TOPIC WISE MULTIPLE CHOICE QUESTIONS

7.2 SHM AND UNIFORM CIRCULAR MOTION

(1) Velocity of a body executing SHM is given by

(a) $\omega\sqrt{x_o^2 - x^2}$ (b) $\omega\sqrt{x^2 - x_o^2}$

(c) $x_o\sqrt{\omega^2 - x^2}$ (d) $x\sqrt{\omega^2 - x_o^2}$

(2) The profile of periodic waves generated by a source executing S.H.M. is represented by an: LHR-2017 (G-II)

(a) circle (b) sine curve

(c) tangent curve (d) cosine curve

(3) The distance covered during one vibration of an oscillating body in terms of amplitude 'A' is: LHR-2017 (G-I)

(a) A/2 (b) A

(c) 2A (d) 4A

(4) The velocity of a particle having SHM is v at mean position. If its amplitude is doubled then velocity at mean position will be SGD-2016 (G-I)

(a) $v/2$ (b) v

(c) 2 v (d) 4 v

(5) The distance covered by a body in one complete vibration is 20 cm, what is the amplitude of the vibration: BWP-2019 (G-II)

(a) 10 cm (b) 80 cm

(c) 5 cm (d) 20 cm

(6) When a particle is moving in a circular path, its projection along diameter executes DGK-2018 (G-II)

(a) linear motion (b) circular motion

(c) simple harmonic motion (d) perpetual motion

(7) At what distance from mean position the energy of vibrating body is half potential and half kinetic (x_0 = amplitude)

(a) $\frac{x_0}{2}$ (b) $\frac{x_0}{4}$

(c) $\frac{x_0}{\sqrt{2}}$ (d) $\sqrt{2}x_0$

(8) The total distance traveled by an object moving with SHM in a time equal to its period if its amplitude is x_0

(a) zero (b) $2x_o$

(c) $3x_o$ (d) $4x_o$

(9) Maximum velocity of a body executing SHM is

(a) $v = \omega\sqrt{x_0^2 - x^2}$ **(b)** $v = \omega x_0$

(c) $v = \omega x$ **(d)** $v = \omega\sqrt{x^2 - x_0^2}$

(10) By increasing the weights on an oscillatory spring, the period of oscillation would be

(a) increases **(b)** decreased

(c) remain same **(d)** may increase or decrease

(11) The acceleration of projection of a point on the diameter moving on a circle is

(a) $-\omega x$ **(b)** $-\omega x^2$

(c) $-\omega^2 x$ **(d)** ωx^2

(12) When x = x_0 then the velocity of body executing SHM will be

(a) maximum **(b)** minimum

(c) zero **(d)** none of these

(13) The maximum displacement of a body executing SHM is represented by

(a) x **(b)** x_o

(c) ωt **(d)** $x_o\omega$

7.3 PHASE

(14) The phase determines the state of motion of the

(a) rotatory point **(b)** translatory point

(c) random point **(d)** vibratory point

(15) If the initial Phase is $\frac{\pi}{2}$ then displacement of SHO is: **BWP-2019 (G-I)**

(a) $x = x_o^2 \sin \omega t$ **(b)** $x = x_o \sin \omega t$

(c) $x = x_o \cos \omega t$ **(d)** zero

(16) If a body starts its motion in a circular path from its extreme position its initial phase is

(a) $\frac{\pi}{2}$ **(b)** $\frac{3\pi}{2}$

(c) π **(d)** $\frac{\pi}{4}$

(17) The phase angle θ=ωt of a body performing SHM indicates

(a) both direction and displacement **(b)** only direction of displacement

(c) both magnitude and direction **(d)** none of these

(18) The expression for displacement $x = x_o \sin(\omega t + 90^\circ)$ is equal to

(a) $x = x_o \sin \omega t$ **(b)** $x = x_o \cos \omega t$

(c) $x = x_o \tan \omega t$ **(d)** $x = -x_o \cos \omega t$

(19) The angle $\theta = \omega t$ executing SHM is known as

(a) amplitude **(b)** displacement

(c) phase **(d)** time period

7.4 HORIZONTAL MASS SPRING SYSTEM

(20) If a mass is attached to an elastic spring then its maximum velocity v_o **MTN-2019 (G-II)**

(a) $v_o = x_o\sqrt{\frac{m}{k}}$ (b) $v_o = x_o\sqrt{\frac{k}{m}}$
(c) $v_o = x\sqrt{\frac{k}{m}}$ (d) $v_o = x\sqrt{\frac{m}{k}}$

