## DiEssays; banes to subjets vince emprenance in the course of the trains out statiff '.Ul' 1. Derive Newton's formula for the velocity of longitudinal wave in an elastic medium. What is Laplace's correction to the Newton's formula? Discuss the effect of pressure and temperature of air on the velocity of sound in air. 2. Describe various modes of vibration of air column in open and closed pipes. Show that a closed pipe can produce only odd harmonics whereas an open pipe can produce C. Short answer questions all harmonics. 3. Derive an expression for a harmonic wave. What are the characteristics of a pre 4. What are beats? Discuss the formation of beats analytically as well as graphically. 5. Explain Doppler effect. Obtain the general expression for the apparent frequency of What are (a) progressive wave (b) stationary wave (c) nodes and antinode; bnuoz 4. What is the meaning of overtones and harmonics? Give an example of a harmonic which is not an overtone. E. Problems 1. A uniform wire is stretched under a tension 2 kg f. The length of the wire is 0.5 m and its mass is $3.735 \times 10^{-5}$ kg. Calculate (i) the speed of transverse vibrations of the string (ii) and the fundamental frequency of vibrations of the string. [Ans: 512 ms<sup>-1</sup>; 512 Hz.] 2. A steel wire of length 1 m and diameter 0.5 mm is stretched by a load 10 kg. Calculate the fundamental frequency of the wire. ( $g = 9.8 \text{ ms}^{-2}$ , density of steel = 7.8 x $10^3 \text{ kg m}^{-3}$ ) $10^3 \text{ kg m}^{-3}$ [.zH 12.651 h::anA] es and antinodes not seen in light.due to superposition of incident and 3. The velocity of sound in air is 348 ms<sup>-1</sup>. Find the wavelength of the sound emitted by a string of frequency 464 Hz. Seven vacantate and for an account you woll of the world of the state of the [Ans: $0.75 \, \mathrm{m}$ ] produced by a vibrating timing fork becomes louder when its stem 4. A person drops a stone into a well and hears the sound of the splash after 5.35 s. If the depth of the well is 122.5 m, calculate the velocity of sound in air. [Ans: 350 ms<sup>-1</sup>] 5. Calculate the velocity of sound in air at $27^{\circ}$ C( $\gamma = 1.40$ ; Density of air at STP = 12. A vibrating tuning fork is carried with high speed rowards a wall, (ξπmlga/e2rIhears [Ans: $347.57 \text{ ms}^{-1}$ ] 6. Calculate the ratio of specific heats for hydrogen. Density of hydrogen at STP = 1.255 kg m<sup>-3</sup> (velocity of sound in hydrogen at STP = 336 m s<sup>-1</sup>) at the stability of sound in hydrogen at STP = 336 m s<sup>-1</sup>). [4.1 :anA] 14. A listener and a sound source are going with the same velocity in the same direction.

7. At what temperature is the velocity of sound in air double the velocity at 0°C? [Ans: 819°C]

8. Calculate the speed of sound in oxygen at 0°C.  $\gamma = 1.4$ ; M = 32 g mol<sup>-1</sup>; R =8.31 J mol<sup>-1</sup> K<sup>-1</sup>

[152m 218r:anApund pulse (for example, a short pip by a whistle) is sent across a medium.

9. The sound of a gun is heard by an observer 6 s after the flash of the gun is seen. Calculate the distance of the gun from the observer. The atmospheric temperature is 20°C. (Velocity of sound at 0°C is 331 ms<sup>-1</sup>) [m 7005azma] wave function? Explain the propogation constants

10. The equation of a transverse wave travelling along a coil spring is, not ground  $\triangle 0.02$ . band  $y = 4.0 \sin \pi (0.010 x_{1} - 2.0 t) \text{ cm. Find (i) amplitude (ii) wavelength (iii) initial$ phase at the origin (iv) speed and (v) frequency of the wave. [Ans: 300 Hz.1 [Ans: (i)  $4.0 \times 10^{-2}$  m; (ii) 2 m; (iii) 0; (iv)  $2.0 \text{ ms}^{-1}$ ; (v) 1 Hz.] 21. The transverse displacement of a string is given by, super lamamental and built 15 at both ends. (Velocity of sound in air =  $348.16 \text{ ms}^{-1}$ )  $y(x,t) = 0.060 \sin \frac{2\pi x}{3} \cos(120\pi t)$  m.

