Physics 11

Waves Unit Test Solutions

1.	a. [ ]	b. [ ]	c. [ ]	d. [X]
2.	a. [ ]	b. [ ]	c. [ ]	d. [X]
3.	a. [X]	b. [ ]	c. [ ]	d. [ ]
4.	a. [ ]	b. [X]	c. [ ]	d. [ ]
5.	a. [ ]	b. [ ]	c. [ ]	d. [X]
6.	a. [ ]	b. [X]	c. [ ]	d. [ ]
7.	a. [ ]	b. [X]	c. [ ]	d. [ ]
8.	a. [ ]	b. [ ]	c. [X]	d. [X]
9.	a. [ ]	b. [X]	c. [X]	d. [ ]
10.	a. [X]	b. [ ]	c. [ ]	d. [ ]
11.	a. [ ]	b. [ ]	c. [X]	d. [X]
12.	a. [ ]	b. [X]	c. [ ]	d. [ ]
13.	a. [ ]	b. [X]	c. [ ]	d. [ ]
14.	a. [ ]	b. [ ]	c. [ ]	d. [X]
15.	a. [ ]	b. [X]	c. [ ]	d. [ ]
16.	a. [ ]	b. [ ]	c. [X]	d. [ ]
17.	a. [ ]	b. [ ]	c. [X]	d. [ ]
18.	a. [X]	b. [ ]	c. [ ]	d. [ ]
19.	a. [X]	b. [ ]	c. [ ]	d. [ ]
20.	a. [ ]	b. [ ]	c. [ ]	d. [X]
21.	a. [ ]	b. [X]	c. [ ]	d. [ ]
22.	a. [ ]	b. [X]	c. [ ]	d. [ ]
23.	a. [ ]	b. [ ]	c. [X]	d. [ ]
24.	a. [ ]	b. [X]	c. [ ]	d. [ ]
25.	a. [X]	b. [ ]	c. [ ]	d. [ ]

1. **Problem**
   Which unit is used to measure frequency?

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

   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. wave speed
   d. wavelength

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

3. **Problem**
   When waves spread out around the edge of a barrier, _____ occurs.

   a. diffraction
   b. rarefaction
   c. superposition
   d. interference

   Solution
   Diffraction occurs when waves spread out around the edge of a barrier.

4. **Problem**
   In a standing wave on a string, nodes are points where

   a. the wave is reflected
   b. no displacement occurs
   c. energy is lost
   d. maximum 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. properties of the medium
   c. energy of the wave
   d. wavelength

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

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. period
   b. frequency
   c. wavelength
   d. speed

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. wavelength
   b. frequency
   c. period
   d. speed

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

10. **Problem**
A 779 Hz pure tone is played at the same time as a 223 Hz pure tone. What beat frequency will be produced?

   a. 556 Hz
   b. 356 Hz
   c. 679 Hz
   d. 736 Hz

   Solution
   The beat frequency is

$$f_{beat} = |f_2 - f_1| = |779\,\text{Hz} - 223\,\text{Hz}| = 556\,\text{Hz}$$

11. **Problem**
A student has two tuning forks, one with a frequency of 481 Hz and the other with frequency unknown. When struck together, the tuning forks produce 19 beats per second. What are the possible frequencies of the unknown tuning fork? **Select all that apply**.

   a. 443 Hz
   b. 519 Hz
   c. 462 Hz
   d. 500 Hz

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

$$f_1 - f_{beat} = 462\,\text{Hz}$$

   and

$$f_1 + f_{beat} = 500\,\text{Hz}$$

12. **Problem**
What is the decibel level of a sound that has an intensity of $9.1 \times 10^0\,\mathrm{W/m^2}$?

    a. 113 dB
    b. 130 dB
    c. 66 dB
    d. 100 dB

    Solution
    The decibel level is

$$10 \cdot \log_{10}\left(\frac{9.1 \times 10^0}{1 \times 10^{-12}}\right) = 130\,\mathrm{dB}$$

13. **Problem**
What is the intensity of a 46 dB sound?

    a. 1.45E-05 $\mathrm{W/m^2}$
    b. 3.98E-08 $\mathrm{W/m^2}$
    c. 1.38E-07 $\mathrm{W/m^2}$
    d. 1.51E-05 $\mathrm{W/m^2}$

    Solution
    The intensity of the sound is

$$10^{4.6-12} = 3.981E-08\,\mathrm{W/m^2}$$

14. **Problem**
How many times more intense is a 105 dB sound than a 80 dB sound?

    a. 33.2
    b. 100
    c. 262
    d. 320

    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 $0.459\,\text{s}$ later. The speed of sound in water is $1482\,\text{m/s}$. How far away is the object that reflected the sonar signal?

