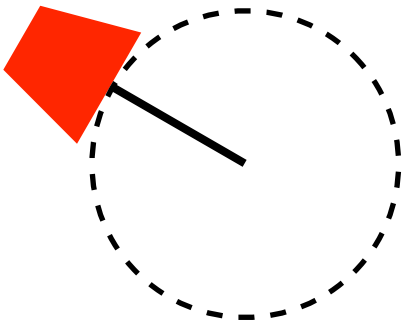
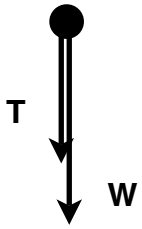
Whirling a bucket

A bucket of water is whirled around in a vertical circle with radius 1m.

What is the minimum speed that it can be whirled so the water remains in the bucket?



Solution: Look at the FBD for the bucket at the top of the whirl: both the tension and the weight force are pointing down, so the net force is also down.



The *minimum* net force is going to be when $T = 0$ (the weight can't change, but the amount of tension in the string can). In this case, the net force just equals the weight force, and since the bucket is moving in a circle, this net force must be the centripetal force.

so

$$F_c = mv^2/r = W = mg$$

so

$$v^2 = gr$$

$$v = \sqrt{(gr)}$$

Take $r = 1$m (say); then

$$v = \sqrt{g} = \sqrt{9.8} = 3.1 \text{ ms}^{-1}$$

so

$$\omega = v/r = 3.1 \text{ rad s}^{-1}$$

$$T = 2\pi/\omega = 2 \text{ s}$$

so the water will not fall out if the bucket is whirled around once every 2 s.