(21) Base units of spring constant is: **LHR-2019 (G-I)**

(a) $kg^{-1}s^{-2}$ (b) $kg^{-1}ms^{-2}$
(c) $kg^{1}s^{-2}$ (d) $kg\,s^{-2}$

(22) $\sqrt{\frac{l}{g}}$ and $\sqrt{\frac{m}{k}}$ has same: **RWP-2019 (G-I)**

(a) numerical value (b) units
(c) damping (d) time period

(23) The angular frequency is

(a) $\omega = \sqrt{\frac{m}{k}}$ (b) $\omega = \sqrt{\frac{k}{m}}$
(c) $\omega = 2\pi\sqrt{\frac{k}{m}}$ (d) $\omega = 2\pi\sqrt{\frac{m}{k}}$

(24) If four springs, each of spring constant k are connected in parallel then the resultant spring constant is

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

(25) Frequency of a mass spring system is given by

(a) $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$ (b) $2\pi\sqrt{\frac{k}{m}}$
(c) $2\pi\sqrt{\frac{m}{k}}$ (d) $\frac{1}{2\pi}\sqrt{\frac{m}{k}}$

(26) The acceleration for a mass spring system at any instant is given by

(a) $a = \frac{k}{x}m$ (b) $a = \frac{k}{m}x$
(c) $a = -\frac{k}{m}x$ (d) $a = -\frac{k}{x}m$

(27) The time period of the mass spring system is given by

(a) $T = \frac{1}{2\pi}\sqrt{\frac{m}{k}}$ (b) $T = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$
(c) $T = 2\pi\sqrt{\frac{m}{k}}$ (d) $T = 2\pi\sqrt{\frac{k}{m}}$

(28) The relation between instantaneous velocity and maximum velocity is

(a) $V = V_o\sqrt{1-\frac{x^2}{v^2}}$ **(b)** $V = V_o\sqrt{\frac{x^2}{v^2}-1}$

(c) $V = V_o\sqrt{\frac{x_0^2}{x^2}-1}$ **(d)** $V = V_o\sqrt{1-\frac{x^2}{x_0^2}}$

(29) If the amplitude becomes double then at mean position the maximum velocity of mass spring system will

(a) double **(b)** half

(c) quadrupled **(d)** becomes zero

(30) The instantaneous displacement "x" of mass m in "mass spring system" given by

(a) $x = x_o \sin\sqrt{\frac{k}{m}}t$ **(b)** $x = x_o \sin\sqrt{\frac{m}{k}}t$

(c) $x = x_o \cos\sqrt{\frac{k}{m}}t$ **(d)** $x = x_o \cos\sqrt{\frac{m}{k}}t$

7.5 SIMPLE PENDULUM

(31) If length of simple pendulum becomes four times, then its time period is

(a) remains same **(b)** is doubled

(c) quadrupled **(d)** $\sqrt{2}$ times

(32) In order to double period of a simple pendulum the length of the pendulum should be increased by: **LHR-2019 (G-II)**

(a) four times **(b)** three times

(c) two times **(d)** eight times

(33) When the bob of simple pendulum is at extreme position then its K.E is: **GRW-2019 (G-II)**

(a) maximum **(b)** minimum

(c) zero **(d)** small

(34) The component of the weight which balances the tension in pendulum is **DGK-2016 (G-II)LHR-2018 (G-I)**

(a) mg cosθ **(b)** mg sinθ

(c) mg tanθ **(d)** –mg sinθ

(35) If amplitude of a simple pendulum is increased by 4 times the time period will be: **FSD-2018, LHR 2015 (G-I)**

(a) four times **(b)** half

(c) **same** **(d)** **two times**

(36) At which place the motion of a simple pendulum will be slowest: **FSD-2017**

(a) Karachi **(b)** K-2

(c) Murree **(d)** Lahore

(37) Frequency of seconds pendulum is **(SGD 2015)**

(a) 1Hz **(b)** 2Hz

(c) 0.5Hz **(d)** 0.99Hz

(38) Time period of simple pendulum only depends on its: **MTN-2018 (G-I)**

(a) mass **(b)** amplitude

(c) density **(d)** length

(39) **The frequency of Simple Pendulum is given by:** **BWP-2016 (G-I)**

(a) $\frac{1}{2\pi}\sqrt{\frac{g}{\ell}}$ **(b)** $2\pi\sqrt{\frac{g}{\ell}}$

(c) $\frac{1}{2\pi}\sqrt{\frac{\ell}{g}}$ **(d)** $2\pi\sqrt{\frac{\ell}{g}}$

(40) **If Mass of Pendulum becomes double, then its time period will be:** **(BWP 2015)**