    a. $680\,\text{m}$
    b. $340\,\text{m}$
    c. $178\,\text{m}$
    d. $257\,\text{m}$

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

$$d = vt/2 = (1482\,\text{m/s})(0.459\,\text{s})/2 = 340\,\text{m}$$

16. **Problem**
A parked car emits an alarm sound with a frequency of 2628 Hz. If the speed of sound in air is 335 m/s, what frequency will an observer hear while driving toward the parked car at a speed of 30 m/s?

    a. 3610 Hz
    b. 1570 Hz
    c. 2860 Hz
    d. 2060 Hz

    Solution
    The doppler shifted frequency for an approaching observer is

$$f_{obs} = f_{source}(1 + v_{source}/v_{sound}) = 2863\,\text{Hz}$$

17. **Problem**
A car horn emits a frequency of 471 Hz when the car is stationary. If the speed of sound in air is 347 m/s, what frequency will an observer hear as the car is approaching at a speed of 5 m/s while the horn is sounding?

    a. 311 Hz
    b. 672 Hz
    c. 478 Hz
    d. 368 Hz

    Solution
    The doppler shifted frequency for an approaching source is

$$f_{obs} = \frac{f_{source}}{1 - v_{source}/v_{sound}} = 478\,\text{Hz}$$

18. **Problem**
What frequency is a major sixth above 435 Hz?

    a. 725 Hz
    b. 458 Hz
    c. 636 Hz
    d. 551 Hz

    Solution
    The frequency is

$$(1.6666667)(435\,\text{Hz}) = 725\,\text{Hz}$$

19. **Problem**
What frequency is 11 semitones above 545 Hz?

    a. 1029 Hz
    b. 1497 Hz
    c. 701 Hz
    d. 580 Hz

    Solution
    The frequency is

$$(545\,\text{Hz}) \times 2^{11/12} = 1029\,\text{Hz}$$

20. **Problem**
A wave has a period of $8.69\,\text{seconds}$. What is its frequency?

    a. $0.15\,\text{Hz}$
    b. $0.0722\,\text{Hz}$
    c. $0.133\,\text{Hz}$
    d. $0.115\,\text{Hz}$

    Solution
    Frequency is the reciprocal of the period. Therefore,

$$f = \frac{1}{T} = \frac{1}{8.69\,\text{s}} = 0.115\,\text{Hz}$$

21. **Problem**
A wave has a wavelength of $11\,\text{cm}$ and a frequency of $10\,\text{Hz}$. What is its speed?

    a. $0.616\,\text{m/s}$
    b. $1.1\,\text{m/s}$
    c. $0.787\,\text{m/s}$
    d. $0.972\,\text{m/s}$

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

$$v = \lambda f = (0.11\,\text{m})(10\,\text{Hz}) = 1.1\,\text{m/s}$$

22. **Problem**
A wave has a frequency of $17\,\text{Hz}$ and a speed of $34\,\text{m/s}$. What is its wavelength?

    a. $1.4\,\text{m}$
    b. $2\,\text{m}$
    c. $220\,\text{m}$
    d. $354\,\text{m}$

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

$$\lambda = \frac{v}{f} = \frac{34\,\text{m/s}}{17\,\text{Hz}} = 2\,\text{m}$$

23. **Problem**
The distance between the two fixed ends of a piece of string is $0.669\,\text{m}$. When the string is vibrating at harmonic number 5, the frequency is $1927\,\text{Hz}$. What is the speed of the waves on the string?

    a. $260\,\text{m/s}$
    b. $317\,\text{m/s}$
    c. $516\,\text{m/s}$
    d. $459\,\text{m/s}$

    Solution
    The wavelength is

$$\lambda = \frac{2L}{n} = 0.2676\,\text{m}$$

    The speed is the wavelength times the frequency.

$$v = f\lambda = (1927\,\text{Hz})(0.2676\,\text{m}) = 516\,\text{m/s}$$

24. **Problem**
One organ pipe has a length of 2.0 m. A second pipe should have a pitch one octave higher. The pipe should be how long?

    a. 0.865 m
    b. 1 m
    c. 1.16 m
    d. 1.34 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.

$$L = (2\,\text{m})/(2) = 1\,\text{m}$$

25. **Problem**
What is the wavelength of harmonic number 9 in a closed-pipe resonator of length 1.7 m?

a. 0.756 m
b. 1 m
c. 0.915 m
d. 0.837 m

Solution
The wavelength is

$$\lambda = \frac{4L}{n} = 0.756\,\text{m}$$