CBSE

OSCILLATIONS WS 7

Class 11 - Physics

Section A

1. For a particle executing simple harmonic motion, which of the following statements is not correct? **[1]**

   a) total energy of the particle always remains the same.

   b) restoring force is always directed towards a fixed point.

   c) acceleration of the particle is maximum at the equilibrium position.

   d) restoring force is maximum at the extreme positions.

2. When two springs of spring force constant k and 2k are connected in series then force constant becomes k_s, if they are connected in parallel, then force constant becomes k_p. Ratio $\frac{k_s}{k_p}$ is **[1]**

   a) $\frac{1}{2}$

   b) $\frac{2}{1}$

   c) $\frac{2}{9}$

   d) $\frac{1}{3}$

3. A mass M is suspended from a spring of negligible mass. The spring is pulled a little and then released so that the mass executes simple harmonic oscillations with a time period T. **[1]**

   a) T = $4\pi\sqrt{\frac{m}{k}}$

   b) T = $8\pi\sqrt{\frac{m}{k}}$

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

   d) T = $10\pi\sqrt{\frac{m}{k}}$

4. A weightless spring that has a force constant k oscillates with frequency n when a mass m is suspended from it. The spring is cut into two equal halves and a mass 2m is suspended from it. The frequency of oscillation will now become: **[1]**

   a) $\frac{2}{\sqrt{2}}$

   b) 2n

   c) $\frac{n}{\sqrt{2}}$

   d) n

5. A loaded vertical spring executes S.H.M. with a time period of 4 sec. The difference between the kinetic energy and potential energy of this system varies with a period of: **[1]**

   a) 8 sec

   b) 1 sec

   c) 2 sec

   d) 4 sec

6. A body of mass 5 kg hangs from a spring and oscillates with a time period of 2π seconds. If the body is removed, the length of the spring will decrease by: **[1]**

   a) 2π metres

   b) k/g metres

   c) g metres

   d) g/k metres

7. A simple spring has length l and forces constant K. It is cut into two springs of lengths l_1 and l_2 such that l_1 = $n.l_2$ (where n is an integer), the force constant of the spring of length l_2 is **[1]**

   a) $\frac{K}{n(1+n)}$

   b) $\frac{K}{(n+1)}$

c) K (1 + n)

d) $\frac{2K}{(n+1)}$

8. Let T_1 and T_2 be the time periods of springs A and B when mass M is suspended from one end of each spring. If both springs are taken in series combination, the time period is T, then **[1]**

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

b) $\frac{1}{T} = \frac{1}{T_1} + \frac{1}{T_2}$

c) $T = T_1 + T_2$

d) $T^2 = T_1^2 + T_2^2$

9. A spring of force constant k is cut into lengths of ratio 1 : 2 : 3. They are connected in series and the new force constant is k'. Then they are connected in parallel and force constant is k''. Then k' : k'' is: **[1]**

a) 1 : 11

b) 1 : 6

c) 1 : 9

d) 1 : 14

10. **Assertion (A):** The amplitude of oscillation can never be infinite. **[1]**
Reason (R): The energy of oscillator is continuously dissipated.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

11. **Assertion (A):** If a man with a wrist watch on his hand falls from the top of a tower, its watch gives correct time during the free fall. **[1]**
Reason (R): The working of the wrist watch depends on spring action and it has nothing to do with gravity.

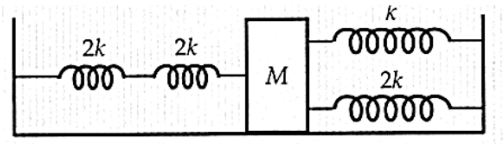
a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

12. Four massless springs whose force constants are 2k, 2k, k and 2k respectively are attached to a mass M kept on a frictionless plane as shown in the figure. If the mass M is displaced in the horizontal direction, then the frequency of the system is: **[1]**