(a) doubled **(b)** half

(c) one fourth **(d)** remain same

(41) **Time period of seconds pendulum on moon is**

(a) 1/3 sec **(b)** 2 sec

(c) 3 sec **(d)** $\sqrt{6}$ sec

(42) **Length of seconds pendulum is**

(a) 0.996m **(b)** 0.992m

(c) 0.99m **(d)** 0.9m

(43) **If mass length of simple pendulum becomes 4 times then its time period becomes**

(a) Double **(b)** half

(c) remains same **(d)** four times

(44) **The restoring force acting on the bob of simple pendulum of mass 'm' is**

(a) mg **(b)** mg Sinθ

(c) –mg Sinθ **(d)** –mg Cosθ

(45) **A simple pendulum is 50cm long. Its frequency of vibration on the surface of the earth is**

(a) 1 Hz **(b)** 0.5 Hz

(c) 0.70 Hz **(d)** 0.65 Hz

(46) **The time period of simple pendulum is directly proportional to**

(a) $\sqrt{\frac{m}{g}}$ **(b)** $\sqrt{l}$

(c) $\sqrt{g}$ **(d)** $\sqrt{\frac{g}{l}}$

(47) **When a bob of simple pendulum is at extreme position then it has maximum**

(a) K.E **(b)** P.E

(c) both a and b **(d)** no energy

(48) **In vibratory motion of a simple pendulum, the component of force is responsible**

(a) mg cosθ **(b)** mg sinθ

(c) mg **(d)** mg tanθ

(49) **At mean position, the simple pendulum has**

(a) maximum K.E **(b)** maximum P.E

(c) zero K.E **(d)** minimum K.E

(50) **Tension in the string of simple pendulum is maximum at**

(a) mean position **(b)** extreme positions

(c) midway between mean and extreme position **(d)** cannot be determined

(51) **The time period of simple pendulum depends upon**

(a) length of pendulum **(b)** amplitude of pendulum

(c) length and gravity **(d)** mass of pendulum

(52) **The component of weight $mg\sin\theta$ in simple pendulum is**

(a) along the center **(b)** perpendicular to string
(c) along the string **(d)** none of these

(53) **For simple pendulum the value ω is given by**

(a) $\omega = \sqrt{\frac{\ell}{g}}$ **(b)** $\omega = \sqrt{\frac{g}{\ell}}$
(c) $\omega = \sqrt{\frac{1}{g\ell}}$ **(d)** $\omega = \frac{g}{\ell}$

(54) **The time period of simple pendulum is inversely by proportional to**

(a) $\sqrt{\ell}$ **(b)** $\sqrt{\frac{1}{\ell}}$
(c) $\sqrt{g}$ **(d)** $\sqrt{\frac{1}{g}}$

(55) **The time period of simple pendulum is given by**

(a) $T = \frac{1}{2\pi}\sqrt{\frac{\ell}{g}}$ **(b)** $T = \frac{1}{2\pi}\sqrt{\frac{g}{\ell}}$
(c) $T = 2\pi\sqrt{\frac{\ell}{g}}$ **(d)** $T = 2\pi\sqrt{\frac{g}{\ell}}$

(56) **In simple pendulum the value of "g" can be calculated by**

(a) $g = \frac{4\pi^2\ell}{T^2}$ **(b)** $g = \frac{4\pi^2\ell^2}{T^2}$
(c) $g = \frac{2\pi\sqrt{\ell}}{T^2}$ **(d)** $g = \frac{2\pi\sqrt{\ell}}{T}$

(57) **The length of simple pendulum is given by**

(a) $\ell = \frac{T^2g^2}{4\pi^2}$ **(b)** $\ell = \frac{T^2g}{4\pi^2}$
(c) $\ell = \frac{4\pi^2}{T^2g^2}$ (d) $\ell = \frac{Tg^2}{4\pi^2}$

(58) **How long must be length of a simple pendulum in order to have a period of one second**

(a) 1m **(b)** 50m
(c) 0.25 m (d) 1.5 m

7.6 ENERGY CONSERVATION IN SHM

(59) **Total energy of mass spring system is equal to**

(a) (K.E) max **(b)** (P.E) max
(c) both a & b **(d)** neither a nor b

(60) **The total energy of mass-spring system is independent of:** **GRW-2019 (G-I)**

(a) mass of the body **(b)** amplitude
(c) spring constant **(d)** nature of material of spring

