PHYSICS

BOOKS - CENGAGE PHYSICS

SOUND

Worked Examples

1. A boy's audible range is 30-16,500 Hz. If the speed of sound in air is 330 m s^{-1}, what is the

shortest and longest wavelength of sound, in air, which the boy can hear?

2. The sound from the blast of a ship's siren takes 2 s to travel to another ship. How far apart are the ships? [Take velocity of sound = 340 m s^{-1}]

3. Aman standing on a terrace hears a thunder. The time interval between a lightning flash and first clap of thunder was found to be 15 s. Calculate the distance of the flash from the observer. [Speed of sound in air 332 m s^{-1}]

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4. A child hears the echo of a sound 4 s after its reflection from a cliff. How far is the cliff

from the child? [Take velocity of sound in air = 344 m s^{-1}]

5. A stone is dropped into a well, 44.1 metres deep. The sound of the splash is heard 3.13 seconds after the stone is dropped. Find the velocity of sound in air.

6. The speed of sound at $12°C$ is 328 m s^{-1}

Calculate the speed of sound at $40°C$.

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7. The speed of sound at $12°C$ is 328 m s^{-1}

Calculate the speed of sound at $-15°C$.

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8. An observer standing between two cliffs fires a gun. He hears one echo after 1.5 s and another after 3.5 s. If the velocity of sound is 330 m s^{-1}, find

(i) the distance of the observer from the first cliff

(ii) distance between the two cliffs.

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9. A sound wave has a frequency of 256 Hz and a wavelength of 1.3 m. Calculate its wave velocity. What difference would be felt by a listener receiving this wave and another of wavelength 2.6 m?

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Mandatory Exercise Exercise Set I

1. Which of the following sound waves, can we hear?

10 Hz, 20 Hz, 500 Hz, 1500 Hz, 15,000 Hz, 25,000 Hz

2. The sound of an explosion on the surface of a lake is heard by a boatman 100 m away, and by a diver 100 m below the point of explosion

(i) Of the two persons mentioned, who would

hear the sound first?

(ii) Give a reason for your answer for (i).

(iii) If the sound takes time 't' to reach the boatman, how much time will it take, approximately, to reach the diver?

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3. The speed of sound in humid air is more than in dry air, why? Will the speed of sound in humid hydrogen be more than in dry hydrogen? Why?

4. At the stands of a race track you notice smoke from the starter's gun before you hear it fire. Explain.

5. At the instant that a high pressure region is created just outside the prongs of a vibrating tuning fork, what is being created inside, between the prongs?

6. Why is the tremor of the ground from a distant explosion felt before the sound of the explosion can be heard?

7. What kind of wind conditions would make sound more easily heard at long distances? Less easily heard at long distances?

8. Why do marchers at the end of a long parade, following a band, be out of step with marchers near the front?

9. Why does a tuning fork eventually stop vibrating?

10. When a sound wave moves past a point in air, are there changes in the density of air at this point? Explain.

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11. Why is it so quiet after a snowfall?

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12. Why is soft furnishing used in concert halls?

13. The speed of sound in air at $0°C$ is approximately

    A. 332 m s^{-1}

    B. 1450 m s^{-1}

    C. 5100 m s^{-1}

D. 3×10^8 m s^{-1}

Answer: A

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14. Of the following, the correct statement is

   A. Sound and light are both transverse

      waves

   B. Sound and light are both longitudinal

      waves

C. Sound wave is transverse and light wave

is longitudinal

D. Sound wave is longitudinal and light

wave is transverse

Answer: D

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15. The speed of sound in air at NTP is 332 m s^{-1}. If air pressure becomes four times the normal, then the speed of sound will

A. double

B. quadruple

C. remain the same

D. become $1/4$ of the original value

Answer: C

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16. Velocity of sound in air is 332 ms^{-1}. Its velocity in vacuum will be

A. $> 332 ms^{-1}$

B. $= 332 ms^{-1}$

C. $< 332 ms^{-1}$

D. meaningless

Answer: D

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17. Who will hear first a guitarist's first note - a person in the concert hall seated 10 m away from the guitarist or a radio listener in his

apartment some 100 km away from the hall? (Radio waves travel with a speed of 3,00,000 km s^{-1})

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18. What type of wave is a sound wave? Give reason for your answer.