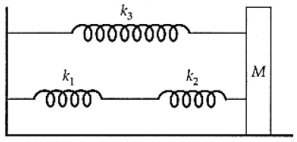
a) $\frac{1}{2\pi}\sqrt{\frac{7k}{M}}$

b) $\frac{1}{2\pi}\sqrt{\frac{k}{4M}}$

c) $\frac{1}{2\pi}\sqrt{\frac{4k}{M}}$

d) $\frac{1}{2\pi}\sqrt{\frac{k}{7M}}$

13. If the mass M in the figure is slightly displaced and then released, the frequency of oscillation of the block is **[1]**



a) $\frac{1}{2\pi}\sqrt{\frac{k_1k_2+k_2k_3+k_3k_1}{M(k_1+k_2)}}$

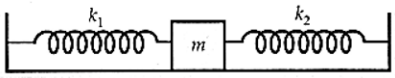
b) $\frac{1}{2\pi}\sqrt{\frac{k_1k_2+k_2k_3+k_3k_1}{M(k_1+k_3)}}$

c) $\frac{1}{2\pi}\sqrt{\frac{k_1+k_2+k_3}{M}}$

d) $\frac{1}{2\pi}\sqrt{\frac{k_1k_2+k_2k_3+k_3k_1}{(k_2+k_3)M}}$

14. If both spring constants k_1 and k_2 are increased to $4k_1$ and $4k_2$ respectively, then new frequency in terms of **[1]**

original frequency f is



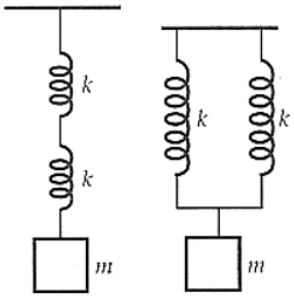
a) 2f

b) f

c) 4f

d) $\frac{f}{2}$

15. Two identical springs of constant k are connected in series and parallel as shown in the figure. **[1]**



A mass m is suspended from them. The ratio of their frequencies of vertical oscillations will be

a) 4 : 1

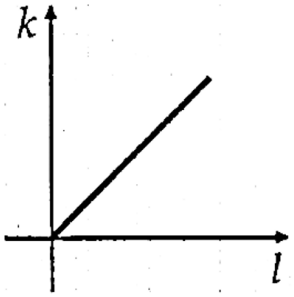
b) 1 : 2

c) 2 : 1

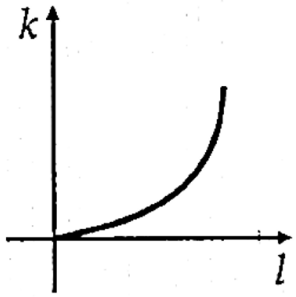
d) 1 : 1

16. Which of the following graphs depicts spring constant k versus length l of the spring correctly? **[1]**

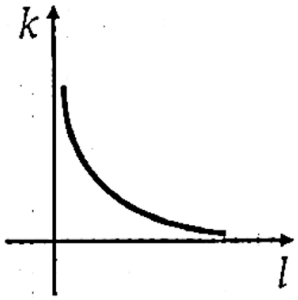
a)



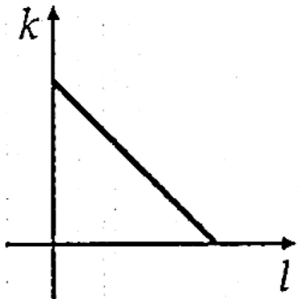
b)



c)



d)



17. Define force constant and give its dimensional formula. **[1]**

18. Define force constant. Give its SI unit. **[1]**

19. A spring is cut into two halves. How is the spring constant of each half affected? **[1]**

20. A spring having a force constant k is divided into three equal parts. What would be the force constant for each individual part? **[1]**

21. How is the length of seconds pendulum related with acceleration due gravity of any planet? **[1]**

22. Why is restoring force necessary for a body to execute S.H.M.? **[1]**

23. Which of the following condition is not sufficient for simple harmonic motion and why? (i) acceleration and displacement (ii) restoring force and displacement **[1]**

24. A man with a wristwatch on his hand falls from the top of a tower. Does the watch give correct time during the free fall? **[1]**

25. Time period of a particle in S.H.M. depends on the force constant K and mass m of the particle **[1]**

$\left(T = \frac{1}{2\pi}\sqrt{\frac{m}{k}}\right)$. A simple pendulum for small angular displacement executes S.H.M approximately. Why then is the time period of a pendulum independent of the mass of the pendulum?

