

# PHYSICS 1020

## Homework #1

(Due Feb. 4, 2019)

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  $1.62 \text{ m/s}^2$ . 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 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. A spring is made of copper wire of diameter 2.0 mm. The diameter of the spring coil is 2.0 cm, and there are 50 turns of wire in the spring. (a) What is the spring constant of the spring? (b) If five such springs were connected in series, what would be the effective spring constant of the combination? (c) If five such springs were connected in parallel, what would be the effective spring constant of the combination?

9. **(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  $\pi$  has the usual mathematical meaning:  $\pi = 3.14159265 \dots$ )

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

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

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

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

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

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

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

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

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