22. A man spin did which enters the whistle of an engine, which has a very spin of the string is 1.5 m and its mass is  $3.0 \times 10^{-2}$  kg, (i) Does the function is  $3.0 \times 10^{-2}$  kg. represent a travelling wave or a stationary wave? (ii) Interpret the wave superposition of two travelling waves in opposite direction. What are the wavelength, frequency and speed of propagation of each wave (iii) determine the tension in the string. [Ans: (i) stationary wave (ii)  $\lambda = 3$  m,  $\nu = 60$  Hz, V=180 ms<sup>-1</sup> (iii) 648 N.] 12. 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 its ends are open? (Speed of sound =  $340 \text{ ms}^{-1}$ ) [NCERT] [og ; jinomrad terif : anA] 13, Two sitar strings A and B playing the note Ga are slightly out of tune and produce beats of frequency 6 Hz. The tension in the string A is slightly reduced and the beat frequency is found to reduce to 3 Hz. If the original frequency of A is 324 Hz, what INCERTI (V-V) is the frequency of B? [.zH 818!:anA] ine approaches the observer, W is positive me 14. A stretched string produces 5 beats per second with a tuning fork of frequency 512 Hz. With another tuning fork of frequency 510 Hz, it makes 3 beats. Calculate the frequency of vibration of the string. I reason the most your seron enigne aft as [Ans: 507 Hz.] 15. Two notes of wavelengths 2.04 m and 2.08 m produce 200 beats per minute in a gas. Find the velocity of sound in the gas. Hint: No. of beats per second =  $v_1 - v_2 = v/\lambda_1 - \overline{v}/\lambda_2 = v[1/\lambda_1 - 1/\lambda_2]$   $\sqrt{-255} = \sqrt{-255}$ [Ans: 353.6 ms<sup>-1</sup>] 16. Estimate the speed of sound in air at STP. The mass of 1-mol of the gas is given to be and a car are moving on parallel tracks in opposite directions each and a car are moving on parallel tracks in opposite directions each 75. A railway engine and a calcare moving on parametrizers in opposite antecuous each [7-sm 3.186 :snA] km/b, the engine is continuously sounding the horn of frequency 512 Hz. THE LE VENERAL TO THE TENSION OF A SONOMETER WIRE IS increased by 4.5 kg., the pitch of the note emitted by a given length of the wire increases in the ratio 4:5. Calculate the original tension of the wire. [Ans: 8 kg wt] [Ans: 585 Hz; 449 Hz.] 18. Calculate the fundamental frequency of the note emitted by a tube of length 27/cm if the tube is (1) closed at one end (2) open at both ends.  $V_1 = 345.6 \text{ ms}^{-1}$ sound entranged of sound in air. What 19. The shortest length of an air column in a pipe closed at one end resonating with a fork of frequency 320 Hz, is 0.26 m. Calculate the velocity of sound in air. [Ans: 332.80 ms<sup>-1</sup>]  $v_1 = 0$ ;  $v_2 = 0.03$   $v_3 = 0$  [Ans: 332.80 ms<sup>-1</sup>]

20. A tuning fork is found to resonate with an air column closed at one end for lengths lail 27 cm and 82 cm. Calculate the frequency of the tuning fork. (Velocity of sound phase at the origin (iv) speed and (v) frequency of the waye.  $= 330 \text{ ms}^{-1}$ 

[Ans: (i)  $4.0 \times 10^{-2}$  m; (ii) 2 m; (iii) 0; (iv) 2.0 ms<sup>-1</sup>; (v) 1 Hz.] [Ans: 300 Hz.]