(61) Total energy of a particle executing S.H.M. is: **LHR-2017 (G-II)**

(a) $\frac{1}{2}kx^2$ **(b)** $\frac{1}{2}k\left(x_o^2 - x^2\right)$

(c) $\frac{1}{2}kx_o^2$ **(d)** $\frac{1}{2}k\left(x^2 - x_o^2\right)$

(62) The P.E stored by a mass spring system at an extension of 2cm is 10J. The P.E stored by the same system at an extension of 4cm will be **FSD-2016 (G-I)**

(a) 10 J **(b)** 20 J

(c) 30 J **(d)** 40 J

(63) When amplitude of oscillation is doubled, then its energy becomes: **DGK-2018 (G-I)**

(a) double **(b)** four times

(c) one half **(d)** six times

(64) Total energy of mass spring system at displacement $x = \frac{x_o}{2}$ will be: **BWP-2017 (G-II)**

(a) $\frac{1}{2}kx_o^2$ **(b)** $\frac{1}{2}k\left(x_o^2 - x^2\right)$

(c) kx_o^2 **(d)** $\frac{1}{4}kx_o^2$

(65) The time period of an oscillating mass spring system is 10 second. If mass attached to spring is doubled then time period becomes **DGK-2016 (G-I)**

(a) 10 s **(b)** 20 s

(c) 5 s **(d)** $10\sqrt{2}$ s

(66) In oscillation

(a) P.E remains constant **(b)** K.E remains constant

(c) total energy remains constant **(d)** both P.E and K.E remains constant

(67) When the K.E of the mass spring system is maximum then the P.E of the system is

(a) doubled **(b)** zero

(c) half **(d)** maximum

(68) In mass spring system the work done in displacing the mass 'm' through x_o is

(a) $\frac{1}{2}kx_o$ **(b)** $\frac{1}{2}kx$

(c) $\frac{1}{2}kx_o^{\,2}$ **(d)** $\frac{1}{2}kx^2$

(69) At mean position the P.E of bob of simple pendulum

(a) remain same **(b)** is maximum

(c) is minimum **(d)** none of these

(70) When the bob of simple pendulum is at extreme position the value of K.E is

(a) maximum **(b)** zero

(c) minimum **(d)** none of these

(71) At any instant 't' if the displacement is x, then P.E at that instant is given by

(a) $P.E=\frac{1}{2}kx_0^2$ (b) $P.E=kx^2$

(c) $P.E=\frac{1}{2}kx^2$ (d) $P.E=2kx^2$

(72) The maximum K.E of mass spring system is

(a) $K.E=\frac{1}{2}kx_0^2$ (b) $K.E=\frac{1}{2}kx^2$

(c) $K.E=2kx_0^2$ (d) $K.E=kx_0^2$

(73) At any instant the K.E of vibrating mass spring system is given by

(a) $K.E=\frac{1}{2}kx_0^2\left(1-\frac{x^2}{x_0^2}\right)$ (b) $K.E=\frac{1}{2}kx_0^2$

(c) $K.E=\frac{1}{2}kx_0^2\left(1-\frac{x_0^2}{x^2}\right)$ (d) $K.E=\frac{1}{2}kx_0^2\left(1-\frac{x^2}{x_0^2}\right)$

(74) The variation of P.E and K.E with displacement is essential for maintaining

(a) oscillations **(b)** linear motion

(c) random motion **(d)** translatory motion

(75) The periodic exchange of energy is a basic property of all

(a) rotational system **(b)** oscillatory system

(c) translatory system **(d)** rotatory system

7.7 FREE AND FORCED OSCILLATION

(76) A body is said to be free vibration when it oscillates

(a) with interference of an external force **(b)** without interference of an external force

(c) with interference of an frictional force **(d)** without interference of an restoring force

(77) The frequency of free vibration is known as

(a) harmonic frequency **(b)** simple frequency

(c) natural frequency **(d)** relative frequency

(78) If a freely oscillating system is subjected to an external force, then

(a) forced vibrations take place **(b)** harmonic vibrations take place

(c) frictional force vibrations take place **(d)** all of these

(79) Loud music is an example of

(a) forced vibration **(b)** free vibration

(c) resonance **(d)** harmonic vibration

(80) Swing is an example of

(a) free oscillations **(b)** forced oscillations

(c) damped oscillations **(d)** none of these

7.8 RESONANCE

(81) The resonance occurs when the frequency of the applied force is equal to

(a) harmonic frequency **(b)** driven harmonic oscillator

(c) resonance **(d)** relative frequency

(82) The waves used is microwave oven has frequency

MTN-2016 (G-I), GRW-2016 (G-I), LHR-2016 (G-I)

