DPP - Daily Practice Problems

Name :

Date :

Start Time :

End Time :

PHYSICS 28

SYLLABUS : Oscillations-2 (Oscillations of a spring, simple pendulum, free, forced and damped oscillations, Resonance)

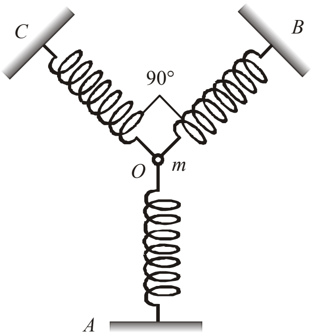
Max. Marks : 112 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 28 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

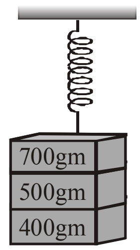
DIRECTIONS (Q.1-Q.20) : There are 20 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 A particle of mass m is attached to three identical springs A, B and C each of force constant k as shown in figure.
If the particle of mass m is pushed slightly against the spring A and released then the time period of oscillations is



(a) $2\pi\sqrt{\frac{2m}{k}}$ (b) $2\pi\sqrt{\frac{m}{2k}}$ (c) $2\pi\sqrt{\frac{m}{k}}$ (d) $2\pi\sqrt{\frac{m}{3k}}$

Q.2 Three masses 700g, 500g, and 400g are suspended at the end of a spring as shown and are in equilibrium.
When the 700g mass is removed, the system oscillates with a period of 3 seconds, when the 500 gm mass is also removed, it will oscillate with a period of



(a) 1 s
(b) 2 s
(c) 3 s
(d) $\sqrt{\frac{12}{5}}s$

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ

Space for Rough Work

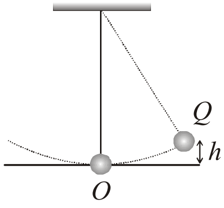
Q.3 The bob of a simple pendulum is displaced from its equilibrium position O to a position Q which is at height h above O and the bob is then released.
Assuming the mass of the bob to be m and time period of oscillations to be 2.0 sec, the tension in the string when the bob passes through O is

(a) $m(g+\pi\sqrt{2g\,h})$

(b) $m(g+\sqrt{\pi^2 g\,h})$

(c) $m\left(g+\sqrt{\frac{\pi^2}{2}g\,h}\right)$

(d) $m\left(g+\sqrt{\frac{\pi^2}{3}g\,h}\right)$



Q.4 A spring of force constant k is cut into two pieces such that one piece is double the length of the other. Then the long piece will have a force constant of

(a) $(2/3)k$ (b) $(3/2)k$ (c) $3k$ (d) $6k$

Q.5 A pendulum suspended from the ceiling of a train has a period T, when the train is at rest. When the train is accelerating with a uniform acceleration a, the period of oscillation will

(a) increase (b) decrease
(c) remain unaffected (d) become infinite

Q.6 A simple pendulum is set up in a trolley which moves to the right with an acceleration a on a horizontal plane. Then the thread of the pendulum in the mean position makes an angle θ with the vertical is

(a) $\tan^{-1}\frac{a}{g}$ in the forward direction

(b) $\tan^{-1}\frac{a}{g}$ in the backward direction

(c) $\tan^{-1}\frac{g}{a}$ in the backward direction

(d) $\tan^{-1}\frac{g}{a}$ in the forward direction

Q.7 The time period of a second's pendulum is 2 sec. The spherical bob which is empty from inside has a mass of 50 gm. This is now replaced by another solid bob of same radius but having different mass of 100 gm. The new time period will be

(a) 4 sec (b) 1 sec (c) 2 sec (d) 8 sec

Q.8 The length of a simple pendulum is increased by 1%. Its time period will

(a) Increase by 1% (b) Increase by 0.5%
(c) Decrease by 0.5% (d) Increase by 2%

Q.9 The bob of a pendulum of length l is pulled aside from its equilibrium position through an angle θ and then released. The bob will then pass through its equilibrium position with a speed v, where v equals

