Physicsaholics

DPP – 4 (Sound Wave)

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/94

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Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/45

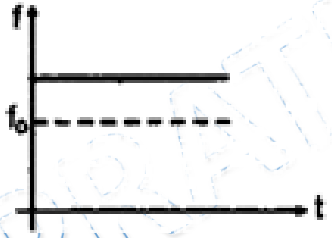
Q 1. The frequency changes by 10% as the source approaches a stationary observer with constant speed v_s. What would be the percentage change in frequency as the source recedes the observer with the same speed?

(a) 8.3% (b) 20% (c) 16.7% (d) 10%

Q 2. When a source of sound of frequency f crosses a stationary observer with a speed v_s (<< speed of sound v), the apparent change in frequency Δf is given by:

(a) $\frac{2fv_s}{v}$ (b) $2fvv_s$ (c) $\frac{2fv}{v_s}$ (d) $\frac{fv_s}{v}$

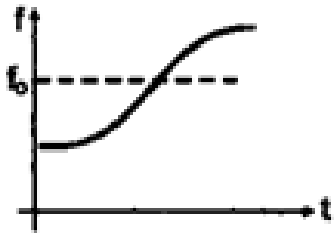
Q 3. Source and observer both starts moving simultaneously from origin one along x-axis and the other along y-axis with speed of source =2 (speed of observer). The graph between the apparent frequency observed by observer (f) and time (t) would be:



(a)

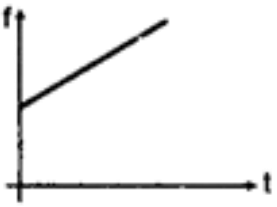
(b)

(c)

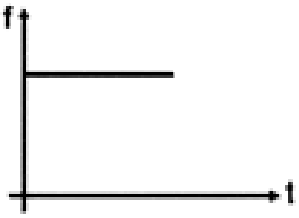


(d)

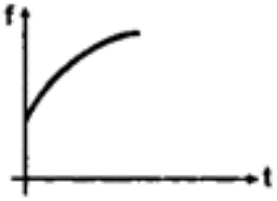
Q 4. An observer starts moving with uniform acceleration a towards a stationary sound source of frequency f_0. As the observer approaches the source, the apparent frequency f heard by the observer varies with rime t as:



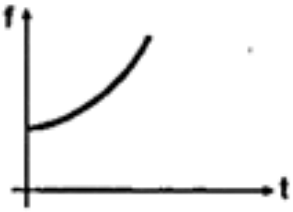
(a)



(b)



(c)



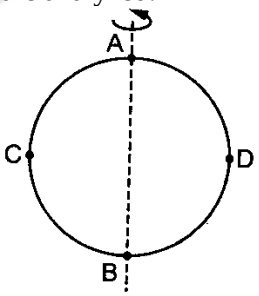
(d)

Q 5. A train is moving with a constant speed along a circular track. The engine of the train emits a sound of frequency f. The frequency heard by the guard at rear end of the train:
(a) is less than f
(b) is greater than f
(c) is equal to f
(d) may be greater than, less than or equal to f depending on the factors like speed of train, length of train and radius of circular track

Q 6. A conveyor belt moves to the right with speed v = 300 m/min. A pieman puts pies on the belt at a rate of 20 per minute while walking with speed 30 m/min towards a receiver at the other end. The frequency with which they are received by the stationary receiver is:330 m/ sec.
(a) 26.67/minute (b) 30/minute (c) 22.22/minute (d) 24/minute

Q 7. Two stars P and Q have slightly different surface temperatures T_P and T_Q respectively, with $T_P > T_Q$. Both stars are receding from the earth with speeds V_P and V_Q relative to the earth. The wavelength of light at which they radiate the maximum energy is found to be the same for both.
(a) $V_P > V_Q$
(b) $V_P < V_Q$
(c) $V_P = V_Q$, and the size of Q > the size of P
(d) Nothing can be said regarding V_P and V_Q from the given data.

Q 8. Assume that the sun rotates about an axis through its centre and perpendicular to the plane of rotation of the earth about the sun. The appearance of the sun, from any one point on the earth, is shown. Light belonging to a particular spectral line, as received from the points A, B, C and D on the edge of the sun, are analyzed.



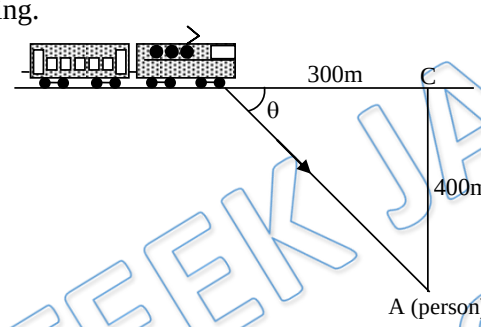
(a) Light from all four points have the same wavelength.
(b) Light from C has greater wavelength than the light from D.
(c) Light from D has greater wavelength than the light from C.
(d) Light from A has the same wavelength as the light from B.

