UNIT 7
OSCILLATION

1. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
C

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

2. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

3. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

4. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

5. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

6. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

7. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

8. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

9. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

10. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

11. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

12. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

13. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

14. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

15. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

16. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

17. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

18. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

19. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

20. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

21. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

22. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

23. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

24. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

25. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

26. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

27. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

28. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

29. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

30. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

31. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

32. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

33. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

34. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

35. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

36. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

37. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

38. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

39. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

40. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

41. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

42. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

43. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

44. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

45. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

46. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

47. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

48. WHAT DOES THE AMPLITUDE OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
D

EXPLANATION:
The amplitude of a simple pendulum is the maximum displacement from the equilibrium position. It depends on the initial conditions, not on mass or length.

49. WHAT DOES THE PERIOD OF A SIMPLE PENDULUM DEPEND ON?

A. Mass
B. Length
C. Both mass and length
D. Neither mass nor length

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length and g is the acceleration due to gravity. The period depends only on length and gravity, not on mass.

50. WHAT IS THE PERIOD OF A SIMPLE PENDULUM WITH A LENGTH OF 1 METER?

A. 1 second
B. 2 seconds
C. 3 seconds
D. 4 seconds

ANSWER:
B

EXPLANATION:
The period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. For a length of 1 meter, the period is approximately 2 seconds.

EXERCISE

Select the correct answer from the following choices.

1. Tuning of a radio set is an example of

a. Mechanical resonance b. Musical resonance
c. Electrical resonance d. Free vibrations

2. The heating and cooking of food evenly by microwave oven is an example of

a. S.H.M b. Resonance
c. Damped Oscillation d. Free oscillation

3. The time period of the same pendulum at Karachi and Murree are related as:

a. $T_K = T_M$ b. $T_K > T_M$
c. $T_K < T_M$ d. $2T_K = 3T_M$

4. In an isolate system the total energy of vibrating mass and spring is:

a. Variable b. Low c. High d. Constant

5. While deriving the equation of time period for simple pendulum which quantity should kept small?

a. Length of simple pendulum b. Amplitude
c. Mass of simple pendulum d. Gravitational acceleration g

6. If the period of oscillation of mass (m) suspended from a spring is 2s, then the period of mass 4m will be

a. 1s b. 2s c. 3s d. 4s

7. The time period of a simple pendulum is 2 seconds. If its length is increased by 4 times, then its period becomes

a. 1s c. b. 12 s c. 8 s d. 4 s

8. To make the frequency double of a spring oscillation, we have to:

a. Reduce the mass to one fourth b. Quadruple the mass
c. Double the mass d. Half the mass

9. The restoring force of SHM is maximum when particle:

a. Displacement is maximum b. Half way between them
c. Crossing mean position d. At rest

10. Two springs of spring constants k_1 and k_2 are joined in series. The effective spring constant of the combination is given by

a. $(k_1 + k_2)/2$ b. $k_1 + k_2$
c. $k_1k_2/(k_1 + k_2)$ d. $\sqrt{k_1k_2}$

11. In a garden, a boy is swinging in the standing position. How will the time period of the swing be affected if the boy sits down in the swing?

a. Time period will not change

b. Time period will increase
c. Time period will decrease
d. Time period will depend on the weight of the boy

12. 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, the period of oscillation will

a. Increase b. Decrease
c. Remain unaffected d. Become infinite

Answers:

1.	(a)	**2.**	(b)	**3.**	(c)	**4.**	(d)	**5.**	(b)		
6.	(b)	**7.**	(b)	**8.**	(a)	**9.**	(a)	**10.**	(c)		
11.	(c)	**12.**	(b)								

Write the short answers of the following questions.

Q.1 Give two applications in which resonance plays an important role?

Answer

Tuning a radio (Electrical resonance)

- Tuning of radio is a good example of electrical resonance. To tune a radio:
- We turn the knob of a radio.
- It changes the natural frequency of electrical circuit of receiver until it becomes equal to the frequency of transmitter.
- Now the resonance is produced and energy absorption is maximum.
- Hence a station is tuned.

Cooking by microwave oven

- Resonance plays an important role in heating and cooking food by microwave oven.
- The microwaves produce by oven are absorbed due to resonance by water and fats molecules in the food.
- This increases the internal energy of the molecules.
- They get heat up and so food is cooked.

