Homework Set 10: Simple Harmonic Motion
Due Wednesday, October 9, 2024

Problems From TM5

1) *3-1.* A simple harmonic oscillator consists of a *100-g* mass attached to a spring whose force constant is 10^4 *dyne/cm*. The mass is displaced 3 cm and released from rest. Calculate

a) the natural frequency ν_o and the period τ_o,
b) the total energy, and
c) the maximum speed.

2) *3-3.* The oscillator of Problem 3-1 is set into motion by giving it an initial velocity of *1 cm/s* at its equilibrium position. Calculate

a) the maximum displacement and,
b) the maximum potential energy.

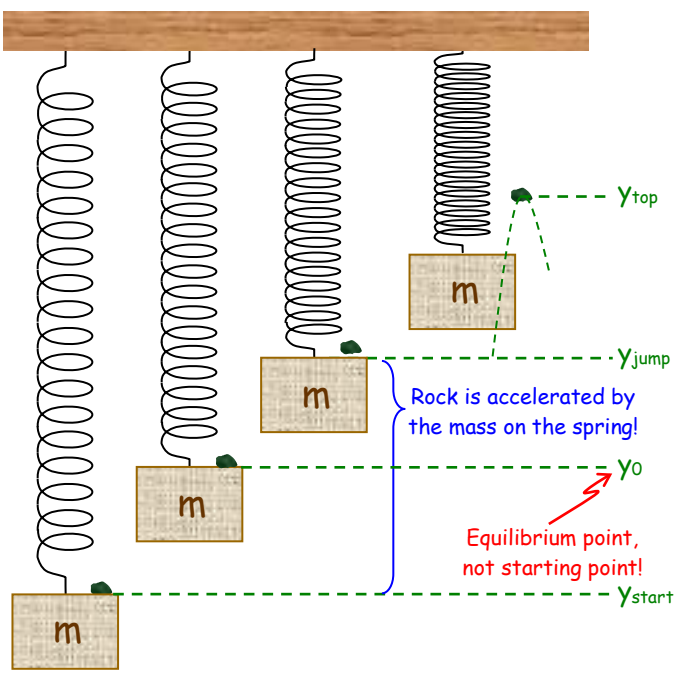
cgs Units:
Length: cm
Mass: g
Time: s
Force: dyne = $\frac{g \cdot cm}{s^2}$
$1\ N = 1\times10^5\ d$
Energy: erg = dyne•cm = $\frac{g \cdot cm^2}{s^2}$
$1\ J = 1\times10^7\ erg$

3) A block suspended from a spring is oscillating vertically with a frequency of *4 Hz* and an amplitude of *7 cm*. A very small bit of rock is placed on top of the oscillating block just as it reaches its lowest point. Assume that the rock has no effect on the oscillation.

a) At what distance above the block's equilibrium position does the rock lose contact with the block?
(Hint: What force pushes the rock up? How is this force related to the spring? Draw the FBD for the rock and include the acceleration due to the "launcher"; for SHM, $\ddot{y} = -\omega^2 y$.)

b) What is the speed of the rock when it leaves the block?
(Hint: What force accelerates it and goes to zero when it leaveaves the block? What speed was the "launcher" going? Remember the crane lifting the bricks HW 01.1)

c) What is the greatest distance above the block's equilibrium position reached by the rock?

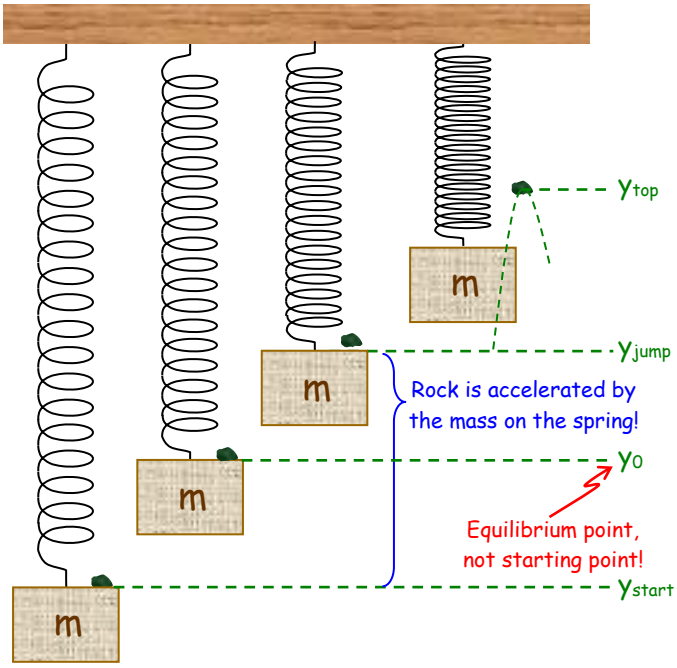


3) A block suspended from a spring is oscillating vertically with a frequency of *4 Hz* and an amplitude of *7 cm*. A very small bit of rock is placed on top of the oscillating block just as it reaches its lowest point. Assume that the rock has no effect on the oscillation.

a) At what distance above the block's equilibrium position does the rock lose contact with the block?

(HINT: WHAT FORCE PUSHES THE ROCK UP? HOW IS THIS FORCE RELATED TO THE SPRING? DRAW THE FBD FOR THE ROCK AND INCLUDE THE ACCELERATION DUE TO THE "LAUNCHER"; FOR SHM, $\ddot{y} = -\omega^2 y$.)

b) What is the speed of the rock when it leaves the block?

(HINT: WHAT FORCE ACCELERATES IT AND GOES TO ZERO WHEN IT LEAVEAVES THE BLOCK? WHAT SPEED WAS THE "LAUNCHER" GOING? REMEMBER THE CRANE LIFTING THE BRICKS HW 01.1)

c) What is the greatest distance above the block's equilibrium position reached by the rock?