EQUATIONS

1. A body executing simple harmonic motion has maximum acceleration

1) At the mean positions
2) At the two extreme position
3) At any position
4) The question is irrelevant

2. A particle moves on the x-axis according to the equation x = A + B sin ωt. The motion is simple harmonic with amplitude

1) A
2) B
3) A + B
4) $\sqrt{A^2 + B^2}$

3. If the maximum acceleration of a S.H.M. is a and the maximum velocity is b, then amplitude of vibration is given by

1) b^2a
2) a^2b
3) $\frac{b^2}{a}$
4) $\frac{a^2}{b}$

4. For a particle executing S.H.M, which of the following statements is not correct?

1) The total energy of a particle always remains the same
2) The restoring force is always directed towards a fixed point
3) The restoring force is maximum at the extreme positions
4) The acceleration of the particle is maximum at the equilibrium position

5. Choose the correct statement.

a) Any motion that repeats itself in equal intervals of time along the same path is called periodic motion.

b) The displacement of a particle in periodic motion can always be expressed in terms of sine and cosine functions of time.

c) A body in periodic motion moves back and forth over the same path is called oscillatory or vibrating motion

d) Simple harmonic motion is a particular case of periodic motion.

1) Only a, b, d are true
2) Only b, c, d are true
3) Only a, c, d are true
4) All are true

6. In a periodic motion when a body moves to and fro about a fixed mean position its acceleration.

1) Proportional to displacement of body from mean position and is always directed towards the mean position.

2) Inversely proportional to displacement of body from mean position and is always directed away from mean position.

3) Proportional to displacement of body from mean position and is always directed away from mean position

4) May be proportional to displacement but unspecified direction.

7. In S.H.M.

1) The acceleration and displacement of a body are proportional to each other and opposite in direction.

2) The accelerations and displacement of body are proportional to each other and same in direction.

3) The acceleration and displacement of body are inversely proportional to each other and opposite in direction

4) The acceleration and displacement are inversely proportional to each other and same in direction.

8. The uniform circular motion in general can be described as a combination of two simple harmonic motions.

1) Acting perpendicular to each other 2) Acting parallel to each other

3) Acting anti parallel to each other 4) Acting inclines to each other with less than 90^0

9. Statement (a): The velocity of simple harmonic oscillator is maximum at mean position

Statement (b): At extreme position the acceleration of simple harmonic oscillator is maximum.

Statement (c): The velocity of simple harmonic oscillator is minimum at extreme position

1) a, b are true 2) Only a is true 3) b , c are true 4) All are true

10. **For a simple harmonic oscillator the frequency of oscillation is independent of**

1) Time period 2) Acceleration 3) Angular velocity 4) Amplitude

11. **The phase difference between velocity and acceleration of simple harmonic oscillator.**

1) π 2) $\frac{\pi}{2}$ 3) $\frac{\pi}{4}$ 4) $\frac{\pi}{3}$

12. **The phase difference between acceleration and displacement of simple harmonic oscillator**

1) π 2) $\frac{\pi}{2}$ 3) $\frac{\pi}{4}$ 4) $\frac{\pi}{3}$

13. **Statement (a): During simple harmonic oscillation kinetic energy converted in potential energy and vice - versa**

Statement (b): Total mechanical energy of simple harmonic oscillator is directly proportional to square of the frequency of oscillation

Statement (c): Simple harmonic oscillator obeys the law of conservation of energy.

Statement (d): Total mechanical energy of oscillator is directly proportional to a square of the amplitude of the oscillation

1) a , b are true 2) c , d are true 3) a , b , d are true 4) a , b , c , d are true

14. **Total energy of particle performing S.H.M. depends on**

1) Amplitude, time period 2) Amplitude, Time period and displacement

3) Amplitude, displacement 4) Time period, displacement

15. **The work done by the body which is in S.H.M, against the restoring force is stored in the form of**

1) K.E. 2) P.E. 3) Both P.E. & K.E. 4) Total energy

16. **The phase of simple harmonic motion at t =0 is called**

1) Phase constant 2) Initial phase 3) Epoch 4) All the above

17. In S.H.M. at the equilibrium position

a) K.E is minimum **b) acceleration is zero**

c) Velocity is maximum **d) P.E is maximum**

1) All true 2) b, c, d true 3) a, b, c true 4) a, b, d true

18. (A): The motion of sewing needle is an example for SHM

(R): A liquid is taken in U-tube. Liquid in one limb is pressed and released It executes SHM

1) A and R are true but R is not the explanation for A

2) A and R are true R is the explanation for A

3) A is true R is false 4) A is false R is correct

19. (A): The phase difference between displacement and velocity in SHM is 90^0

(R): The displacement is represented by y = A sin wt.