Q.2 What happens to the period of simple pendulum if its length is doubled?

Answer

Since time period of simple pendulum is given as:

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

Let $$T = 2\pi\sqrt{\frac{L}{g}} \quad \text{.....(1)}$$

Is the initial time period of simple pendulum, if length of the pendulum is doubled i.e $L_2 = 2L_1$. The new time period becomes

$$T_2 = 2\pi\sqrt{\frac{L_2}{g}} \quad \text{.....(2)}$$

Putting $L_2=2L_1$ in equation (2) we get,

$$T_2 = 2\pi\sqrt{\frac{L_1}{g}}$$

$$T_2 = 2\pi\sqrt{\left(2\frac{L_1}{g}\right)}$$

$$T_2 = \sqrt{2}\,T_1 \quad \text{.....(3)}$$

From equation (3), it is clear that if length of simple pendulum is doubled, its time period becomes $\sqrt{2}$ times of initial time period.

Q.3 What will be the frequency of a simple pendulum, if its length is 1m.

Answer

Since frequency of simple pendulum is given as

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

Put $g = 9.74\ \frac{m}{s^2}$ & $g = 9.8\ m/s^2$ & $l = 1m$, we get

$$f = \frac{1}{2\times3.14}\sqrt{\frac{9.8\ m/s^2}{1m}}$$

$$f = 0.49Hz$$

Q.4 Give one practical example each of free and forced oscillation?

Answer

Free Oscillations

A body is said to be executing free vibrations if it oscillates with its natural frequency without the interference of an external force.

For example

A simple pendulum vibrates freely with its natural frequency that depends only upon the length of the pendulum.

Forced oscillations

A body is said to be executing forced vibrations if it oscillates with the interference of an external force.

For example

- If the mass of vibrating pendulum is stud respectively, then forced vibrations are produced.
- The vibration of factory floor caused by the running of heavy machinery is another example.

Driven harmonic oscillator

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

Q.5 A simple pendulum set into vibrations and left untouched, eventually stops why?

Answer

When a simple pendulum set into vibrations and left untouched, it eventually stops because the amplitude of vibrations becomes smaller & smaller due to friction or resistance & some other forces. Thus, the mechanical energy of simple pendulum is converted into heat & sound energies.

Q.6 Explain why in S.H.M. accelerations is zero when the velocity is greatest.

Answer:

In S.H.M. mathematical expression for velocity & acceleration are given as

$$v = \omega\sqrt{\left(\frac{A^2 - x^2}{x^2}\right)} \quad \text{.....(1)}$$

$$a = -\omega^2 x \quad \text{.....(2)}$$

Velocity will be maximum if $x=0$ i.e. if the vibrating body is at mean position, so

Equation (1) $\Rightarrow v = \omega\sqrt{\frac{A^2}{x^2}}$ .....(3)

& Equation (2) $\Rightarrow a = 0$ .....(4)

Equation (3) and (4) show that when velocity is greatest or maximum, acceleration is zero. Also at mean position restoring force is zero so velocity will be maximum & acceleration will be zero.

Q.7 Is there a connection between F & x in mass spring system? Explain?

Answer:

According to Hook's Law

$$F \propto kx$$

.....(1)

Where F is restoring force, 'x' is displacement & k is spring constant.

Equation (1) $\Rightarrow$

$$F = -kx$$

.....(2)

From equation (2) it is clear that displacement in mass spring system is directly proportional to restoring force 'F' i.e. large force is required to compress or stretch a mass spring system within the elastic limit.

Q.8 What happens to the frequency of simple pendulum as it oscillation die down from large amplitude to small?

Answer

Since frequency of simple pendulum is given as

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{L}} \quad \text{.....(1)}$$

From the above equation it is clear that the frequency 'f' of simple pendulum does not depend on amplitude. So, if its oscillation die down from large amplitude to small amplitude, frequency remains constant.

Q.9 A singer, holding a note of right frequency, can shatter a glass. Explain.

Answer

A singer can shatter a glass, holding a note of right frequency. because when frequency of note becomes equal to the frequency of glass molecules resonance occurs & glass molecules then vibrate with larger amplitude. If the amplitude is excessively large, glass can be shatter down.

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Numerical Problems

1. A force of 2.4 N is required to displace a body attached to spring through 10.1 m from its mean position. Calculate the spring constant.

