WEEKLY TEST MEDICAL PLUS - 01 TEST - 25 R & B
SOLUTION Date 24 -11-2019

[PHYSICS]

1. C

2. $K = \frac{1}{2} m\omega^2 (A^2 - y^2)$, $U = \frac{1}{2} m\omega^2 y^2$

$K = U$ or $\frac{1}{2} m\omega^2 (A^2 - y^2) = \frac{1}{2} m\omega^2 y^2$

i.e., $2y^2 = A^2$ or $y = \frac{A}{\sqrt{2}}$.

3. B
4. D

5. According to theory section,

$$f = \frac{1}{2\pi}\sqrt{\frac{BA^2}{MV_0}}$$

$\therefore$ $T = 2\pi\sqrt{\frac{MV_0}{BA^2}} = 2\pi\sqrt{\frac{M(hA)}{BA^2}} = 2\pi\sqrt{\frac{Mh}{BA}}$.

As $B = P$

Hence, $T = 2\pi\sqrt{\frac{Mh}{PA}}$

6. B
7. B
8. D
9. B
10. C
11.

Time taken by the pendulum to move from A to O and from O to $A = \frac{T}{2}$.

Time period of oscillation $\propto \sqrt{L}$.

$\therefore$ $\frac{T_1}{T} = \sqrt{\frac{L/4}{L}} = \frac{1}{2}$ or $T_1 = \frac{T}{2}$

Time taken to complete half the oscillation $= \frac{T}{4}$.

Total time period of oscillation

$= \frac{T}{2} + \frac{T}{4} = \frac{3T}{4}$.

12. B
13. A

14. Displacement-time equation of the particle will be,

$x = A \cos \omega t$

Given that; $x_1 = A \cos \omega$

$x_2 = A \cos 2\omega$

and $x_3 = A \cos 3\omega$

Now, $\frac{x_1 + x_3}{2x_2} = \frac{A(\cos\omega + \cos 3\omega)}{2A\cos 2\omega}$

$= \frac{2A\cos 2\omega \cos\omega}{2A\cos 2\omega} = \cos\omega$.

$\therefore$ $\omega = \cos^{-1}\left(\frac{x_1 + x_3}{2x_2}\right) = \frac{2\pi}{T}$

or $T = \frac{2\pi}{\omega}$, where $\omega = \cos^{-1}\left(\frac{x_1 + x_3}{2x_2}\right)$.

15. A
16. A
17. A
18. D

19. For simple harmonic motion, $v = \omega\sqrt{a^2 - x^2}$

When $x = \frac{a}{2}, v = \omega\sqrt{a^2 - \frac{a^2}{4}} = \omega\sqrt{\frac{3}{4}a^2}$

As $\omega = \frac{2\pi}{T}$,

$\therefore$ $v = \frac{2\pi}{T}.\frac{\sqrt{3}}{2}a$

or $v = \frac{\pi\sqrt{3}a}{T}$

20. For a particle to execute simple harmonic motion, its displacement at any time t is given by:
$x(t) = a(\cos \omega t + \phi)$
Where, a = amplitude; ω = angular frequency; ϕ = phase constant
Let us choose $\phi = 0$
$\therefore \quad x(t) = a \cos \omega t$
Velocity of a particle, $v = \frac{dx}{dt} = -a\omega \sin \omega t$
Kinetic energy of a particle is, $K = \frac{1}{2}mv^2 = \frac{1}{2}ma^2\omega^2 \sin^2 \omega t$
Average kinetic energy $< K > = < \frac{1}{2}ma^2\omega^2 \sin^2 \omega t >$
$= \frac{1}{2}m\omega^2 a^2 < \sin^2 \omega t >$
$= \frac{1}{2}m\omega^2 a^2 \left(\frac{1}{2}\right) \left[\because < \sin^2 \theta > = \frac{1}{2}\right]$
$= \frac{1}{4}ma^2(2\pi\nu)^2 \quad [\because \omega = 2\pi\nu]$
$= \pi^2 ma^2\nu^2.$

21. A
22. B
23. A

24. $I = \frac{P_0^2}{2\rho v} = \frac{(1.01 \times 10^5)^2}{2 \times 1.3 \times 332}$
$= 1.18 \times 10^7 \text{ W/m}^2$
$\therefore \quad \text{SL} = 10 \log \frac{I}{I_0} = 10 \log \frac{10^7}{10^{-12}} = 190 \text{ dB}.$

25. A
26. D

27. $y = 2 \sin \pi(0.5x + 200t)$
$y = 2 \sin (\pi \times 0.5x + 200\pi t)$
comparing with
$y = r \sin\left(\frac{2\pi}{\lambda} vt - \frac{2\pi}{\lambda} x\right)$
Amplitude $r = 2$ cm and
$\frac{2\pi}{\lambda} vt = 200\pi t$
$\frac{v}{\lambda} = 100 \quad \ldots(i)$
and $\frac{2\pi}{\lambda} x = \pi \times 0.5x$
$\lambda = \frac{2}{0.5} = 4 \text{ cm} \quad$ [Put in eqn. (i)]
$v = \lambda \times 100 = 4 \times 100$
$= 400$ cm/sec.

