

**Question 1)** A person blows into the open-end of a long pipe. As a result, a high-pressure pulse of air travels down the pipe. When this pulse reaches the other end of the pipe.

- (A) a high-pressure pulse starts travelling up the pipe if the other end of the pipe is open
- (B) a low -pressure pulse starts travelling up the pipe, if the other end of the pipe is open
- (C) a low-pressure pulse starts travelling up the pipe, if the other end of the pipe is closed
- (D) a high-pressure pulse starts travelling up the pipe, if the other end of the pipe is closed

**Answer: (B) and (D)**

**Solution:**

At the open-end, the sound pulse will reflect with a phase change of  $\pi$  radian. While at the closed-end, the sound pulse will reflect without any phase change

**Question 2)** A student is performing the experiment of Resonance Column. The diameter of the column tube is 4 cm. The frequency of the tuning fork is 512 Hz. The air temperature is  $38^{\circ}\text{C}$  in which the speed of sound is 336 m/s. The zero of the meter scale coincides with the top end of the Resonance Column tube. When the first resonance occurs, the reading of the water level in the column is:-

- (A) 14.0 cm
- (B) 15.2 cm
- (C) 16.4 cm
- (D) 17.6 cm

**Answer:(B) 15.2 cm**

**Solution:**

In resonance column experiment

$$\lambda/4 = l_1 + e$$

$$v/4f = l_1 + e \text{ (since, } \lambda = v/f)$$

$$l_1 = (v/4f) - e$$

$$= (v/4f) - (0.3)d$$

$$= [33600/(4 \times 512)] - (0.3)(4)$$

$$= 16.4 - 1.2 = 15.2 \text{ cm}$$

**Question 3)** A stationary source emits a sound of frequency  $f_0 = 492 \text{ hz}$ . The sound is reflected by a large car

approaching the source with a speed of 2m/s. The reflected signal is received by the source and superposed with the original. What will be the beat frequency of the resulting signal in Hz ? (Given that the speed of sound in air is 330 m/s and the car reflects the sound at the frequency it has received).

**Answer: 6Hz**

**Solution:**

Frequency of the sound as received by a large car approaching the source

$$f_1 = \frac{(C + V_0)}{C} f_0$$
$$= \frac{(330 + 2)}{330} \times 492 \text{ Hz}$$

This car now acts as source for reflected sound wave

$$f_{\text{reflected}} = f_1$$

Frequency of the sound received by the source

$$f_2 = \frac{C}{C - V_0} f_{\text{reflected}}$$
$$= \left[ \frac{330}{330 - 2} \right] \times f_1$$
$$= \frac{330}{328} \times \frac{332}{330} \times (492) \text{ Hz}$$
$$= 498 \text{ Hz}$$

$$\text{Beat frequency} = |f_0 - f_2|$$

$$= 498 - 492 = 6 \text{ Hz}$$

**Question 4) In an experiment to measure the speed of sound by a resonating air column, a tuning fork of frequency 500 Hz is used. The length of the air column is varied by changing the level of water in the resonance tube. Two successive resonances are heard at air columns of length 50.7 cm and 83.9 cm. Which of the following statements is (are) true?**

- (A) The speed of sound determined from this experiment is 332 m/s
- (B) The end correction in this experiment is 0.9 cm
- (C) The wavelength of the sound wave is 66.4 cm
- (D) The resonance at 50.7 cm corresponds to the fundamental harmonic

**Answer: (A) and (C)**

**Solution:**

Let  $n_1$  harmonic is corresponding to 50.7 cm &  $n_2$  harmonic is corresponding 83.9 cm. since both one consecutive harmonics.

$$\text{Difference} = \lambda/2$$

$$\text{Therefore, } \lambda/2 = (83.9 - 50.7) = 33.2 \text{ cm}$$

$$\lambda = 66.4 \text{ cm}$$

$$\lambda/4 = 16.6 \text{ cm}$$

Length corresponding to fundamental mode must be close to  $\lambda/4$  and 50.7 cm must be an odd multiple of this length  $16.6 \times 3 = 49.8 \text{ cm}$ .