(a) $\sqrt{2gl(1-\sin\theta)}$ (b) $\sqrt{2gl(1+\cos\theta)}$
(c) $\sqrt{2gl(1-\cos\theta)}$ (d) $\sqrt{2gl(1+\sin\theta)}$

Q.10 A simple pendulum is executing simple harmonic motion with a time period T. If the length of the pendulum is increased by 21%, the percentage increase in the time period of the pendulum of is

(a) 10% (b) 21% (c) 30% (d) 50%

Q.11 A chimpanzee swinging on a swing in a sitting position, stands up suddenly, the time period will

(a) Become infinite (b) Remain same
(c) Increase (d) Decrease

Q.12 A simple pendulum consisting of a ball of mass m tied to a thread of length l is made to swing on a circular arc of angle θ in a vertical plane. At the end of this arc, another ball of mass m is placed at rest. The momentum transferred to this ball at rest by the swinging ball is

(a) Zero (b) $m\theta\sqrt{\frac{g}{l}}$ (c) $\frac{m\theta}{l}\sqrt{\frac{l}{g}}$ (d) $\frac{m}{l}2\pi\sqrt{\frac{l}{g}}$

Q.13 The time period of a simple pendulum of length L as measured in an elevator descending with acceleration $g/3$ is

(a) $2\pi\sqrt{\frac{3L}{g}}$ (b) $\pi\sqrt{\left(\frac{3L}{g}\right)}$ (c) $2\pi\sqrt{\left(\frac{3L}{2g}\right)}$ (d) $2\pi\sqrt{\frac{2L}{3g}}$

RESPONSE GRID					
	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ
	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ
	13. ⓐⓑⓒⓓ				

Space for Rough Work

Q.14 A mass m is suspended from the two coupled springs connected in series. The force constant for springs are k_1 and k_2. The time period of the suspended mass will be

(a) $T = 2\pi\sqrt{\left(\frac{m}{k_1 + k_2}\right)}$ (b) $T = 2\pi\sqrt{\left(\frac{m}{k_1 + k_2}\right)}$

(c) $T = 2\pi\sqrt{\left(\frac{m(k_1 + k_2)}{k_1 k_2}\right)}$ (d) $T = 2\pi\sqrt{\left(\frac{mk_1 k_2}{k_1 + k_2}\right)}$

Q.15 A spring having a spring constant k is loaded with a mass m. The spring is cut into two equal parts and one of these is loaded again with the same mass. The new spring constant is

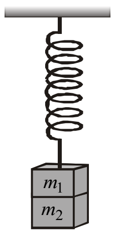
(a) $k/2$ (b) k (c) $2k$ (d) k^2

Q.16 A mass $m = 100$ gm is attached at the end of a light spring which oscillates on a frictionless horizontal table with an amplitude equal to 0.16 metre and time period equal to 2 sec. Initially the mass is released from rest at $t = 0$ and displacement $x = -0.16$ metre. The expression for the displacement of mass at any time t is

(a) $x = 0.16\cos(\pi t)$ (b) $x = -0.16\cos(\pi t)$

(c) $x = 0.16\sin(\pi t + \pi)$ (d) $x = -0.16\sin(\pi t + \pi)$

Q.17 Two masses m_1 and m_2 are suspended together by a massless spring of constant k. When the masses are in equilibrium, m_1 is removed without disturbing the system. The amplitude of oscillations is



(a) $\frac{m_1 g}{k}$

(b) $\frac{m_2 g}{k}$

(c) $\frac{(m_1 + m_2)g}{k}$

(d) $\frac{(m_1 - m_2)g}{k}$

Q.18 The composition of two simple harmonic motions of equal periods at right angle to each other and with a phase difference of π results in the displacement of the particle along

(a) Straight line (b) Circle

(c) Ellipse (d) Figure of 8

Q.19 A particle with restoring force proportional to displacement and resisting force proportional to velocity is subjected to a force $F \sin \omega t$. If the amplitude of the particle is maximum for $\omega = \omega_1$ and the energy of the particle is maximum for $\omega = \omega_2$, then (where ω_0 natural frequency of oscillation of particle)