26. If the body is given a small displacement from the mean position, a force comes in to play which tends to bring the body back to the mean point, this give rise to vibrations. Define phase of a vibrating particle. **[1]**

27. When a pendulum clock is taken to a mountain, it becomes slow. But a wristwatch controlled by a spring remains unaffected. Explain. **[1]**

28. What is the force equation of an SHM? **[1]**

29. When a 2.0 kg body is suspended by a spring, the spring is stretched. If the body is pulled down slightly and released, it oscillates up and down. What force is applied on the body by the spring when it passes through the mean position? (g = 9.8 newton/kg) **[1]**

30. Two identical springs of force constant k each are connected in parallel. What will be the equivalent spring constant? **[1]**

Section B

31. A spring compressed by 0.1 m develops a restoring force of 10 N. A body of mass 4 kg is placed on it. Deduce **[2]**

    i. the force constant of the spring

    ii. the depression of the spring under the weight of the body and

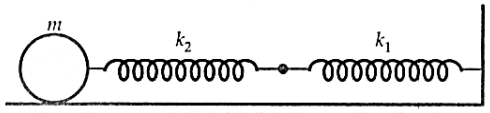
    iii. the period of oscillation, if the body is disturbed.

32. A body of mass 12 kg is suspended by coil spring of natural length 50 cm and force constant $2.0 \times 10^3 Nm^{-1}$. What is the stretched length of the spring? If the body is pulled down further stretching the spring to a length of 59 cm and then released, then what is the frequency of oscillation of the suspended mass? (Neglect the mass of the spring) **[2]**

33. A 40gm mass produces on extension of 4cm in a vertical spring. A mass of 200gm is suspended at its bottom and left pulling down. Calculate the frequency of its vibration. **[2]**

34. Two springs are joined and connected to a mass m as shown in Figure. If the force constants of the two springs are k_1 and k_2, show that the frequency of oscillation of mass m is **[2]**

$v = \frac{1}{2\pi}\sqrt{\frac{k_1 k_2}{(k_1+k_2)m}}$



35. A spring compressed by 0.2 m develops a restoring force of 25 N. A body of mass 5 kg is placed over it. Deduce: **[2]**

    i. force constant of the spring

    ii. the depression of the spring under the weight of the body and

    iii. the period of oscillation, if the body is disturbed. Take g = 10 N kg^{-1}.

36. A mass of 2 kg is attached to the spring of spring constant 50 Nm^{-1}. The block is pulled to a distance of 5cm from its equilibrium position at x = 0 on a horizontal frictionless surface from rest at t = 0. Write the expression for its displacement at anytime t. **[2]**

37. A spring compressed by 0.1 m develops a restoring force 10 N. A body of mass 4 kg is placed on it. Deduce **[2]**

    i. the force constant of the spring.

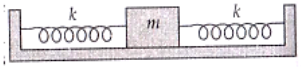
    ii. the depression of the spring under the weight of the body (take g = 10 N/kg)

    iii. the period of oscillation after the body is distributed and

iv. frequency of oscillation

38. A harmonic oscillator is oscillating with a frequency of 3 Hz. Its acceleration amplitude is $0.36\pi^2$ ms^{-2}. Determine its velocity amplitude and the amplitude of displacement. **[2]**

39. Two identical springs of spring constant K are attached to a block of mass *m* and to fixed supports as shown in Figure. When the mass is displaced from equilibrium position by a distance x towards right, find the restoring force. **[2]**



40. Two identical springs, each of force constant k are connected in **[2]**

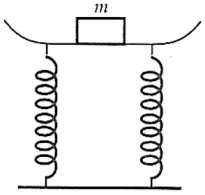
i. series

ii. parallel, and they support a mass m.