Therefore 50.7 is 3rd harmonic

If end correction is e, then

$$e + 50.7 = 3\lambda/4$$

$$e = 49.8 - 50.7 = -0.9 \text{ cm}$$

Speed of sound,  $v = f\lambda$

$$\text{Therefore, } v = 500 \times 66.4 \text{ cm/sec} = 332 \text{ m/s}$$

**Question 5) The ratio of the speed of sound in nitrogen gas to that in helium gas, at 3000 K is**

- (a)  $\sqrt{2}/7$
- (b)  $\sqrt{1}/7$
- (c)  $(\sqrt{3})/5$
- (d)  $(\sqrt{6})/5$

**Answer: (c)  $(\sqrt{3})/5$**

**Solution:**

$$v = \sqrt{\gamma RT/M}$$

$$v_{N_2}/v_{He} = [\sqrt{(7/5)RT/14}] / [\sqrt{(5/3)RT/4}]$$

$$= \sqrt{3}/5$$

**Question 6) A tuning fork of frequency 480 Hz is used in an experiment for measuring the speed of sound (v) in the air by the resonance tube method. Resonance is observed to occur at successive lengths of the air column,  $l_1 = 30 \text{ cm}$  and  $l_2 = 70 \text{ cm}$ . Then v is equal to**

- (a) 332 m/s
- (b) 384 m/s

(c) 338 m/s

(d) 379 m/s

**Answer: (b) 384 m/s**

**Solution:**

$$v = 2f(l_2 - l_1)$$

$$= 2 \times 480 (70 - 30) \times 10^{-2}$$

$$v = 384 \text{ m/s}$$

**Question 7)** A pipe of length 85 cm is closed from one end. Find the number of possible natural oscillations of air column in the pipe whose frequencies lie between 1250 Hz. The velocity of sound in air is 340 m/s.

(a) 12

(b) 8

(c) 6

(d) 4

**Answer: (c) 6**

**Solution:**

Fundamental frequency of a closed organ pipe is  $f_1 = v/4l = 340/(4 \times 0.85)$

$$= 100 \text{ Hz}$$

The natural frequencies of the organ pipe is 100 Hz, 300 Hz, 500 Hz, 700 Hz, 900 Hz, 1100 Hz. These values are below 1250 Hz.

**Question 8)** A police car with a siren of frequency 8 kHz is moving with a uniform velocity of 36 km/hr towards a tall wall that reflects the sound waves. The speed of sound in air is 320 m/s. The frequency of the siren heard by the car driver is

(a) 8.50 kHz

(b) 8.25 kHz

(c) 7.75 kHz

(d) 7.50 kHz

**Answer: (a) 8.50 kHz**

**Solution:**

$$f' = f \left[ \frac{v+v_0}{v-v_s} \right]$$

$$v = 320 \text{ m/s}$$

$$v_0 = v_s = 36 \times (5/18)$$

$$= 10 \text{ m/s}$$

$$f' = 8 \left[ \frac{320+10}{320-10} \right]$$

$$= 8 \left( \frac{330}{310} \right)$$

$$= 8.516 \text{ kHz}$$

**Question 9)** Two factories are sounding their siren at 800 Hz. A man goes from one factory to other at a speed of 2m/s. The velocity of sound is 320 m/s. The number of beats heard by the person in one second is given by

- (a) 2
- (b) 4
- (c) 8
- (d) 10

**Answer:(d) 10**

**Solution:**

When the man is approaching the factory

$$n' = \left[ \frac{V_v + V_0}{V} \right] n$$

$$= \left[ \frac{320 + 2}{320} \right] \times 800$$

$$n'' = \left[ \frac{V_v - V_0}{V} \right] n$$

$$= \left[ \frac{320 - 2}{320} \right] \times 800$$

$$n' - n'' = \left[ \frac{322 - 318}{320} \right] \times 800$$

$$= 10 \text{ Hz}$$

**Question 10)** A musician using an open flute of length 50 cm produces second harmonic sound waves. A person runs towards the musician from another end of a hall at a speed of 10 km/h. If the wave speed is 330 m/s, the frequency heard by the running person can be close to

- (a) 666 Hz
- (b) 753 Hz

(c) 500 Hz

(d) 333 Hz

Answer: (a) 666 Hz

Solution:

The frequency produced by flute,  $f_0 = 2 (V/2l)$

$$= 2(330/2(0.5))$$

$$= 660 \text{ Hz}$$

Velocity of the observer = 10 km/h

$$= 10 \times (5/18)$$

$$= 25/9 \text{ m/sec}$$

$$f' = f_0 [(V_s + V_{ab})/(V_s + 0)]$$

$$= 660 \times [(330 + (25/9))/330]$$

$$= 671.12 \text{ Hz} \approx 666 \text{ Hz}$$