Q 9. When source and detector are stationery and wind blow at speed v_w = 10 m/s, speed of sound is v = 330 m/s, find apparent wavelength of sound in direction of wind and wavelength of sound is 33 m
(a) 33 m (b)1 m (c) 34 m (d) $\frac{1089}{32}$

Q 10. The statement "Doppler effect increases the intensity of wave as received by detector, when source is approaching detector" is
(a) True (b) False
(c) Irrelevant (d) Information is insufficient

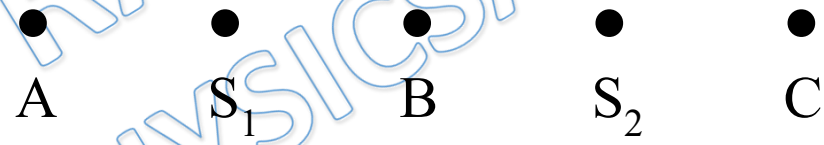
Q 11. A sound source of frequency f is moving on x axis with constant speed v_s. An observer is standing on –y axis at diatance d from origin. If speed of sound is v, find frequency of sound detected by observer at the instant when source is crossing origin?
(a) $\frac{fv^2}{v^2-v_s^2}$ (b) $\frac{fv^2}{v^2+v_s^2}$ (c) $\frac{fv}{v-v_s}$ (d) $\frac{fv}{v+v_s}$

Q 12. A train approaching a railway crossing at a speed of 120 km/h sounds a short whistle at frequency 640 Hz when it is 300m away from the crossing. The speed of sound in air is 340 m/s. What will be the frequency heard by a person standing on a road perpendicular to the track through the crossing at a distance of
400 m from the crossing.



(a) 660 Hz (b) 680 Hz (c) 720 Hz (d) 740 Hz

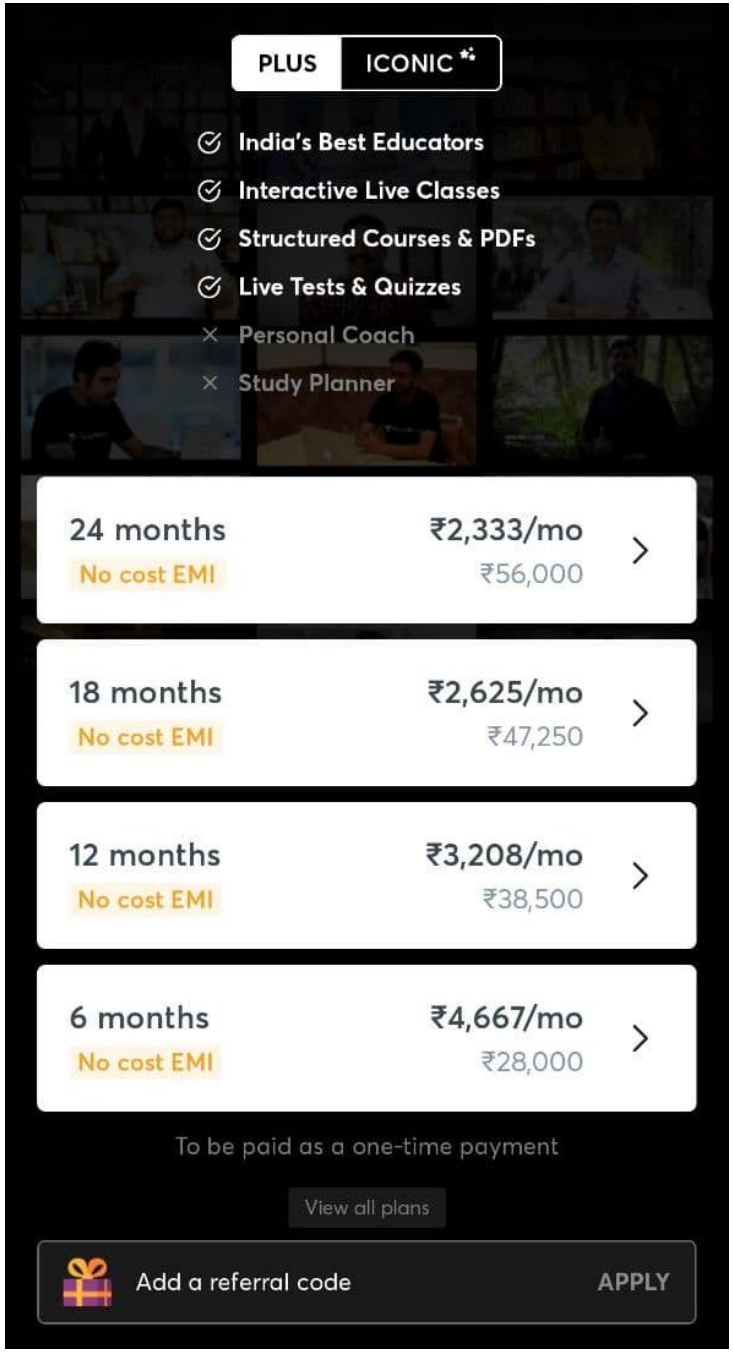
Q 13.



In the figure shown, S_1 and S_2 represents two stationary sources of sound having equal frequency, one observer is moving from A toward C with velocity V_0 then –
(a) Beats for three position A, B and C will be heard
(b) Beats will be heard from A and C but not in case of B
(c) Beats will be not heard for A and C but will be heard for B
(d) Beats will be not heard for three positions of A, B and C

Answer Key

Q.1 a	**Q.2 a**	**Q.3 b**	**Q.4 a**	**Q.5 c**
Q.6 c	**Q.7 a**	**Q.8 c, d**	**Q.9 c**	**Q.10 a**
Q.11 a	**Q.12 b**	**Q.13 c**		