Calculate the ratio of the time periods of the mass in the two systems.

41. A mass M is suspended from a spring of negligible mass. The spring is pulled a little and then released so that the mass executes SHM of time period T. If the mass is increased by m, the time period becomes $\frac{5T}{3}$. What is the ratio $\frac{m}{M}$? **[2]**

42. A tray of mass 12 kg is supported by two identical springs as shown in the figure. When the tray is pressed down slightly and released, it executes SHM with a time period of 1.5 s. What is the force constant of each spring? When a block of mass M is placed on the tray, the period of SHM changes to 3.0 s. What is the mass of the block? **[2]**



43. A small trolley of mass 2.0 kg resting on a horizontal turn table is connected by a light spring to the centre of the table. When the turntable is set into rotation at a speed of 300 rpm, the length of the stretched spring is 40 cm. If the original length of the spring is 35 cm, determine the force constant of the spring. **[2]**

44. What is ratio of frequencies of the vertical oscillations when two springs of spring constant K are connected in series and then in parallel? **[2]**

45. A spring balance has a scale that reads from 0 to 50kg. The length of the scale is 20cm. A body suspended from this spring, when displaced and released, oscillates with a period of 0.60s. What is the weight of the body? **[2]**

46. The periodic time of a mass suspended by a spring (force constant k) is T. If the spring is cut in three equal pieces, what will be the force constant of each part? If the same mass be suspended from one piece, what will be the periodic time? **[2]**

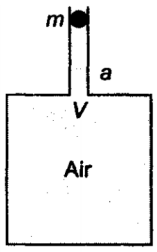
47. An uncalibrated spring balance is found to have a period of oscillation of 0.314 s, when a 1 kg weight is suspended from it? How does the spring elongate, when a 1 kg weight is suspended from it? [Take π = 3.14] **[2]**

48. There are two springs, one delicate and another hard or stout one. For which spring, the frequency of the oscillator will be more? **[2]**

Section C

49. An air chamber of volume V has a neck area of cross-section 'a' into which a ball of mass m just fits and can move up and down without any friction (see figure). Show that when the ball is pressed down a little and released, it executes an SHM. Obtain an expression for the time period of oscillations assuming pressure-volume **[3]**

variations of air to be isothermal.



50. A 5 kg collar is attached to a spring of spring constant 500 Nm^{-1}. It slides without friction over a horizontal rod. The collar is displaced from its equilibrium position by 10.0 cm and released. Calculate **[3]**

a. the period of oscillation,

b. the maximum speed and

c. maximum acceleration of the collar.

Section D

51. **State True or False:** **[4]**

(a) In the differential form of SHM, $\frac{d^2x}{dt^2} + \left(\frac{k}{m}\right)x = 0$ (for spring + mass system), the quantity x is the deformation in the spring. **[1]**

(b) There is a dependence of frequency on g in a spring mass system. **[1]**

(c) Restoring torque and restoring force both exist in oscillatory motion simultaneously. **[1]**

(d) Restoring force is proportional to the displacement, provided the displacement is large. **[1]**

52. **Fill in the blanks:** **[4]**

(a) A particle executes SHM of amplitude 2 cm. At extreme position the restoring force is 4N. At the point midway between the mean arid extreme positions, the restoring force is _____. **[1]**

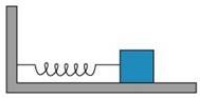
(b) Restoring force does not depend on the _____, but it depends on the displacement. **[1]**

(c) The relation F = - kx is known as _____ for SHM. **[1]**

(d) The time period of the vertical oscillations of a massless loaded spring is independent of the _____. **[1]**

Section E

53. A spring having with a spring constant 1200 N m^{-1} is mounted on a horizontal table as shown in Fig. A mass of 3 kg is attached to the free end of the spring. The mass is then pulled sideways to a distance of 2.0 cm and released. **[5]**



Determine

i. the frequency of oscillations,

ii. maximum acceleration of the mass, and

iii. the maximum speed of the mass.