(a) 124502 Hz **(b)** 145MH

(c) 1425 MHz **(d)** 2450 MHz

(83) Tuning of radio is the best example of:
DGK-2018(G-II), SGD-2016 (G-II), GRW 2015(G-I)
(a) mechanical resonance **(b)** electrical resonance
(c) magnetic resonance **(d)** musical resonance

(84) The wavelength of waves used in microwave oven is
(a) 15cm **(b)** 12cm
(c) 10cm **(d)** 8cm

(85) In microwave oven, heating is produced by phenomenon of
(a) resonance **(b)** harmonic vibration
(c) free oscillation **(d)** forced oscillation

(86) Resonance occurs when the frequency of the applied force is ________ to one of natural frequency
(a) equal **(b)** smaller
(c) greater **(d)** none of these

(87) At resonance the transfer of energy is
(a) zero **(b)** minimum
(c) maximum **(d)** none

(88) While tuning a radio when two frequencies (receiving and transmitting) are match, energy absorption is
(a) zero **(b)** minimum
(c) maximum **(d)** none of these

(89) Food is heated in microwave ovens by the effect of
(a) mechanical resonance **(b)** electrical resonance
(c) sharpness of resonance **(d)** none of these

ANSWER KEYS

(Topic Wise Multiple Choice Questions)

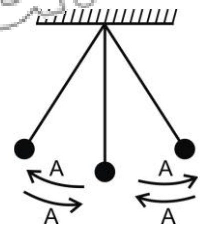
1	a	16	a	31	b	46	b	61	c	76	b
2	b	17	a	32	a	47	b	62	d	77	c
3	d	18	b	33	c	48	b	63	b	78	a
4	c	19	c	34	a	49	c	64	a	79	a
5	c	20	b	35	c	50	a	65	a	80	b
6	c	21	d	36	c	51	c	66	c	81	b
7	c	22	b	37	c	52	b	67	b	82	d
8	d	23	b	38	d	53	b	68	a	83	b
9	b	24	c	39	a	54	c	69	d	84	b
10	c	25	a	40	d	55	b	70	b	85	a
11	c	26	c	41	b	56	a	71	c	86	a
12	c	27	c	42	c	57	b	72	a	87	c
13	b	28	d	43	c	58	c	73	a	88	c
14	d	29	a	44	c	59	c	74	a	89	b
15	c	30	a	45	a	60	a	75	b		

SHORT QUESTIONS

(From Textbook Exercise)

7.4. What is the total distance traveled by an object moving with SHM in a time equal to its period, if its amplitude is A?

SGD-14(G-I), GRW-14(G-II), LHR-15(G-II)



Ans: We know that time period is the time to complete one round trip about mean position. Therefore, in 1 time period, a body covers distance 4A, where A is the amplitude of the body.

7.5. What happens to the period of a simple pendulum if its length is doubled? What happens if the suspended mass is doubled?

SGD-15(G-I)&(G-II), MTN-15(G-I)&(G-II), LHR-15(G-I), DGK-16 (G-I)&(G-II), BWP-16 0(G-I), SGD-18 (G-I), GRW-18, LHR-18 (G-I), LHR-19 (G-II), RWP-19 (G-I)

Ans:

(a) We know that the time period of the simple pendulum is given by

$$T = 2\pi\sqrt{\frac{l}{g}}$$

If the length is doubled:

$$T' = 2\pi\sqrt{\frac{2l}{g}}$$

$$T' = \sqrt{2}\left(2\pi\sqrt{\frac{l}{g}}\right) \Rightarrow T' = \sqrt{2}T$$

This shows that the time period becomes $\sqrt{2}$ times the initial time period.

(b) As time period of a simple pendulum is independent of the mass of a bob, therefore, if the mass is doubled then the time period of simple pendulum remains same.

7.6. Does the acceleration of a simple harmonic oscillator remain constant during its motion? Is the acceleration ever zero? Explain.

