Wave-3

***Option in bold letters is the answer**

Q1. A tube closed at one end and containing air is excited. It produces the fundamental note of frequency 512 Hz. If the same tube is open at both the ends the fundamental frequency that can be produced is

(a) 1024 Hz (b) 512 Hz (c) 256 Hz (d) 128 Hz

Sol. (a) Fundamental frequency of open pipe is double that of the closed pipe.

For closed end: $f = \frac{v}{4l}, 3\frac{v}{4l}, 5\frac{v}{4l}, 7\frac{v}{4l}$ ….

For open end: $f = 2\left(\frac{v}{4l}\right), 4\left(\frac{v}{4l}\right), 6\left(\frac{v}{4l}\right), 8\left(\frac{v}{4l}\right)$……

Q2. A closed pipe and an open pipe have their first overtones identical in frequency. Their lengths are in the ratio

(a) 1 : 2 (b) 2 : 3 **(c) 3 : 4** (d) 4 : 5

Sol. (c)

First over tone of closed pipe = First over tone of open pipe ⇒ $\mathbf{3}\left(\frac{v}{4l_1}\right) = \mathbf{4}\left(\frac{v}{4l_2}\right)$; where $\boldsymbol{l_1}$ and $\boldsymbol{l_2}$ are the lengths of closed and open organ pipes ⇨ henve $\frac{l_1}{l_2} = \frac{3}{4}$

Q3. If *v* is the speed of sound in air then the shortest length of the closed pipe which resonates to a frequency *n*

(a) $\frac{v}{4n}$ (b) $\frac{v}{2n}$ (c) $\frac{2n}{v}$ (d) $\frac{4n}{v}$

Sol. (a) For shortest length of pipe mode of vibration must be fundamental i.e., $n = \frac{v}{4l} \Rightarrow l = \frac{v}{4n}$

Q4. Apparatus used to find out the velocity of sound in gas is

(a) Melde's apparatus **(b) Kundt's tube** (d) Quicke's tube (d) None of these

Q5. Fundamental frequency of pipe is 100 Hz and other two frequencies are 300 Hz and 500 Hz then

(a) Pipe is open at both the ends

(b) Pipe is closed at both the ends

(c) One end open and another end is closed

(d) None of the above

Sol. **(c)** For closed end organ pipe ⇨ $f = \frac{v}{4l}, 3\frac{v}{4l}, 5\frac{v}{4l}, 7\frac{v}{4l}$ ….. ⇨ 1 : 3 : 5 : ….. ⇨100 : 300 : 500

Q6. **In a resonance tube the first resonance with a tuning fork occurs at 16 cm and second at 49 cm. If the velocity of sound is 330 m/s, the frequency of tuning fork is**

(a) 500 (b) 300 (c) 330 (d) 165

Sol. **(a)** For resonance tube ⇒ $v = 2f\,(l_2 - l_1)$

$$\Rightarrow f = \frac{v}{2\,(l_2 - l_1)} = \frac{330}{2 \times (0.49 - 0.16)} = 500\ Hz$$

Q7. **In a resonance pipe the first and second resonances are obtained at depths 22.7 cm and 70.2 cm respectively. What will be the end correction**

(a) 1.05 cm (b) 115.5 cm (c) 92.5 cm (d) 113.5 cm

Sol. **(a)**

$$e = \frac{l_2 - 3l_1}{2} = \frac{70.2 - 3 \times 22.7}{2} = 1.05\ cm$$

Q8. **A hallow cylinder with both sides open generates a fundamental frequency *f* in air. When the cylinder vertically immersed into water by half its length the second harmonic will be**

(a) f **(b) 2*f*** (c) *f*/2 (d) *f*/4

Sol. **(a)**

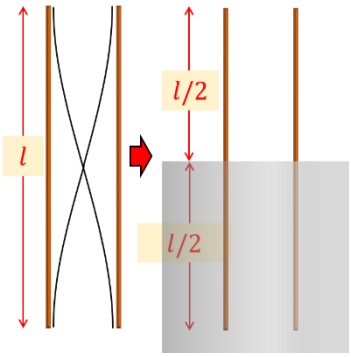
$\left[for\ open\ end:\ f = 2n\left(\frac{v}{4l}\right)\right]$

Fundamental(n=1)

$\Rightarrow f = 2 \times 1\left(\frac{v}{4l}\right)$

$\Rightarrow f = \frac{v}{2l}$

$\Rightarrow v = 2fl$ ……(1)



$\left[for\ closed\ end:\ f = (2n-1)\left(\frac{v}{4l}\right)\right]$

$for fundamental\ frequency:$

$f' = (2n-1)\left(\frac{v}{4l}\right)$ (2fl, 1, l/2)

$\Rightarrow f' = (2 \times 1 - 1)\left(\frac{2fl}{4\,l/2}\right) = f$

Second harmonic $= 2f' = \mathbf{2f}$