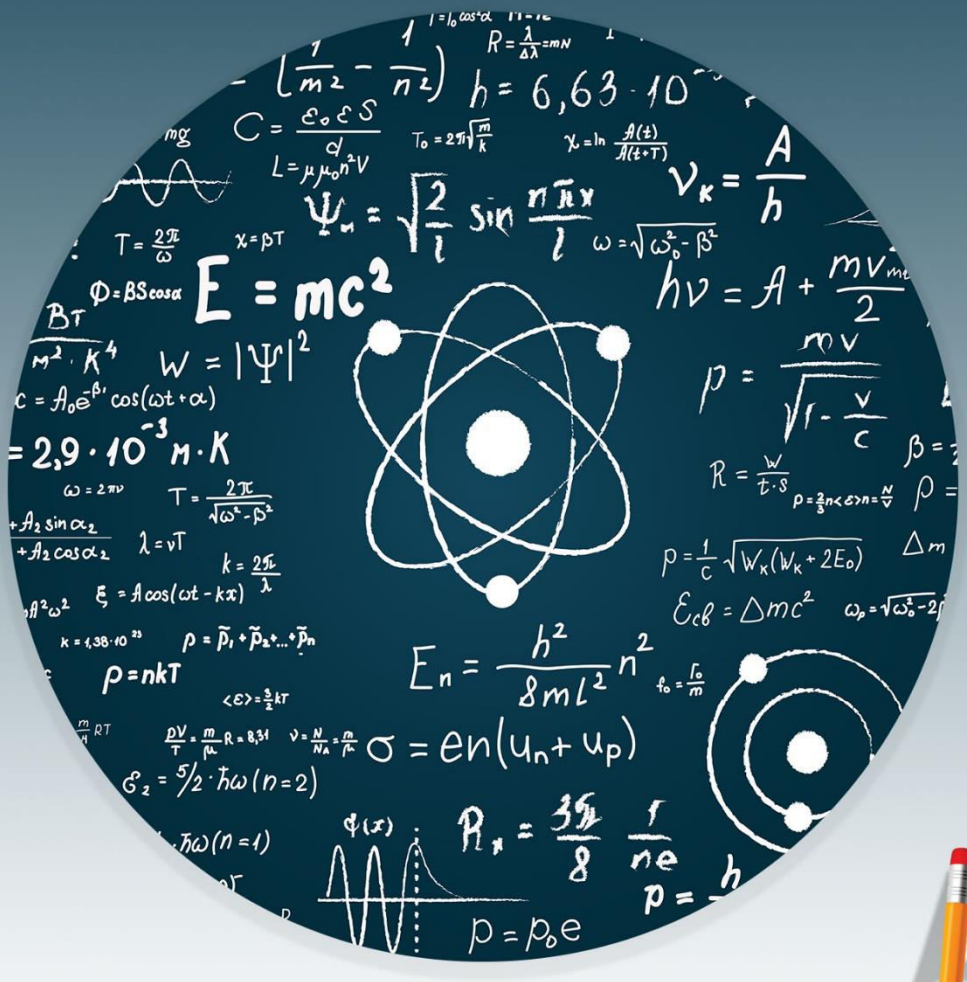
PHYSICS



WORKSHEET-15

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-15

Topics:- SHM, SHM and Uniform Circular Motion, Simple Pendulum, Conservation of Energy in SHM, Free and Forced Oscillations, Resonance & its Applications, Principle of Superposition, Electromagnetic Spectrum

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Q.1 The product of angular frequency (ω) and time period will be:

A) 1 C) 2π

B) $\frac{\pi}{2}$ D) π

Q.2 A simple pendulum is oscillating in a lift. If the lift starts moving upwards with a uniform acceleration then the time period will:

A) Remain unaffected C) Be longer

B) Be shorter D) May be "B" or "C"

Q.3 A particle is executing S.H.M, then the graph of velocity as a function of displacement is:

A) Straight line C) Ellipse

B) Circle D) Hyperbola

Q.4 A particle is executing S.H.M, then the graph of acceleration as a function of displacement is:

A) Straight line C) Ellipse

B) Circle D) Hyperbola

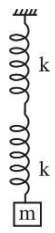
Q.5 A particle executing SHM has an acceleration of 64 cm s^{-2} when its displacement is 4 cm, its period in seconds is:

A) $\pi/2$ C) π

B) $\pi/4$ D) 2π

Q.6 If time period of this

is T, then the time period of this



will be:

A) $T/\sqrt{2}$ C) $T/2$

B) $\sqrt{2}\,T$ D) 2T

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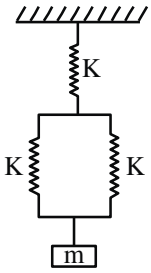
Q.7 **If the time period of**  **is T, then the time period of this**



this will be:

A) $T/\sqrt{2}$ C) $\sqrt{2}\,T$

B) $T/2$ D) $\sqrt{\frac{3}{2}}T$

Q.8 **At t = 0 a body performing SHM is at mean position, when** $t = T/4$ **it will be at:**

A) At extreme position
B) Between mean and extreme position
C) Beyond extreme position
D) Again at mean position

Q.9 **The displacement of particle in SHM in one time period if its amplitude of vibration is "a" will be:**

A) Zero C) 2a
B) a D) 4a

Q.10 **A system can vibrate only if it has:**

A) Inertia C) Plasticity
B) Restoring force D) Both "A" and "B"

Q.11 **The maximum velocity of harmonic oscillator is 10** $cm\ s^{-1}$**. If its amplitude is 10 cm. What is its maximum acceleration?**

A) 100 $cm\ s^{-2}$ C) 10 $cm\ s^{-2}$
B) 1 $cm\ s^{-2}$ D) 0.1cm s^{-2}

Q.12 **The time in which a body executing SHM is at a distance of** $\frac{x_o}{2}$ **from the mean position is (where T is its time period):**

A) $\frac{T}{2}$ C) $\frac{T}{8}$

B) $\frac{T}{4}$ D) $\frac{T}{12}$

Q.13 A particle execute SHM with a time period of 2 s and amplitude 5 cm. Maximum value of its velocity is:

A) $10\ \pi$ cm s^{-1} C) $2.5\ \pi$ cm s^{-1}

B) $20\ \pi$ cm s^{-1} D) $5\ \pi$ cm s^{-1}

Q.14 The time period of simple pendulum measured inside a stationary lift is T. If the lift starts moving upward with an acceleration of g, what will be the time period?

A) $\frac{T}{3}$ C) $\sqrt{\frac{3}{2}}T$

B) $\frac{T}{\sqrt{2}}$ D) $\frac{\sqrt{3}}{2}T$

Q.15 The bob of a simple pendulum of period T is given a negative charge. If it is allowed to oscillate above a positively charged plate, the new time period will be:

A) Equal to T C) Less than T

B) More than T D) Infinite

Q.16 The relation of restoring force in a simple pendulum if it makes an angle "θ" with horizontal is:

A) $mg\sin\theta$ C) $mg\cos\theta$

B) $mg\tan\theta$ D) $mg\cot\theta$

Q.17 The time period of variation in total energy of a simple harmonic oscillator is:

A) 2T C) 0

B) $\frac{T}{2}$ D) Infinite

Q.18 The frequency of variation in K.E or P.E of a simple harmonic oscillator is:

A) f C) $3f$

B) $2f$ D) $\frac{f}{2}$

Q.19 The maximum number of equal parts in which time period of a simple harmonic oscillator can be divided are (when displacement is equal in each part):

USE THIS SPACE FOR SCRATCH WORK

A) 4 C) 8

B) 6 D) Infinite

USE THIS SPACE FOR SCRATCH WORK

Q.20 The relation for time period of a horizontal mass spring system is $T = 2\pi\sqrt{\frac{x}{g}}$. What will be it's time period if taken on moon (at moon $g_m = \frac{g}{6}$).