BWP-15(G-I), GRW-15(G-I), LHR-16 (G-I) & (G-II), FSD-17, BWP-19 (G-I & II)

Ans: Acceleration of harmonic oscillator does not remain constant. It is directly proportional to the displacement from the mean position.

$$a \propto -x$$

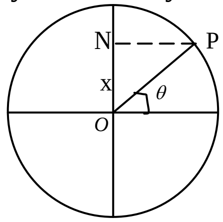
- At mean position: x = 0. Hence: a = 0
- At extreme position: $x = x_o$. Thus a = maximum

7.7. What is meant by phase angle? Does it define angle between maximum displacement and the driving force?

MTN-15(G-II), GRW-16 (G-I), SGD-16 (G-I), MTN-16 (G-I) & (G-II), SWL-19

Ans: "The angle which specifies the displacement as well as the direction of motion of point executing S.H.M. is called phase angle"

No, it does not define the angle between the maximum displacement and the driving force. It is the angle between the rotating vector and the reference line. Phase angle is $\theta = \omega t$, where ω is angular frequency and t is any instant of time.



7.8. Under what conditions does the addition of two simple harmonic motions produce a resultant, which is also simple harmonic? *LHR-14(G-II), SWL-13*

Ans: Under the following conditions, the addition of two simple harmonic motions produces a resultant, which is also simple harmonic.

- The two S.H.M are parallel.
- They have same frequency.
- They have constant phase difference.

7.11 Explain the relation between total energy, potential energy and kinetic energy for a body oscillating with SHM. *BWP-15(G-I), MTN-16 (G-I), MTN-18 (G-I)*

Ans: We know that:

$$(P.E.)_{max} = \frac{1}{2} k x_0^2$$

$$(K.E)_{max} = \frac{1}{2} k x_0^2$$

For any displacement x, the energy is partly P.E and partly K.E Hence

Total energy = P.E + K.E

$$= \frac{1}{2}kx^2 + \frac{1}{2}kx_0^2\left(1 - \frac{x^2}{x_0^2}\right)$$

$$= \frac{1}{2} kx_0^2$$

This shows that total energy during S.H.M. remains constant

7.12 Describe some common phenomena in which resonance plays an important role?
SGD-15(G-II), BWP-15(G-I), GRW-15(G-I), LHR-15(G-I), DGK-16 (G-I), GRW-18, FSD-19 (G-I)

Ans: **(i) Suspension Bridge**

The column of soldiers, while marching on a bridge of long span are advised to break their steps. Their rhythmic march might set up oscillations of dangerously large amplitude in the bridge structure.

(ii) Tuning a Radio

Tuning a radio is the best example of electrical resonance. When we turn the knob of a radio, to tune a station, we are changing the natural frequency of the electric circuit of the receiver, to make it equal to the transmission frequency of the radio station. When the two frequencies match, energy absorption is maximum and this is the only station we hear.

(iii) Micro Wave Oven *SWL-16, SWL-18*

The waves produced in this type of oven have a wavelength of 12cm at a frequency of 2450MHz. At this frequency the waves are absorbed due to resonance by water and fat molecules in the food, heating them up and so cooking the food.

7.13 If a mass spring system is hung vertically and set into oscillations, why does the motion eventually stop?
DGK-15(G-I), FSD 15(G-II), MIRPUR (AJK) 15, MTN-16 (G-II), LHR-16 (G-I) & (G-II), SWL-17, LHR-17 (G-I), DGK-18 (G-I) & (G-II), MTN-18 (G-I), SGD-18 (G-I), FSD-19 (G-I), BWP-19 (G-I), MTN-19 (G-II)

Ans: In the vertical mass spring system, the motion eventually stops due to friction and drag force, Energy is dissipated from the oscillating system, its amplitude decreases gradually and becomes smaller and eventually it stops.

TOPIC WISE SHORT QUESTIONS

7.2 SHM AND UNIFORM CIRCULAR MOTION

(90) Define S.H.M.

Ans: Such a type of vibratory motion in which the acceleration at any instant of a body executing S.H.M is proportional to the displacement and is always directed towards mean position is called S.H.M

Mathematically, $\vec{a} \propto -\vec{x}$

7.3 PHASE

(5) What is the value of phase angle with reference to?
(i) Complete revolution
(ii) Half the wave length
(iii) ¼ the of a vibration

Ans: The phase angles are

For complete revolution $\theta = 360^o$ = 2π radian

For half the wavelength $\theta = 180^o$ = π radian

For ¼ th of a vibration $\theta = 90^o$ = $\frac{\pi}{2}$ radian

(6) Define phase angle.

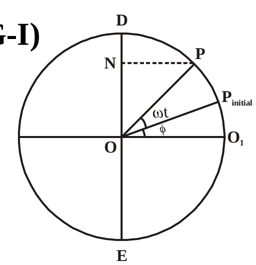
Ans: The angle θ = ωt which specifies the displacement as well as the direction of motion of the point executing S.H.M is known as phase.