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19. List the reasons for the following property of the medium of travel for sound waves

Elastic

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20. List the reasons for the following property of the medium of travel for sound waves

Inertial

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21. List the reasons for the following property of the medium of travel for sound waves

Frictionless

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22. How is the velocity of sound related to its elastic coefficient?

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23. What was Newton's approximation while determining the elastic coefficient of air, what is the elastic coefficient of air according to Newton's approximation?

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24. What was Laplace's improvement to Newton's expression for velocity of sound?

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25. How is loudness defined?

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26. What is the sensitivity of human ear and how does it vary with frequency?

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27. How is $music/noise$ characterised, write the factors giving brief explanation.

28. Give example of usage of ultrasonic wave representation in the nature?

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29. Give some examples of chemical and biological effects of ultrasonic sound.

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1. The frequency of a source of sound is 15 Hz.

How many times does it vibrate in a minute?

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2. State one factor that determines pitch of a

note

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3. State one factor that determines the intensity of the sound heard

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4. State one factor that determines the quality of the note

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5. (i) What vibrates to produce sound in

(a) a violin (b) an organ pipe (c) a drum?

(ii) If the sound of the same pitch is produced by three instruments mentioned above, why do the qualities of sound differ?

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6. Why does the intensity or loudness of the sound emitted by a plucked wire increase, when it is mounted on a board?

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7. If the frequency of a wave is 330 Hz, and velocity of wave in air is 330 m s^{-1}, then, the wavelength of the wave is

    A. 0.5 m

    B. 1 m

    C. 2 m

    D. not certain

Answer: B

8. The wave velocity v, in a medium of elasticity

E and density d, is given by

A. $v = \dfrac{E}{d}$

B. $v = \sqrt{Ed}$

C. $v = \sqrt{\dfrac{d}{E}}$

D. $v = \sqrt{\dfrac{E}{d}}$

Answer: D

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9. A source is producing 15 waves in 3 s. The distance between a crest and a trough is 10 cm. Find frequency of the wave.

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10. A source is producing 15 waves in 3 s. The distance between a crest and a trough is 10 cm. Find the wavelength of the wave.

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11. A source is producing 15 waves in 3 s. The distance between a crest and a trough is 10 cm. Find the velocity of the wave.

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12. A body is vibrating 6000 times in 1 min. If the velocity of sound in air is 300 m s^{-1}, find the frequency of the wave.

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13. A body is vibrating 6000 times in 1 min. If the velocity of sound in air is 300 m s^{-1}, find the wavelength of the wave.

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14. If the velocity of sound in a medium is 1400 m s^{-1}, and its wavelength is 1 km, what is its frequency? Can you hear this sound?

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15. A sound wave of wavelength 68 cm travels 850 min 2.5 s. Calculate the velocity of the sound.

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16. A sound wave of wavelength 68 cm travels 850 min 2.5 s. Calculate the frequency of the sound.

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17. When a violin was played the sound level was measured to be 50 dB. Calculate the sound intensity of the violin.

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Mandatory Exercise Exercise Set Iii

1. How do people on a ship make use of sound to avoid running into cliffs and rocks in bad weather?

2. Would there be a Doppler effect if the source were stationary and the listener in motion? Why or why not? In which direction should the listener move to hear a higher frequency?

3. The minimum distance required for producing echo is

A. 1.7 m

B. 17 m

C. 10 m

D. 300 m

Answer: B

4. In a stethoscope, the sound of heartbeat travels

A. by bending along the tube

B. in a straight line

C. by undergoing multiple reflections

D. as a sonic boom

Answer: C

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5. An ultrasonic sound is sent from a ship towards the bottom of the sea. This sound is received after 2 s. If the velocity of sound in

water is 1400 m s^{-1}, calculate the depth of the sea at the place.

6. An oil tanker explodes in the sea. At that instant, an aircraft and a submarine were present vertically above and below the oil tanker respectively and at equal distances from it. Find the ratio of the time taken by the sound waves to reach them. [The speed of

sound in air=340 m s^{-1}, speed of sound in sea water= 1520 m s^{-1}]

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7. A man standing 50 m away from a wall fires a gun. Calculate the time required for an echo to be heard. [The speed of sound in air is 320 m s^{-1}]

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8. A ship on the surface of water sends a signal and receives it back after 4 s from a submarine inside the water. Calculate the distance of the submarine from the ship. [The speed of sound in water is 1450 m s^{-1}]

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9. Cats can hear sound frequencies up to 70,000 Hz. Bats send and receive ultrasound frequency squeaks up to 120,000 Hz. Which

one of them hears the shorter wavelengths - cats or bats?

