Physics I (PHYS 200): PS 10

Fall 2013 v1.0

This is the penultimate problem set of the semester.

Reading:

In this past week we have worked with HRW Chapters 12 (on statics) and 14 (on fluids)
Since the last problem set we worked in Chapters 13 (Newtonian gravitation), 15 (oscillations), and 16 (waves)
As intersting as this material is, I *will not* include sections 16-3, 16-4, and 16-6 on the final.
In the week after break we'll move on to discuss Chapter 17 (more waves) and Chapter 18 (thermodynamics).

Problems:

Due in class Friday, December 6.

(1) HRW Chapter 13 Problem 20
(2) HRW Chapter 13 Problem 22
(3) HRW Chapter 13 Problem 36
(4) HRW Chapter 13 Problem 37
(5) HRW Chapter 13 Problem 54
(6) HRW Chapter 13 Problem 55
(7) HRW Chapter 13 Problem 74
(8) HRW Chapter 15 Problem 11
(9) HRW Chapter 15 Problem 40
(10) HRW Chapter 15 Problem 53
(11) A block of mass $M = 2.4$ kg, at rest on a frictionless table, is attached to a wall by a spring with constant $k = 9.6$ N/m. Desperaux the Mouse (of mass $m = 19$ g) "flying" along at a remarkable 7.3 m/s leaps and holds onto the block.
  (a) Assuming the spring is not compressed significantly during the impact, find the velocity of Despereaux and the block immediately after he lands on the block.
  (b) Determine the amplitude of the resulting simple harmonic motion.
  (c) Determine the angular frequency ω of the resulting simple harmonic motion.
  (d) Let's write the general solution for Despereaux's position as a function of time is

$$x(t) = x_m \cos(\omega t + \varphi)$$

  Using the position and speed of Despereaux immediately after he leaps on the block, find φ and write the specific solution, with x_m and φ determined.
(12) Many modern towers contain huge damped oscillator systems designed to oscillate at the same frequency as the buildings themselves. For instance the Taipei 101 tower has a 728 ton pendulum built into the 90 - 87th floors. You can view a video of the relative motion during an earthquake on this same web page.
  (a) Why are these damped oscillator systems built?
  (b) In the video the period of oscillation is about 7.1 s. Assuming a lightly damped simple pendulum, find the natural angular frequency.