$x = x_o Sin(\omega t + \phi)$ ∴ ϕ = initial phase

(7) Define phase angle with diagram. **SGD-2016 (G-I)**

Ans: The angle θ = ωt which specifies the displacement as well as the direction of motion of the point Executing S.H.M is known as phase.

$x = x_o Sin(\omega t + \phi)$ ∴ ϕ = initial phase



7.4 A HORIZONTAL MASS SPRING SYSTEM

(8) In a mass-spring system, if force of 10N and displacement is 0.4 m. Find the value of spring constant.

Ans: F = 10N

x = 0.4 m

k=?

We know that

F= k x

$k = \frac{F}{x} = \frac{10}{0.4}$

k = 25 N/m

7.5 SIMPLE PENDULUM

(9) What is second pendulum and also write its length, time period and frequency

Ans: Second Pendulum

A pendulum which complete one vibration in two seconds is called a second's pendulum

Time period	2 seconds
Length	0.99m or 1 meter
Frequency	0.5 Hz

(10) Calculate the length of a simple pendulum if its frequency is 0.5 C.P.S (g = 9.8 m/s²)

Ans: $\ell = ?$

$f = 0.5\, c.p.s$

$g = 9.8\, m/s^2$

$f = \frac{1}{2\pi}\sqrt{\frac{g}{\ell}}$

taking squaring on both sides

$f^2 = \frac{1}{4\pi^2}\left(\frac{g}{l}\right)$

$\ell = \frac{g}{4\pi^2 f^2} \Rightarrow \ell = \frac{9.8}{4(3.14)^2 \times (0.5)^2}$

$\ell = 0.99\, m$

(11) Write any three uses of simple pendulum?

Ans: **(i)** The value of g can be found by simple pendulum
(ii) We can find the frequency of vibrating body by simple pendulum
(iii) It may used to calculate the time period.

(12) Is the motion of a simple pendulum Isochronous? Explain.

Ans: Yes, if the time period of harmonic oscillator does not change with the amplitude, such a motion is said to be isochronous motion. For example, the motion of simple pendulum is isochronous since it is independent of its amplitude.

(13) Which force actually provides the restoring force to the simple pendulum?

Ans: The vertical component of weight provides the restoring force which is directed towards the mean position and it is actually responsible for the motion of simple pendulum.

$F_r = W_y = mg \sin\theta$

(14) Which physical quantity remains constant throughout the oscillatory motion of simple pendulum?

Ans: Only the acceleration due to gravity 'g' remains constant throughout the simple harmonic motion of the simple pendulum.

(15) Calculate the length of the simple pendulum which completes one vibration in one second. (FSD 2014)

Ans: $\ell = ?$

$T = 1\text{sec}$

$g = 9.8\, m/s^2$

$T = 2\pi\sqrt{\frac{l}{g}}$

taking squaring on both sides

$T^2 = 4\pi^2 \frac{l}{g}$

$\frac{gT^2}{4\pi^2} = l$

$l = \frac{9.8(1)^2}{4\pi^2}$

$l = 0.248\, m$

(16) The amplitude of simple pendulum should be small why? Explain. (FSD-2018)

Ans: The amplitude of simple pendulum should be very small so that we may deal with linear motion instead of the circular motion because simple harmonic motion is linear motion. otherwise equation of simple harmonic motion

$a = -const\ x$

$a \propto -x$

is not satisfied

(17) What is the frequency of a second's pendulum?

Ans: Time period of second's pendulum = T = 2 second

Frequency of second's pendulum = f =?

$f = \frac{1}{T}$

$= \frac{1}{2} = 0.5$ Hz

7.6 ENERGY CONSERVATION IN SHM

(18) Find the P.E of a mass attached to a spring at an amplitude of 10 cm, if k is 10 N/m

Ans: P.E =?

$x_o = 10cm = \frac{10}{100} = 0.1$ m

$k = 10 \frac{N}{m}$

$P.E = \frac{1}{2} k x_o^2$

$= \frac{1}{2}(10)(0.1)^2$

P.E = 0.05 J

(19) What is the law of conservation of energy in S.H.M? LHR-2017 (G-II)

Ans: It states that the total energy of the vibrating mass and spring remains constant at every instant in its path but interconverted. This is called law of conservation of energy in S.H.M. At the extreme position oscillator have maximum P.E while at the mean position its K.E is maximum but total energy is constant at every position which depend upon amplitude of the oscillator.

(20) What will be the potential energy of a mass attached to a spring at amplitude of 5 cm, if its spring constant is $10Nm^{-1}$? SWL-2017

P.E =?

