Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period \_\_\_\_\_

**Simple Harmonic Motion**

Tip: When solving the following problems, work in the units of meters, Hertz, seconds, and kilograms.

1. A mass of 0.55 kg attached to a vertical spring stretches the spring 36 cm from equilibrium. Calculate the spring constant.

2. A load of 45 N attached to a spring that is hanging vertically stretches the spring 0.14 m, what is the spring constant?

3. A slingshot consists of a light leather pouch attached between two rubber bands. It takes a force of 32 N to stretch the bands 1.2 cm. What would be the equivalent spring constant of the rubber bands?

4. In problem 3 above, if the pouch is pulled 3 cm from its equilibrium position, what is the applied force?

5. Which of the following periodic motions are simple harmonic motions?

a. a child swinging on a playground swing (small angle)

b. a record rotating on a turntable (do ya’ll even know what that is)

c. a oscillating clock pendulum

6. The period of the pendulum at the Houston Museum of Natural Science is 8.63 seconds. Calculate the length of the string supporting the “bob.”

7. If the length of the string in problem 6 above were doubled, what would the period be?

8. You are building a Foucault pendulum to have a period of 1s. How long will the pendulum arm be?

9. Calculate the period and frequency of a 3.5 m long pendulum at the following locations.

a. the North pole; g=9.32 m/s2

b. Chicago; g=9.803 m/ s2

c. Jakarta, Indonesia; g=9.782 m/ s2

14. The speed of electromagnetic radiation is 3 x 108 m/s. Calculate the wavelength of the following frequencies;

a. 97.3 MHz, the frequency of “The Arrow.”

b. 740 kHz, the frequency of KTRH

c. 1830 kHz, an amateur radio operating frequency

15. The red light emitted by a He-Ne laser has a wavelength of 633 nm. If the speed of light is 3 x 108 m/s, what is the frequency of the laser light?

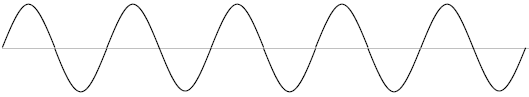
16. A tuning fork produces a sound with a frequency of 256 Hz and the speed of sound in air is 340 m/s, calculate the wavelength of that frequency.

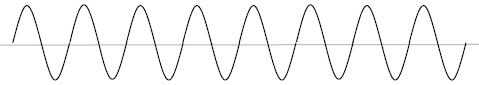
**Properties of Waves**

1. Define the *period* of a pendulum?
2. What is the period of a pendulum that takes one second to make a complete back-and-forth vibration?
3. Which of these pendulums would have the greatest *length* measured in meters: a pendulum with a period of 2 seconds or a pendulum with a period of 1.5 seconds?
4. Describe how a *sine curve* is related to a wave.
5. Draw a picture of a wave and label these parts of the wave: *amplitude, crest, trough,* and *wavelength*.
6. Distinguish between the *period* and *frequency* of a wave. How do these two quantities relate to each other?
7. Does the *medium* in which a wave travels move along with the wave itself? Defend your answer.
8. How does the *speed* of a wave relate to its *frequency* and *wavelength*?
9. As the frequency of sound of sound is increased, does the wavelength increase or decrease? Give an example.
10. Distinguish between a *transverse* wave and a *longitudinal* wave.
11. Distinguish between *constructive interference* and *destructive interference*.
12. Is *interference* a property of only some types of waves or is it a property of all types of waves?
13. What causes a standing wave?
14. When a wave source moves toward a receiver, does the receiver encounter an increase in wave *frequency*, wave *speed*, or both?
15. A nurse counts 76 heartbeats in one minute. What are the *period* and the *frequency* of the patient’s heartbeat?
16. New York’s 300-meter high Citicorp® Tower oscillates in the wind with a period of 6.80 seconds. Calculate its frequency of vibration.
17. Calculate the speed of waves in a puddle that are 0.15 meters apart and made by tapping the water surface twice each second.
18. Calculate the speed of waves in water that are 0.4 meters apart and have a frequency of 2 Hz.
19. Red light has a longer wavelength than violet light. Which of the two has a greater frequency?
20. If you triple the frequency of a vibrating object, what will happen to its period?
21. How much distance (in wavelengths) does a wave cover in one period?
22. If a wave vibrates up and down twice each second and travels a distance of 20 m each second, what is its frequency? It wave speed?

The time from the beginning to the end of the wave train in each situation is 1 second.