28. A
29. C
30. A

31. $y = 4 \cos^2(t/2) \sin (1000t)$
$= 2[2 \cos^2(t/2) \sin (1000t)]$
$= 2(1 + \cos t) \sin (1000t)$
$= 2 \sin (1000t) + 2 \sin (1000t) \cos t$
$= 2 \sin (1000t) + \sin (1001t) + \sin (999t)$
i.e., the given wave represents the superposition of three waves.

32. Resultant amplitude,
$A_R = \sqrt{A_1^2 + A_2^2 + 2A_1A_2 \cos \phi}$
$= \sqrt{A^2 + A^2 + 2A^2 \cos \phi}$
But $\quad A_R = A$
$\therefore \quad A = \sqrt{2A^2(1 + \cos \phi)}$
$= \sqrt{4A^2 \cos^2 \frac{\phi}{2}} = 2A \cos \frac{\phi}{2}$
or $\quad \cos \frac{\phi}{2} = \frac{1}{2}$ or $\phi = \frac{2\pi}{3}$.

33. C

34. Path difference, $\Delta x = S_2D - S_1D$
$= 5 - 4 = 1 \text{ m}$
$\therefore$ The corresponding phase difference will be,
$\phi = \frac{2\pi}{\lambda} \cdot \Delta x = \frac{2\pi}{4} \cdot 1 = \frac{\pi}{2}$
Using, $\quad I = I_1 + I_2 + 2\sqrt{I_1I_2} \cos \phi,$
$I = I_0 + I_0 + 2\sqrt{I_0I_0} \cos \frac{\pi}{2} = 2I_0.$

35. A
36.

Let the frequency of first tuning fork is f.
The frequencies of other tuning forks are,
$(f - 3), (f - 2 \times 3), \ldots (f - 17 \times 3), \ldots (f - 25 \times 3).$
As per given condition,
$f = 2(f - 25 \times 3)$
or $\quad f = 25 \times 6 = 150 \text{ Hz}$
The frequency of 18th tuning fork
$= f - 17 \times 3 = 150 - 51 = 99 \text{ Hz}.$

37. $\text{Frequency} = \frac{\text{Velocity}}{\text{Wavelength}}$
$\nu_1 = \frac{v}{\lambda_1} = \frac{330}{5} = 66 \text{ Hz}$
and $\quad \nu_2 = \frac{v}{\lambda_2} = \frac{330}{5.5} = 60 \text{ Hz}$
Number of beats per second $= \nu_1 - \nu_2$
$= 66 - 60 = 6.$

38.

$\nu - 5 = 440$ Hz
and $\quad \nu - 8 = 437$ Hz
$\therefore \quad \nu = 445$ Hz (by both the methods)
It could have been 435 Hz. It would have satisfied $440 - \nu = 5$ but this would not have satisfied 437 Hz.

39. Let v be the velocity of sound in medium

$$\nu_1 = \frac{v}{\lambda_1} = \frac{v}{1} \quad \text{and} \quad \nu_2 = \frac{v}{\lambda_2} = \frac{v}{1.01}$$

Number of beats per second,

$$n = \nu_1 - \nu_2$$

or $$\frac{10}{3} = \frac{v}{1} - \frac{v}{1.01}$$

$$= v\left[\frac{1}{1} - \frac{100}{101}\right]$$

or $$\frac{10}{3} = \frac{v}{101}$$

or $$v = \frac{101 \times 10}{3} = 336.7\ \text{ms}^{-1}.$$

40. Path difference for a given phase difference δ is given by:

$$\Delta x = \frac{\lambda}{2\pi}\delta$$

Given that, $\delta = 60^\circ = \frac{\pi}{3}$

$$\Delta x = \frac{\lambda}{2\pi} \times \frac{\pi}{3}$$

$\therefore$ $$\Delta x = \frac{\lambda}{6}.$$

41. A

42. $$n_p = \frac{v}{4L}, \quad n_q = \frac{v}{2L}$$

$$n_r = \frac{2v}{2L}, \quad n_s = \frac{3v}{4L}$$

$\therefore$ $n_p : n_q : n_r : n_s = 1 : 2 : 4 : 3.$

43. For second resonance, $L = \frac{3\lambda}{4}$

Given that; $\lambda = (15 + 1)4 = 64$ cm

Hence, $L = \frac{3}{4} \times 64 = 48$ cm

$\therefore$ Length of the tube $= L - e = 48 - 1 = 47$ cm.

44. C

45. C