SAXONY EGYPT UNIVERSITY
FOR APPLIED SCIENCE AND TECHNOLOGY

GAP121 Physics I

Academic Year: 24/25
Semester: Spring 2025

Problem Set 5

Simple Harmonic Vibrations

Select the correct answer

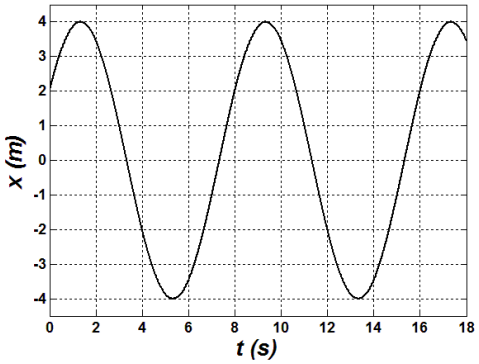
1. The position x of an object varies with time t. For which of the following equations relating x and t is the motion of the object simple harmonic motion? (There may be more than one correct choice.)

a) $x = 5 \sin^2 3t$ b) $x = 8 \cos 3t$ c) $x = 4 \tan 2t$ d) $x = 5 \sin 3t$ e) $x = 2 \cos(3t - 1)$

2. An object is executing simple harmonic motion. What is true about the acceleration of this object? (There may be more than one correct choice.)

a) The acceleration is a maximum when the displacement of the object is a maximum.
b) The acceleration is a maximum when the speed of the object is a maximum.
c) The acceleration is a maximum when the displacement of the object is zero.
d) The acceleration is zero when the speed of the object is a maximum.
e) The acceleration is a maximum when the object is instantaneously at rest.

3. The simple harmonic motion of an object is described by the graph shown in the figure. What is the equation for the position $x(t)$ of the object as a function of time t?



a) $x(t) = (4.0 \text{ m}) \sin [(2\pi/8.0 \text{ s}) t + \pi/3.0]$
b) $x(t) = (4.0 \text{ m}) \cos [(2\pi/8.0 \text{ s}) t + 2\pi/3.0]$
c) $x(t) = (4.0 \text{ m}) \cos [(2\pi/8.0 \text{ s}) t + \pi/3.0]$
d) $x(t) = (4.0 \text{ m}) \cos [(2\pi/8.0 \text{ s}) t - \pi/3.0]$
e) $x(t) = (8.0 \text{ m}) \cos [(2\pi/8.0 \text{ s}) t + \pi/3.0]$

4. A simple harmonic oscillator has an amplitude of 3.50 cm and a maximum speed of 26.0 cm/s. What is its speed when the displacement is 1.75 cm?

a) 12.0 cm/s b) 22.5 cm/s c) 14.2 cm/s d) 15.0 cm/s e) 17.0 cm/s

5. The displacement of an object oscillating on a spring is given by $x(t) = x_m \cos(\omega t + \varphi)$. If the initial displacement is zero and the initial velocity is in the negative x direction, then the phase constant φ is:

a) 0 b) $\pi/2$ rad c) π rad d) $3\pi/2$ rad e) 2π rad

6. A certain spring elongates **9.0mm** when it is suspended vertically and a block of mass M is hung on it. The natural angular frequency of this block-spring system is:

a) 0.088 rad/s b) 33 rad/s c) 200 rad/s d) 1140 rad/s e) cannot be computed

7. A mass-spring system is oscillating with amplitude A. The kinetic energy will equal the potential energy only when the displacement is:

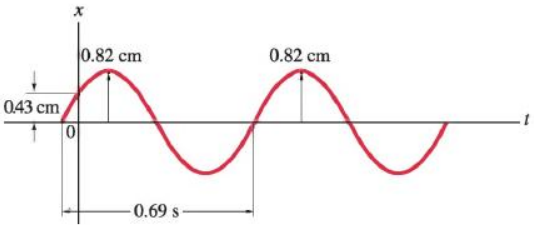
a) zero b) $\pm A/4$ c) $\pm A/\sqrt{2}$ d) $\pm A/2$ e) anywhere between $-A$ and $+A$

8. If a simple pendulum is taken from sea level to the top of a high mountain and started at the same angle of 5°, it would oscillate at the top of the mountain

a) slightly slower b) slightly faster c) at exactly the same frequency
d) not at all—it would stop (e) none of these.

Problems

1. The graph of displacement vs. time for a small mass m at the end of a spring is shown in Fig. 1. At t = 0, x = 0.43 cm. (a) If m = 9.5 g, find the spring constant, k. (b) Write the equation for displacement x as a function of time.



2. An object of unknown mass m is hung from a vertical spring of unknown spring constant k, and the object is observed to be at rest when the spring has extended by 14 cm. The object is then given a slight push and executes SHM. Determine the period T of this oscillation.

3. (a) At what displacement of a SHM is the energy half kinetic and half potential? (b) What fraction of the total energy of a SHM is kinetic and what fraction potential when the displacement is one third the amplitude?

4. A pendulum has a period of 1.35 s on Earth. What is its period on Mars, where the acceleration of gravity is about 0.37 that on Earth?