Solid Mechanics 2 Tutorial Sheets

Tutorial Sheets and Answers for DE2's Enjoyment

Tutorial Sheet 7: Vibrations

Topics covered are:

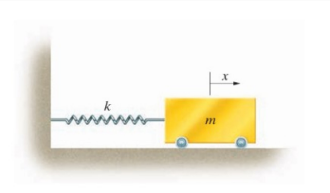
- Freely moving spring-mass oscillating systems
- Pendulums

Tips

- This needs to be done in radians!
- With spring systems on an angle be really careful if the system is starting at equilibrium, or you need to calculate the starting 'offset'.
- I've used mainly the equations taken directly from the formula sheet, but you can rearrange/combine them for certain variable combos to make them easier for use during the exam.

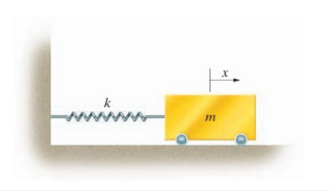
Question 1

The mass m=4 kg. The spring is unstretched when x=0. The period of vibration of the mass is measured and determined to be 0.5 s. The mass is displaced to the position x=0.1 m and released from rest at t=0. Determine its position at t=0.4 s.



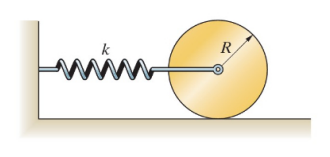
Question 2

The mass m=4 kg. The spring is unstretched when x=0. The frequency of vibration of the mass is measured and determined to be 6 Hz. The mass is displaced to the position x=0.1 m and given a velocity dx/dt=5 m/s at t=0. Determine the amplitude of the resulting vibration.



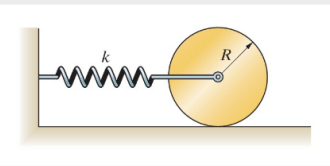
Question 3

The 89 N disk rolls on the horizontal surface.Its radius is R=152.4 mm. Determine the spring constant k so that the frequency of vibration of the system relative to its equilibrium position is f=1 Hz.



Question 4

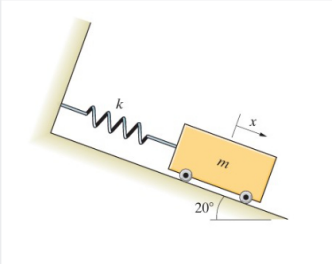
The 89 N disk rolls on the horizontal surface. Its radius is R= 152.4 mm. The spring constant is k=218.9 N/m. At t=0, the spring is unstretched and the disk has a clockwise angular velocity of 2 rad/s. What is the amplitude of the resulting vibrations of the center of the disk?



Question 5

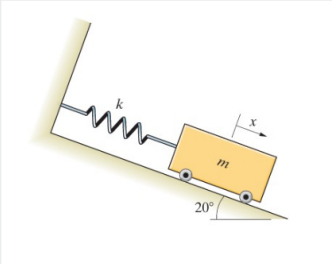
The mass m=4 kg and the spring constant is k=64 N/m. For vibration of the spring-mass oscillator relative to its equilibrium position, determine

(a) The frequency
(b) The period



Question 6

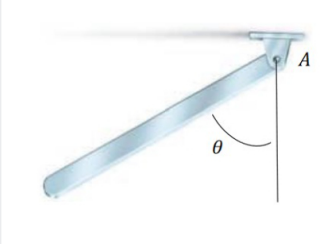
The mass m=4 kg and the spring constant is k=64 N/m. The spring is unstretched when x=0. At t=0, x =0 and the mass has a velocity of 2 m/s down the inclined surface. What is the value of x at t=0.8 s?



Question 7

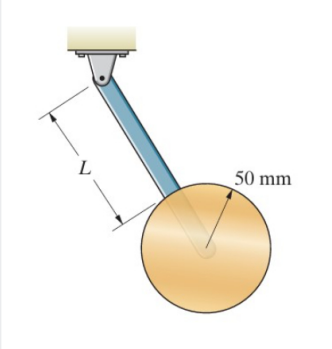
Consider the one-degree of freedom system below (a pendulum). The slender bar is rotated to some angle θ, released, and it oscillates back and forth.

(a) Draw the free-body diagram of the bar.
(b) Using Newton's 2nd law write the moment balance about the centre of rotation A.
(c) Write the general equation to determine the frequency of a pendulum.
(d) Determine the frequency of the pendulum in rad/s and Hz.



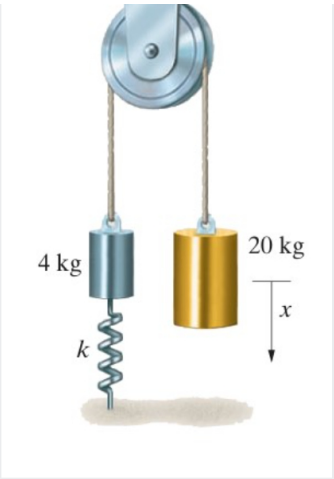
Question 8

You are asked to design a pendulum clock, and you begin with the pendulum. The mass of the disk is 2 kg. Determine the length L of the bar so that the period of small oscillations of the pendulum is 1 s. For this question, neglect the mass of the bar.



Question 9

The spring constant is k=785 N/m. The spring is unstretched when x=0. Neglect the mass of the pulley, that is, assume that the tension in the rope is the same on both sides of the pulley. The system is released from rest with x=0. Determine x=0 as a function of time.



Question 10

The spring constant is k=785 N/m. The spring is unstretched with x=0. The radius of the pulley is 125 mm, and moment of inertia about its axis is I=0.05 kgm ^{2}. The system is released from rest with x=0. Determine x as a function of time.