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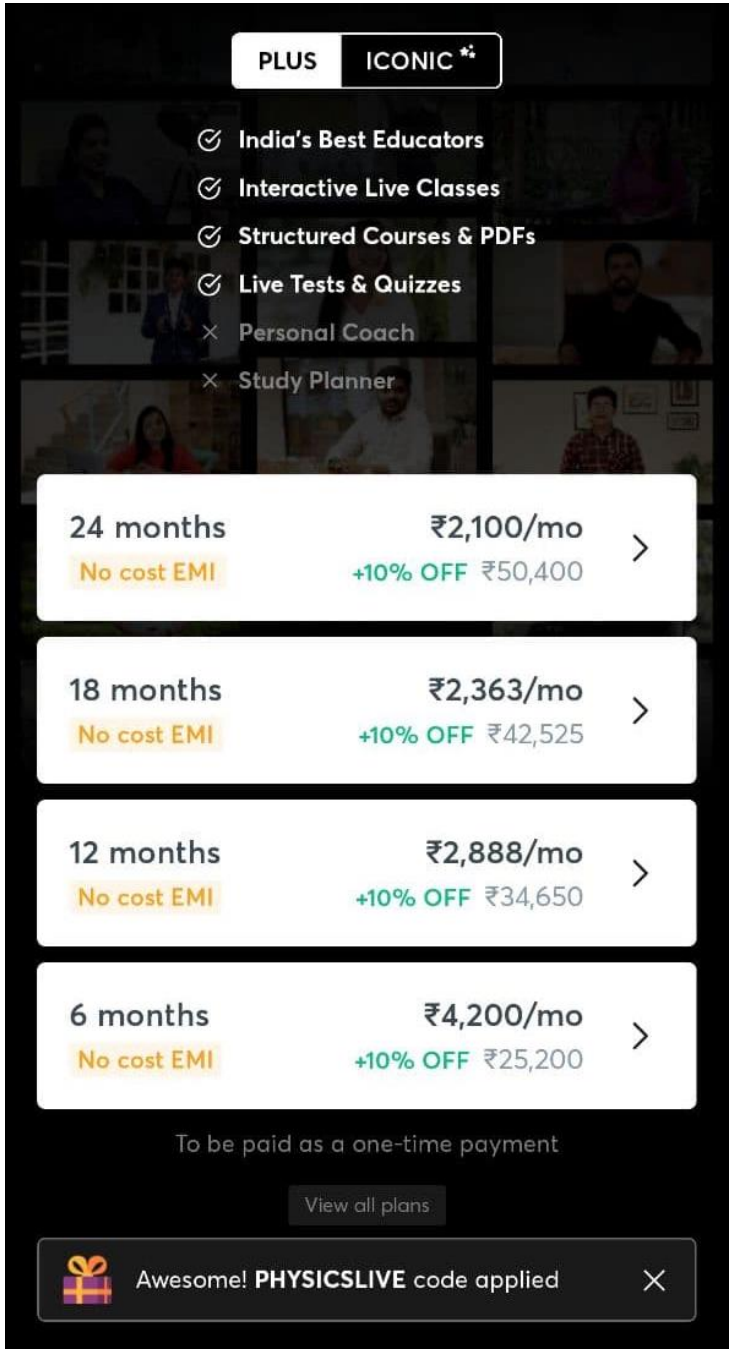
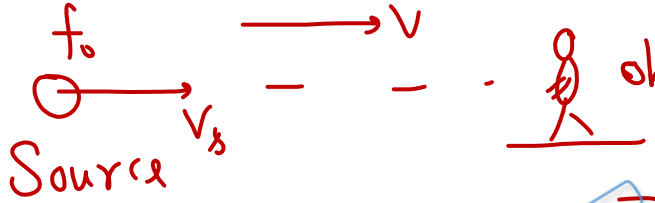


Written Solution

DPP- 4 Sound : Doppelr’s Effect

By Physicsaholics Team

Q1) The frequency changes by 10% as the source approaches a stationary observer with constant speed v_s. What would be the percentage change in frequency as the source recedes the observer with the same speed?



$$f' = f_0\left[\frac{V+V_0}{V-V_s}\right] = f_0\left[\frac{V}{V-V_s}\right] = \frac{110}{100}f_0$$

change in freq

$$\frac{\Delta f}{f_0}\times 100 = \frac{1}{12}\times 100 = 8.33$$

(a) 8.3% (b) 20% (c) 16.7% (d) 10%

$$\frac{V}{V-V_s} = \frac{11}{10} \Rightarrow 10V = 11V - 11V_s \Rightarrow 11V_s = V \Rightarrow V_s = V/11$$

If source is moving away →

$$f'' = f_0\left[\frac{V}{V+V_s}\right] = f_0\left[\frac{V}{V+V/11}\right] = \frac{11f_0}{12} \Rightarrow \Delta f = f_0 - \frac{11f_0}{12} = \frac{f_0}{12}$$

Q2) When a source of sound of frequency f crosses a stationary observer with a speed v_s (<< speed of sound v), the apparent change in frequency Δf is given by:

When source is approaching observer,

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

When source is moving away

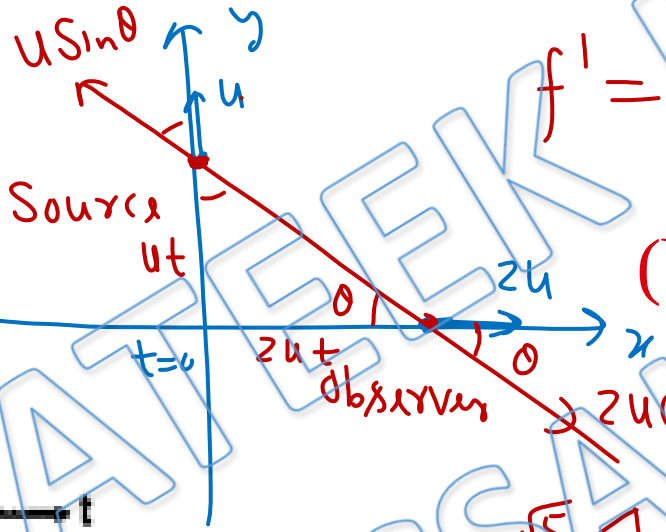
$$f' = f\left[\frac{v}{v + v_s}\right]$$