A) T will increase

B) T will remain same

C) T will decrease

D) T may increase or decrease

Q.21 k is spring constant, its unit is same as that of:

A) Pressure C) Surface tension

B) Tension D) Energy

Q.22 The spring constant of two springs are added for maximum equivalent when they are connected in:

A) Series C) Perpendicular

B) Parallel D) None of these

Q.23 When a spring of spring constant k is cut into two parts of same length, then the effective value of spring constant is:

A) 2k C) $\frac{k}{2}$

B) k D) $\frac{k}{4}$

Q.24 If the displacement in SHM is written by equation $x = x_o\cos\omega t$ the value of initial phase in this case is:

A) 0^o C) 90^o

B) 45^o D) 180^o

Q.25 Spring constant of a spring and its length are related as:

A) $k \propto l$ C) $k \propto \sqrt{l}$

B) $k \propto l^{-1}$ D) $k \propto l^{-\frac{1}{2}}$

Q.26 A simple pendulum has frequency of 2 Hz. How long does it take to move from mean to extreme position:

A) 0.12 s C) 0.5 s

B) 0.2 s D) 0.05 s

Q.27 Equation for displacement in SHM is $x = x_o \sin\omega t$. The value of acceleration at instant $t = \frac{T}{4}$ is:

A) $x_o\omega$ C) $x_o\sqrt{\omega}$

B) $x_o\omega^2$ D) $x_o\frac{\omega}{2}$

Q.28 The relation for instantaneous velocity for a simple harmonic oscillator is:

A) $v = \omega\sqrt{x_0^2 - x^2}$ C) $v = \sqrt{\frac{k}{m}\left(x_0^2 - x^2\right)}$

B) $v = \sqrt{\frac{g}{\ell}\left(x_0^2 - x^2\right)}$ D) All of these

Q.29 Which of the following can be true for "ω"?

A) $\sqrt{\frac{k}{m}}$ C) $\sqrt{\frac{g}{\ell}}$

B) $\frac{2\pi}{T}$ D) All of these

Q.30 For a simple harmonic oscillator which of the following is true for maximum acceleration?

A) $a = -\omega^2 x_\circ$ C) $a = \frac{-k}{m}x_\circ$

B) $a = \frac{-g}{\ell}x_\circ$ D) All of these

Q.31 The ratio of maximum velocity and maximum acceleration for simple harmonic oscillator can be written as:

A) $\frac{T}{2\pi}$ C) $\sqrt{\frac{\ell}{g}}$

B) $\sqrt{\frac{m}{k}}$ D) All of these

Q.32 The displacement covered by a simple harmonic oscillator in a time of $\frac{3}{2}T$ while starting from extreme position with amplitude "a":

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A) Zero C) 4a

B) 2a D) 6a

Q.33 Referring to data in Q.32, the distance covered is:

A) Zero C) 4a

B) 2a D) 6a

Q.34 The time taken by a simple harmonic oscillator to travel from extreme to half of mean $\left(x = \frac{x_\circ}{2}\right)$ is:

A) $\frac{T}{4}$ C) $\frac{T}{8}$

B) $\frac{T}{12}$ D) $\frac{T}{6}$

Q.35 A simple harmonic oscillator starts it's journey from mean and moves towards +ve extreme then what is true?

A) It's initial phase is zero

B) We use $x = x_\circ \cos\theta$ for it

C) We use $x = x_\circ \sin\theta$ for it

D) Both "A" & "C"

Q.36 Which of the following equations can be used for a simple harmonic oscillator?

A) $x = x_\circ \sin\theta$ C) $x = x_\circ \cos\theta$

B) $x = -x_\circ \cos\theta$ D) All of these

Q.37 A uniform circular motion is:

A) A periodic motion only

B) A simple harmonic motion only

C) Both periodic and harmonic motion

D) Neither periodic not harmonic motion

Q.38 In SHM when K.E is maximum then which of the following is incorrect?