Data:

Applied force F = 0.4 N

Displacement of the body from mean position x=0.1 m

Spring constant k = ?

Solution

According to Hook's law

$$F = kx$$

or

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

Putting values we get

$$k = \frac{0.4N}{0.1m}$$

$$k = 4N/m$$

2. A body of mass 0.025 kg attached to a spring is displaced through 5.10 m to right of mean position. If the spring constant is 0.4 N/m and its velocity at the end of this displacement is 0.4 m/s. Calculate (i) Time Period (ii) frequency (iii) Angular frequency (iv) total energy (v) amplitude (vi) maximum velocity (vii) maximum acceleration.

Data:

Mass of the body = 0.025kg

Displacement from mean position x = 5.1 m

Spring constant k = 0.4 N/m

Linear velocity v = 0.4 m/s

i) Time period T=?

ii) frequency f=?

iii) Angular frequency ω=?

iv) Total energy E=?

v) Amplitude a=?

vi) Maximum velocity v_0=?

vii) Maximum acceleration a_0=?

Solution

(i) Since $T = 2\pi\sqrt{\frac{m}{k}}$

or

$$T = 2 \times 3.14\sqrt{\frac{0.025kg}{0.4N/m}}$$

$$T = 1.1 s$$

(ii) As $f = \frac{1}{T}$

$$f = 0.91 Hz$$

(iii)

$$\omega = 2\pi f$$

$$\omega = 2 \times 3.14 \times 0.91$$

$$\omega = 5.71 s^{-1}$$

(iv) Since E, $E = \frac{1}{2}m\omega^2 a^2$

$$E = \frac{1}{2} \times 0.025 \times (5.4)^2 \times (5.1 \times 0.4 \times 10^{-2})^2$$

$$E_t = 4.4 \times 10^{-2} J$$

$$E_t = 0.4 \times 10^{-1} J$$

(v) As $a = \frac{v_0}{\omega}$ or $a = \sqrt{\frac{E_t}{k}}$

$$a = \frac{0.4}{5.4} m$$

$$a = \sqrt{\frac{0.4 \times 10^{-1}}{0.4}}$$

$$a = 0.07 m$$

(vi) Since maximum velocity is given as

$$v = a\sqrt{\frac{k}{m}}$$

$$v_0 = 0.4 \times \sqrt{\frac{0.4}{0.025}}$$

(vii) Maximum acceleration a_0 is given as

$$a_0 = \omega_0$$

$$a_0 = \frac{0.4}{0.025} \times 0.4$$

$$a_0 = 3.2 m/s$$

3. A simple pendulum completes an vibration in one second. Calculate its length when g=9.81 m/s²

Data:

Frequency of simple pendulum f=1 Hz.

Length of the simple pendulum l=?

Acceleration due to gravity g = 9.81 m/s²

Time period T = 1 sec

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

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

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

or $T = \frac{2\pi\sqrt{l}}{\sqrt{9.81 m/s^2}}$

$$l = 0.248 m$$

4. Calculate the length of a second pendulum having time period of 2 seconds when g=9.81 m/s.

Data:

Time period of pendulum T=2 sec.

Acceleration due to gravity g=9.81 m/s²

Solution

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

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

or $T = \frac{2\pi\sqrt{l}}{\sqrt{9.81 m/s^2}}$

or $T = \frac{2\pi\sqrt{l}}{\sqrt{9.81 m/s^2}}$

$$l = 0.992 m$$

5. A body of mass 'm' suspended from a spring with spring constant 'k' vibrates with '$\frac{1}{2}$'. When its length is cut into half and suspended from one of the halves, the frequency is 'f'. Find out f_0.

Solution

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \quad \text{.....(1)}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{2k}{m}} \quad \text{.....(2)}$$

(Spring constant will be doubled if the spring is cut in two equal parts)

$$f = \sqrt{2} f_0$$

6. A mass of the end of spring describes 5.6 M. with 1h 40 sec. Find out the acceleration when the displacement is 0.04 m.

Data:

Time period T = 5.6 sec

Displacement x = 0.04 m

Acceleration a=?