(a) $\frac{2fv_s}{v}$ (b) $2fvv_s$ (c) $\frac{2fv}{v_s}$ (d) $\frac{fv_s}{v}$

$$\Delta f = fv\left[\frac{1}{v - v_s} - \frac{1}{v + v_s}\right] = fv\left[\frac{v + v_s - v + v_s}{v^2 - v_s^2}\right]$$

$$= \frac{2fvv_s}{v^2 - v_s^2} = \frac{2fvv_s}{v^2} = \frac{2fv_s}{v}$$

Q3) Source and observer both starts moving simultaneously from origin one along x-axis and the other along y-axis with speed of source =2 (speed of observer). The graph between the apparent frequency observed by observer (f) and time (t) would be:



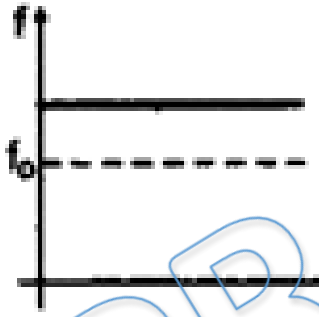
$$f' = f_0\left[\frac{v + (-2u\cos\theta)}{v - (-u\sin\theta)}\right] = \text{Constant}$$

$f' < f_0$

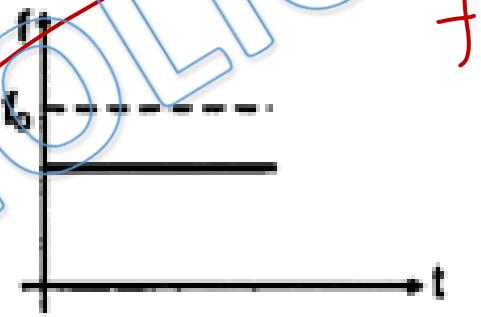
↓

Since distance between source & observer is increasing

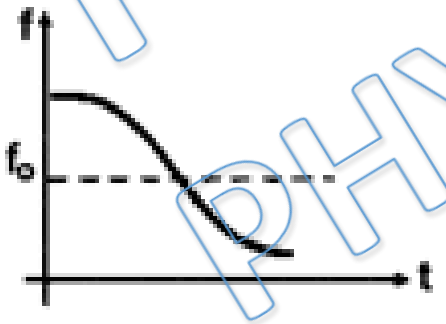
(a)



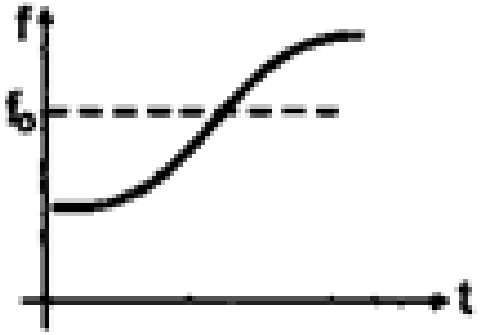
(b)



(c)



(d)