Wave 1

  
a) How many waves are there in this wave train? \_\_\_\_\_ b) Wavelength \_\_\_\_\_\_ cm

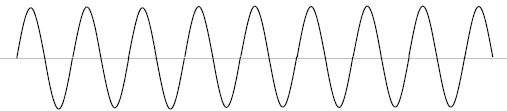
c) Amplitude \_\_\_\_\_\_\_ cm d) frequency \_\_\_\_\_\_\_\_ Hz e) speed \_\_\_\_\_\_\_ cm/s  
  
Wave 2  


a) How many waves are there in this wave train? \_\_\_\_\_ b) Wavelength \_\_\_\_\_\_ cm

c) Amplitude \_\_\_\_\_\_\_ cm d) frequency \_\_\_\_\_\_ Hz e.) speed \_\_\_\_\_ cm/s

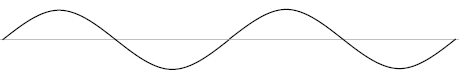
Wave 3  
WaveWo5  
a) How many waves are there in this wave train? \_\_\_\_\_ b) Wavelength \_\_\_\_\_\_ cm

c) Amplitude \_\_\_\_\_\_\_ cm d) frequency \_\_\_\_\_\_ Hz e.) speed \_\_\_\_\_ cm/s

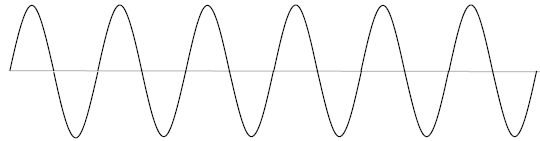
Wave 4  
  
a) How many waves are there in this wave train? \_\_\_\_\_ b) Wavelength \_\_\_\_\_\_ cm

c) Amplitude \_\_\_\_\_\_\_ cm d) frequency \_\_\_\_\_\_ Hz e.) speed \_\_\_\_\_ cm/s  
  
Wave 5  
WaveWo7  
a) How many waves are there in this wave train? \_\_\_\_\_ b) Wavelength \_\_\_\_\_\_ cm

c) Amplitude \_\_\_\_\_\_\_ cm d) frequency \_\_\_\_\_\_ Hz e.) speed \_\_\_\_\_ cm/s

Wave 6  
  
a) How many waves are there in this wave train? \_\_\_\_\_ b) Wavelength \_\_\_\_\_\_ cm

c) Amplitude \_\_\_\_\_\_\_ cm d) frequency \_\_\_\_\_\_ Hz e.) speed \_\_\_\_\_ cm/s  
  
Wave 7  
If this entire wave train is 30 meters long what is the wavelength of this wave? \_\_\_\_\_\_\_



**Sound**

1. What is the source of all sounds?
2. How does pitch relate to frequency?
3. Distinguish between infrasonic and ultrasonic sounds
4. Distinguish between compressions and rarefactions of sound waves
5. How are compressions and rarefactions produced?
6. A bomb explodes in outer space. Would a Zurponian from the planet “Zurp” be able to hear the explosion? Explain your answer…
7. What is the speed of sound in dry air at room temperature?
8. How does air temperature affect the speed of sound?
9. How does the speed of sound in air compare with the speed of sound in water or steel? Why?
10. How is resonance produced in a vibrating object?
11. How does tuning a radio station have to do with resonance?
12. Give an example of the reflection of a sound?
13. A boy yells across a canyon and hears his echo 3 seconds later. What is the distance from the boy to the canyon wall?

14. Sound travels at about 340 m/s in room temperature air. If somebody strikes the "A" key near the middle of a keyboard on a piano, our ears vibrate at 440 Hz. What is the wavelength of this note?



**Doppler Effect**

1. When an automobile moves towards a listener, the sound of its horn seems relatively

a. Low pitched b. High Pitched c. Normal

1. When the automobile moves away from the listener, its horn seems

a. Low pitched b. High Pitched c. Normal

1. The changed pitch of the Doppler effect is due to changes in

a. Wave speed b. wave frequency

1. Circle the letter of each statement about the Doppler Effect that is true.
   1. It occurs when a wave source moves towards an observer
   2. It occurs when an observer moves towards a wave source
   3. It occurs when a wave source moves away an observer
   4. It occurs when an observer moves away a wave source
2. True / False: A moving wave source does not affect the frequency of the wave encountered by the observer.
3. True / False: A higher frequency results when a wave source moves towards an observer.
4. Two fire trucks with sirens on speed towards and away from an observer as shown below.