Mandatory Exercise Exercise Set Iv

1. The velocity of sound according to Laplace-Newton's expression.

A. $\sqrt{\dfrac{\gamma P}{\rho}}$

B. $\sqrt{\dfrac{P}{\rho}}$

C. $\sqrt{\dfrac{P}{\gamma\rho}}$

D. $\sqrt{P\gamma}$

Answer: A

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2. The medium through which sound is to propagate must be

A. Elastic, Inertial, Frictionless

B. Rigid, Frictionless

C. Inertial, Frictionless

D. None of these

Answer: A

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3. What is the elastic coefficient if temperature remains constant (Isothermal expansion).

A. γP

B. RT

C. nRT

D. P

Answer: D

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4. If the SI unit of mass is taken to be g

If the SI unit of distance is taken to be km

If the SI unit of time is taken to be s

What will be the expression for SI unit of

intensity?

A. $\dfrac{g}{s^2}\,km$

B. $\dfrac{g}{s^3}\,km$

C. $g\,/\,s^3$

D. $\dfrac{km}{s^3}$

Answer: C

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5. At which frequency do we perceive the sound most sensitively?

A. 2500 Hz

B. 20 kHz

C. 3500 Hz

D. 40 Hz

Answer: C

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6. Higher the pitch of a sound higher is its

A. frequency

B. amplitude

C. wavelength

D. speed

Answer: A

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7. Which phenomenon correctly explains the red-shift observed in waves emitted from celestial bodies

A. Doppler's effect

B. Newton's law of gravitation

C. Scattering of light

D. Dispersion of light

Answer: A

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8. If the speed of sound is v at a certain temperature and the time gap required for a normal person to differentiate between two

waves is t sec then minimum distance required

for echo is in m)

A. vt

B. $v\left(t + E^2\right)$

C. $\dfrac{vt}{2}$

D. v(t+16.6)

Answer: C

9. The velocity of sound will have the largest value in

A. air

B. water

C. vacuum

D. metal

Answer: B

10. The speed of sound of a wave having frequency 200 Hz in air is 340 m/s. The speed of sound of wave of frequency 400 Hz in the same air is

A. 340 m/s

B. 680 m/s

C. 170 m/s

D. $3 \times 10^8 m/s$

Answer: A

11. The ratio of velocity of sound measured in hydrogen and oxygen gas at a given temperature will be

A. 1:1

B. 2:1

C. 1:4

D. 4:1

Answer: D

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12. The quantity on which loudness of the sound depends is

A. metre

B. amplitude

C. frequency

D. wavelength

Answer: B

13. The method used to calculate the depth of ocean beds in ships is

A. Sonic Boom

B. Sonar

C. Laser

D. None

Answer: B

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14. If the velocity of sound is taken to be 340 m/s, the minimum distance to hear an echo is

A. 34 m

B. 17.2 m

C. 68 m

D. cannot be determined

Answer: B

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15. On increasing the humidity in the atmosphere the speed of sound will

A. increase

B. decrease

C. remain same

D. become zero

Answer: A

16. A sound source emits sound waves of frequency 500 Hz and wavelength 0.2 m. How long does it take the waves to travel 300 m.

A. 75 s

B. 60 s

C. 12 s

D. 3 s

Answer: D

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17. A sound wave produces 50 crests and 50 troughs in 0.5 sec. What is the frequency of the wave?

A. 100 Hz

B. 150 Hz

C. 50 Hz

D. 125 Hz

Answer: A

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18. For sound waves to propagate in a medium it should have the property of

    A. Elasticity

    B. Inertia

    C. Both inertia and elasticity

    D. Either inertia or elasticity

Answer: C

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19. Speed (v), wavelength (λ) and the frequency (f) of sound are related as

A. $\lambda = v \times f$

B. $v = f\lambda$

C. $f = v\lambda$

D. none

Answer: B

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20. Ultrasonic waves have frequency

A. below 20 Hz

B. between 20 Hz and 20 kHz

C. only above 20 kHz

D. none

Answer: C

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21. The frequency of a wave travelling at a speed of 500 m/s is 25 Hz. Its time period is

A. 20 s

B. 0.05s

C. 25 s

D. 0.04 s

Answer: D

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22. For two particles vibrating in the same phase, the minimum distance between them is called

A. Wavelength

B. Frequency

C. Amplitude

D. Phase

Answer: A

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23. A wave of frequency 1000 Hz travels between X and Y. a distance of 600 m in 2 sec. How many wavelengths are there in distance XY.

