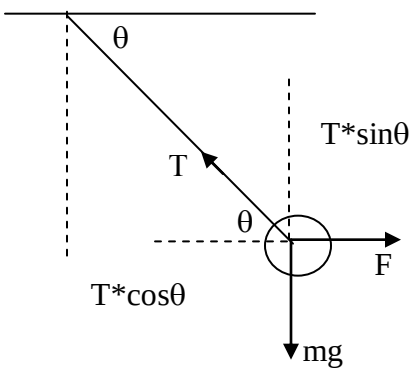
Q- A 2.0 kg ball tied to a string fixed to the ceiling is pulled to one side by a force F to an angle of 37 degrees from the ceiling.
a) Just before the ball is released and allowed to swing back and forth, how large is the force F that is holding the ball in position.
b) Just before the ball is released and allowed to swing back and forth, what is the tension in the string?

a) Mass of the ball m = 2.0 kg

The angle between the string and the ceiling $\theta = 37^0$

Let the tension in the string is T
Just before the release the ball will be in equilibrium and hence the forces are balanced.



There are three forces acting on the ball in this situation

i. The weight mg vertically downwards
ii. The tension T in the string along the string and
iii. The force applied F in horizontal direction.

As the two forces other then tension T are perpendicular, resolving tension in horizontal and vertical direction we have

The horizontal component T cos θ and the vertical component T sin θ

And hence balancing the forces we have the equations

F - T cos θ = 0 ---------- (1)

And T sin θ = mg ---------- (2)

Substituting the value of T in equation 1 from equation 2 and rearranging we have

$$F = \left(\frac{mg}{\sin\theta}\right) * \cos\theta = mg\cot\theta = 2.0 * 9.8 * 1.33 = 26\ N$$

b) Just before the ball is released and allowed to swing back and forth, what is the tension in the string?

From equation 2 we have

$$T = \frac{mg}{\sin\theta} = \frac{2.0*9.8}{\sin 37^0} = 32.6\ N$$