A) Which truck produces a higher than normal siren frequency?

B) Which truck produces a lower than normal siren frequency?

# Electromagnetic Waves

Crest Frequency Mechanical Infrared

Trough Transverse Radio Gamma

Wavelength Longitudinal Ultraviolet X-Rays

Visible Light Amplitude Electromagnetic

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ waves are used to penetrate solids and are used in doctor’s offices and as airports.

2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the distance between one point of a wave to the same point in the next wave.

3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the number of waves per unit of time.

4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ waves occur when the motion of the medium is parallel to the direction of the wave.

5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ waves have a color spectrum known as ROYGBIV.

6. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ waves disturb matter.

7. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the top of a wave.

8. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the bottom of a wave.

9. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the maximum distance that matter is displaced from the resting position.

10. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ waves are produced by stars and galaxies.

11. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ waves occur when the motion of the medium is at right angles (perpendicular) to the direction of the wave.

12. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ waves are often used in heat lamps.

13. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ waves are utilized by insects to locate nectar.

14. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ waves are transverse waves that disturb electromagnetic fields.

15. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ waves have the shortest wavelength and the highest frequency.

**Light and EM Spectrum**

Match each kind of wave with one item from column one and one item from column two.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| COLUMN 1 |  | WAVE |  | COLUMN 2 |
| A. used in remote controls for TVs and VCRs | \_\_\_\_\_ | RADIO | \_\_\_\_\_ | H. used to find a broken bone or illegal plane carry-on |
| B. goes through most matter  except bone and lead | \_\_\_\_\_ | MICROWAVE | \_\_\_\_\_ | I. used to kill bacteria on food |
| C. highest frequency and  energy | \_\_\_\_\_ | INFRARED | \_\_\_\_\_ | J. ROY G. BV |
| D. can cause skin cancer or promote vitamin D  production | \_\_\_\_\_ | VISIBLE | \_\_\_\_\_ | K. shortest wavelength |
| E. longest wavelength | \_\_\_\_\_ | ULTRAVIOLET | \_\_\_\_\_ | L. most dangerous waves |
| F. used to transmit cellular phone calls | \_\_\_\_\_ | X-RAY | \_\_\_\_\_ | M. TV signals, and used in remote control devices like car alarms and garage door openers |
| G. wavelengths and frequencies that can be seen by the human eye | \_\_\_\_\_ | GAMMA | \_\_\_\_\_ | N. radiant heat rays |

**Light and Color**

1. What color(s) of light does a blue glass bottle reflect? What color(s) does it absorb?
2. How do you think the health of a plant would be affected if it only received green light? Why?
3. What are the primary light colors?
4. What are the complementary light colors?
5. What colors of ink do color ink-jet printers use to produce the colors you see?

Tip: Color of Objects – The “color” of an object depends on what colors of light it reflects out of the colors of light striking it.

1. What color would a “white” shirt appear to be for each of the following colors of light shining on it?
   1. Red: \_\_\_\_\_ b. Green: \_\_\_\_\_ c. Blue: \_\_\_\_\_ d. White:\_\_\_\_\_
2. What color would a “red” shirt appear to be for each of the following colors of light shining on it?
   1. Red: \_\_\_\_\_ b. Green: \_\_\_\_\_ c. Blue: \_\_\_\_\_ d. White:\_\_\_\_\_
3. What color would a “green” shirt appear to be for each of the following colors of light shining on it?
   1. Red: \_\_\_\_\_ b. Green: \_\_\_\_\_ c. Blue: \_\_\_\_\_ d. White:\_\_\_\_\_
4. What color would a “magenta” shirt appear to be for each of the following colors of light shining on it?
   1. Red: \_\_\_\_\_ b. Green: \_\_\_\_\_ c. Blue: \_\_\_\_\_ d. White:\_\_\_\_\_
5. What color would a “yellow” shirt appear to be for each of the following colors of light shining on it?
   1. Red: \_\_\_\_\_ b. Green: \_\_\_\_\_ c. Blue: \_\_\_\_\_ d. White:\_\_\_\_\_
6. What color would a “black” shirt appear to be for each of the following colors of light shining on it?
   1. Red: \_\_\_\_\_ b. Green: \_\_\_\_\_ c. Blue: \_\_\_\_\_ d. White:\_\_\_\_\_