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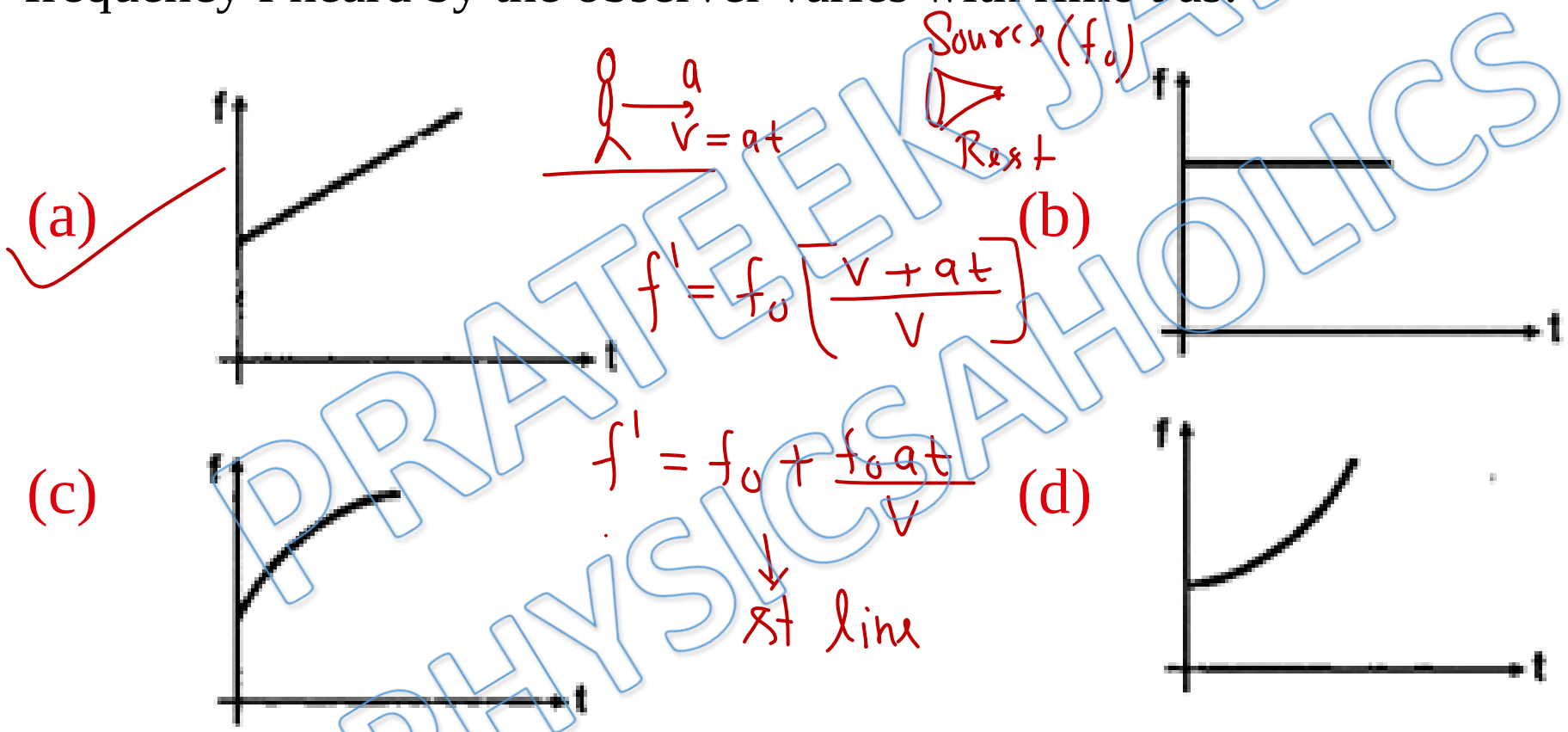
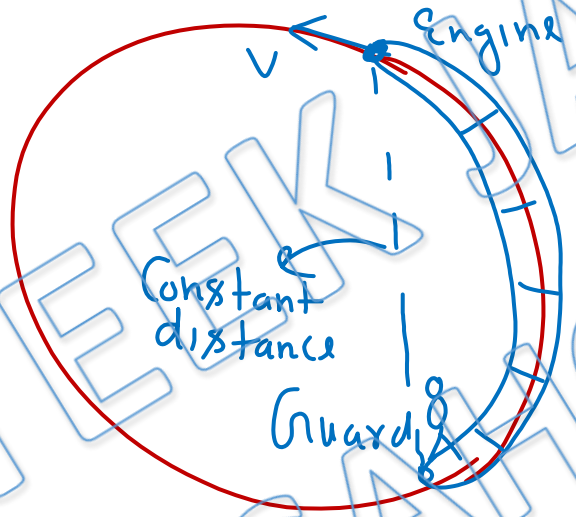


Q5) A train is moving with a constant speed along a circular track. The engine of the train emits a sound of frequency f. The frequency heard by the guard at rear end of the train:



Since distance b/w Source & observer is Constant

$\Rightarrow f' = f$

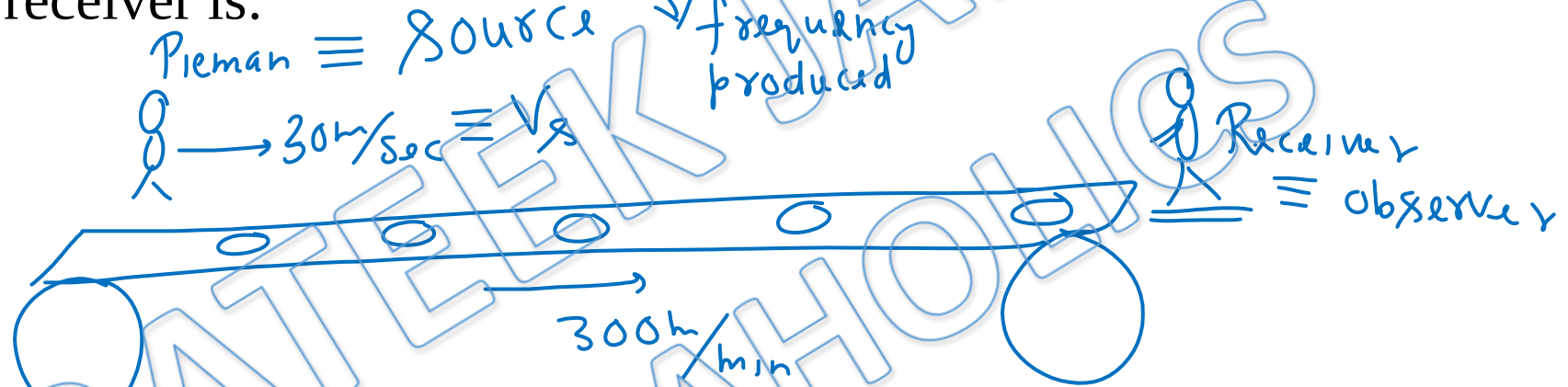
(a) is less than f

(b) is greater than f

(c) is equal to f

(d) may be greater than, less than or equal to f depending on the factors like speed of train, length of train and radius of circular track

Q6) A conveyor belt moves to the right with speed v = 300 m/min . A pieman puts pies on the belt at a rate of 20 per minute while walking with speed 30 m/min towards a receiver at the other end. The frequency with which they are received by the stationary receiver is:



