

Quiz #9: Oscillations

Problem 1 (2 points)

A simple pendulum of length  $L$  and mass  $M$  has frequency  $f$ . To increase its frequency to  $2f$ :

- a) increase its length to  $4L$
- b) increase its length to  $2L$
- c) decrease its length to  $L/2$
- d) decrease its length to  $L/4$
- e) decrease its mass to  $M/4$

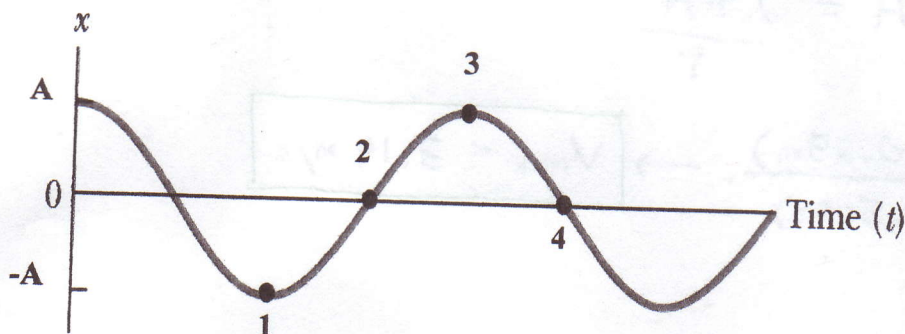
$$f = \frac{1}{2\pi} \sqrt{\frac{g}{L}}$$

$$f \propto \sqrt{\frac{1}{L}}$$

D

Problem 2 (4 points)

A mass connected to a horizontal spring is pulled back a distance  $x = A$  and released from rest on a frictionless surface. The figure below shows the position of the mass versus time. Answer the questions below with *one or more* of the four points indicated on the plot.



a) When is the speed equal to zero?

1 + 3

b) When is the acceleration positive?

1

c) When is the velocity positive?

2

d) When is the kinetic energy a maximum?

2 + 4

**Problem 3 (4 points)**

An unknown mass  $m$  is attached to a massless spring of constant  $k = 10.0 \text{ N/m}$ . The mass oscillates with a period of  $T = 0.500 \text{ s}$ . The amplitude of the oscillation is measured to be  $25.0 \text{ cm}$ .

a) What is the mass  $m$ ?

$$K = 10.0 \text{ N/m}$$

$$T = 0.500 \text{ s}$$

$$A = 0.25 \text{ m}$$

$$T = 2\pi \sqrt{\frac{m}{k}} \rightarrow T^2 = 4\pi^2 \left(\frac{m}{k}\right)$$

$$m = \frac{kT^2}{4\pi^2}$$

$$m = \frac{(10.0 \text{ N/m})(0.500 \text{ s})^2}{4\pi^2} \rightarrow m = 0.063 \text{ kg}$$

b) What is the maximum speed of the mass?

$$V_{\max} = 2\pi f A = \frac{2\pi A}{T}$$

$$V_{\max} = \frac{2\pi(0.25 \text{ m})}{(0.500 \text{ s})} \rightarrow V_{\max} = 3.14 \text{ m/s}$$

c) What is the maximum acceleration of the mass?

$$a_{\max} = (2\pi f)^2 A = 4\pi^2 f^2 A$$

$$a_{\max} = \frac{4\pi^2 A}{T^2} = \frac{4\pi^2(0.25)}{(0.500 \text{ s})^2} \rightarrow a_{\max} = 39.5 \text{ m/s}^2$$