Quiz 1 A Solutions

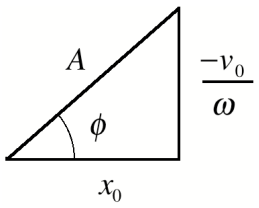
1. A 0.20-kg mass is suspended from a spring with a force constant of 45.0 N/m. It is pulled 0.03 m from its equilibrium position and released with an initial velocity of 0.60 m/s directed back towards the equilibrium. Calculate the following quantities for the resulting harmonic motion:

   a. Angular frequency ω.

   $$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{45.0\ \text{N/m}}{0.20\ \text{kg}}} = \boxed{15.0\ \text{s}^{-1}}$$

   b. Amplitude A.

   $$A = \sqrt{x_0^2 + \left(\frac{v_0}{\omega}\right)^2}$$

   $$x_0 = 0.03\ \text{m} \quad \text{and} \quad \frac{-v_0}{\omega} = \frac{-(-0.60\ \text{m/s})}{15\ \text{s}^{-1}} = +0.04\ \text{m}.$$

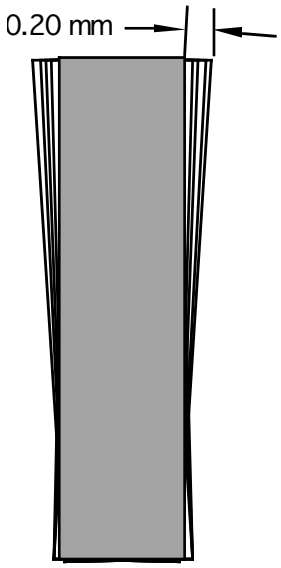
   $$A = \sqrt{(0.03\ \text{m})^2 + (0.04\ \text{m})^2} = \boxed{0.05\ \text{m}}$$

2. The tines of a 440-Hz tuning fork swing over a distance of 0.40 mm from one extreme to the other. Their simple harmonic then has a 0.20-mm amplitude. Calculate the following for the vibrating tines:

   a. Maximum velocity

   $$\omega = 2\pi f = 2\pi(440\ \text{Hz}) = 2764.6\ \text{s}^{-1}$$

   $$v_{\max} = \omega A = (2764.6\ \text{s}^{-1})(0.20 \times 10^{-3}\ \text{m}) = \boxed{0.553\ \text{m/s}}$$

   b. Maximum acceleration

   $$a_{\max} = \omega v_{\max} = \omega^2 A = (2764.6\ \text{s}^{-1})^2 (0.20 \times 10^{-3}\ \text{m}) = \boxed{1519\ \text{m/s}^2}$$

$x(t) = A\cos(\omega t + \phi)$	$v(t) = -\omega A \sin(\omega t + \phi)$	$a(t) = -\omega^2 A \cos(\omega t + \phi)$	$\omega = \sqrt{k/m}$