

Physics 11

Waves Unit Test Solutions

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| 25. a. | <input type="checkbox"/> | b. | <input type="checkbox"/> | c. | <input checked="" type="checkbox"/> | d. | <input type="checkbox"/> |

1. Problem

Which unit is used to measure frequency?

- a. metres per second (m/s)
- b. hertz (Hz)
- c. seconds per metre (s/m)
- d. second (s)

Solution

Frequency can be measured in units of hertz (Hz)

2. Problem

The shortest distance between two points on a wave where the wave pattern is repeated is the

- a. period
- b. amplitude
- c. frequency
- d. wavelength

Solution

The wavelength is the shortest distance between two points on a wave where the wave pattern is repeated.

3. Problem

The change in the direction of waves at the boundary between two different media is

- a. resonance
- b. diffraction
- c. superposition
- d. refraction

Solution

Refraction is the change in the direction of waves at the boundary between two different media.

4. Problem

In a standing wave on a string, nodes are points where

- a. maximum displacement occurs
- b. energy is lost
- c. the wave is reflected
- d. no displacement occurs

Solution

Nodes are where no displacement occurs.

5. Problem

When a wave enters a medium in which its speed decreases, which change must occur?

- a. frequency increases
- b. frequency decreases
- c. wavelength increases
- d. wavelength decreases

Solution

When the speed decreases across a boundary between two media, the frequency remains the same while the wavelength decreases.

6. Problem

What does the speed of a mechanical wave depend on? **Select all that apply.**

- a. amplitude
- b. wavelength
- c. properties of the medium
- d. energy of the wave

Solution

The speed of a mechanical wave depends only on the properties of the medium (temperature, density, tension, viscosity, stiffness, etc.)

7. Problem

Which of the following does **not** describe the pitch of a sound?

- a. a musical note
- b. high or low
- c. loud or soft
- d. frequency of vibration

Solution

Pitch can be described using a frequency, a musical note, or as high or low. It is not described by loud or soft (that is amplitude).

8. Problem

A wave travels from a more-dense medium into a less-dense medium. Which quantities must be greater for the transmitted wave than for the incident wave? **Select all that apply.**

- a. wavelength
- b. frequency
- c. speed
- d. period

Solution

When moving from a more dense medium to a less dense one, the speed and the wavelength are greater for the transmitted wave than the incident wave. The frequency and the period remain the same.

9. Problem

When a wave travels from one medium to another, which properties must be the same for both the incident and transmitted waves? **Select all that apply.**

- a. frequency
- b. wavelength
- c. period
- d. speed

Solution

The frequency and the period are the same for both the incident and transmitted waves.

10. Problem

A 769 Hz pure tone is played at the same time as a 616 Hz pure tone. What beat frequency will be produced?

- a. 170 Hz
- b. 204 Hz
- c. 153 Hz
- d. 188 Hz

Solution

The beat frequency is

$$f_{beat} = |f_2 - f_1| = |769 \text{ Hz} - 616 \text{ Hz}| = 153 \text{ Hz}$$

11. Problem

A student has two tuning forks, one with a frequency of 586 Hz and the other with frequency unknown. When struck together, the tuning forks produce 12 beats per second. What are the possible frequencies of the unknown tuning fork? **Select all that apply.**

- a. 562 Hz
- b. 586 Hz
- c. 49 Hz
- d. 574 Hz

Solution

The beat frequency is $f_{beat} = |f_2 - f_1|$ Therefore, the two possible frequencies are

$$f_1 - f_{beat} = 574 \text{ Hz}$$

and

$$f_1 + f_{beat} = 598 \text{ Hz}$$

12. Problem

What is the decibel level of a sound that has an intensity of $3.1 \times 10^{-1} \text{ W/m}^2$?

- a. 85 dB
- b. 129 dB
- c. 115 dB
- d. 162 dB

Solution

The decibel level is

$$10 \cdot \log_{10} \left(\frac{3.1 \times 10^{-1}}{1 \times 10^{-12}} \right) = 115 \text{ dB}$$

13. Problem

What is the intensity of a 91 dB sound?

- a. $1.29\text{E-}04 \text{ W/m}^2$
- b. $1.26\text{E-}03 \text{ W/m}^2$
- c. $1.78\text{E-}02 \text{ W/m}^2$
- d. $1.48\text{E-}04 \text{ W/m}^2$

Solution

The intensity of the sound is

$$10^{9.1-12} = 1.259\text{E-}03 \text{ W/m}^2$$

14. Problem

How many times more intense is a 105 dB sound than a 80 dB sound?