(a) 26.67/minute (b) 30/minute (c) 22.22/minute (d) 24/minute

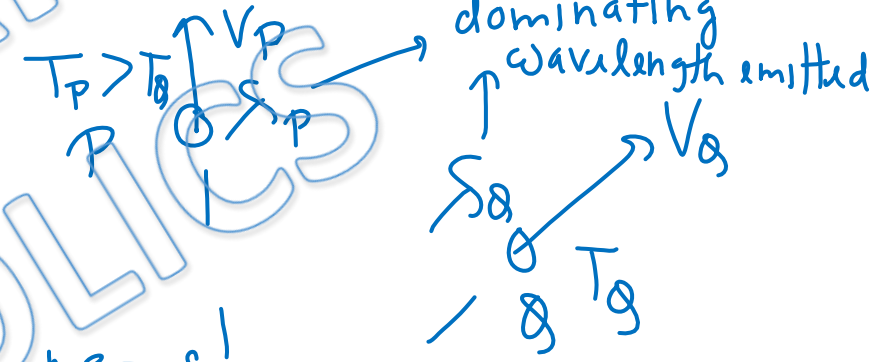
Pie ≡ Sound pulse

$$\text{frequency received} = 20\left[\frac{300+0}{300-30}\right] = \frac{20 \times \cancel{300}^{100}}{\cancel{27}_{9}\cancel{0}}$$

Q7) Two stars P and Q have slightly different surface temperatures T_P and T_Q respectively, with $T_P > T_Q$. Both stars are receding from the earth with speeds V_P and V_Q relative to the earth. The wavelength of light at which they radiate the maximum energy is found to be the same for both.

$\lambda_m T = b \rightarrow$ Wien's displacement law

$\lambda_m \propto \frac{1}{T}$



(a) $V_P > V_Q$ (b) $V_P < V_Q$

(c) $V_P = V_Q$, and the size of Q > the size of P

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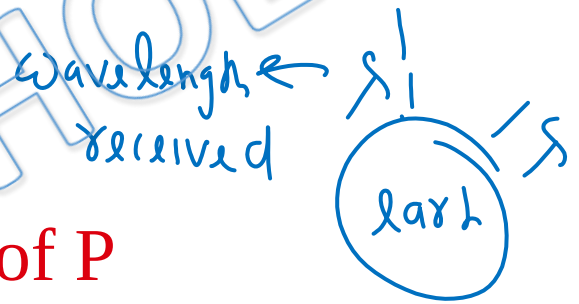


$\lambda_P < \lambda_Q$

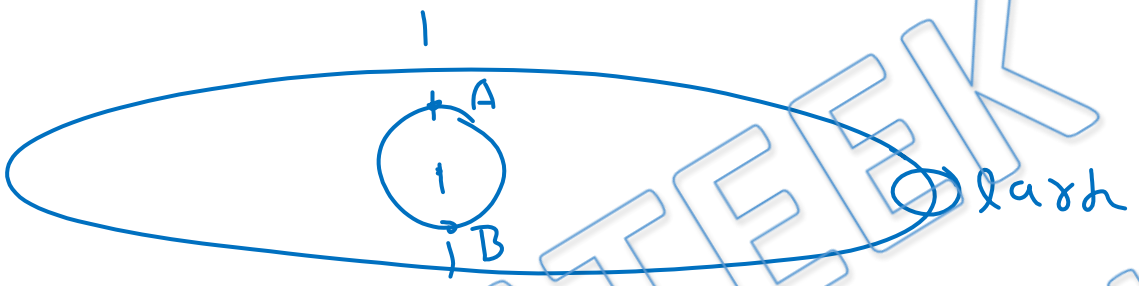
$\Delta\lambda_P = \lambda' - \lambda_P$

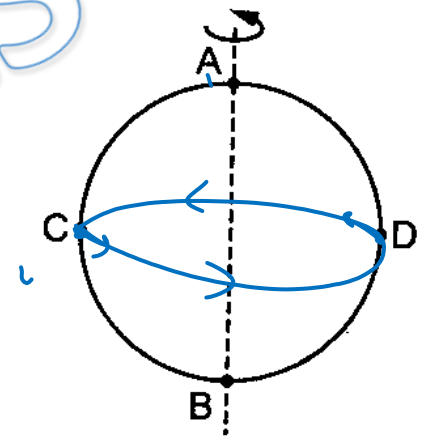
$\Delta\lambda_Q = \lambda' - \lambda_Q$

$\Delta\lambda_P > \Delta\lambda_Q$

$\Rightarrow \quad V_P > V_Q$

Q8) Assume that the sun rotates about an axis through its centre and perpendicular to the plane of rotation of the earth about the sun. The appearance of the sun, from any one point on the earth, is shown. Light belonging to a particular spectral line, as received from the points A, B, C and D on the edge of the sun, are analyzed.





(a) Light from all four points have the same wavelength.

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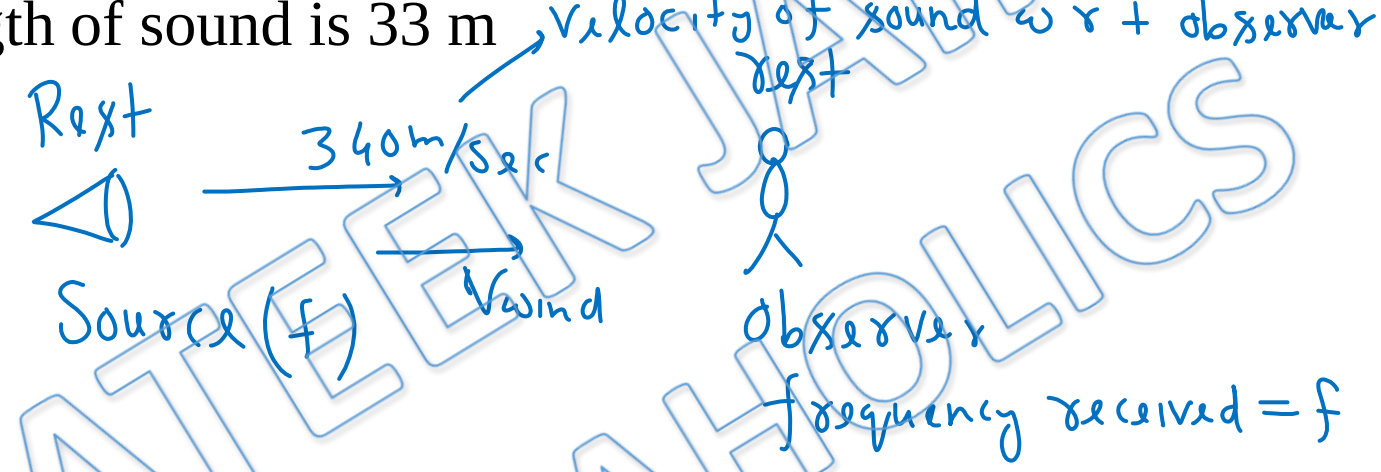
(c) Light from D has greater wavelength than the light from C.

