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A mass m is dropped from a height h onto a platform resting on top of a spring at equilibrium. We say that t_o is when the mass comes into first contact with the platform. After a change in time (t) of 0.148s the platform passes the new equilibrium point a distance (d) of 19.6cm from its initial position at t_o. Find a function for the position y as a function of time, the height (h) it was released from above the platform, and its intitial velocity (v_o) at time t_o.

$$mg - kx = m\frac{d^2x}{dt^2} \tag{1}$$

$$x = \frac{mg}{k} + y \tag{2}$$

Plugging equation (2) into equation (1) we get:

$$mg - k(\frac{mg}{k} + y) = m\frac{d^2x}{dt^2} \tag{3}$$

After some more work we come up with a equation for the position as a function of time:

$$y(t) = y_o cos(w_o t) + \frac{v_o}{w_o} sin(w_o t) \tag{4}$$

Some things to keep in mind:

$$y_o = d \tag{5}$$

$$w_o = \sqrt{\frac{k}{m}} \tag{6}$$

$$k = \frac{ma}{d} \tag{7}$$

$$v_o = \sqrt{2gh} \tag{8}$$

$$y(t) = y(0.148s) = 0 \tag{9}$$

$$y(t_o) = y(0) = 19.6cm = 0.196m \tag{10}$$

Working with these equations we can get a value for w_o

$$w_o = \sqrt{\frac{mg}{dm}} = \sqrt{\frac{g}{d}} = \sqrt{\frac{9.8m/s^2}{0.196m}} = \sqrt{50}s^{-1}$$

Solving equation (4) for v_o we get

$$v_o = -\frac{dw_o cos(w_o t)}{sin(w_o t)}$$

Plugging in our values for w_o, t, and d we get

$$v_o = -\frac{(0.196m)(\sqrt{50}s^{-1})cos(\sqrt{50}s^{-1})(0.148s)}{sin(\sqrt{50}s^{-1})(0.148s)} = -\frac{0.69378m/s}{0.86569}$$

$$v_o = -0.80142m/s$$

Using equation (8) we can solve for h and get

$$h = \frac{v_o^2}{2g} = \frac{(-0.80142m/s)^2}{2(9.8m/s^2)}$$

$$h = 0.032769m$$