National University

of Computer & Emerging Sciences

Assignment 3

Fall 2025

***NS 1001 Applied physics* BS-CS, DS(All sections)**

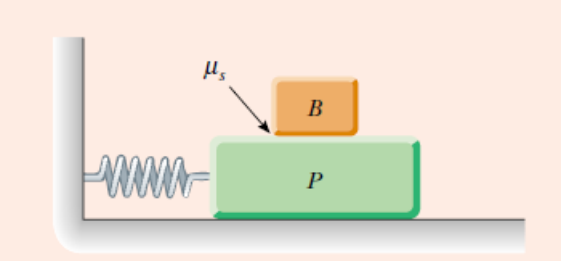
CLO:2 Use oscillations and analyze different types of waves graphically & mathematically.

Q.1. A 0.500-kg object attached to a spring with a force constant of 8.00 N/m vibrates in simple harmonic motion with an amplitude of 10.0 cm. Calculate (a) the maximum value of its speed and acceleration, (b) the speed and acceleration when the object is 6.00 cm from the equilibrium position, and (c) the time interval required for the object to move from $x = 0$to $x = 8.00$cm.

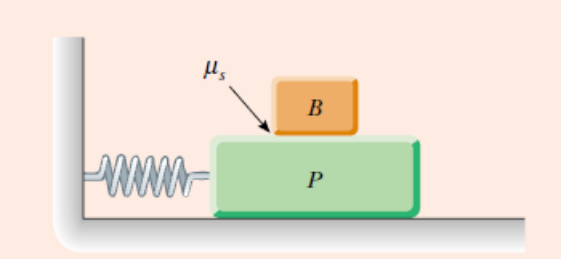
Q.2. A 2.00-kg object is attached to a spring and placed on a horizontal, smooth surface. A horizontal force of 20.0 N is required to hold the object at rest when it is pulled 0.200 m from its equilibrium position (the origin of the x-axis). The object is now released from rest with an initial position of $x_i = 0.200$ m, and it subsequently undergoes simple harmonic oscillations. Find
(a) the force constant of the spring,
(b) the frequency of the oscillations, and
(c) the maximum speed of the object. Where does this maximum speed occur?
(d) Find the maximum acceleration of the object. Where does it occur?
(e) Find the total energy of the oscillating system.
(f) Find the speed and
(g) the acceleration of the object when its position is equal to one third of the maximum value.

Q.3 A large block *P*executes horizontal simple harmonic motion as it slides across a frictionless surface with a frequency $f = 1.50$ Hz. Block *B*rests on top of it, as shown in Figure, and the coefficient of static friction between the two is

$\mu_s = 0.600$. What maximum amplitude of oscillation can the system have if block $B$is not to slip?

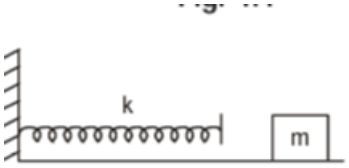


Q.4. A large block Pexecutes horizontal simple harmonic motion as it slides across a frictionless surface with a frequency f. Block Brests on it, as shown in Fig, and the coefficient of static friction between the two is μ_s. What maximum amplitude of oscillation can the system have if the upper block is not to slip?_



Q.5. At $t = 0$, the displacement of a point $x(0)$in a linear oscillator is -8.6 cm, its velocity $v(0) = -0.93$ m/s, and its acceleration $a(0) = +48\ m/s2$ What are the angular frequency $\omega$and the frequency ν?
(b) What is the phase constant?
(c) What is the amplitude of the motion?

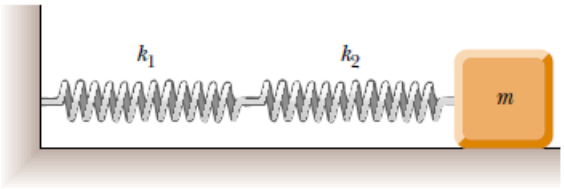
Q.6. The 100 g mass shown in figure is pushed to the left against a light spring of spring constant $k = 500$ N/mand compresses the spring 10 cm from its relaxed position. The system is then released and the mass shoots to the right. If friction is ignored, how fast will the mass be moving as it shoots away?



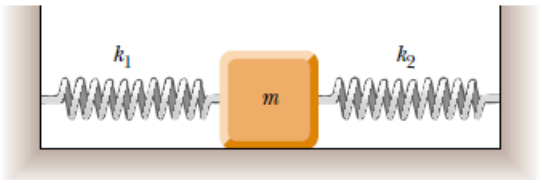
Q.7. A block of mass $m$is connected to two springs of force constants $k_1$and $k_2$as shown in Figures a and b. In each case, the block moves on a frictionless table after it is displaced from equilibrium and released. Show that in the two cases the block exhibits simple harmonic motion with periods

(a) $T = 2\pi\sqrt{\dfrac{m(k_1 + k_2)}{k_1 k_2}}$

(b) $T = 2\pi\sqrt{\dfrac{m}{k_1 + k_2}}$



(a)



Q.8.

A sinusoidal wave is described by

$$y = (0.25\text{ m})\sin(0.30x - 40t)$$

where $x$and $y$are in meters and $t$is in seconds. Determine for this wave the
(a) amplitude,
(b) angular frequency,
(c) angular wave number,
(d) wavelength,
(e) wave speed, and
(f) direction of motion.

Q.9. A transverse wave on a string is described by the equation

$$y(x,t) = (0.350\text{ m})\sin[(1.25\text{ rad/m})x + (99.6\text{ rad/s})t].$$

Find the transverse speed and transverse acceleration of an element of string at x= 1 and t=0 .

Q.10.

Two waves traveling in opposite directions produce a standing wave.
The individual wave functions

$y = A\sin(kx - \omega t)$are $y_1 = (4.0\text{ cm})\sin(3.0x - 2.0t)$and

$y_2 = (4.0\text{ cm})\sin(3.0x + 2.0t)$,where $x$and $y$are measured in centimeters.(a) Find the amplitude of the simple harmonic motion of the particle of the medium located at $x = 2.3$ cm.(b) Find the positions of the nodes and antinodes.(c) What is the amplitude of the simple harmonic motion of a particle located at an antinode?

Q.11Two waves are described by the wave functions, $y_1(x,t) = 5.0\sin(2.0x - 10t)$and $y_2(x,t) = 10\cos(2.0x - 10t)$ where y_1, y_2, and $x$are in meters and $t$is in seconds. Show that the wave resulting from their superposition is also sinusoidal. Determine the amplitude and phase of this sinusoidal wave.

Q.12. Two sinusoidal waves combining in a medium are described by the wave functions,$y_1 = (3.0\text{ cm})\sin[\pi(x + 0.60t)]$

and $y_2 = (3.0\text{ cm})\sin[\pi(x - 0.60t)]$ where x is in centimeters and $t$is in seconds. Determine the maximum transverse position of an element of the medium at
(a) $x = 0.250$ cm,
(b) $x = 0.500$ cm, and
(c) $x = 1.50$ cm.

(d) Find the three smallest values of $x$corresponding to antinodes.

Q.13.A 10.6-kg object oscillates at the end of a vertical spring that has a spring constant of 2.05×10^4 N/m. The effect of air resistance is represented by the damping coefficient $b = 3.00$ N.s/m.

(a) Calculate the frequency of the damped oscillation.
(b) By what percentage does the amplitude of the oscillation decrease in each cycle?
(c) Find the time interval that elapses while the energy of the system drops to 5.00%of its initial value.