A. 3.3

B. 300

C. 180

D. 2000

Answer: D

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24. What is the speed of a 150 Hz wave whose wavelength is measured to be 0.3 m?

A. $45 \, m/s$

B. $5 \times 10m/s$

C. $0.002 \, m/s$

D. none

Answer: A

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25. A thunder clap is heard 5.5 seconds after the lightening flash. The distance of the flash is

A. 1780 m

B. 1815 m

C. 300 m

D. 3560 m

Answer: B

26. Which of the following quantities remain unchanged when sound travels from a highly polluted region to a pollution free region.

A. Velocity

B. Amplitude

C. Frequency

D. Wavelength

Answer: C

27. Sound waves in air are

A. electromagnetic waves

B. mechanical waves

C. matter waves

D. either (a) or (b)

Answer: B

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28. Loud sound can travel a larger distance due to

A. higher amplitude

B. higher energy

C. higher frequency

D. higher speed

Answer: B

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29. The pitch of sound depends on

A. frequency

B. amplitude

C. both (a) and (b)

D. none

Answer: A

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30. The frequency which is not audible to the human ear is

A. 50 Hz

B. 500 Hz

C. 5000 Hz

D. 50000 Hz

Answer: D

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31. A sound source emits sound waves of 400 Hz. It produces waves of wavelength 2.5 m. The velocity of sound waves is

   A. 100 m/s

   B. 1000 m/s

   C. 10000 m/s

   D. 3000 km/s

Answer: B

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32. A source of frequency of 500 Hz emits waves of wavelength 0.4 m. How long does the waves take to travel 600 m?

A. 3 s

B. 6 s

C. 9 s

D. 12 s

Answer: A

1. Give reasons for the following:

Thunder and lightning occur simultaneously, but thunder is heard only after the lightning is seen.

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2. Give reasons for the following:

Strings of a musical instrument are usually mounted on a hollow box.

3. Give reasons for the following:

Strings of different thickness are used in stringed instruments.

4. Give reasons for the following:

A rough surface is more effective in reducing echoes than a smooth one.

5. Give reasons for the following:

The flash of lightning sometimes produces a series of thunder.

6. Give reasons for the following:

Bats can fly even in darkness avoiding obstruction.

7. Give reasons for the following:

It is not possible to converse with a friend on the surface of the moon.

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8. Give reasons for the following:

The velocity of sound is greater in solids than in gases at NTP.

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9. Give reasons for the following:

Bells are made of metals and not of wood.

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Consolidated Exercise Effects Of Tnterference Of Sound

1. Sound-off exploration

Get a sound system with a pair of detachable speakers and set it for monoral sound (not

stereo). Reverse the wiring on one of the speakers by switching the positive and negative inputs. Your speakers are then out of phase.

When you put on the sound system, the resulting sound will not be as full and as loud as from speakers properly connected in phase. Why?

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2. Sound-off exploration

Get a sound system with a pair of detachable speakers and set it for monoral sound (not stereo). Reverse the wiring on one of the speakers by switching the positive and negative inputs. Your speakers are then out of phase.

Place the speakers facing each other. Put on the music and bring them closer to each other. You will hear a weaker sound. Why?

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3. Sound-off exploration

Get a sound system with a pair of detachable speakers and set it for monoral sound (not stereo). Reverse the wiring on one of the speakers by switching the positive and negative inputs. Your speakers are then out of phase.

What will you hear when the pair of speakers are brought face to face and touching?