A) P.E is zero C) Displacement is zero

B) Acceleration is zero D) None of these

Q.39 A pendulum has time period T on earth. As the value of g on the surface of moon is $\frac{1}{6}$th times than on earth, then the time period of such a pendulum on the moon's surface will be:

A) $\sqrt{6}T$ C) $\frac{T}{6}$

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B) $\frac{T}{\sqrt{6}}$ D) 6T

Q.40 A simple pendulum is present in a lift which is accelerated downwards by g, then its time period in lift will become:

A) $\frac{1}{\sqrt{2}}$ times C) $\frac{2}{\sqrt{3}}$ times

B) 2 times D) Infinite

Q.41 In SHM when displacement is equal to $\frac{x_o}{2}$, then the ratio of P.E to K.E is:

A) 2:3 C) 3:2

B) 1:3 D) 3:1

Q.42 In simple pendulum at any instant tension of string is _____ when it makes angle "θ" with horizontal is:

A) T = mg C) T = mg sinθ

B) T = mg cosθ D) T= - mg sin θ

Q.43 In SHM how many times does K.E and P.E become equal during one period?

A) 1 time C) 3 times

B) 2 times D) 4 times

Q.44 When K.E and P.E in SHM become equal the displacement is?

A) $\frac{x_o}{2}$ C) $\sqrt{2}x_o$

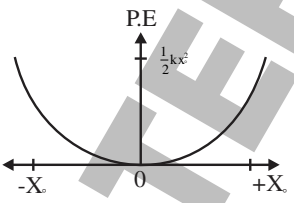
B) $\frac{x_o}{\sqrt{2}}$ D) $\frac{\sqrt{3}x_o}{2}$

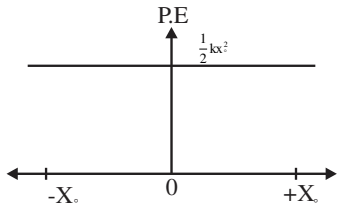
Q.45 The time period of a simple pendulum is independent of:

A) Length of pendulum C) Value of gravity

B) Centre of mass D) None of these

Q.46 The graph of P.E vs displacement for a harmonic oscillator is:

A) 

C) 

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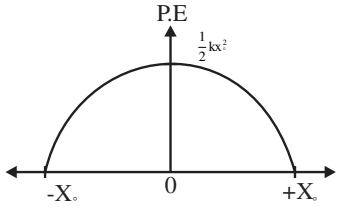


B) D) None of these

Q.47 A body performing SHM has displacement $x = x_\circ \sin(wt + \phi)$, when t=0, $x = x_\circ$. What is the value of phase initial?

A) π C) $\frac{\pi}{2}$

B) $\frac{\pi}{4}$ D) $\frac{\pi}{3}$

Q.48 Angular displacement of a point moving in a circle of radius 10 cm, when displacement of projection of this point along vertical diameter of circle is 8.66 cm, will be:

A) 30° C) 75°

B) 45° D) 60°

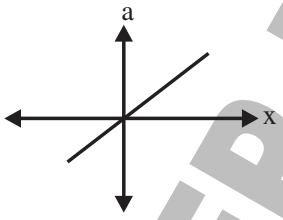
Q.49 In mass spring system, mass "m" is attached with spring of constant "k" with time period "T_1", then mass is replaced with "5m" with same spring. What will be the time period T_2 now:

A) $T_2 = \sqrt{5}T_1$ C) $T_2 = 5T_1$

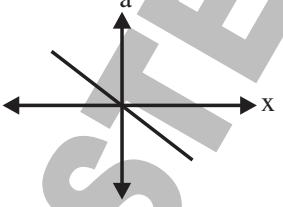
B) $T_2 = T_1$ D) $T_2 = \frac{T_1}{\sqrt{5}}$

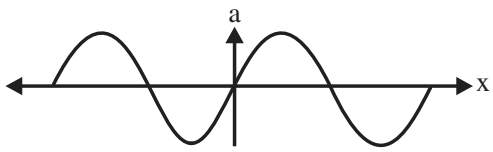
Q.50 The acceleration of a body executing SHM varies with instantaneous displacement as:

A)



B)



C) 

