

Name: \_\_\_\_\_  
Hour: \_\_\_\_\_ Date: \_\_\_\_\_

## Physics: *Waves and Sound HW*

### Set 1: Simple Harmonic Motion of a Mass-Spring System

- A spring of force constant 24.5 N/m is attached to different masses and the system is set in motion. Find the period and frequency of vibration for masses of the following magnitudes:
  - 2.82 kg
  
  
  
  
  
  
  
  
  
  
  - 83 g
- Four people in a 1268 kg car have a combined mass of 248 kg. The car's frame is supported by four springs, each with a force constant of 35 kN/m. What is the period of vibration of the car when it is driven over a pothole?
- A 0.37 kg mass is attached to a spring and set into vibration. If the period is 0.186 s, what is the spring constant?
- A 289 N object vibrates with a period of 3.11 s when hanging from a vertical spring. Determine the spring constant.
- A mass of 250 g is attached to a certain spring and set in motion. It is observed to make ten complete vibrations in 12.8 s. Determine the force constant of the spring.

ANSWERS:      1a.  $T = 2.13$  s,  $f = 0.469$  Hz      2. 0.65 s      4. 120. N/m  
                 1b.  $T = 0.37$  s,  $f = 2.7$  Hz      3. 420 N/m      5. 6.0 N/m

## Set 2: Hooke's Law

6. A 65 N weight is attached to a vertical spring, causing the spring to stretch 17.5 cm. Find the spring constant.
7. A water-balloon launcher shoots balloons with the aid of two elastic bands. If it takes a 360 N force to stretch the bands 0.94 m, what is the equivalent spring constant of the two bands?
8. Suppose a vertically-suspended spring stretches 21.3 cm from its equilibrium position when a 600. g mass is attached to it.
- Find the spring constant.
  - Compared to a spring having  $k = 75 \text{ N/m}$ , is the spring in Q8a stiffer or less stiff? Explain briefly.
9. How much force is required to pull a spring 6.40 cm from its equilibrium position if the spring constant is 18.4 kN/m?

## Set 3: Simple Harmonic Motion of a Simple Pendulum

10. You need to know the height of a balcony. If a pendulum suspended nearly to the ground from the balcony has a period of 9.28 s, how tall is the tower?
11. What should be the length of a pendulum, if its period is to be 5.00 s?

ANSWERS:      6. 370 N/m                      8a. 27.6 N/m                      9. 1180 N                      11. 6.21 m  
                    7. 380 N/m                      8b. less stiff                      10. 21.4 m

12. A 46.7 kg circus-performer swings back and forth on a trapeze in a pendulum-like motion. If the period of motion is 4.16 s, calculate the effective length of the pendulum.
13. Calculate the period and frequency of a 2.000 m long pendulum in the following global cities:
- a. Rio de Janeiro, where  $g = 9.788 \text{ m/s}^2$                       b. Helsinki, where  $g = 9.819 \text{ m/s}^2$

#### Set 4: Wave Speed

14. On a piano, the G above middle-C has a frequency of 384 Hz. If the air temperature is  $0.00^\circ\text{C}$ , find the wavelength of the sound waves of this note on the piano.
15. A tuning fork produces sound with a frequency of 426 Hz and a wavelength in air of 0.829 m.
- a. For this case, what is the speed of sound in air?
- b. What would be the wavelength of this same sound in copper, in which sound travels at 3900 m/s?
16. The light emitted by a particular argon laser has a wavelength of 466 nm and travels at  $3.00 \times 10^8 \text{ m/s}$ . Determine the frequency of this laser's light.
17. The speed of all electromagnetic radiation in empty space is  $3.00 \times 10^8 \text{ m/s}$ . Determine the wavelength of electromagnetic waves emitted at the following frequencies:
- a. radio waves at 670 kHz    b. gamma rays at  $1 \times 10^{14} \text{ MHz}$

ANSWERS:            12. 4.30 m    14. 0.862 m    16.  $6.44 \times 10^{14} \text{ Hz}$   
                         13a.  $T = 2.840 \text{ s}$ ,  $f = 0.3521 \text{ Hz}$             15a. 353 m/s    17a. 450 m  
                         13b.  $T = 2.836 \text{ s}$ ,  $f = 0.3526 \text{ Hz}$             15b. 9.2 m    17b.  $3 \times 10^{-12} \text{ m}$

### Set 5: Harmonics

18. A string 76.4 cm long has a fundamental frequency of 442 Hz. What is the speed of the waves on the string?
19. A recorder is basically an open tube. If the length of a typical recorder is 43.5 cm, what are the first three harmonics of a recorder when all keys are closed and the air temperature is 20.0°C?
20. Find the fundamental frequency of a 28.0 cm harp string when the speed of waves on the string is 287 m/s.
21. Find the fundamental frequency of a 0.296 m long, closed organ pipe, if the air temperature is 25.0°C.

### Set 6: Intensity of Sound Waves

22. Find the sound intensity 6.0 m away from an amplifier when its power output is 0.178 W.
23. At one point during a concert, the sound power output of a junior high band is 63 W. What is the intensity of the sound to a listener 15 m from the band?
24. If an alto's voice generates  $6.4 \times 10^{-7} \text{ W/m}^2$  at 2.5 m, how much sound power is the singer generating?
25. The power output of a cello is 0.24 W. At what distance is the intensity of the cello  $3.8 \times 10^{-4} \text{ W/m}^2$ ?

ANSWERS:      18. 675 m/s                      20. 512 Hz                      22.  $3.9 \times 10^{-4} \text{ W/m}^2$                       24.  $5.0 \times 10^{-5} \text{ W}$   
                    19. 394 Hz, 788 Hz, 1182 Hz                      21. 292 Hz                      23.  $0.022 \text{ W/m}^2$                       25. 7.1 m