(d) Light from A has the same wavelength as the light from B.

Q9) When source and detector are stationary and wind blow at speed v_w = 10 m/s, speed of sound is v = 330 m/s, find apparent wavelength of sound in direction of wind and wavelength of sound is 33 m



(a) 33 m (b)1 m (c) 34 m (d) $\frac{1089}{32}$

$$f = \frac{v}{\lambda} = \frac{v_{app}}{\lambda_{app}}$$

$$\frac{330}{33} = \frac{340}{\lambda_{app}}$$

$$\lambda_{app} = 34\ m$$

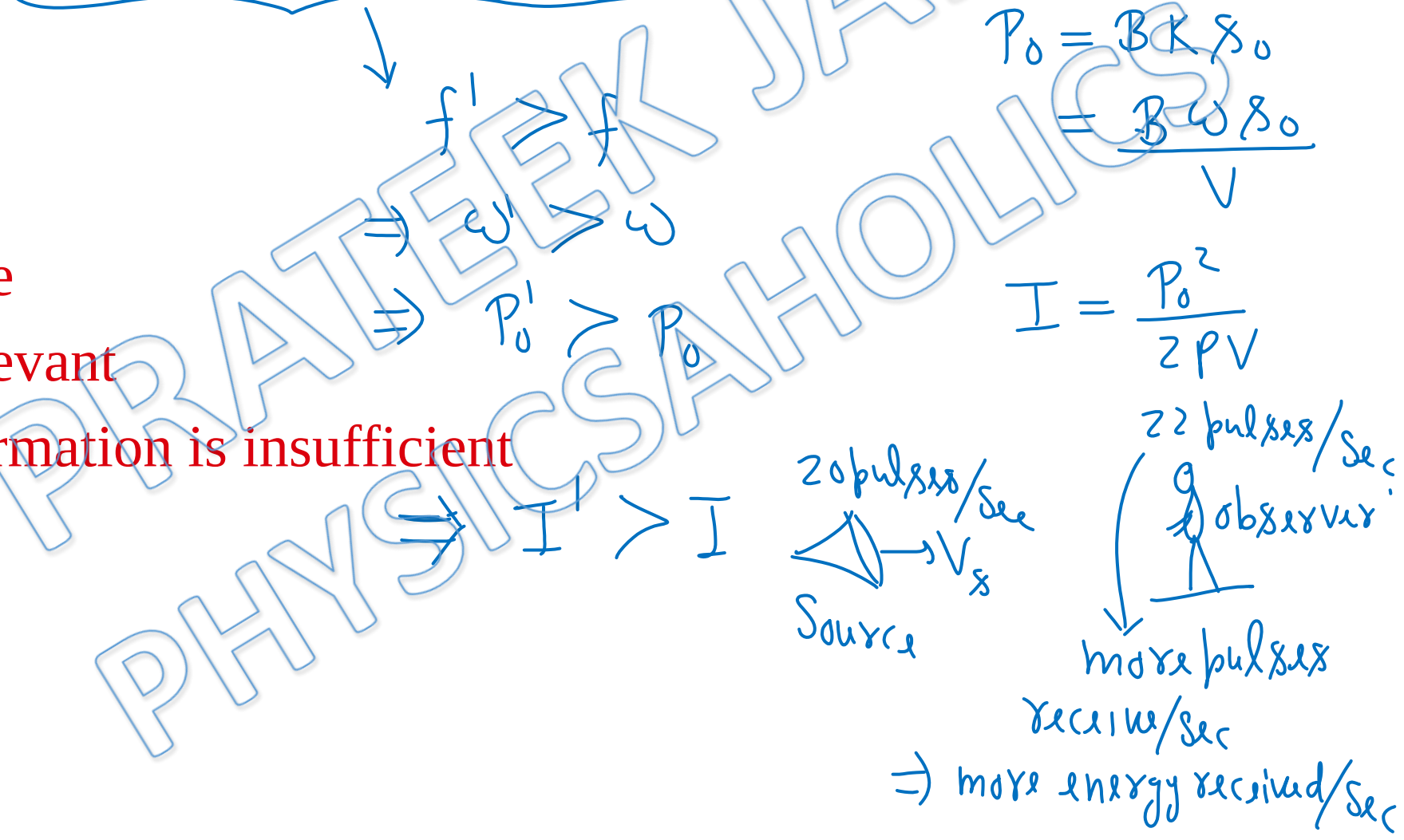
Q10) The statement "Doppler effect increases the intensity of wave as received by detector, when source is approaching detector" is