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4. Beat

A tone is a sound of distinct pitch and duration. When two tones of slightly different frequency are sounded together, a fluctuation in loudness may be heard. The sound is loud, then faint, then loud, then faint, and so on. This periodic variation in loudness is called beats. How are beats caused?
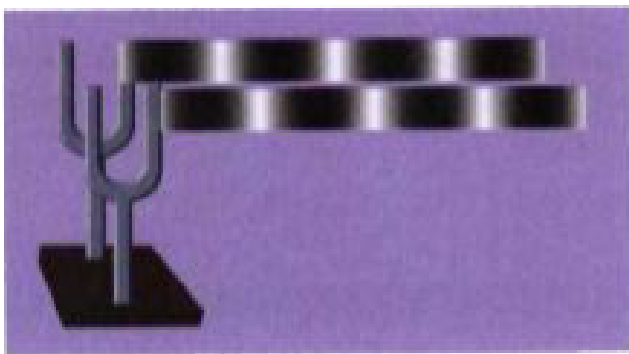
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5. The following table presents a comparison between light and sound. Complete it with appropriate words:

	Light	Sound
	Example:	
(i)	Seeing: light	Listening: sound
(ii)	Transverse: light	?
(iii)	?	Mechanical: sound
(iv)	?	Ultrasound image: bats
(v)	3×10^8 m s^{-1}: light	?
(vi)	?	Infrasound: audible sound: ultrasound
(vii)	Optical fibre: light	?
(viii)	RADAR: radio waves	?
(ix)	Television screen: light	?
(x)	?	Thunder: sound
(xi)	Glow worm: light	?
(xii)	?	Ear drum: sound

1. Read the passage and answer the following question.

It is known that the expansion of air follows adiabatic expansion. When sound waves propagate through the air velocity is given by $\sqrt{\dfrac{P\gamma}{\rho}}$ where $\gamma = \dfrac{C_P}{C_V}$. Assume you are in a planet where it is filled only with dry N_2 and $\gamma = 1.4$ and molar mass of $N_2 = 28$. The temperature of the atmosphere is 300 K. The

ideal gas equation PV = nRT is obeyed where P is pressure, v = volume, n = number of moles, T = temperature, R=8.314 $J\,mol^{-1}K^{-1}$.

What will be a suitable formula for velocity amongst the following

A. $\sqrt{\dfrac{P}{\rho}}$

B. $\sqrt{\dfrac{\gamma nRT}{M}}$

C. $\sqrt{\dfrac{\gamma RT}{M}}$

D. $\sqrt{\dfrac{\gamma}{\rho}}$

Answer: C

2. Read the passage and answer the following question.

It is known that the expansion of air follows adiabatic expansion. When sound waves propagate through the air velocity is given by $\sqrt{\dfrac{P\gamma}{\rho}}$ where $\gamma = \dfrac{C_P}{C_V}$. Assume you are in a planet where it is filled only with dry N_2 and $\gamma = 1.4$ and molar mass of $N_2 = 28$. The temperature of the atmosphere is 300 K. The ideal gas equation PV = nRT is obeyed where P

is pressure, v = volume, n = number of moles, T

= temperature, R=8.314 J $mol^{-1}K^{-1}$.

What will be the velocity in the planet?

A. 350 m/s

B. 340 m/s

C. 353 m/s

D. 360 m/s

Answer: C

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3. Read the passage and answer the following question.

It is known that the expansion of air follows adiabatic expansion. When sound waves propagate through the air velocity is given by $\sqrt{\dfrac{P\gamma}{\rho}}$ where $\gamma = \dfrac{C_P}{C_V}$. Assume you are in a planet where it is filled only with dry N_2 and $\gamma = 1.4$ and molar mass of $N_2 = 28$. The temperature of the atmosphere is 300 K. The ideal gas equation PV = nRT is obeyed where P is pressure, v = volume, n = number of moles, T = temperature, R=8.314 $J\,mol^{-1}K^{-1}$.

If intensity is given by $I = 2\pi^2 f^2 A^2 e v$ and density of N_2 is given by 1.25 g/L, what will be intensity in terms of frequency f and amplitude A?

4. Read the passage and answer the following question.

It is known that the expansion of air follows adiabatic expansion. When sound waves propagate through the air velocity is given by

$$\sqrt{\frac{P\gamma}{\rho}} \text{ where } \gamma = \frac{C_P}{C_V}.$$ Assume you are in a planet where it is filled only with dry N_2 and $\gamma = 1.4$ and molar mass of $N_2 = 28$. The temperature of the atmosphere is 300 K. The ideal gas equation PV = nRT is obeyed where P is pressure, v = volume, n = number of moles, T = temperature, R=8.314 J $mol^{-1}K^{-1}$.

