Answer on Question #41988, Physics, Other

A 4.25 m long pendulum with a 1.52 kg mass is pulled sideways until it is displaced 1.63 m horizontally from its rest position. If the mass is released, calculate the speed of the mass when it passes through its equilibrium position?

Solution:

Given:

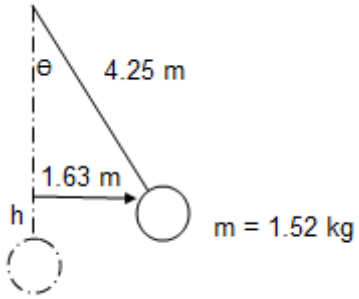
$L = 4.25$ m,

$m = 1.52$ kg,

$x = 1.63$ m,

$v = ?$

A simple pendulum is one which can be considered to be a point mass suspended from a string or rod of negligible mass.



From Figure we obtain

$$\sin\theta = \frac{x}{L} = \frac{1.63}{4.25} = 0.383529$$

Thus,

$$\theta = \sin^{-1}(0.383529) = 22.55°$$

The object was pulled to the right at an angle Θ = 22.55° to the vertical. We can actually find the height h that the object is pulled to by using trigonometric relationships.

The height, h, that the object is pulled to, is therefore:

$$h = L - L\cos\theta = L(1 - \cos\theta) = 4.25 \cdot (1 - \cos 22.55°) = 0.3249 \text{ m}$$

Now we can use energy to find the speed of the mass at any height. Here, we'll use it to find the speed of the object when it is directly under the axis of rotation. In order to do this we need to remember the following:

$$K_o + U_o = K_f + U_f$$

This is an application of what is known as the Law of Conservation of Energy. In essence, what this law says is that energy cannot be created or lost. Whatever amount of energy is present at the beginning in the system, must still be present in the end. After setting the lowest point that the mass reaches as the "zero" height, we can solve as follows:

$$\frac{1}{2}m(0)^2 + mgh_0 = \frac{1}{2}mv^2 + mg(0)$$

$$mgh_0 = \frac{1}{2}mv^2$$

$$v = \sqrt{2gh_0}$$

Notice that, after solving this algebraically, the speed of the mass is independent of the value of the actual mass itself. Therefore, we need not be given the mass of the object to find its speed after dropping a height h. Continuing to solve for the speed, we get:

$$v = \sqrt{2 \cdot 9.81 \cdot 0.3249} = 2.52 \text{ m/s}$$

Answer. $v = 2.52 \text{ m/s}$