Answer on Question #54779-Physics-Mechanics-Kinematics-Dynamics

A particular spring stretches 20 cm when a 500g mass is hung from it. Suppose a 2.0kg mass is attached to the string and it is displaced 40 cm from equilibrium position and released. Find the speed of the mass when x = 10 cm.

Solution

For the first mass the equilibrium will be when

$$m_1 g = k x_1.$$

$$k = \frac{m_1 g}{x_1} = \frac{0.5 \cdot 9.8}{0.2} = 24.5 \frac{N}{m}.$$

From the conservation of energy law

$$\frac{k x_i^2}{2} = \frac{k x_f^2}{2} + \frac{m v^2}{2} + mg(x_i - x_f).$$

For the second mass the equilibrium will be when

$$m_2 g = k x_2.$$

$$x_2 = \frac{m_2 g}{k} = \frac{2.0 \cdot 9.8}{24.5} = 0.8\ m.$$

The speed of the mass when x = 10 cm is

$$v = \sqrt{\frac{k}{m}(x_i^2 - x_f^2) - 2g(x_i - x_f)}$$

$$= \sqrt{\frac{24.5}{2.0}((0.4 + 0.8)^2 - (0.1 + 0.8)^2) - 2 \cdot 9.8\big((0.4 + 0.8) - (0.1 + 0.8)\big)} = 1.4 \frac{m}{s}.$$

Answer: $1.4 \frac{m}{s}$.