a tension force of 2000 N Newtons. Spiderman has a mass of 80 kg.

a. Draw a free body diagram for Spiderman next to the image above.

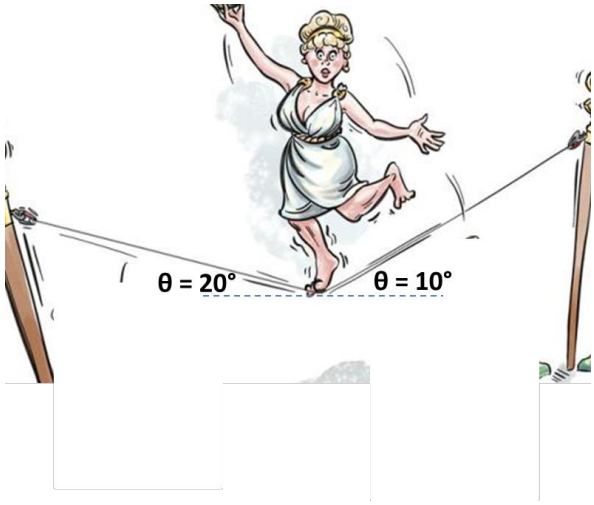
b. Calculate the tension in the left hand string.

$T_{2x} = 2000N \cos 10 = 1969.6N$

$T_{2x} = T_{1x}$

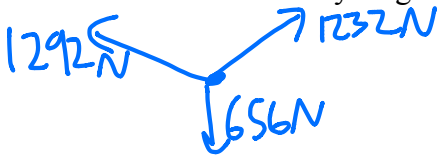
$1969.6N = T_1(\cos 30)$

$T_1 = 2274.4N$



3. A woman of mass 65.6 kg is balancing at rest on a "slack line" as shown in the figure on the above. The tension in the right part of the string is 1232 Newtons and the tension in the left side of the string is 1292 Newtons.

a. Draw a free body diagram for the woman. Try to draw the arrows at a correct length.



b. Since she's at rest, show that all of the forces (in x and in y) on the woman cancel each other out.

$T_{1x} = T_{2x}$

$1292\cos 20 = 1232\cos 10$

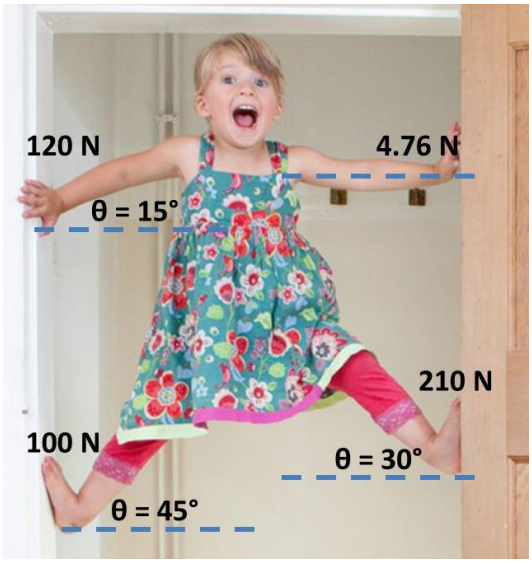
$1214 = 1213.3$

$T_{1y} + T_{2y} = F_g$

$1292\sin 20 + 1232\cos 10 = 656$

$441.9 + 213.9$

$655.8 \sim 656$



4. A child supports herself in a doorframe by pushing against it with her arms and feet. Three of her limbs press at an angle, while her left arm is perpendicular to the wall. She is stationary, so all forces must cancel out.
   a. What is the mass of the girl?

$\underline{y}: 120\sin 15 + 100\sin 45 + 210\sin 30 = mg$

$206.8N = m(10)$

$m = 20.7kg$

   b. Show that the horizontal forces are balanced.

$120\cos 15 + 100\cos 45 = 4.76N + 210\cos 30$

$186.6 = 186.6$ ✓