QB365

Important Questions - Waves

11th Standard CBSE

Physics

Reg.No. :

Time : 01:00:00 Hrs

Total Marks : 50

Section-A

1) A wave pulse is described by $y(x,t) = ae^{-(bx - at)^2}$ where a, b and c are positive constants.What is the speed of this wave? **1**

2) The density of oxygen is 16 times the density of hydrogen.Whta is the relation between the speed of sound in two gases? **1**

3) The velocity of sound in a tube conatining air at 27^0C and a pressure of 76 cm of mercury is 330 m / s. What will it be when pressure is increased to 100 cm. of mercury and the temperature is kept constant? **1**

4) Does a vibrating source always produce sound? **1**

5) How speed of sound waves in air varies with humidity? **1**

6) The displacement of an elastic wave is given by the function $y = 3\sin \omega t + 4\cos\omega t$ Where, y is in cm and t is in second.Calculate the resultant amplitude. **1**

7) If the speed of a transverse wave on a stretched string of length 1 m is 60 m/s.What is the fundamental frequency of vibration? **1**

8) A progressive wave of frequency 500 Hz is travelling with a velocity of 360 m/s. How far particles are two points 60^o out of phase? **1**

9) Third overtone of a closed organ pipe is in unison with fourth harmonic of an open organ pipe. Find the ration of lengths of the pipes. **1**

10) What frequency of the sound you hear coming directly from the siren? **1**

Section-B

11) A steel wire has a length of 12 m and a mass of 2.10 kg. What will be the speed of a transverse wave on this wire when a tension of 2.06×10^4N is applied? **2**

12) A pipe 20 cm long is closed at one end. Which harmonic mode of the pipe is resonantly excited by a source of 1237.5 Hz? (sound velocity in air $=330ms^{-1}$) **2**

13) What is the amplitude of a point 0.375 m away from one end? **2**

14) A narrow sound pulse (e.g. a short pip by a whistle) is sent across a medium. **2**

(i) Does the pulse have a definite (a) frequency, (b) wavelength, (c) speed of propagation?

(ii) If the pulse rate is 1 after every 20 s, (that is the whistle is blown for a split of second after every 20 s), is the frequency of the note produced by the whistle equal to 1/20 or 0.05 Hz?

15) At what temperature (in ^{0}C) Will be speed of sound air be 3 times its value at 0^0 C? **2**

16) A standing wave is formed by two harmonic waves, $Y_1 = Asin(kx - \varpi t)$ and $Y_2 = Asin(kx - \varpi t)$ travelling on a string in opposite directioons. Mass density of the string is ρ and area of cross-section is s. Find the total mechanical energy between two adjacent nodes on the string. **2**

17) A stone dropped from the top of a tower of height 300m in high splashes into the water of pond near the base of the tower. When is the splash heard at the top, given that the speed of sound in air is $340ms^{-1}$ **2**

18) If C is rms speed of molecules in a gas and V is the speed of sound waves in the gas, show that c/v is constant and independent of temperature for all diatomic gases. **2**

19) A train, standing at the outer signal of a railway station blows a whistle of frequency 400 Hz in still air. What is the speed of sound in each case? The speed of sound in still air can be taken as $340ms^{-1}$. **2**

20) A pipe 20 cm long is closed at one end. Which harmonic mode of the pipe is resonantly excited by a 430 Hz source? Will the same source be in resonance with the pipe if both ends are open? (speed of sound in air 340 ms^{-1}) **2**

Section-C

21) **Wave function** **5**

The two individual wave functions are

y_1 = (5 cm) sin (4x - t) and y_2 = (5 cm) sin (4x + t)

Where x and y are in centimetres.Find out the maximum displacement of the motion at x = 2.0 cm. Also, find the positions of nodes and antinodes.

22) Estimate the speed of sound in air at STP. The mass of 1 mole of air is 29.0×10^{-3} kg. **5**

23) Two waves of equal frequencies have their amplitudes in the ration of 3:5. They are superimposed on each other.Calculate the ratio of I_{max}/I_{min}. **5**

24) **An Amazing Sitar** **5**

Two sitar strings A and B playing the note 'Dha' are slightly out of tune and produce beats of frequency 5 Hz. The tension of string B is slightly increased and the frequency is found to decrease to 3 Hz. What is the original frequency of B, if the frequency of A is 427 Hz?

