

5. A train is moving on a straight track with speed 20 ms^{-1} . It is blowing its whistle at the frequency of 1000 Hz . The percentage change in the frequency heard by a person standing near the track as the train passes him is (speed of sound = 320 ms^{-1}) close to:

- (1) 18%
- (2) 24%
- (3) 6%
- (4) 12%

→ correct option

Apparent frequency when train is approaching the person:

$$f_1 = \frac{c}{c - v_s} f_0$$

When train is moving away →

$$f_2 = \frac{c}{c + v_s} f_0$$

Δf as train passes the person = $f_1 - f_2$

$$\Delta f = f_0 \left(\frac{c}{c - v_s} - \frac{c}{c + v_s} \right) = \frac{2cv_s}{c^2 - v^2} f_0$$

$$v_s = 20 \text{ m/s}, \quad c = 320 \text{ m/s}, \quad f_0 = 1000 \text{ Hz}$$

$$\begin{aligned} \% \text{ age change in frequency} &= \frac{\Delta f}{f_1} \times 100 \\ &= \frac{2v_s f_0}{c^2 - v^2} \times \frac{c - v_s}{f_0} \times 100 = \frac{2v_s}{c + v_s} \times 100 \end{aligned}$$

$$= \frac{2 \times 20}{340} \times 100 \approx 12\% \quad \text{(4) is correct}$$