- a. 34.8
- b. 320
- c. 188
- d. $2.4\text{E+}03$

Solution

The relative intensity of the sound is

$$I_2/I_1 = 10^{10.5-8} = 320$$

15. Problem

A sonar signal (sound wave) is emitted from a submarine and returns 0.335 s later. The speed of sound in water is 1497 m/s. How far away is the object that reflected the sonar signal?

- a. 465 m
- b. 501 m
- c. 183 m
- d. 251 m

Solution

The distance to the object is half the distance traveled by the sonar signal because the sonar had to go there and back.

$$d = vt/2 = (1497 \text{ m/s})(0.335 \text{ s})/2 = 251 \text{ m}$$

16. Problem

A parked car emits an alarm sound with a frequency of 2031 Hz. If the speed of sound in air is 341 m/s, what frequency will an observer hear while driving toward the parked car at a speed of 19 m/s?

- a. 1490 Hz
- b. 1790 Hz
- c. 2140 Hz
- d. 1260 Hz

Solution

The doppler shifted frequency for an approaching observer is

$$f_{obs} = f_{source}(1 + v_{source}/v_{sound}) = 2144 \text{ Hz}$$

17. Problem

A car horn emits a frequency of 485 Hz when the car is stationary. If the speed of sound in air is 330 m/s, what frequency will an observer hear as the car is approaching at a speed of 7 m/s while the horn is sounding?

- a. 707 Hz
- b. 496 Hz
- c. 654 Hz
- d. 314 Hz

Solution

The doppler shifted frequency for an approaching source is

$$f_{obs} = \frac{f_{source}}{1 - v_{source}/v_{sound}} = 496 \text{ Hz}$$

18. Problem

What frequency is a major third above 891 Hz?

- a. 1110 Hz
- b. 555 Hz
- c. 946 Hz
- d. 684 Hz

Solution

The frequency is

$$(1.25)(891 \text{ Hz}) = 1110 \text{ Hz}$$

19. Problem

What frequency is 11 semitones above 171 Hz?

- a. 284 Hz
- b. 323 Hz
- c. 215 Hz
- d. 250 Hz

Solution

The frequency is

$$(171 \text{ Hz}) \times 2^{11/12} = 323 \text{ Hz}$$

20. Problem

A wave has a frequency of 18.7 Hz. What is its period?

- a. 0.0535 s
- b. 0.0654 s
- c. 0.0788 s
- d. 0.0712 s

Solution

Period is the reciprocal of the frequency Therefore,

$$T = \frac{1}{f} = \frac{1}{18.7 \text{ Hz}} = 0.0535 \text{ s}$$

21. Problem

A wave has a wavelength of 19 cm and a frequency of 59 Hz. What is its speed?

- a. 8.69 m/s
- b. 11.2 m/s
- c. 370 m/s
- d. 1120 m/s

Solution

Wave speed is wavelength times frequency. Remember to convert to SI base units (metres)

$$v = \lambda f = (0.19 \text{ m})(59 \text{ Hz}) = 11.2 \text{ m/s}$$

22. Problem

A wave has a frequency of 48 Hz and a speed of 76 m/s. What is its wavelength?

- a. 1.58 m
- b. 3650 m
- c. 955 m
- d. 1130 m

Solution

Wave speed is wavelength times frequency ($v = \lambda f$). Therefore,

$$\lambda = \frac{v}{f} = \frac{76 \text{ m/s}}{48 \text{ Hz}} = 1.58 \text{ m}$$

23. Problem

The distance between the two fixed ends of a piece of string is 0.757 m. When the string is vibrating at harmonic number 5, the frequency is 1259 Hz. What is the speed of the waves on the string?

- a. 234 m/s
- b. 535 m/s
- c. 278 m/s
- d. 381 m/s

Solution

The wavelength is

$$\lambda = \frac{2L}{n} = 0.3028 \text{ m}$$

The speed is the wavelength times the frequency.

$$v = f\lambda = (1259 \text{ Hz})(0.3028 \text{ m}) = 381 \text{ m/s}$$

24. Problem

One organ pipe has a length of 2.0 m. A second pipe should have a pitch one major seventh higher. The pipe should be how long?

- a. 0.818 m
- b. 1.07 m
- c. 1.44 m
- d. 1.57 m

Solution

The speed is the same in both pipes and both resonate at their fundamental frequency. Therefore,

frequency and wavelength are inversely proportional to each other. In order for the second pipe to play a higher sound, it must have a shorter length.

$$L = (2 \text{ m}) / (1.875) = 1.07 \text{ m}$$

25. Problem

What is the wavelength of harmonic number 5 in a closed-pipe resonator of length 1.38 m?

- a. 0.96 m
- b. 0.6 m
- c. 1.1 m
- d. 1.37 m

Solution

The wavelength is

$$\lambda = \frac{4L}{n} = 1.1 \text{ m}$$