D) None of these

ANSWER KEY (Worksheet-15)									
1	C	11	C	21	C	31	D	41	B
2	B	12	D	22	B	32	B	42	C
3	C	13	D	23	A	33	D	43	D
4	A	14	B	24	C	34	D	44	B
5	A	15	C	25	B	35	D	45	D
6	B	16	C	26	A	36	D	46	A
7	D	17	D	27	B	37	A	47	C
8	A	18	B	28	D	38	D	48	D
9	A	19	A	29	D	39	A	49	A
10	D	20	B	30	D	40	D	50	B

SOLUTIONS

Unit – 4 (WS-15)

Q.1 Answer is "C"

Solution:- $T = \frac{2\pi}{\omega} \Rightarrow T\omega = 2\pi$

Q.2 Answer is "B"

Solution:- Use relation, $T = 2\pi\sqrt{\frac{\ell}{g+a}}$

Q.3 Answer is "C"

Solution:- The shapes of different graphs for a body executing SHM are:

i. Graph between velocity & displacement is an ellipse.

ii. Graph between K.E/P.E & displacement is a parabola.

iii. Graph between total energy & displacement is a straight line.

iv. Graph between force/acceleration & displacement is straight line.

v. Graph between displacement & time a sinusoid.

Q.4 Answer is "A"

Solution:- The shapes of different graphs for a body executing SHM are:

i. Graph between velocity & displacement is an ellipse.

ii. Graph between K.E/P.E & displacement is a parabola.

iii. Graph between total energy & displacement is a straight line.

iv. Graph between force/acceleration & displacement is straight line.

v. Graph between displacement & time a sinusoid.

Q.5 Answer is "A"

Solution:- Use relation; $a = \omega^2 x$ also put $\omega = \frac{2\pi}{T}$ and solve:

Q.6 Answer is "B"

Solution:- In series use formula $k_{eq} = \frac{k}{n}$

Q.7 Answer is "D"

Solution:- The equivalent spring constant of the final combination of springs:

$$k_{eq} = \frac{(2k)(k)}{2k+k} = \frac{2}{3}k \quad \text{so,}$$

$$T' = 2\pi\sqrt{\frac{m}{k_{eq}}} = 2\pi\sqrt{\frac{m}{\frac{2}{3}k}} = \sqrt{\frac{3}{2}}\left(2\pi\sqrt{\frac{m}{k}}\right)$$

$$T' = \sqrt{\frac{3}{2}}T$$

Q.8 Answer is "A"

Solution:- In $\frac{T}{4}$ time the body covers a distance equal to the amplitude, now as the body starts moving from mean position, it will reach to extreme position in $\frac{T}{4}$.

Q.9 Answer is "A"

Solution:- In one time period the particle returns back to same position from where it starts moving, so displacement becomes zero.

Q.10 Answer is "D"

Solution:- A body vibrates because of inertia and restoring force. Restoring force brings the body back to mean

position while inertia does not allow the body to stop at mean position.

Q.11 Answer is "C"

Solution:- $a_\circ = \omega^2 x_\circ$;

$$v_\circ = x_\circ \omega \quad \Rightarrow \quad a_\circ = \frac{v_\circ^2}{x_\circ}$$

Q.12 Answer is "D"

Solution:- Use relation:- $x = x_\circ \sin\theta$ and put $x = \frac{x_\circ}{2}$ and solve

Q.13 Answer is "D"

Solution:-

Use relation:- $v_o = \omega x_\circ = \frac{2\pi}{T} \times x_\circ$

Q.14 Answer is "B"

Solution:- Use relation: $T' = 2\pi\sqrt{\frac{\ell}{g+a}}$

put
a = g and solve

Q.15 Answer is "C"

Solution:- Attraction is produced, due to which pendulum moves faster towards mean position, hence "T" decreases and "f" increases.

Q.16 Answer is "C"

Solution:- Normally pendulum makes an angle "θ" with vertical then $F_r = mg\sin\theta$, but in this case as it makes angle "θ" with horizontal so relation becomes

$F_r = mg\cos\theta$

Q.17 Answer is "D"

Solution:- As total energy never changes so it may take an infinite time to be zero.

Q.18 Answer is "B"

Solution:- In a single oscillation two times K.E or P.E are completely converted into each other.