(a) $\omega_1 = \omega_0$ and $\omega_2 \neq \omega_0$ (b) $\omega_1 = \omega_0$ and $\omega_2 = \omega_0$

(c) $\omega_1 \neq \omega_0$ and $\omega_2 = \omega_0$ (d) $\omega_1 \neq \omega_0$ and $\omega_2 \neq \omega_0$

Q.20 Amplitude of a wave is represented by $A = \frac{c}{a + b - c}$

Then resonance will occur when

(a) $b = -c/2$ (b) $b = 0$ & $a = c$

(c) $b = -a/2$ (d) None

DIRECTIONS (Q.21-Q.23) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct

(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.21 Two blocks A and B each of mass m are connected by a massless spring of natural length L and spring constant k. The blocks are initially resting on a smooth horizontal floor with the spring at its natural length. A third identical block C also of mass m moves on the floor with a speed v along the line joining A and B and collides with A. Then

(1) The kinetic energy of the A – B system at maximum compression of the spring is $mv^2/4$

(2) The maximum compression of the spring is $v\sqrt{m/2k}$

(3) The kinetic energy of the A-B system at maximum compression of the spring is zero

(4) The maximum compression of the spring is $v\sqrt{m/k}$

Q.22 A simple pendulum of length L and mass (bob) M is oscillating in a plane about a vertical line between angular limits $-\phi$ and $+\phi$. For an angular displacement $\theta(|\theta| < \phi)$, the tension in the string and the velocity of the bob are T and v respectively. The following relations hold good under the above conditions

(1) $T - Mg\cos\theta = \frac{Mv^2}{L}$

(2) $T\cos\theta = Mg$

(3) The magnitude of the tangential acceleration of the bob $|a_T| = g\sin\theta$

(4) $T = Mg\cos\theta$

RESPONSE GRID					
	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ
	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	

Space for Rough Work

Q.23 Identify wrong statements among the following

(1) The greater the mass of a pendulum bob, the shorter is its frequency of oscillation

(2) A simple pendulum with a bob of mass M swings with an angular amplitude of 40°. When its angular amplitude is 20°, the tension in the string is less than Mgcos20°.

(3) The fractional change in the time period of a pendulum on changing the temperature is independent of the length of the pendulum.

(4) As the length of a simple pendulum is increased, the maximum velocity of its bob during its oscillation will also decreases.

DIRECTIONS (Q.24-Q.25) : Read the passage given below and answer the questions that follows :

A particle performs linear SHM such that it is placed on platform & platform along with particles oscillate vertically up and down with amplitude A = 1cm. If the particle does not loose contact with platform anywhere and mass of particle is 1 kg, find :

Q.24 The minimum, possible time period (Take $\pi = \sqrt{g}$)

(a) 0.1 sec. (b) 0.2 sec.
(c) 0.3 sec. (d) 0.4 sec.

Q.25 For minimum time period condition average potential energy between t = 0 to t = 0.05 sec (Take g = 10 m/s^2)

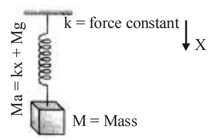
(a) 0.025 Joule (b) 0.1 Joule
(c) 0.08 Joule (d) 0.06 Joule

DIRECTIONS (Q.26-Q.28) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(c) Statement -1 is False, Statement-2 is True.
(d) Statement -1 is True, Statement-2 is False.

Q.26 **Statement-1 :** Consider motion for a mass spring system under gravity, motion of *M* is not a simple harmonic motion unless *Mg* is negligibly small.

Statement-2 : For simple harmonic motion acceleration must be proportional to displacement and is directed towards the mean position.



Q.27 **Statement-1 :** The periodic time of a hard spring is less as compared to that of a soft spring.

Statement-2 : The periodic time depends upon the spring constant, and spring constant is large for hard spring.

Q.28 **Statement-1 :** The percentage change in time period is 1.5%, if the length of simple pendulum increases by 3%

Statement-2: Time period is directly proportional to length of pendulum.

