PRACTICE PROBLEMS

WAVES

Waves

1. Which of the following are examples of longitudinal waves? (Select all that apply)
   - A A wave traveling through a long spring
   - B A wave traveling through water
   - C A sound wave traveling through the air
   - D A wave traveling along a string

2. Which of the following is transported with all types of waves? (Select all that apply)
   - A Physical matter
   - B Energy
   - C Sound
   - D None of the above

3. Which of the following are examples of transverse waves? (Select all that apply)
   - A An ocean wave
   - B A wave traveling along a string
   - C A wave traveling through a long spring
   - D A sound wave traveling through the air

4. Wave A and wave B have the same frequenc, but wave A has three times the wavelength of wave B. How do the speeds of wave A and wave B compare?
   - A $v_A = v_B$
   - B $v_A = v_B/3$
   - C $v_A = 3v_B$
   - D $v_A = 9v_B$

5. A person is sitting on the beach near the ocean. They observe that there is 4 seconds between each wave that crashes on the beach. What is the frequency of the ocean waves traveling towards the beach?
   - A 0.25 Hz
   - B 1 Hz
   - C 2 Hz
   - D 4 Hz

6. Two guitar strings with the same length are tuned so they have the same tension. String A has more mass than string B. A wave will travel faster through which string?
   - A String A
   - B String B
   - C A wave will travel the same speed through each string
   - D Cannot be determined

7. How many crests are in the wave shown in Figure 1?

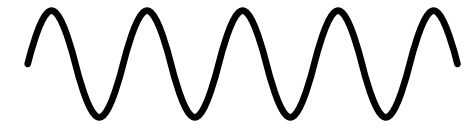

Figure 1

8. How many troughs are in the wave shown in Figure 1?

9. How many wavelengths are in the wave shown in Figure 1?

10. A wave is shown in Figure 2. What is the amplitude of the wave?

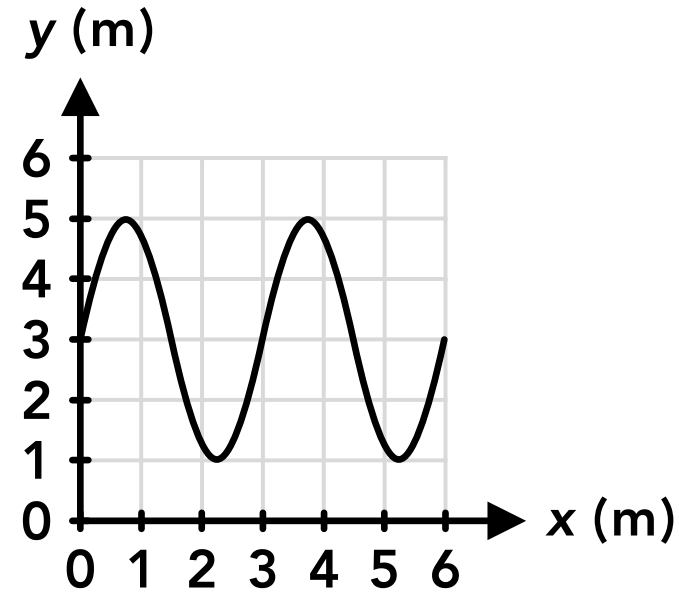

Figure 2

11. A wave is shown in Figure 2. What is the wavelength?

12. If the wave shown in Figure 2 takes 5 seconds to travel the distance of one wavelength, what is the wave speed?

13. A 80 cm long string has a mass of 600 g. If one end of the string is plucked and a wave travels across the string at 10 m/s, what is the tension in the string?

Answers

1. A, C
2. B
3. A, B
4. C
5. A
6. B
7. 5
8. 4
9. 4.5
10. 2 m
11. 3 m
12. 0.6 m/s
13. 75 N

Answers - Waves

1. **Answer: A, C**
   In a longitudinal wave the physical material moves back and forth parallel to the direction of the wave. This is the case for a wave traveling through a spring and a sound wave traveling through the air, where the physical material stretches and compresses in the direction of the wave motion. In a water wave and a wave traveling through a string, the material moves up and down, perpendicular to the wave direction.

2. **Answer: B**
   All waves transport energy in some form: kinetic energy, potential energy, electromagnetic energy, etc.

3. **Answer: A, B**
   In a transverse wave the physical material moves perpendicular to the direction of the wave. This is the case for water waves (ocean waves) and waves traveling along a string. A wave traveling through a long spring and a sound wave traveling through the air are longitudinal waves, where the physical material moves back and forth parallel to the direction of the wave.

4. **Answer: C**
   The equation for wave speed is given below. If the frequency is the same and the wavelength is multiplied by 3 then the wave speed must be multiplied by 3.
   $v = \lambda f$

5. **Answer: A**
   4 seconds is the period of the waves. Frequency is the inverse of the period.
   $$f = \frac{1}{T} = \frac{1}{4\text{ s}} = 0.25\text{ Hz}$$

6. **Answer: B**
   The equations for the wave speed in a string and the linear density of a string are given below. The wave speed is inversely proportional to the square root of the linear density, which is directly proportional to the mass of the string. If the lengths and tensions are the same for both strings, a greater mass will result in a slower wave speed.
   $\mu \quad \frac{m}{L} \qquad v_{\text{string}} = \sqrt{\frac{T_s}{\mu}} = \sqrt{\frac{T_s L}{m}}$

7. **Answer: 5**
   A crest is the upper amplitude or the top of a wave.

8. **Answer: 4**
   A trough is the lower amplitude of the bottom of a wave.

9. **Answer: 4.5**
   A wavelength is the length of a repeating section of the wave.

10. **Answer: 2 m**
    The amplitude of a wave is the distance between the middle of the wave and a crest or trough, or half of the distance between the crests (at 5 m) and the troughs (at 1 m) which is 4 m.

11. **Answer: 3 m**
    The wavelength is the length of a repeating section of the wave. That is the distance between two crests, the distance between two troughs, or the distance of three nodes across. There are also 2 wave lengths that fit in the 6 m, so the wavelength is 3 m.

12. **Answer: 0.6 m/s**
    The wavelength is 3 m, and the wave speed is the wavelength divided by the period (5 seconds).
    $$v = \frac{\Delta x}{t} = \frac{\lambda}{T} = \frac{3\text{ m}}{5\text{ s}} = 0.6\text{ m/s}$$

13. **Answer: 75 N**
    $$\mu = \frac{0.6\text{ kg}}{0.8\text{ m}} = 0.75\text{ kg/m}$$
    $$v_{string} = \sqrt{\frac{T_s}{\mu}} \qquad (10\text{ m/s}) = \sqrt{\frac{T_s}{0.75\text{ kg/m}}} \qquad T_s = 75\text{ N}$$