Q.19 Answer is "A"

Solution:- If we make four parts of time period each of value $\frac{T}{4}$, then in each part equal displacement i.e $x = x_\circ$ is covered. If we make more than four parts of time period. Then equal displacement will not be covered in each part, e.g body takes $\frac{T}{12}$ time to cover $\frac{x_\circ}{2}$ distance from mean position and $\frac{T}{6}$ to cover $\frac{x_\circ}{2}$ distance from extreme position.

Q.20 Answer is "B"

Solution:- At moon when $g' = \frac{g}{6}$ then x' also becomes $\frac{x}{6}$. So according to formula $T = 2\pi\sqrt{\frac{x}{g}} = \text{constant}$.

Q.21 Answer is "C"

Solution:- The units of spring constant and surface tension are same i.e N m^{-1}.

Q.22 Answer is "B"

Solution:- In parallel combination of springs;

$k_{eq} = k_1 + k_2 + k_3 + ...$

$k_{eq} > k_1, k_2 .....$

Q.23 Answer is "A"

Solution:- When a spring of spring constant "k" is divided into "n" equal

parts then spring constant of each part is given as:

$k_{part} = nk$

Q.24 Answer is "C"

Solution:- The general equation of instantaneous displacement for projection is:

$x = x_\circ \sin(\theta + \phi)$

If $\phi = 90°$

$x = x_\circ \cos\theta$

Q.25 Answer is "B"

Solution:- Longer the spring, larger will be change in its length i.e "x", smaller will be the spring constant.

i.e

$k = \frac{F}{x} \qquad (\therefore x = \Delta\ell \propto \ell)$

$k \propto \frac{1}{x}$

$k \propto \frac{1}{\ell}$

Q.26 Answer is "A"

Solution:-

Step-I

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

Step-II

From mean to extreme position body will take to $\frac{T}{4}$.

Q.27 Answer is "B"

Solution:- For the given displacement equation, initial phase is zero which means body is initially at mean position. In time $\frac{T}{4}$ it will move from mean to extreme position i.e x becomes $x_\circ$, so

$a = \omega^2 x = \omega^2 x_\circ$

Q.28 Answer is "D"

Solution:- The instantaneous velocity of projection of a body moving on a circular path is

$v = \omega\sqrt{x_0^2 - x^2}$

For mass spring system

$\omega = \sqrt{\frac{k}{m}}$ so, $v = \sqrt{\frac{k}{m}(x_0^2 - x^2)}$

For simple pendulum

$\omega = \sqrt{\frac{g}{\ell}}$ so, $v = \sqrt{\frac{g}{\ell}(x_0^2 - x^2)}$

Q.29 Answer is "D"

Solution:- Angular frequency of projection is

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

Angular frequency of mass spring system is

$\omega = \sqrt{\frac{k}{m}}$

Angular frequency of simple pendulum is

$\omega = \sqrt{\frac{g}{\ell}}$

Q.30 Answer is "D"

Solution:- Maximum acceleration of projection, simple pendulum and mass spring system is given as respectively;

$a = -\omega^2 x_\circ$

$a = -\frac{g}{\ell} x_\circ$

$a = -\frac{k}{m} x_\circ$

Q.31 Answer is "D"

Solution:- The different relations of maximum velocity and accelerations are;

$$v_\circ = \omega x_\circ = x_\circ \sqrt{\frac{k}{m}} = x_\circ \sqrt{\frac{g}{\ell}}$$

$$a_\circ = \omega^2 x_\circ = x_\circ \left(\sqrt{\frac{k}{m}}\right)^2 = x_\circ \left(\sqrt{\frac{g}{\ell}}\right)^2$$

Just take ratio.

Q.32 Answer is "B"

Solution:- In one time period T the body will move from the extreme position to other extreme position and back to the same extreme position, so displacement will be zero in "T". In next $\frac{T}{2}$ the body will move from extreme position to other extreme covering a displacement of $2x_\circ$.

