



Assignment 4

Oscillations

Q.1. Consider an object on a spring whose position is given by

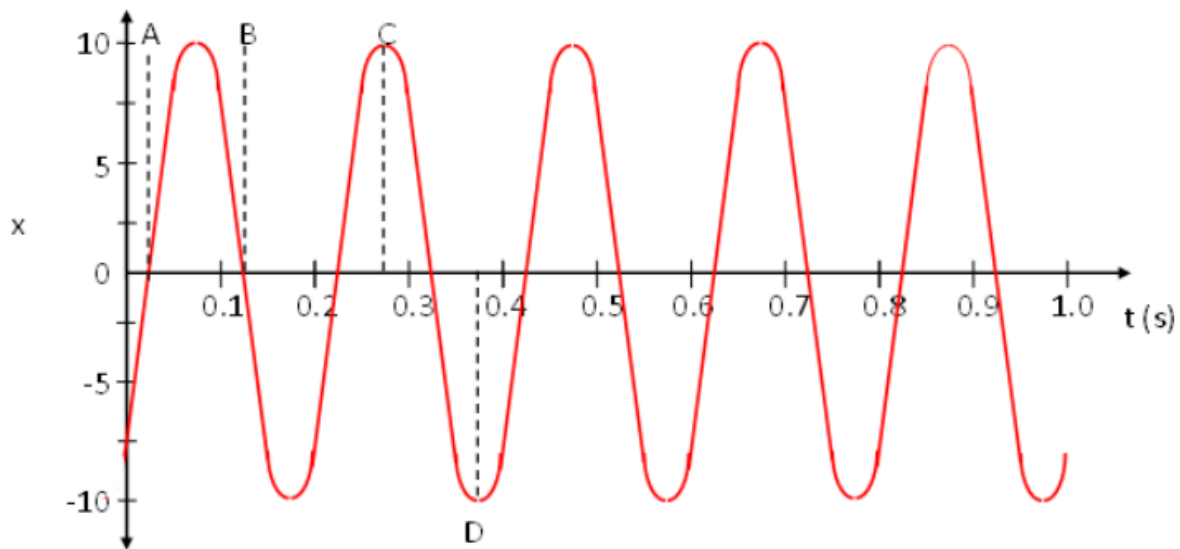
$x(t) = (5\text{ cm}) \cos(9.90\text{ s}^{-1}t)$. (a) What is the maximum speed of the object? (b) When does this maximum speed first occur after $t=0$? (c) What is the maximum of the acceleration of the object? (d) When does the maximum magnitude of the acceleration first occur after $t=0$?

Q.2. An object oscillates with angular frequency $\omega=8\text{ rad/s}$. At $t=0$, the object is at $x=4\text{ cm}$ with an initial velocity $v_x = -25\text{ cm/s}$. (a) Find the amplitude and phase constant for the motion. (b) Write x as a function of time.

Q.3. A 3 kg object attached to a spring oscillates with an amplitude of 4 cm and a period of 2 s . (a) What is the total energy? (b) What is the maximum speed of the object? (c) At what position x_1 is the speed equal to half its maximum value?

Q.4. A block of mass M is on a frictionless surface below. It is attached to a wall by two springs with same constant K . Initially the block is at rest and the springs are unstretched. The block is pulled a distance A and then released. (a) What is the speed of the block as it passes through equilibrium? (b) What is the angular frequency ω ? (c) If two springs were replaced by one spring so that ω remain same, what would be its spring constant have to be?