(a) True

(b) False

(c) Irrelevant

(d) Information is insufficient



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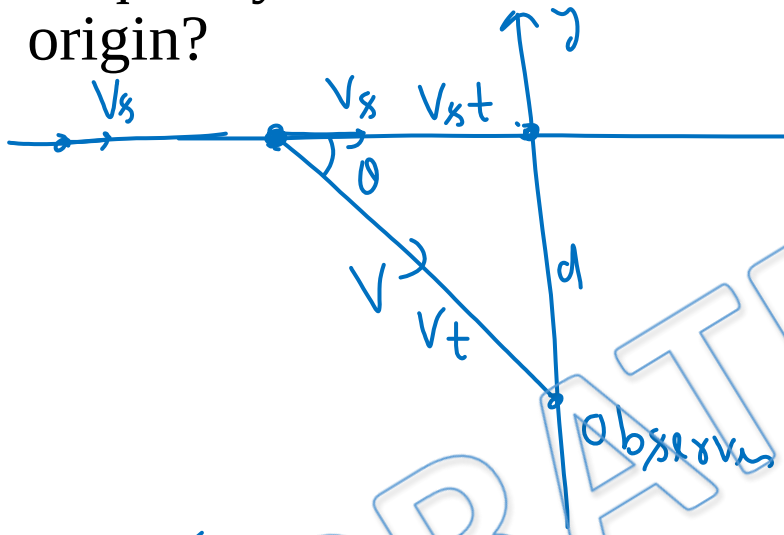


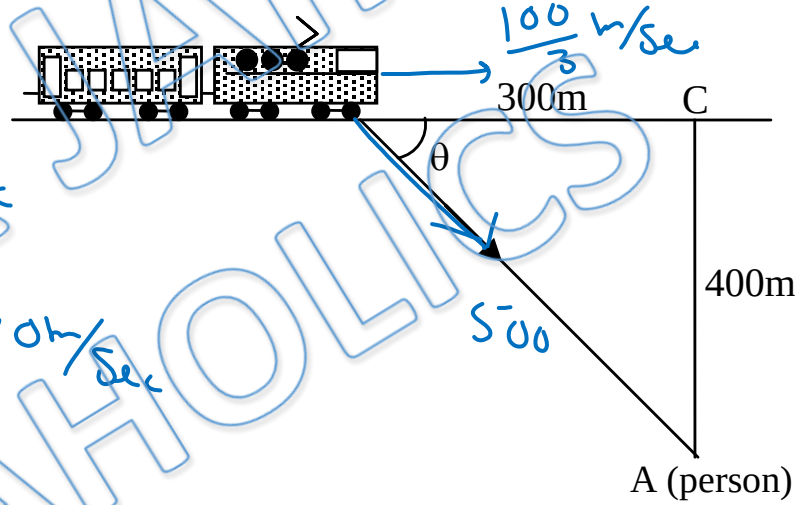
$$\cos\theta = \frac{v_s t}{vt} = \frac{v_s}{v}$$

(a) $\frac{fv^2}{v^2-v_s^2}$ (b) $\frac{fv^2}{v^2+v_s^2}$ (c) $\frac{fv}{v-v_s}$ (d) $\frac{fv}{v+v_s}$

$$f' = f\left[\frac{V+0}{V-V_s\cos\theta}\right] = f\left[\frac{V}{V-V_s V_s/V}\right]$$

$$= \frac{fV^2}{V^2-V_s^2}$$

Q12) A train approaching a railway crossing at a speed of 120 km/h sounds a short whistle at frequency 640 Hz when it is 300m away from the crossing. The speed of sound in air is 340 m/s. What will be the frequency heard by a person standing on a road perpendicular to the track through the crossing at a distance of 400 m from the crossing.



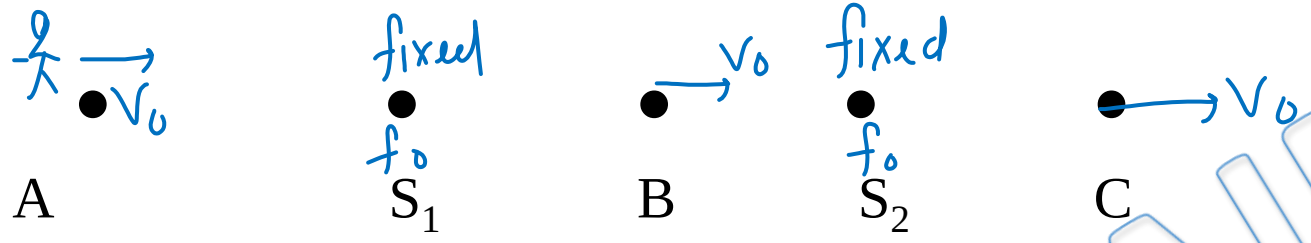
$V_x = 120 \times \frac{5}{18}\ m/Sec = \frac{100}{3}\ m/Sec$

$V_x \cos\theta = \frac{100}{3} \times \frac{3}{5} = 20\ m/Sec$

(a) 660 Hz (b) 680 Hz (c) 720 Hz (d) 740 Hz

$f' = 640\left[\frac{340}{340-20}\right]$

$= \frac{640 \times 340}{320} = 680\ Hz.$

Q13) 

In the figure shown, S_1 and S_2 represents two stationary sources of sound having equal frequency, one observer is moving from A toward C with velocity V_0 then –

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(b) Beats will be heard from A and C but not in case of B

(c) Beats will be not heard for A and C but will be heard for B

(d) Beats will be not heard for three positions of A, B and C

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