1) A and R true and R is correct explanation for A

2) A and R are true and R is not correct explanation for A

3) A is true R is false 4) A is false R is true

20. When a body in SHM match the items in column A with that in column B.

Item - I	**Item - II**
a) Velocity is maximum	e) At half of the amplitude
b) Kinetic energy is $3/4^{th}$ of total energy	f) At the mean position
c) P.E. is $3/4^{th}$ of total energy	g) At extreme position
d) Acceleration is maximum	h) At $\frac{\sqrt{3}}{2}$ times amplitude

1) a - f, b - e, c - h, d - g 2) a - e, b - f, c - g, d - h

3) a - g, b - h, c - e, d - f 4) a - h, b -e, c - f, d – e

21. When a body in SHM match the statements in column A with that in column B.

Column - I	**Column II**
a) Velocity is maximum	e) At half of the amplitude
b) Kinetic energy is 3/4th of total energy	f) At the mean position
c) P.E. is 3/4th of total energy	g) At extreme position
d) Acceleration is maximum	h) At $\frac{\sqrt{3}}{2}$ times amplitude

1) a - f, b - e, c - h, d - g
2) a - e, b - f, c - g, d - h
3) a - g, b - h, c - e, d - f
4) a - h, b -e, c - f, d – e

22. The time period of oscillation of the particle in SHM is 'T'. Then match the following

Column - I	**Column II**
a) $\frac{3}{8}$ th of oscillation from extreme position	e) $\frac{2T}{3}$
b) $\frac{3}{8}$ th of oscillation from mean position	f) $\frac{T}{3}$
c) $\frac{5}{8}$ th of oscillation from extreme position	g) $\frac{7T}{12}$
d) $\frac{5}{8}$ th of oscillation from mean position	**h)** $\frac{5T}{12}$

1) a - e ; b- g ; c - f ; d - h
2) a - f; b - h ; c - e ; d - g
3) a - f ; b - e ; c - h ; d - g
4) a - e ; b - f ; c - g ; d – h

23. A): The displacement time graph for a particle in SHM is sine curve, when the motion begins from mean position.

R): The displacement of a particle in SHM is given by $y = A \sin \omega t$

1) A and R true and R is correct explanation for A

2) A and R are true and R is not correct explanation for A

3) A is true R is false

4) A is false R is true

24. A): In damped vibrations, Amplitude of oscillation decreases.

R): Damped vibrations indicate loss of energy due to air resistance

1) A and R true and R is correct explanation for A

2) A and R are true and R is not correct explanation for A

3) A is true R is false

4) A is false R is true

25. A): SHM is an example of varying velocity and varying acceleration.

R): For a particle performing SHM in non-viscous medium its total energy is constant

1) A and R true and R is correct explanation for A

2) A and R are true and R is not correct explanation for A

3) A is true R is false

4) A is false R is true

26. The time period of a particle performing linear SHM is 12s. What is the time taken by it to make a displacement equal to half its amplitude?

1) 1sec 2) 2sec 3) 3sec 4) 4sec

27. The equation motion of a particle in S.H.M is $a + 16\pi^2 x = 0$. In the equation 'a' is the linear acceleration (in m/sec^2) of the particle at a displacement 'x' in meter. The time period of S H M in seconds is

1) $\frac{1}{4}$ 2) $\frac{1}{2}$ 3) 1 4) 2

28. The displacement of a particle executing SHM is given by Y = 10 sin (3t + $\pi/3$)m and 't' is in seconds. The initial displacement and maximum velocity of the particle are respectively

1) $5\sqrt{3}$ m and 30m/sec
2) 15m and $15\sqrt{3}$ m/sec
3) $15\sqrt{3}$ m and 30 m/sec
4) $20\sqrt{3}$ m and 30 m/sec

29. A particle is vibrating in SHM with amplitude of 4cm. At what displacement from the equilibrium position it has half potential and half kinetic

1) 1cm
2) $\sqrt{2}$ cm
3) 2 cm
4) $2\sqrt{2}$ cm

30. A particle moves according to the law x = a cos$\frac{\pi t}{2}$. The distance covered by it in the time interval between t = 0 to t = 3 sec is

1) 2 a
2) 3a
3) 4 a
4) a

31. For a body in S.H.M the velocity is given by the relation v = $\sqrt{144-16x^2}$ m/sec. The maximum acceleration is

1) 12 m/sec^2
2) 16 m /sec^2
3) 36 m/sec^2
4) 48 m/sec^2

32. Two SHMs are represented by the equations y_1= 10 sin (3pt+ π/4) and y_2 = 5 [sin 3πt+ $\sqrt{3}$ cos 3t]. Their amplitudes are in the ratio

1) 1:2
2) 2:1
3) 1:3
4) 1:1

33. A body executing SHM at a displacement 'x' its PE is E_1 , at a displacement 'Y' its PE is E_2. The P.E at a displacement (x + y) is

