

PHYSICS 1020

Homework #1

(Due Feb. 5, 2018)

1. (KJF 14-3) In taking your pulse, you count 75 heartbeats in 1 min. What are the period (in s) and frequency (in Hz) of your heart's oscillations?
2. (KJF 14-19) The position of a 50 g oscillating mass is given by $x(t) = (2.0 \text{ cm}) \cos(10t)$, where t is in seconds. Determine:
 - a. The amplitude.
 - b. The period.
 - c. The spring constant.
 - d. The maximum speed.
 - e. The total energy.
 - f. The velocity at $t = 0.40 \text{ s}$.
3. (KJF 14-27) The acceleration due to gravity on the surface of the Moon is 1.62 m/s^2 . What is the length of a pendulum whose period on the Moon matches the period of a 2.00-meter-long pendulum on the Earth?
4. Prove that an oscillating uniform rod has the same period whether the rod is oscillated about one end, or is oscillated about a point $2/3$ the way from one end.
5. At what displacement from equilibrium is the energy of a simple harmonic oscillator half kinetic energy and half potential energy?
6. (KJF 14-33) A thin, circular hoop with a radius of 0.22 m is hanging from its rim on a nail. When pulled to the side and released, the hoop swings back and forth as a physical pendulum. The moment of inertia of a hoop for a rotational axis passing through its edge is $I = 2MR^2$. What is the period of oscillation of the hoop?

7. A clock uses oscillations of a simple plane plane pendulum to keep time, and the pendulum consists of a light metallic rod ending in a heavy bob. When the temperature rises in the summer, how is the clock affected? (That is, will the clock run faster or slower?) Why?

8. **(Extra credit)** Examine the following mathematical derivation. Are the steps shown correct? If not, explain in detail exactly where the error is, and what was done wrong. (Here π has the usual mathematical meaning: $\pi = 3.14159265\dots$)

$$x = (\pi + 3)/2 \tag{1}$$

$$2x = \pi + 3 \tag{2}$$

$$2x(\pi - 3) = (\pi + 3)(\pi - 3) \tag{3}$$

$$2\pi x - 6x = \pi^2 - 9 \tag{4}$$

$$9 - 6x = \pi^2 - 2\pi x \tag{5}$$

$$9 - 6x + x^2 = \pi^2 - 2\pi x + x^2 \tag{6}$$

$$(3 - x)^2 = (\pi - x)^2 \tag{7}$$

$$3 - x = \pi - x \tag{8}$$

$$\pi = 3 \tag{9}$$