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Section-A

1) c / b **1**

2) $vH_2 = 4vO_2$ **1**

3) will remain same **1**

4) **1**

A vibrating source produced when it vibrates in a medium and frequency of vibration lies within the audible range (20 Hz to 20 KHz).

5) **1**

Speed of sound waves in air increases with increases with increase in humidity. This is because presence of moisture decreases the density of air.

6) The resultant amplitude will be $y = \sqrt{y_1^2 + y_2^2} = \sqrt{9+16} = \sqrt{25} = 5cm$ **1**

7) 30 Hz **1**

8) 0.12m **1**

9) 7:8 **1**

10) 1031.25 Hz **1**

Section-B

11) l = 12m, M =2.10 kg, T = 2.06×10^{4}N, v =? **2**

$\mu = \frac{M}{l} = \frac{2.10}{12} kg/m$

$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{2.06\times10^4}{2.10/12}} = 3.43 \times 10^2 m/s$

12) Length of pipe(l) =20 cm=20x10^{-2} m **2**

$v_{funda} = \frac{v}{4L} = \frac{330}{4\times20\times10^{-2}}$

$v_{funda} = \frac{330\times100}{80} = 412.5 \quad Hz$

$\frac{v_{given}}{v_{funda}} = \frac{1237.5}{412.5} = 3$

Hence, 3rd harmonic mode of the pipe is resonantly excited by the source of given frequency.

13) Given, $Y = 0.06 \sin \frac{2\pi}{3} x \cos(120\pi)$ **2**

Putting x= 0.375 m

Amplitude, $Y = 0.06 \sin \frac{2\pi}{3} \times (0.375)$

$= 0.06 \sin \frac{\pi}{4} = \frac{0.06}{\sqrt{2}} = 0.042 \quad m$

14) (i) A short pip by a whistle **2**

(a) will not have a fixed frequency.

(b) will not have fixed wavelength.

(c) will have the definite speed that will be equal to the speed of sound in air.

(ii) 0.05 Hz will be the frequency of repetition of the short pip.

15) We know that, speed, $v \infty \sqrt{T}$ **2**

By formula v = $\frac{xRT}{p}$ Where T is in kelvin

$\frac{v_t}{v_0} = \sqrt{\frac{273+t}{273+0}} = 3$

$\Rightarrow \frac{273+t}{273} = 9 \Rightarrow \quad t = 9 \times 273 - 273 = 2184^0 C$

16) $\frac{\rho A^2 \varpi^2 \pi s}{k}$ **2**

17) Given, h=300m, g=9.8m/s^2, v=340ms^{-1} **2**

t_1 = time taken by stone to strike the water surface

$t_1 = \sqrt{\frac{2h}{g}} = \sqrt{\frac{300}{49}} = 7.82s \left(as \quad h = 0 + \frac{1}{2}gt_1^2\right)$

t_2 = time taken by the splash's sound to reach top of the tower

$t_2 = \frac{h}{v} = \frac{300}{340} = 0.882 \quad \left[v = \frac{h}{t_2}\right]$

Total time, t = time to hear splash of sound

= $t_1 + t_2$ =7.82+0.882=8.702

18) From Kinetic theory of gases, **2**

$p = \frac{1}{3} p c^2$, where c is rms speed of molecules of gas.

$\Rightarrow c = \sqrt{\frac{3p}{p}}$

v = speed of sound in the gas = $\sqrt{\frac{p}{\Upsilon \rho}}$

$\Rightarrow from \quad eqs. (i) \quad and \quad (ii)$

$\frac{c}{v} = \sqrt{\frac{3p}{\rho} \times \frac{\rho}{\Upsilon \rho}} = \sqrt{\frac{3}{\Upsilon}}$