What will be the loudness if sound waves of A = 2 m and 50 Hz frequency are generated

    A. 50 dB

    B. 100 dB

C. 200 dB

D. 400 dB

Answer: C

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5. Read the passage and answer the following question.

It is known that the expansion of air follows adiabatic expansion. When sound waves propagate through the air velocity is given by

$\sqrt{\dfrac{P\gamma}{\rho}}$ where $\gamma = \dfrac{C_P}{C_V}$. Assume you are in a planet where it is filled only with dry N_2 and $\gamma = 1.4$ and molar mass of $N_2 = 28$. The temperature of the atmosphere is 300 K. The ideal gas equation PV = nRT is obeyed where P is pressure, v = volume, n = number of moles, T = temperature, R=8.314 $J\,mol^{-1}K^{-1}$.

Assume the temperature reaches 373 K and water vapour rapidly gets mixed with N_2 gas to bring significant change in the density of air. What will happen to the velocity of sound? (Hint: N_2 gas is denser than water vapour)

A. decreases

B. increases

C. does not change

D. insufficient information

Answer: B

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Consolidated Exercise Multiple Choice Questions With One Or More Than One Correct Answer

1. Sound waves are

    A. longitudinal

    B. transverse

    C. mechanical

    D. electromagnetic

Answer: A::C::D

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2. Factors affecting the velocity of sound are

A. density of the medium

B. amplitude of sound waves

C. temperature of the medium

D. direction of wind

Answer: A::C::D

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3. Which of the following are the consequences of reflection of sound?

A. resonance

B. hearing an echo

C. ultrasound scanning

D. SONAR

Answer: A::B::C::D

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4. Ultrasonic, infrasonic, and audible sound waves are travelling in a homogeneous medium. It is correct to say that

A. their velocities are nearly equal

B. their frequencies are equal

C. their frequencies remain constant

D. their wavelengths are equal

Answer: A::C::D

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5. Which of the following is true?

A. On increasing the humidity of air the velocity of sound waves increase

B. On increasing the humidity of air the velocity of sound waves decrease.

C. The sound waves velocity in air is not influenced by the pressure.

D. On increasing the temperature the velocity of sound waves decrease.

Answer: A::C::D

6. The velocity of sound waves is 340 m/s at $30°C$ then what would be the velocity at $40°C$?

A. 350 m/s

B. 349 m/s

C. 345.56 m/s

D. 346.01 m/s

Answer: C

7. Which of the following is true about the factors influencing intensity?

    A. Intensity $\propto f^2$

    B. Intensity $\propto$ density

    C. Intensity $\propto$ amplitude

    D. Intensity $\propto$ velocity

Answer: A::C::D

8. Which of the following is true about loudness?

A. It is the magnitude of listener's perception

B. Loudness can be represented in bel or decible scale

C. Loudness $= 10 \log\left(\dfrac{I}{I_0}\right)$ bel where

$I_0 = 10^{-12} W/m^2$

D. The minimum loudness human ear can

perceive is 0 dB

Answer: A::B::D

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9. Which of the following is true about

music/noise?

A. Noise is always louder than music

B. Noise is unpleasant to human ear whereas music is pleasant to human ear

C. Higher the amplitude higher is the loudness for a particular sound wave

D. Pitch is a direct measurement of frequency

Answer: A::B::C::D

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10. Which of the following is true about ultrasonic waves?

A. Ultrasonic waves have frequency higher than 20 kHz

B. Ultrasonic waves show chemical effect like liberating I_2 from KI

C. Ultrasonic waves can act as catalyst in certain chemical reaction

D. All inaudible waves are called as ultrasonic waves.

Answer: A::B::C::D

11. Identify the correct applications of ultrasonic waves.

A. Welding (direct application of heating effect of ultrasonic waves)

B. Used in SONAR

C. To clean metals off grease, dirt, oil

D. To heal tendons

Answer: A::B::C::D

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12. If the loudness at a frequency of 25 Hz is 2 dB then at 100 Hz

    A. The loudness becomes 20 dB

    B. The loudness becomes 14 dB

    C. The intensity at 25 Hz is $16I_0$

D. The intensity at 100 Hz is $25.6I_0$

Answer: A::B::D

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13. Infrasonic sound waves can be utilised as

   A. waves to understand the location by

      sound navigation and ranging

   B. high energy waves to kill malignant,

      cancerous cells

C. drilling (low frequency vibration breaks down certain rocks easier)

D. to sense the magnitude of the level of earthquakes

Answer: A::C::D

 View Text Solution

14. Identify the time statements about oscillations

A. A freely swinging pendulum is performing forced oscillations.

B. A spring with one end fixed and other end fixed to a mass if displaced on a table with friction and released will perform damped oscillations.