21. Find the fundamental frequency of the note emitted by a tube of length 0.34 m open at both ends. (Velocity of sound in air =  $348.16 \text{ ms}^{-1}$ )

[Ans: 512 Hz.]  $y(x, t) = 0.060 \sin \frac{2\pi x}{\cos(120\pi t)} \text{ m}.$ 

22. A man standing near a railway line hears the whistle of an engine, which has a velocity of 72 km/hr. What frequencies does the man hear the note when the engine is (a) coming towards him (b) going away from him; if the true frequency of whistle is (a) coming towards in (b) going a way for the composite of the composite o

23. A man on the railway platform observes that as the train passed him at 90 km/hr., the frequency of the whistle of the train appeared to drop to 490 Hz. Calculate the frequency of the whistle. (Velocity of sound  $= 350 \text{ ms}^{-1}$ ) ends are open? (Speed of sound = 340 ms

24. The apparent frequency of the whistle of an engine changes in the ratio 6:5 as the engine passes a stationary observer. Calculate the velocity of the engine. (Velocity of 1-sm 25: snA] quency 6 Hz. The tension in the sking A is slight sm 250 = bnuoz beat

frequency is found to reduce to 3 Hz. If  $t \in \text{cNgind}$  frequency is found to reduce to  $V_l = V_l =$ [INH As the engine approaches the observer,  $V_s$  is positive

14. A stretched string produces 5 beats per second with a tuning  $\frac{(5250)}{(2)} = \frac{1}{(2)} = \frac{1}{($ 

As the engine moves away from the observer,  $V_s$  is negative and and it is voneup

[Ans: 507 Hz.] (ii) Two notes of wavelengths 2.04 m and 2.08 m produce  $y \left( \frac{352}{s^2 + 252} \right) \frac{1}{1111} \frac{1}{2} \frac{1}{2} \frac{1}{111} \frac{1}{2} \frac{1}{2} \frac{1}{111} \frac{1}{2} \frac{1}{2} \frac{1}{111} \frac{1}{2} \frac{1}{2} \frac{1}{111} \frac{1}{2} \frac{1}{2}$ Find the velocity of sound in the gas.

Eqns: (i)/(ii)  $\frac{|v_1'|}{v_2'} = \frac{352 + V_s}{352 - V_s}$ ; i.e.,  $\frac{6}{5} = \frac{|352 + V_s|}{352 - V_s}$  and the same of the s

It Estimate the speed of sound in air at STP. The ham 281=1,V of the gas is given to be

25. A railway engine and a car are moving on parallel tracks in opposite directions each with speed 90 km/h, the engine is continuously sounding the horn of frequency 512 Hz. enter Calculate the frequency of sound of the horn heard by the driver of the car when (a) the lengine and the car approach each other and (b) the two are moving away from each tension o. the wire. other (Velocity of sound =  $340 \text{ ms}^{-1}$ )

[Ans: 585 Hz; 449 Hz.] [Ans: 8 kg wt]

26. A bat is flitting about in a cave, navigating via ultrasonic sound. Assume that the sound emission frequency of the bat is 40 kHz. During one fast sweep directly towards [3] a flat wall surface, the bat is moving at 0.03 times the speed of sound in air. What frequency does the bat hear the sound reflected off the wall? [NCERT]

Hint: Take the bat as the source and wall as the listener:

 $v_l = 0;$   $v_s = 0.03 v;$  v = 40 kHz;[Ans: 332.80 ms<sup>-1</sup>]

Now, take the wall as the source and bat as the listener:

and to consequently 
$$v_s = 0$$
;  $v_l = -0.03 v$ ;  $v = v' = 41.24 \text{ kHz}$ ;  $v'' = ?$ 

$$v'' = \left(\frac{v - v_l}{v - v_s}\right) v' = \left(\frac{v + 0.03 \, v}{v}\right) \times 41.24 = 42.47 \, \text{kHz}$$

 $V = A \sin(2\pi I) I(vx + x) + \phi I.$