1) $\sqrt{E} = \sqrt{E_1} - \sqrt{E_2}$
2) $\sqrt{E} = \sqrt{E_1} + \sqrt{E_2}$
3) E = E_1 + E_2
4) E = E_1 – E_2

34. An object is attached to the bottom of a light vertical spring and set vibrating. The maximum speed of the object is 15 cm / sec and the period is 628 m sec. The amplitude of the motion in centimeter is

1) 3
2) 2
3) 1.5
4) 1.0

35. The angular velocities of three bodies in SHM are ω_1 ω_2 ω_3 with their respective amplitudes as A_1 A_2 A_3. If all three bodies have same mass and velocity then

1) $A_1 \omega_1 = A_2 \omega_2 = A_3 \omega_3$
2) $A_1 \omega_1^2 = A_2 \omega_2^2 = A_3 \omega_3^2$
3) $A_1^2 \omega_1 = A_2^2 \omega_2 = A_3^2 \omega_3$
4) $A_1^2 \omega_1^1 = A_2^2 \omega_2^2 = A_3^2 \omega_3^3$

36. Four simple harmonic vibrations $x_1 = 8 \sin \omega t$, $x_2 = 6 \sin(\omega t + \pi/2)$, $x_3 = 4 \sin(\omega t + \pi)$ and $x_4 = 2 \sin\left(\omega t + \frac{3\pi}{2}\right)$ are superimposed on each other. The resulting amplitude is

1) 20
2) $8\sqrt{2}$
3) $4\sqrt{2}$
4) 4

37. The displacement of a particle executing S.H.M from its mean porition is given by $x = 0.5 \sin(10\pi\ t + 1.5) \cos(10\pi\ t + 1.5)$. The ratio of the maximum velocity to the maximum acceleration of the body is given by

1) 20π
2) $\frac{1}{20\pi}$
3) $\frac{1}{10\pi}$
4) 10π

38. The total mechanical energy of a harmonic oscillator of amplitude 1m and force constant 200 N/m is 150J. Then

1) The minimum P E is Zero
2) The maximum P E is 100 J
3) The minimum P E is 50 J
4) The maximum P E is 50 J

39. A particle of mass 'm' is attached to a spring of spring constant ω_0. An external force F(t) proportional to cos ωt ($\omega \neq \omega_0$) is applied to the oscillator. The time displacement of the oscillator will be proportional to

1) $\frac{m}{(\omega_0 - \omega^2)}$
2) $\frac{m}{(\omega_0^2 + \omega^2)}$
3) $\frac{1}{m(\omega_0^2 + \omega^2)}$
4) $\frac{1}{m(\omega_0^2 - \omega^2)}$

40. A body executes SHM under the action of force 'F' with a time period 4/5 sec. If the force is changed to 'F_2' to execute SHM with time period (3/5) sec. If the both the forces F_1 and F_2 act simultaneously in the same direction on the body, its time period in seconds is (in see) .

1) $\frac{12}{25}$
2) $\frac{12}{15}$
3) $\frac{25}{24}$
4) $\frac{25}{12}$

41. A particle is executing simple harmonic motion along a straight line 8cm long. While passing through mean position its velocity is 16cm/s. Its time period will be

(1) 0.157 sec (2) 1.57 sec (3) 15.7 sec (4) 0.0157 sec

42. A particle of mass 0.8 kg. is executes S.H.M. its amplitude is 1.0m and time period is $\frac{11}{7}$ sec. The velocity of the particle, at the instant when its displacement is 0.6m will be

(1) 32 m/s (2) 3.2 m/s (3) 0.32 m/s (4) zero

KEY

1) 2	2) 4	3) 3	4) 4	5) 4	6) 1	7) 1	8) 1	9) 4
10) 4	11) 2	12) 1	13) 4	14) 1	15) 2	16) 4	17) 3	18) 1
19) 1	20) 1	21) 1	22) 2	23) 1	24) 1	25) 2	26) 2	27) 2
28) 1	29) 4	30) 2	31) 4	32) 4	33) 2	34) 3	35) 1	36) 3
37) 2	38) 3	39) 4	40) 1	41) 2	42) 2			