C. A continuous periodic force which is vibrating with a constant frequency and amplitude (It is maintained by using external energy) is set into contact with

a block which is connected to one end of

a spring lying on a table with friction,

the block will perform forced

oscillations.

D. The same conditions as in (c) except the

table is frictionless will perform damped

oscillations.

Answer: A::B::C::D

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1. Give some examples to show that sound is produced by vibrations.

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2. How does the velocity of sound change by the factor as mentioned?

Density

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3. How does the velocity of sound change by the factor as mentioned?

Temperature

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4. How does the velocity of sound change by the factor as mentioned?

Wind

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5. How does the velocity of sound change by the factor as mentioned?

Pressure

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6. How does the velocity of sound change by the factor as mentioned?

Humidity

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7. What are the factors affecting intensity? From the factors derive a probable formula of intensity.

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8. How is $timbre/quality$ defined?

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9. What are the three kinds of vibrations? Explain in brief with example.

Challenging Exercise

1. A worker's helmet slips and falls when he is 78.4 m above the ground. He hears the sound of the helmet hitting the ground 4.23 seconds after it slipped. Find the speed of sound in air.

2. The speed of sound is 314 ms. The temperature of the surrounding atmosphere is -10ºC. Calculate the speed of sound at (i) $-40^{\circ}\,C$.

[Hint: For every $1^{\circ}C$ fall in temperature, the speed decreases by 0.6 m s^{-1}]

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3. The speed of sound is 314 ms. The temperature of the surrounding atmosphere

is -10ºC. Calculate the speed of sound at $40°\,C$.

[Hint: For every $1°\,C$ fall in temperature, the speed decreases by 0.6 m s^{-1}]

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4. A person standing between two vertical cliff's produces a sound. Two successive echoes are heard at 4 s and 6 s. Calculate the distance between the cliffs. [The speed of sound in air = 320 m s^{-1}]

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5. An observer standing in front of a vertical wall claps 10 times in 1 s. He adjusts his distance from the wall in such a way that the sound of his clapping coincides with the echo. This happens when his distance from the wall is 17.5 m. What is the velocity of sound?

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6. How many times more intense is a 90-dB sound than a 40-dB sound?

7. What is the approximate distance of a thunderstorm when you note a 3-s delay between the flash of lightning and the sound of thunder?

8. You watch a distant person hammering a piece of iron at a regular rate of 1 stroke per

second. You hear the sound of the hammer exactly synchronized with the blows you see. And then you hear one more blow after you see him stop hammering. How far away is he from you?

9. Calculate the velocity of sound in a mixture of gases made up of 2 parts by volume of oxygen, one part by volume of carbon dioxide and 3 parts by volume of nitrogen, all volumes

measured at NTP. $\gamma = 1.4$ for nitrogen and oxygen and $\gamma = 1.31$ for carbon dioxide. R = 8.4 $J/$mole-K.

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10. Show that the velocity of sound in a gas is given by $v_t = v_0 + (v_0/546)t$, where v_0 is the velocity at $0°C$ and t is the temperature of the gas in $°C$. Assume $t << 273$.

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11. A 5-watt source sends out waves in air at frequency 1000 Hz. Deduce the intensity at a 100-m distance, assuming spherical distribution. If $v = 350ms^{-1}$ and $\rho = 1.3kgm^{-3}$, deduce the displacement amplitude.

12. A person is standing between two cliffs, suppose it takes at least t sec for an average human ear to differentiate between two

sound waves. The person produces sound waves having velocity v, he is standing at distance d_1 and d_2 from the two cliffs. What is the relation between d_1, d_2, v required so that he can distinctly hear both the echoes. What is the minimum value of d_1 and d_2 for the condition to happen?

