

Multiple-Choice Questions of Chapter 10

Question 1

A pendulum is timed as it swings back and forth. The clock is started when the bob is at the left end of its swing. When the bob returns to the left end for the 90th return, the clock reads 60.0 s. a) What is the period of vibration? b) What is the frequency of vibration?

- A) (a) 1.50 s, (b) 0.667 Hz
 B) (a) 0.667 s, (b) 1.50 Hz
 C) (a) 60 s, (b) 0.0167 Hz
 D) (a) 0.0167 s, (b) 60 Hz

$$T = \frac{60}{90} = 0.667 \text{ s}$$

$$f = \frac{1}{T} = 1.5 \text{ Hz}$$

Question 2

A particle vibrates according to the equation $x = 20 \cos 16t$, where x is in centimeters. Find its amplitude, frequency, and position at exactly $t = 0$ s.

- A) $A = 20$ cm, $f = 5.1$ Hz, $x = 20$ cm
 B) $A = 20$ cm, $f = 2.5$ Hz, $x = 20$ cm
 C) $A = 20$ cm, $f = 2.5$ Hz, $x = 0$ cm
 D) $A = 20$ cm, $f = 16$ Hz, $x = 20$ cm

$$x = 20 \cos(16t) \Rightarrow A = 20 \text{ cm}$$

$$\omega = 16 = 2\pi f \rightarrow f = \frac{16}{2\pi} = 2.5 \text{ Hz}$$

$$\text{at } t=0 \quad x = 20 \cos(0) = 20 \text{ cm}$$

Question 3

A particle oscillates according to the equation $y = 5.0 \cos 23t$, where y is in centimeters. Find its frequency of oscillation and its position at $t = 0.15$ s.

- A) $f = 23$ Hz, $y = -4.8$ cm
 B) $f = 3.7$ Hz, $y = -5.0$ cm
 C) $f = 3.7$ Hz, $y = -4.8$ cm
 D) $f = 3.7$ Hz, $y = +4.8$ cm

$$y = 5 \cos 23t \Rightarrow \omega = 23 = 2\pi f$$

$$f = \frac{23}{2\pi} = 3.7 \text{ Hz}$$

$$y \text{ at } t = 0.15 : y = 5 \cos(23 \times 0.15) = -4.8 \text{ cm}$$

Question 4

A 300-g mass at the end of an ideal spring vibrates up and down in such a way that it is 2.0 cm above the tabletop at its lowest point and 16 cm above at its highest point. Its period is 4.0 s. Determine (a) the amplitude of vibration, (b) the spring constant, (c) the speed and acceleration of the mass when it is 9 cm above the table top, (d) the speed and acceleration of the mass when it is 12 cm above the table top.

- A) (a) 8.0 cm (b) 0.24 N/m (c) 0.14 m/s; zero (d) 0.099 m/s, 2.47 m/s²
 B) (a) 9.0 cm (b) 2.96 N/m (c) 0.22 m/s; zero (d) 0.15 m/s, 1.2 m/s²
 C) (a) 7.0 cm (b) 0.74 N/m (c) 0.11 m/s; zero (d) 0.099 m/s, 0.074 m/s²
 D) (a) 14.0 cm (b) 740 N/m (c) 0.121 m/s; zero (d) 0.07 m/s, 0.074 m/s²

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Question 5

A 2.5-kg mass undergoes SHM and makes exactly 3 vibrations each second. Compute (a) the acceleration and (b) the restoring force acting on the body when its displacement from the equilibrium position is 5.0 cm.

- A) 18 m/s², 44 N
 B) 0.00014 m/s², 0.00035 N
 C) 1780 m/s², 8880 N
 D) 5.9 m/s², 0.296 N

$$f = 3 \text{ Hz}, m = 2.5 \text{ kg} \Rightarrow$$

$$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}} \Rightarrow k = \dots = 900 \text{ N/m}$$

$$a) \quad a = \frac{F}{m} = \frac{kx}{m} = \frac{(900)(0.05)}{2.5} = 18 \text{ m/s}^2$$

$$b) \quad F = kx = (900)(0.05) = 45 \text{ N}$$

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$$a_m = \omega^2 A = \frac{k}{m} A = (11.3)^2 (0.07) = 8.9 \text{ m/s}^2$$

$$b) \frac{1}{2} k A^2 = \frac{1}{2} k x^2 + \frac{1}{2} m v^2 \rightarrow \boxed{v = 0.72 \text{ m/s}}$$

Question 6

A 300-g mass at the end of a spring oscillates with an amplitude of 7.0 cm and a frequency of 1.80 Hz. (a) Find its maximum speed and maximum acceleration. (b) What is its speed when it is 3.0 cm from its equilibrium position?

$$f = 1.8 \text{ Hz} = \frac{1}{2\pi} \sqrt{\frac{k}{m}} \Rightarrow$$

$$\sqrt{\frac{k}{m}} = (2\pi)(1.8) = 11.3$$

$$\text{A) } 8.96 \text{ m/s, } 8.9 \text{ m/s}^2 \text{ (b) } 0.45 \text{ m/s}$$

$$\text{B) } 79.2 \text{ m/s, } 895 \text{ m/s}^2 \text{ (b) } 0.512 \text{ m/s}$$

$$\text{C) } 0.79 \text{ m/s, } 8.9 \text{ m/s}^2 \text{ (b) } 0.72 \text{ m/s}$$

$$\text{D) } 0.0062 \text{ m/s, } 0.00055 \text{ m/s}^2 \text{ (b) } 0.0056 \text{ m/s}$$

$$a) v_m = \sqrt{\frac{k}{m}} A = (11.3)(0.07) = 0.79 \text{ m/s}$$

Question 7

With a 50-g mass at its end, a spring undergoes SHM with a frequency of 0.70 Hz. How much work is done in stretching the spring 15 cm from its unstretched length? How much energy is then stored in the spring?

