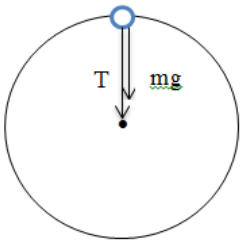
Answer on Question #84882, Physics / Mechanics | Relativity

A 0.75 (kg) ball is tied to a 0.50 m long string and whirled in a vertical circle at a constant speed of 5ms. What is the tension in the string at the top and the bottom of the circle

Solution:

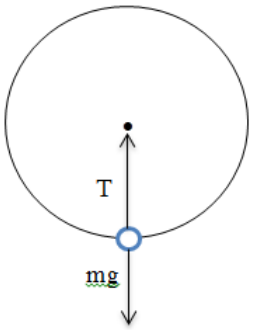
We draw a free body force diagram of the mass. At the top of the circle the two forces acting on a ball are its weight $W = mg$ and tension from the string T. Both of them act vertically downwards. The centripetal force F acting towards the center of the circle is



$$F = \frac{mv^2}{r} = T_{top} + mg$$

where m is mass, v is velocity of the ball and r is radius, $g = 10m/s^2$ is the gravitational acceleration. Then for tension in the string at the top we get

$$T_{top} = \frac{mv^2}{r} - mg = m\left(\frac{v^2}{r} - g\right) = 0.75\left(\frac{5^2}{0.5} - 10\right) = 0.75(50 - 10) = 30N$$



At the bottom of the circle the weight acts vertically downwards, whereas the tension from the string acts vertically upwards so that the centripetal force is

$$F = \frac{mv^2}{r} = T_{bot} - mg$$

Then for T_{bot} we get

$$T_{bot} = \frac{mv^2}{r} + mg = m\left(\frac{v^2}{r} + g\right) = 0.75\left(\frac{5^2}{0.5} + 10\right) = 0.75(50 + 10) = 45N$$

Answer: the tension in the string at the top and the bottom of the circle are

$$T_{top} = 30N, \quad T_{bot} = 45N$$