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13. Two waves are generated at the two ends of a string whose length is given to be d as

shown in the diagram. It is known that they are going to interfere constructively after some time t as shown. What is t in term of the velocity of waves $v \geq l$?
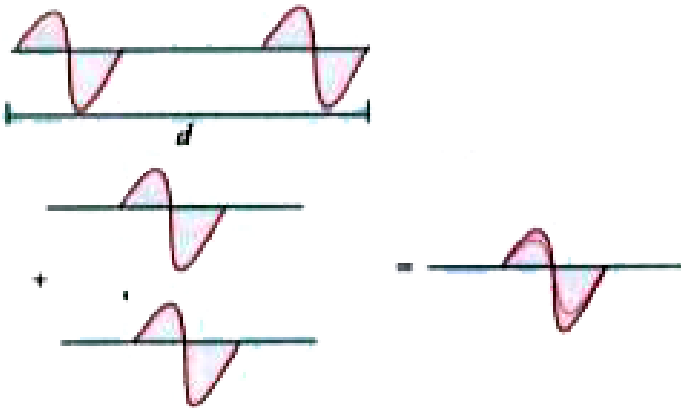
14. We are familiar with the formula velocity = $\sqrt{\dfrac{\text{elastic property}}{\text{density}}}$ Can you guess the elastic property and hence the velocity of sound waves in a rod having density ρ and force constant k?

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15. $\lambda = \dfrac{C_P}{C_v}$, Find γ_{eq} required for the mixture containing 1 mole of Gas A, 2 mole of Gas B

such that γ of $A = \gamma_1$ and γ of $B = \gamma_2$ (and it is given that $C_P = C_V + R$)

16. Find the minimum distance for echo in an atmosphere completely filled with dry N_2 in a temperature of 300 K. Given γ of dry $N_2 = 1.4$, $R = 8.314\mathrm{mol}^{-1}K^{-1}$

1. Which of the following is correct about Doppler effect?

    A. The Doppler effect is the apparent change in the frequency due to relative motion between the source and the listener

    B. The Doppler effect is used to measure the speed of automobiles in police radar

system.

C. Doppler effect exists when either source

or listener or both is/are moving with

respect to the other

D. All of the above

Answer: D

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2. Intensity level of a sound of intensity I is 30 dB. Then the ratio (I/I_0) is ____, where I_0 is the threshold of hearing.

    A. 1000

    B. 3

    C. 30

    D. 30000

Answer: A

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3. Doctor's stethoscope works on the principle of

A. superposition of sound waves

B. beats

C. reflection of sound waves

D. refraction of sound waves

Answer: C

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4. Which of the following examples represents periodic motion but not SHM?

A. The rotation of earth about its axis

B. Motion of an oscillating mercury column in a U-tube

C. An arrow released from a bow

D. Motion of an ant on a straight string

Answer: A

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5. The time period of the second's pendulum is

A. $2\pi s$

B. 2 s

C. π s

D. 4π s

Answer: B

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6. If v_m is the velocity of sound in moist air, v_d is the velocity of sound in dry air, under identical conditions of pressure and temperature

A. $v_m > v_d$

B. $v_m < v_d$

C. $v_m = v_d$

D. $v_m v_d = 1$

Answer: A

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7. A man standing on a cliff claps his hand hears its echo after 1 sec. If sound is reflected from another mountain and velocity of sound in air is 340 m/sec. Then the distance between the man and reflection point is

A. 680 m

B. 340 m

C. 85 m

D. 170 m

Answer: D

8. A source of sound of frequency 600 Hz is placed inside water. The speed of sound in water is 1500 m/s and in air is 300 m/s. The frequency of sound recorded by an observer who is standing in air is

    A. 200 Hz

    B. 3000 Hz

C. 120 Hz

D. 600 Hz

Answer: D

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9. Read the given statements and select the correct options.

Assertion: Sound travels faster in solids than gases.

Reason: Solid possesses greater density than gases.

A. If both the assertion and reason are true and reason is a true explanation of the assertion.

B. If both the assertion and reason are true but the reason is not the correct explanation of assertion.

C. If the assertion is true but reason is false.

D. If both the assertion and reason are

false.

Answer: B

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10. A person speaking normally produces a

sound intensity of 40 dB at a distance of 1 m. If

the threshold intensity for reasonable

audibility is 20 dB, the maximum distance at

which he can be heard clearly is

A. 10 m

B. 5 m

C. 4 m

D. 20 m

Answer: A

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