$$\text{A) } 0.011 \text{ J, } 0.011 \text{ J}$$

$$\text{B) } 11 \text{ J, } 11 \text{ J}$$

$$\text{C) } 110 \text{ J, } 110 \text{ J}$$

$$\text{D) } 0.073 \text{ J, } 0.073 \text{ J}$$

$$W = \frac{1}{2} k x^2 = \frac{1}{2} (0.98)(0.15)^2 = 0.011 \text{ J}$$

$$\text{Work} = \text{Stored Energy} = 0.011 \text{ J}$$

Question 8

A certain spring is stretched 20 cm when a given mass is hung from it. What is the frequency of vibration of the mass if pulled down a little and released?

$$\text{A) } 1.1 \text{ Hz}$$

$$\text{B) } 44 \text{ Hz}$$

$$\text{C) } 0.11 \text{ Hz}$$

$$\text{D) } 7.80 \text{ Hz}$$

$$\checkmark \text{ At this point, } \Sigma F = 0 \rightarrow mg - kx = 0 \quad mg = kx$$

$$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}} = \frac{1}{2\pi} \sqrt{\frac{mg}{x}} = \frac{1}{2\pi} \sqrt{\frac{g}{x}} = \dots = \boxed{1.1 \text{ Hz}} \quad k = \frac{mg}{x}$$

Question 9

A 300-g mass at the end of a spring executes SHM with a period of 2.4 s. Find the period of oscillation of a 133-g mass attached to the same spring.

$$\text{A) } 1.6 \text{ s}$$

$$\text{B) } 0.033 \text{ s}$$

$$\text{C) } 24.7 \text{ s}$$

$$\text{D) } 0.41 \text{ s}$$

$$T = 2\pi \sqrt{\frac{m}{k}} \Rightarrow 2.4 = 2\pi \sqrt{\frac{0.3}{k}} \Rightarrow \boxed{k = 2.1 \text{ N/m}}$$

$$T' = 2\pi \sqrt{\frac{m'}{k}} = 2\pi \sqrt{\frac{0.133}{2.1}} = \boxed{1.6 \text{ s}}$$

Question 10

Find the frequency of vibration on Mars for a simple pendulum that is 50 cm long. Objects weigh 0.40 as much on Mars as on the Earth.

$$\text{A) } 0.057 \text{ Hz}$$

$$\text{B) } 17.8 \text{ Hz}$$

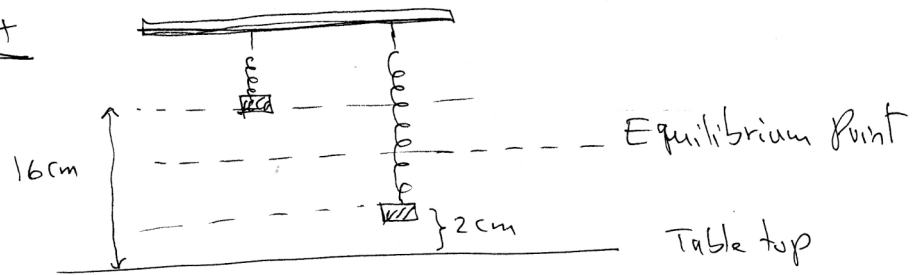
$$\text{C) } 2.22 \text{ Hz}$$

$$\text{D) } 0.45 \text{ Hz}$$

$$T = 2\pi \sqrt{\frac{L}{g_{\text{Mars}}}} = 2\pi \sqrt{\frac{0.5}{(0.4 \times 9.8)}} = 2.24 \text{ s}$$

$$f = \frac{1}{T} = \boxed{0.45 \text{ Hz}}$$

Question 4



a) $2A = 16 - 2 = 14 \text{ cm} \Rightarrow \boxed{A = 7 \text{ cm}}$

b) $T = 2\pi \sqrt{\frac{m}{k}} \rightarrow 4 = 2\pi \sqrt{\frac{0.3}{k}} \Rightarrow \boxed{k = 0.74 \text{ N/m}}$

c) At 9 cm above the table, mass m is at equilibrium point. Thus its speed is $V_m = \sqrt{\frac{k}{m}} A = \boxed{1.1 \text{ m/s}}$

d) At 12 cm above the table top, $x = -3 \text{ cm}$ (i.e. the spring is compressed by 3 cm). $\Rightarrow$

$$\frac{1}{2} k A^2 = \frac{1}{2} k x^2 + \frac{1}{2} m v^2$$
$$(0.74)(0.07)^2 = (0.74)(-0.03)^2 + (0.3) v^2$$
$$\boxed{v = 0.099 \text{ m/s}}$$

and $a = \frac{F}{m} = \frac{-kx}{m} = \frac{-(0.74)(-0.03)}{0.3}$

$$\boxed{a = 0.074 \text{ m/s}^2}$$