HINTS

26. Y = A cos ωt

$$\frac{A}{2} = A\cos wt$$

$$\cos(\omega t) = \frac{1}{2}$$

$$wt = \frac{\pi}{3}$$

$$\frac{2\pi}{T}t = \frac{\pi}{3} \text{ t = T / 6}$$

27. $\left.\begin{array}{l} a = -16\pi^2 x \\ a = -\omega^2 x \end{array}\right\} \Rightarrow \omega^2 = 16\pi^2 \ \ \omega = 4\pi$

$$\frac{2\pi}{T} = 4\pi \Rightarrow T = \frac{2\pi}{4\pi} = \frac{1}{2}$$

28. $t = 0 \Rightarrow y = 10 \ \sin\frac{\pi}{3} = 5\sqrt{3}m$

$$V_{\max} = \omega A = 10 \times 3 = 30 \ m/\sec$$

29. K.E. = P. E.

$$\frac{1}{2}m\omega^2 \ (A^2 - x^2) = \frac{1}{2}m\omega^2 x^2$$

$$A^2 - x^2 = x^2$$

$$A^2 = 2x^2 = x^2 = A^2 / 2$$

$$x = \frac{A}{\sqrt{2}} = \frac{4}{\sqrt{2}} = 2\sqrt{2}cm$$

30. $x = a\cos\frac{\pi}{2}t = a\cos\omega t$

$\omega = \pi/2$ and $\frac{2\pi}{T} = \frac{\pi}{2}$

T = 4 sec

Distance covered will be = 3a

31. $V = \sqrt{144 - 16x^2}$

$= \sqrt{16(9 - x^2)}$

$V = 4\sqrt{3^2 - x^2}$

$V = \omega\sqrt{A^2 - x^2}$

$a_{max} = \omega^2 A = (4^2) \times 3 = 48\, m/\sec^2$

32. $y_1 = 10\sin(3\pi t + \pi/4)$

$y_2 = 5\times 2\left[\sin 3\pi t . \frac{1}{2} + \frac{\sqrt{3}}{2}\cos 3\pi t\right]$

$y_2 = 1D\left[\sin 3\pi t\ \cos\pi/3 + \sin\pi/2\cos 3\pi t\right]$

$y_2 = 1D\sin(3\pi t + \pi/3)$

A1 : A2 = 1 : 1

33. $PE\quad E = \frac{1}{2}m\omega^2 x^2$

$E \propto x^2 \Rightarrow \left.\begin{matrix} x \propto \sqrt{E_1} \\ y \propto \sqrt{E_2} \end{matrix}\right\} \rightarrow 1$

$x + y \propto \sqrt{E} \quad \rightarrow 2$

From (1) and (2) , $\sqrt{E} = \sqrt{E_1} + \sqrt{E_2}$

34. V_{max} = A

$$V_{\max} = A.\frac{2\pi}{T}$$

$$1.5 = A\,.\frac{2\times 3.14}{628\times 10^{-3}}$$ A = 1.5 cm

35. V = A ω

$A_1\omega_1 = A_2\ \omega_2 = A_3\ \omega_3$

36. $A^1 = \sqrt{4^2 + u^2} \Rightarrow A^1 = 4\sqrt{2}units$

37. $$x = \frac{0.5}{2}\times\frac{2\sin\theta\ \cos\theta}{}$$

$$x = \frac{0.5}{2}\times\sin 2\theta$$

$$x = \frac{0.5}{2}\times\sin(20\pi t + 3)$$

x = A sin $(\omega t + \phi)$ $$\frac{A_w}{Aw^2} = \frac{1}{w} = \frac{1}{20\pi}$$

38. TE of the particle is SHM $= \frac{1}{2}kA^2$

$$= \frac{1}{2}\times 200\times 1 = 100J$$

Mechanical energy = 150J at mean position the minimum PE is 150 - 100 = 50J

39. Equation of displacement given by x = A sin ($\omega t + \phi$)

Where $$A = \frac{F_0}{m\sqrt{(\omega^2 - \omega_0^2)}} = \frac{F_0}{m(\omega^2 - \omega_0^2)}$$

Here damping effect is considered to be zero

$$A \propto \frac{1}{m(\omega^2 - \omega_0^2)}$$

40. $F = m\omega^2 A = m\frac{4\pi^2}{T^2}A$

$$\left.\begin{array}{l} F_1 \propto \frac{1}{T_1^2} \\ F_2 \propto \frac{1}{T_2^2} \end{array}\right\} \rightarrow 1$$

$$F_1 + F_2 \propto \frac{1}{T_1^2} \rightarrow 2$$

$$\frac{1}{T_1^2} + \frac{1}{T_2^2} = \frac{1}{T^2}$$

$$T = \frac{T_1 T_2}{\sqrt{T_1^2 + T_2^2}}$$

$$T_2 = \frac{3}{5}\text{sec}$$

$$T = \frac{12}{25}\text{sec}$$

41. $V_m = \omega a = \frac{2\pi}{T}a$

$$T = \frac{2\pi a}{V_m} = \frac{2\times 3.14\times 4}{16} = 1.57s$$

42. $V = \omega\sqrt{a^2 - x^2}$

$$V = \frac{2\pi}{T}\sqrt{a^2 - x^2}$$
$$= \frac{2\times 22\times 7}{7\times 11}\sqrt{1-0.36}$$
$$= 3.2\ m/s$$