RESPONSE GRID

23. ⓐⓑⓒⓓ 24. ⓐⓑⓒⓓ 25. ⓐⓑⓒⓓ 26. ⓐⓑⓒⓓ 27. ⓐⓑⓒⓓ
28. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 28 - PHYSICS			
Total Questions	28	Total Marks	112
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	28	Qualifying Score	42
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

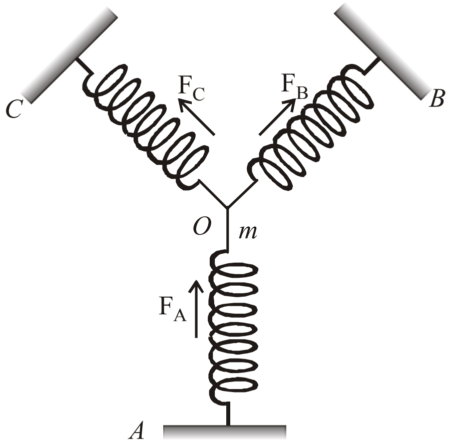
Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

28

1. **(b)** When the particle of mass m at O is pushed by y in the direction of A. The spring A will compressed by y while spring B and C will be stretched by $y' = y\cos 45^\circ$. So that the total restoring force on the mass m along OA.



$$F_{net} = F_A + F_B \cos 45^\circ + F_C \cos 45^\circ$$

$$= ky + 2ky'45^\circ = ky + 2k(y\cos 45^\circ)\cos 45^\circ = 2ky$$

Also

$$F_{net} = k'y \Rightarrow k'y = 2ky \Rightarrow k' = 2k$$

$$T = 2\pi\sqrt{\frac{m}{k'}} = 2\pi\sqrt{\frac{m}{2k}}$$

2. **(b)** When mass 700 gm is removed, the left out mass (500 + 400) gm oscillates with a period of 3 sec

$$\therefore 3 = t = 2\pi\sqrt{\frac{(500+400}{k}}$$

......(i)

When 500 gm mass is also removed, the left out mass is 400 gm.

$$\therefore t' = 2\pi\sqrt{\frac{400}{k}} \quad ...(ii)$$

$$\Rightarrow \frac{3}{t'} = \sqrt{\frac{900}{400}} \Rightarrow t' = 2\,\text{sec}$$

3. **(a)** Slope is irrelevant hence

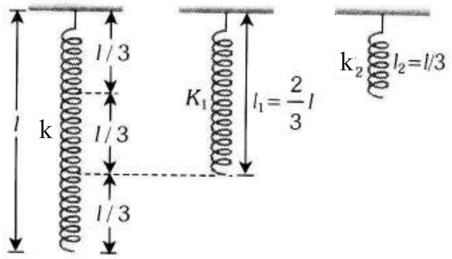
$$T = 2\pi\left(\frac{M}{2k}\right)^{1/2}$$

4. **(a)** Tension in the string when bob passes through lowest point $T = mg + \frac{mv^2}{r} = mg + mv\omega \quad (\therefore v = r\omega)$

Putting $v = \sqrt{2gh}$ and $\omega = \frac{2\pi}{T} = \frac{2\pi}{2} = \pi$

we get $T = m(g + \pi\sqrt{2gh})$

5. **(b)**



Force constant $(k) \propto \frac{1}{Length\ of\ spring}$

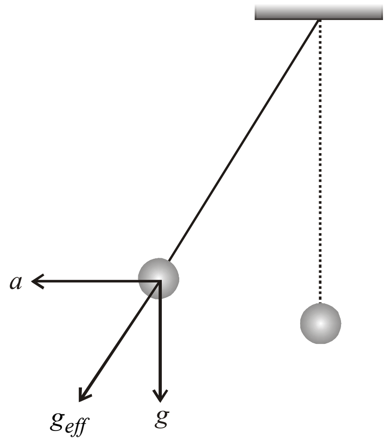
$$\Rightarrow \frac{k}{k_1} = \frac{l_1}{l} = \frac{\frac{2}{3}l}{l} \Rightarrow k_1 = \frac{3}{2}k$$