Ans: $x_o = 5$ cm = $\frac{5}{100}$ = 0.05 m

$k = 10\ Nm^{-1}$

$P.E = \frac{1}{2} k x_o^2$

P.E $= \frac{1}{2}(10)(0.05)^2$

P.E = 0.0125 J

(21) Discuss the law of conservation of energy is oscillating mass-spring system along with graphical representation. **MTN-2018 (G-I)**

Ans: The total energy of the vibrating mass and spring remains constant at every instant in its path but interconverted. This is called law of conservation of energy in S.H.M.

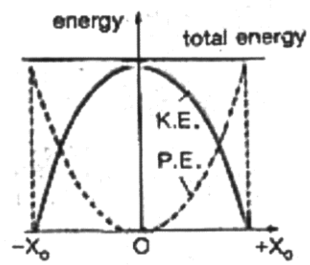
For Simple harmonic Oscillator at any displacement x, the energy is partly P.E, and partly K.E.

Hence, $T.E = E_{total} = P.E_{inst} + K.E_{inst}$

$$T.E = \frac{1}{2}kx^2 + \frac{1}{2}kx_o^2\left(1-\frac{x^2}{x_0^2}\right)$$

$$T.E = \frac{1}{2}kx^2 + \frac{1}{2}kx_o^2 - \frac{1}{2}kx^2$$

$$E_{total} = \frac{1}{2}kx_o^2$$



(22) A mass-spring system is vibrating with 10cm amplitude. Find its K.E and P.E at equilibrium position when spring constant is 20 Nm^{-1}. **LHR-2019 (G-I)**

Ans: Kinetic Energy:

$$K.E = \frac{1}{2}kx_o^2\left(1-\frac{x^2}{x_0^2}\right)$$

$$K.E = \frac{1}{2}(20)(10 \times 10^{-2})^2\left(1-\frac{0^2}{x_0^2}\right)$$

$$K.E = 0.1\ J$$

Potential Energy:

$$P.E = \frac{1}{2}kx^2$$

$$P.E = \frac{1}{2}k0^2$$

$$P.E = 0\ J$$

7.7 FREE AND FORCED OSCILLATION

(23) What is free and forced oscillation? **LHR-2017 (G-I)**

Ans: Free Oscillation:

Oscillation of a system is called free oscillation if it oscillates without the interference of an external force. e.g. simple pendulum when slightly displaced from its mean position vibrates freely with its natural frequency that depends only upon the length of the pendulum.

Forced Oscillation:

If freely oscillating system is subjected to an external force, then forced vibration will take place, the oscillation produced are called forced oscillation. The vibrations of a factory floor caused by the running of heavy machinery is an example of forced vibration. Another example of forced vibration is loud music produced by sounding wooden boards of strings instruments.

(24) What is driven harmonic oscillator? Give example. **LHR-2017 (G-I)**

Ans: Driven harmonic oscillator:

"A physical system undergoing forced vibrations is known as driven harmonic oscillator".

Examples:

(i) Vibrations of factory floor caused by the running of heavy machinery.

(ii) Loud music produced by sounding wooden boards of strings instruments

7.8 RESONANCE

(25) Define resonance and give some examples. **DGK-2018 (G-I) (SGD 2015)**

Ans: The phenomenon of resonance occurs when frequency of the applied force is equal to the natural frequency of vibration of force (driven) harmonic oscillator.

For example:

- Tuning of radio is an example of electrical resonance
- A swing is an example of mechanical resonance
- Heating and cooking of food by microwave oven

(26) Why the soldiers are ordered to break their steps while crossing bridge?

Ans: The soldiers are ordered to break their steps while crossing the big bridge, because if the frequency of their steps coincides with the natural frequency of bridge, the bridge may be set into vibrations of large amplitude. Thus the bridge may collapse due to resonance.

(27) How resonance is produced in tuning a radio set? **FSD-2018**

Ans: Tuning a radio is the best example of electrical resonance. When we turn the knob of a radio, to tune a station, we are changing the natural frequency of the electric circuit of the receiver, to make it equal to the transmission frequency of the radio station. When the two frequencies match, energy absorption is maximum and this is the only station we hear.

(28) How cooking of food is possible in micro-wave oven? **RWP-2014**

Ans: The waves produced in the microwave oven have wavelength of 12cm and frequency of 2450 MHz. At this frequency the waves are absorbed due to resonance by water and fat molecules in the food. In this way heating and cooking occur in the microwave oven.