

## Oscillation Problems I

1. The position as a function for a 0.5 kg mass on the end of a spring is given by  $x = 1.5\cos(3t)$ .
- a. What is the maximum displacement of the mass from the equilibrium position?

$\boxed{1.5}$  (assumed meters) - Just the amplitude

$A = 1.5 \text{ m}$

$\omega = 3 \text{ rad/s}$

$m = 0.5 \text{ kg}$

- b. What is the period of this motion?

$T = \frac{2\pi}{\omega} = \boxed{\frac{2\pi}{3} \text{ s}}$

- c. What is the maximum speed of the mass?

$v_{\max} = A\omega = (1.5)(3) = \boxed{4.5 \text{ m/s}}$

2. A mass on a spring has an angular frequency of 5 rad/s and a maximum speed of 3 m/s.
- a. What is its maximum displacement?

$\omega = 5 \text{ rad/s}$

$v_{\max} = 3 \text{ m/s}$

$v_{\max} = A\omega$

$3 = A(5)$

$\boxed{A = 0.6 \text{ m}}$

- b. What is its maximum acceleration?

$a_{\max} = A\omega^2$

$= (0.6)(5)^2$

$\boxed{= 15 \text{ m/s}^2}$

3. A mass on a spring has a maximum speed of 1.5 m/s and a maximum displacement of 25 cm. What is the period of oscillation?

$v_{\max} = 1.5 \text{ m/s}$

$A = 0.25 \text{ m}$

$v_{\max} = A\omega$

$1.5 = (0.25)\omega$

$\omega = 6 \text{ rad/s}$

$T = \frac{2\pi}{\omega} = \frac{2\pi}{6}$

$T = \frac{\pi}{3}$

$\boxed{T = 1.05 \text{ s}}$

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4. A mass on a spring is oscillating with a frequency of 20 rpm. It also has a maximum acceleration of  $1.5 \text{ m/s}^2$ . What is the amplitude of the oscillation?

$$f = 20 \text{ rpm}$$

$$a_{\text{max}} = 1.5 \text{ m/s}^2$$

$$\left( \frac{20 \text{ rev}}{\text{min}} \right) \left( \frac{1 \text{ min}}{60 \text{ s}} \right) \left( \frac{2\pi \text{ rad}}{1 \text{ rev}} \right) = \frac{40\pi}{60} \text{ rad/s} = \frac{2}{3} \pi$$

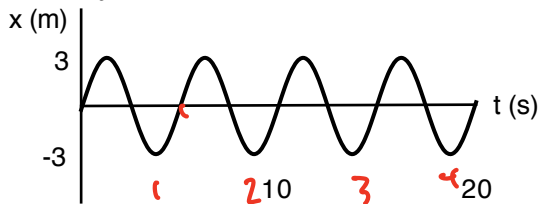
$$\omega = \frac{2}{3} \pi$$

$$a_{\text{max}} = A \omega^2$$

$$1.5 = A \left( \frac{2}{3} \pi \right)^2$$

$$A = 0.34 \text{ m}$$

5. The position as a function of time for an oscillating object is shown. What is the maximum speed of the object?



$$\text{From graph: } A = 3 \text{ m}$$

$$4 \text{ cycles in } 20 \text{ sec}$$

$$\Rightarrow T = 5 \text{ s}$$

$$\therefore T = \frac{2\pi}{\omega}$$

$$5 = \frac{2\pi}{\omega}$$

$$\omega = \frac{2\pi}{5}$$

$$v_{\text{max}} = A \omega$$

$$v_{\text{max}} = (3) \left( \frac{2\pi}{5} \right) = \frac{6\pi}{5}$$

$$v_{\text{max}} = 3.77 \text{ m/s}$$

Answers:

1. a)  $1.5 \text{ m}$     b)  $2/3 \pi \text{ s}$     c)  $4.5 \text{ m/s}$     2. a)  $0.6 \text{ m}$     b)  $15 \text{ m/s}^2$   
 3)  $1/3 \pi \text{ s}$     4)  $0.34 \text{ m}$     5)  $6\pi/5 \text{ m/s}$