Answer on Question #50421, Physics, Mechanics | Kinematics | Dynamics

A string pendulum oscillates in a vertical plane. When it passes through the mean position, the tension in the string is 3 times the weight of the pendulum bob. What is the maximum displacement of the pendulum of the string with respect to the vertical.

(1)30°

(2)45°

(3)60°

(4)90°

Solution:

Consider a body of mass 'm' performs vertical circular motion about the centre and radius 'r'

As the motion is affected by the gravity the velocities of the body and tension in the string will be different at different points of the circle. Let v_1 be the velocity of the body at bottom point. Let T be the tension at the highest points.

The forces acting on the body at the highest position are,

i) Weight of the body acting vertically downward direction,

ii) Tension T in the string, acting vertically downward direction.

Centripetal force acting on object at the bottom position is provided partly by weight and partly by tension in the string.

$$mg - T = \frac{mv_1^2}{r}$$

$$T = 3mg$$

$$\frac{mv_1^2}{r} = 2mg$$

$$v_1^2 = 2gr$$

$KE\ at\ bottom\ =\ 1/2\ m\ v^2 = mgr$

This is the energy the swinging pendulum must have started with.

Gravitational Potential energy at start of pendulum swing $=\ mgr\ (\ 1 -\ cos\ \theta\ )$

$$mgr =\ mgr\ (\ 1 -\ cos\ \theta\ )$$

$$(\ 1 -\ cos\ \theta\ ) = 1$$

$$cos\ \theta = 0$$

$$\theta = 90°$$

Answer: (4)90°