

Problem 3: Balance and energy (15 pts)

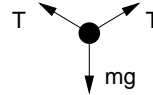
A block of mass m is tied to two strings as shown in the figure below. Each string has a length L . The angle $\theta = 30^\circ$. ($\sin \theta = 1/2$ and $\cos \theta = \sqrt{3}/2$.) Assume the strings are massless.



- Draw the free-body diagram of the block.
- Find the tension of each string.
- We cut one string and the block starts to swing down. Find the speed of the block when it reaches the lowest point.
- Find the tension in the string when the block reaches the lowest point.

Solution:

(a)



- (b) From the balance of the force in the vertical direction, we find

$$mg = 2T \sin \theta = T$$

Thus $T = mg$.

- (c) The change in the potential energy is $mg(L - L \sin \theta) = mgL/2$. Thus

$$\frac{1}{2}mv^2 = \frac{mgL}{2}$$

We find

$$v = \sqrt{gL}$$

- (d) The tension minus weight should provide the acceleration for the circular motion:

$$T - mg = m \frac{v^2}{L}$$

So

$$T = mg + mg = 2mg$$