Fer diatomic gases,

$\Upsilon = 1.4 = \quad constant$

$\Rightarrow \frac{c}{v} = \sqrt{\frac{3}{1.4}} = 1.46 = \quad constant$

19) The speed of sound wave in each case will be same and is 340 m/s. **2**

20) Given L=20 cm =0.2 m, v_n =430 Hz, v=340 m/s **2**

It will behave as closed organ pipe

$$v_n = (2n-1) \frac{v}{4L}, \quad where \quad n = 1, 2, 3....$$

$$\Rightarrow \qquad 430 = (2n-1) \frac{v}{4L} = (2n-1) \times \frac{340}{4 \times 0.2}$$

$$\Rightarrow \quad (2n-1) = \frac{430 \times (0.8)}{340} \Rightarrow 2n = \frac{(430)(0.8)}{340} + 1$$

$$\Rightarrow \qquad n = \frac{43 \times 4}{340} + \frac{1}{2} = \frac{2 \times 172 + 340}{340 \times 2} = \frac{684}{680} = 1.006$$

Hence, it will be the 1st normal mode or harmonic mode of vibration.

In a pipe open at both ends,$v_n = n \times \frac{v}{2l} = \frac{n \times 340}{2 \times 0.2} = 430$

$\Rightarrow n = \frac{430 \times 2 \times 0.2}{340} = \frac{43 \times 2 \times 2}{340} = 0.5$

As n is not integer, hence, open organ pipe cannot be in resonance with the source.

Section-C

21) Given, $y_1 = (5\text{ cm})\sin(4x - t)$ **5**

$y_2 = (5\text{ cm})\sin(4x + t)$

the resulting wave

$y = (2A\sin kx)\cos\omega t$

the resulting wave $(2A\sin kx)\cos\omega t$

Now, compare the given equation

$y_1 = (5\text{ cm})\sin(4x - t)$ with $y_1 = A\sin(kx - \omega t)$

A = 5 cm, k = 4 and ω 1 rad / s

$y = (2A\sin kx)\cos\omega t$

$y = (10\sin 4x)\cos t$

the maximum displacement of the motionat a position

x = 2.0 cm

$y_{max} = 10\sin 4x \,|\, x{=}2.0$

$= 10\sin(4\times 2)$

$= 10\sin(8\text{ rad})$

$y_{max} = 9.89$ cm

The wavelegth by using the relation between wavelegth and the wave number .

$k = \frac{2\pi}{\lambda} = 4$

$\Rightarrow \quad \lambda = \frac{2\pi}{4} = \frac{\pi}{2}$ cm

The nodes and anitinodes can be given as

Nodes at $x = \frac{n\lambda}{2}$

$= n\times\left(\frac{\pi}{4}\right)$ cm,

where n = 0,1,2,....

Antinodes at $x = (2n+1)\,\frac{\lambda}{4}$

$= (2n+1)\times\left(\frac{\pi}{8}\right)$cm,

where n = 0,1,2,...

22) We know that volume of any gas at is 22.4 litre. **5**

Density of air at STP is

$$\rho_0 = \left(\frac{mass}{volume \quad at \quad STP}\right)_{for \quad one \quad mole \quad of \quad air}$$

$$= \frac{29.0\times10^{-3}kg}{22.4\times10^{-3}} = 1.29 \quad kgm^{-3}$$

According to Newton's formula,

Speed of sound, $v = \left[\frac{1.01\times10^5 Nm^{-2}}{1.29kgm^{-3}}\right]^{1/2} = 280 \quad ms^{-1}$

23) $\frac{A_1}{A_2} = \frac{3}{5} \Rightarrow \sqrt{\frac{I_1}{I_2}} = \frac{3}{5}$ **5**

Now, $\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-I_2}\right) = \left(\frac{\sqrt{I_1/I_2}+1}{\sqrt{I_1}/I_2-1}\right)^2$

$$= \left(\frac{3/5+1}{3/5-1}\right)^2 = \frac{64}{4} = \frac{16}{1}$$

24) Here, frequency of A = 427 Hz 5

As number of beats/sec (m) = 5 Hz

Possible frequencies of B are = 432 Hz or 422 Hz

When tension of B is increased, its frequency increases.

Number of beats/s decreases to 3.

Therefore, m is negative.

Hence, original frequency of B = 427-5 = 422 Hz.