6. **(b)** Initially time period was

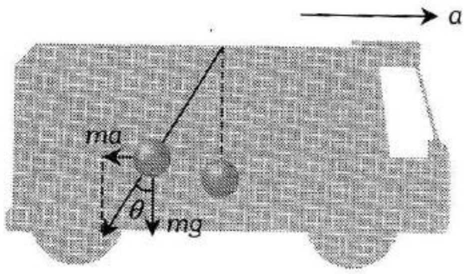
$$T = 2\pi\sqrt{\frac{l}{g}}$$

When train accelerates, the effective value of g becomes $\sqrt{(g^2 + a^2)}$ which is greater than g.

Hence, new time period, becomes less than the initial time period.



7. **(b)** In accelerated frame of reference, a fictitious force (pseudo force) ma acts on the bob of pendulum as shown in figure.



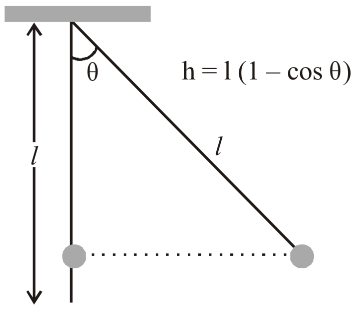
Hence $\tan\theta = \frac{ma}{mg} = \frac{a}{g}$

$\Rightarrow \theta = \tan^{-1}\left(\frac{a}{g}\right)$ in the backward direction.

8. (c) $T = 2\pi\sqrt{\frac{l}{g}}$ (Independent of mass)

9. (b) $T \propto \sqrt{l} \Rightarrow \frac{\Delta T}{T} = \frac{1}{2}\frac{\Delta l}{l} = \frac{1}{2}\times 1\% = 0.5\%$

10. (c) If suppose bob rises up to a height h as shown then after releasing potential energy at extreme position becomes kinetic *energy* of mean position



$\Rightarrow mgh = \frac{1}{2}mv_{max}^2 \Rightarrow v_{max} = \sqrt{2gh}$

Also, from figure $\cos\theta = \frac{l-h}{l}$

$\Rightarrow h = l(1-\cos\theta)$

So, $v_{max} = \sqrt{2gl(1-\cos\theta)}$

11. (a) If initial length $l_1 = 100$ then $l_2 = 121$

By using $T = 2\pi\sqrt{\frac{l}{g}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{l_1}{l_2}}$

Hence, $\frac{T_1}{T_2} = \sqrt{\frac{100}{121}} \Rightarrow T_2 = 1.1T_1$

% increase $= \frac{T_2 - T_1}{T_1}\times 100 = 10\%$

12. (d) After standing centre of mass of the oscillating body will shift upward therefore effective length will decrease and by $T \propto \sqrt{l}$, time period will decrease.

13. (a) No momentum will be transferred because, at extreme position the velocity of bob is zero.

14. (c) The effective acceleration in a lift descending with acceleration $\frac{g}{3}$ is

$$g_{eff} = g - \frac{g}{3} = \frac{2g}{3}$$

$$\therefore T = 2\pi\sqrt{\left(\frac{L}{g_{eff}}\right)} = 2\pi\sqrt{\left(\frac{L}{2g/3}\right)} = 2\pi\sqrt{\left(\frac{3L}{2g}\right)}$$

15. (c) In series $k_{eq} = \frac{k_1k_2}{k_1+k_2}$ so time period

$$T = 2\pi\sqrt{\frac{m(k_1+k_2)}{k_1k_2}}$$

16. (c) Spring constant $(k) \propto \frac{1}{\text{Length of the spring } (l)}$

as length becomes half, k becomes twice i.e. $2k$

17. (b) Standard equation for given condition

$$x = a\cos\frac{2\pi}{T}t \Rightarrow x = -0.16\cos(\pi t)$$

[As $a = -0.16$ *meter*, $T = 2$ sec]

