

PHYSICS 1020

Homework #1

(Due Feb. 1, 2021)

1. (KJF 14-1) When a guitar string plays the note “A,” the string vibrates at 440 Hz. What is the period of the vibration?
2. (KJF 14-19) A block attached to a spring with unknown spring constant oscillates with a period of 2.00 s. What is the period if:
 - a. The mass is doubled?
 - b. The mass is halved?
 - c. The amplitude is doubled?
 - d. The spring constant is doubled?
3. 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.
4. At what displacement from equilibrium is the energy of a simple harmonic oscillator half kinetic energy and half potential energy?
5. (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?
6. (KJF 14-29) Astronauts of the first trip to Mars take along a pendulum that has a period on Earth of 1.50 s. The period on Mars turns out to be 2.45 s. What is the Martial free-fall acceleration?
7. 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?

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: $\pi = 3.14159265 \dots$)

$$x = (\pi + 3)/2 \quad (1)$$

$$2x = \pi + 3 \quad (2)$$

$$2x(\pi - 3) = (\pi + 3)(\pi - 3) \quad (3)$$

$$2\pi x - 6x = \pi^2 - 9 \quad (4)$$

$$9 - 6x = \pi^2 - 2\pi x \quad (5)$$

$$9 - 6x + x^2 = \pi^2 - 2\pi x + x^2 \quad (6)$$

$$(3 - x)^2 = (\pi - x)^2 \quad (7)$$

$$3 - x = \pi - x \quad (8)$$

$$\pi = 3 \quad (9)$$