Q.33 Answer is "D"

Solution:- Total distance in one time period $T = 4x_\circ$

Total distance in $\frac{3T}{2} = \frac{3}{2}(4x_\circ)$

Total distance in $\frac{3T}{2} = 6x_\circ$

Q.34 Answer is "D"

Solution:-

Use relation $x = x_\circ \cos\theta$

put $x = \frac{x_\circ}{2}$ and solve

Q.35 Answer is "D"

Solution:- $\phi = 0°$, $x = x_\circ \sin(\theta + \phi)$

Q.36 Answer is "D"

Solution:- The general equation of instantaneous displacement is:

$$x = x_\circ \sin(\theta + \phi)$$

- If $\phi = 0°$

  $x = x_\circ \sin\theta$

- If $\phi = 90°$

  $x = x_\circ \sin(\theta + 90°)$

  $x = x_\circ \cos\theta$

- If $\phi = 180°$

  $x = x_\circ \sin(\theta + 180°)$

  $x = -x_\circ \sin\theta$

- If $\phi = 270°$

  $x = x_\circ \sin(\theta + 270°)$

  $x = -x_\circ cos\theta$

Q.37 Answer is "A"

Solution:- It's only periodic not S.H.M

Q.38 Answer is "D"

Solution:- K.E is maximum at mean position i.e x=0. At x=0;

$a = -\omega^2 x = 0$

$x = 0$

$P.E = \frac{1}{2} kx^2 = 0$

All these A, B & C option are correct informations

Q.39 Answer is "A"

Solution:- At moon $g = \frac{g}{6}$ use relation

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

Q.40 Answer is "D"

Solution:- Use relation: $T = 2\pi\sqrt{\frac{\ell}{g-a}}$

$\therefore a = g$

So $T = \infty$

Q.41 Answer is "B"

Solution:- At $x = \frac{x_\circ}{2}$

$$P.E = \frac{1}{2}k\left(\frac{x_\circ}{2}\right)^2$$

$$P.E = \frac{1}{4}E_T \text{ ------- (i)}$$

K.E at $x = \frac{x_\circ}{2}$

$$K.E = E_T - P.E$$

$$K.E = E_T - \frac{1}{4}E_T$$

$$K.E = \frac{3}{4}E_T \text{ -------- (ii)}$$

Dividing equation (i) by (ii)

$$\frac{P.E}{K.E} = \frac{1}{3}$$

Q.42 Answer is "C"

Solution:- Generally string makes "θ" with vertical, so have that angle with vertical is 90°-θ, so tension becomes; $T = mg\sin\theta$.

Q.43 Answer is "D"

Solution:- In $\frac{T}{4}$ time when body moves from mean to extreme position, K.E and P.E become equal once at $x = \frac{x_\circ}{\sqrt{2}}$. So in "T" time K.E and P.E will become equal four times.

Q.44 Answer is "B"

Solution:- Put K.E = P.E and find "x".

Q.45 Answer is "D"

Solution:- Time period of simple pendulum is

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

$$\Rightarrow T \propto \sqrt{\ell}; T \propto \frac{1}{\sqrt{g}}$$

Furthermore, length of pendulum depends on position of centre of mass of bob.

Q.46 Answer is "A"

Solution:- The instantaneous P.E of a harmonic oscillator is;

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

$at\ x = 0$	$at\ x = +x_\circ\ or\ x = -x_\circ$
$P.E = 0$	$P.E = \frac{1}{2}kx_0^2$

Q.47 Answer is "C"

Solution:- Given $t = 0; x = x_\circ$, putting in following equation;

$$x = x_\circ \sin(\omega t + \phi)$$

$$x_\circ = x_\circ \sin(0 + \phi)$$

$$1 = \sin\phi$$

$$\phi = \sin^{-1}(1) = 90°$$

Q.48 Answer is "D"

Solution:- Radius $= r = x_\circ = 10cm$

Inst. Displacement=x=8.66 cm

$\theta = ?$

As we know

$$x = x_\circ \sin\theta$$

$$8.66 = 10\sin\theta$$

solving

$$\theta = 60°$$

Q.49 Answer is "A"

Solution:- Time period of mass spring system is given as;

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$T \propto \sqrt{m}$$

Q.50 Answer is "B"

Solution:- For a body executing SHM;

$$a \propto -x$$

STEP

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