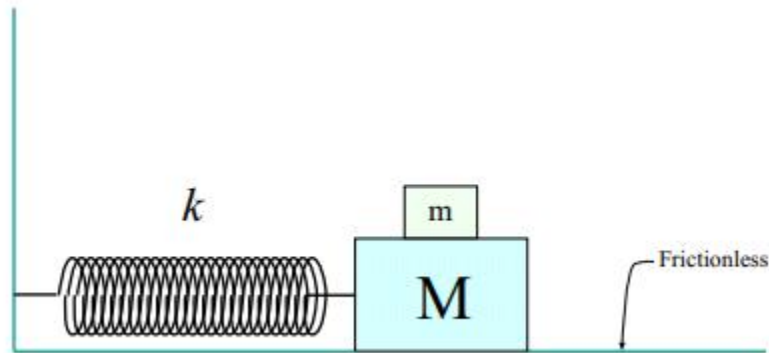
Q.5. The diagram below shows the motion of a 2kg on a horizontal spring. Find the phase constant. Write down the equation of displacement as a function of time? Find the spring constant, total energy, maximum speed and maximum acceleration?



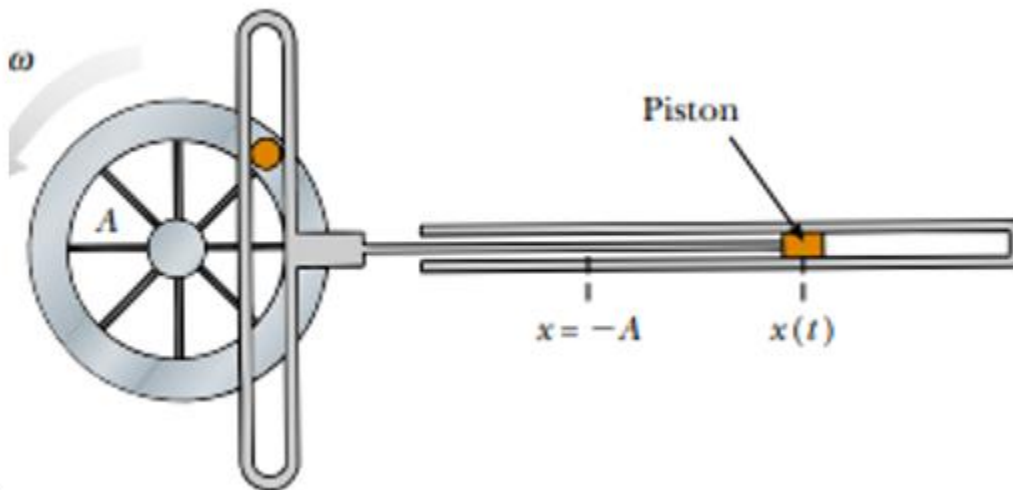
Q.6. Will damped oscillations occur for any values of b and k . Explain?

Q.7. A simple pendulum having a length 2.23m and a mass of 6.74 kg is given an initial speed of 2.06m/s at its equilibrium position. Assume it undergoes simple harmonic motion and determine its period, total energy and maximum angular displacement?

Q.8. Two blocks ($m=1\text{kg}$ and $M=10\text{kg}$) and a spring constant $k=200\text{N/m}$ are arranged on a horizontal frictionless surface as shown in the figure. The coefficient of static friction between the two blocks is 0.40. What is the maximum possible amplitude of simple harmonic motion of the spring block system if no slippage is to occur between the blocks?



Q.9. Consider the simplified single piston engine as shown in the figure. If the wheel rotates with constant angular speed, explain why the piston rod oscillates in simple harmonic motion. Show it making diagram and equations.



Q.10. A pendulum with time period of 1 s is losing energy due to damping. At certain time its energy is 45J. If after completing 15 oscillations its energy has become 15J. What will be the value of b/m ?

Q.11. Consider a damped SHO having $m = 2\text{ kg}$, $b = \ln 2 \text{ N s/m}$, and $k = 100 \text{ N/m}$. Find the time 't' after which energy of oscillations will be reduced to half of the initial value?

Q.12. A 300 g oscillator has a speed of 95.4 cm/s when its displacement is 3.0 cm and 71.4 cm/s when its displacement is 6.0 cm. What is the oscillator's maximum speed?

Q.13. An object in SHM oscillates with a period of 4.0 s and an amplitude of 10 cm. How long does the object take to move from $x = 0.0 \text{ cm}$ to $x = 6.0 \text{ cm}$?