18. (d) $t_1 = 2\pi\sqrt{\frac{m}{k_1}}$ and $t_2 = 2\pi\sqrt{\frac{m}{k_2}}$

Equivalent spring constant for shown combination is $k_1 + k_2$. So time period t is given by

$$t = 2\pi\sqrt{\frac{m}{k_1+k_2}}$$

By solving these equations we get

$$t^{-2} = t_1^{-2} + t_2^{-2}$$

19. (a) With mass m_2 alone, the extension of the spring l is given as

$$m_2g = kl \quad \text{........(i)}$$

With mass (m_1+m_2), the extension l' is given by

$$(m_1+m_2)g = k(l+\Delta l) \quad \text{.......(ii)}$$

The increase in extension is Δl which is the amplitude of vibration. Subtracting (i) from (ii), we get

$$m_1g = k\Delta l$$

or $$\Delta l = \frac{m_1g}{k}$$

20. (a) If $y_1 = a_1\sin\omega t$ and $a_2\sin(\omega t + \pi)$

$$\Rightarrow \frac{y_1}{a_1} + \frac{y_1}{a_2} \Rightarrow y_2 = \frac{a_2}{a_1}y_1$$

This is the equation of straight line.

21. **(c)** Energy of particle is maximum at resonant frequency *i.e.*, $\omega_2 = \omega_0$. For amplitude resonance (amplitude maximum) frequency of driver force

$\omega = \sqrt{\omega_0^2 - b^2 2m^2} \Rightarrow \omega_1 \neq \omega_0$

22. **(b)** $A = \frac{c}{a+b-c}$; when b = 0, a = c, amplitude

$A \to \infty$. This corresponds to resonance.

23. **(b)** Let the velocity acquired by A and B be V, then

$mv = mV + mV \Rightarrow V = \frac{v}{2}$

Also $\frac{1}{2}mv^2 = \frac{1}{2}mV^2 + \frac{1}{2}mV^2 + \frac{1}{2}kx^2$

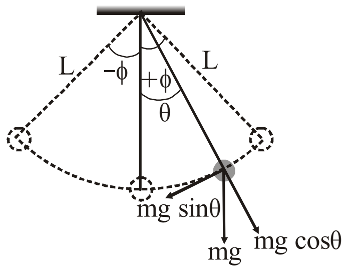
Where x is the maximum compression of the spring.

On solving the above equations, we get $x = v\left(\frac{m}{2k}\right)^{1/2}$

At maximum compression, kinetic energy of the

A – B system $= \frac{1}{2}mV^2 + \frac{1}{2}mV^2 = mV^2 = \frac{mv^2}{4}$

24. **(d)**



From following figure it is clear that

$T - Mg\cos\theta$ = Centripetal force

$\Rightarrow T - Mg\cos\theta = \frac{Mv^2}{L}$

Also tangential acceleration $|a_T| = g\sin\theta$.

25. **(a)** Except (4) all statements are wrong.

26. (b) **27. (b).**

For minimum time period $\omega^2 A = mg$

$\frac{4\pi^2}{T^2}A = mg$, T = 0.2 sec,

At t = 0.05 sec.

$y = A\sin\omega t = 1\ \text{sn}\ \frac{2\pi}{0.2} \times 0.05\text{cm.} = 1\text{cm.}$

$PE = mgy = 1 \times 10 \times \frac{1}{100} = 0.1$ Joule

28. **(c)** Statement -1 is False, Statement-2 is True.

29. **(a)** The time period of a oscillating spring is given by,

$$T = 2\pi\sqrt{\frac{m}{k}} \Rightarrow T \propto \frac{1}{\sqrt{k}}$$

Since the spring constant is large for hard spring, therefore hard spring has a less periodic time as compared to soft spring.

30. **(d)** Time period of simple pendulum of length *l* is,

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

$$\Rightarrow \frac{\Delta T}{T} = \frac{1}{2}\frac{\Delta l}{l}$$

$$\therefore \frac{\Delta T}{T} = \frac{1}{2} \times 3 = 1.5\%$$