Solution

Since

$$a = \frac{k}{m} x \quad \text{.....(1)}$$

But

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

As

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

or

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

or

$$\frac{T}{2\pi} = \frac{5.6 \times 60}{\sqrt{k}}$$

or

$$\frac{T}{2\pi} = \frac{5.6 \times 60}{\sqrt{k}}$$

Put the above value in equation (1) we get

$$a = 24.4N \times 0.04$$

$$a = 0.962 m/s^2$$

7. A block weighing 4 kg extends a spring by 0.14 m from its unstretched position. The block is removed and 0.5 kg body is hung from the same spring. If the spring is now stretched and then released. What is its period of vibration?

Data:

For 4 kg extension in the spring x = 0.14 m

Spring constant k = $\frac{mg}{x} = \frac{4 \times 9.8}{0.14}$

$$k = 280 N/m$$

Time period of vibration when 0.5 kg mass is attached to the spring.

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

or

$$T = 2 \times 3.14\sqrt{\frac{0.5kg}{280 N/m}}$$

$$T = 0.25 sec$$

8. What should be the length of simple pendulum whose period is one second? What is its frequency?

Data:

Time period T = 1 sec

Frequency f = ?

Length = ?

Solution

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

or

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

or

$$T = \frac{2\pi\sqrt{l}}{\sqrt{9.81 m/s^2}}$$

or

$$T = 2.01 m$$

As

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

or

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

or

$$f = 0.5 Hz$$

9. A spring whose spring constant is 90 N/m vertically supports a mass of 2.5kg. It is the rest position. Find the distance by which the mass has pulled down, so that on being released. It may pass the mean position with velocity of 1m/s.

Data:

Spring constant of the spring k=90 N/m

Mass attached to the spring m=2.5kg

Velocity of mass in mean position v_0= 1m/s

Distance traveled by mass x= ?

Solution

As

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

$$\omega = \sqrt{\frac{90}{2.5}}$$

$$\omega = 6 rad/s$$

10. A 300g body vibrates 1.5 H. with amplitude 0.32 m. The restoring force is 20N. Find out (i) T, (ii) a, (iii) v_0, (iv) E_t, (v) E_k, (vi) E_p when the displacement is 12 cm.

Data:

Mass of vibrating body m=0.kg.

Amplitude of vibrating body a=0.20 m

Restoring force F= 4 N

Displacement x = 12 cm = 0.12 m

Spring constant k=200 N/m

(i) Time period T = ?

(ii) Acceleration a = ?

(iii) Velocity v_0 = ?

(iv) E_t = ?

(v) E_k = ?

(vi) E_p = ?

Solution

(i)

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

$$T = 2 \times 3.14\sqrt{\frac{0.3kg}{200}}$$

$$T = 0.3 sec$$

(ii) Since $a = \frac{F}{m}$

$$a = \frac{4}{0.3}$$

$$a = 3 m/s^2$$

(iii) As $v_0 = \omega\sqrt{a^2 - x^2}$

$$v_0 = \frac{2\pi}{T}\sqrt{(0.32)^2 - (0.12)^2}$$

$$v = 1.4 m/s$$

(iv) As

$$E_t = \frac{1}{2}m\omega^2 a^2$$

$$E_t = \frac{1}{2} \times 0.3 \times (7.4)^2$$

$$E_t = 5.4 J$$

(v) As

$$E_k = \frac{1}{2}mv^2$$

$$E_k = \frac{1}{2} \times 200 \times (0.12)^2$$

$$E_k = 1.44 J$$

11. Find the amplitude, frequency and time period of an object oscillating at the end of a spring. The equation for its position of any instant T is given by x = 25 Cos $\frac{\pi}{2}$ t. Find the displacement of the object after 2.05.

Data:

(i) **x = ?**

t = ?

We know that x = x cos (2πft) ..... (1)

Whereas we have,

$$x = 25 \cos\left(\frac{\pi}{2}t\right) \quad \text{.....(2)}$$

Comparing (1) & (2) we have:

$$x_0 = 25 cm \qquad f = \frac{1}{4} Hz$$

(ii) **x = ?**

$$t = 2 sec$$

or

$$x = 25 \cos\left(\frac{\pi}{2} \times 2\right)$$

$$x = 25 \cos\left(\frac{\pi}{2}\right) = 0$$

$$x = 25 \times 0$$

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Objective Type Questions & Answers

Select the correct answer from the following choices:

1) In S.H.M. the acceleration of a body is directly proportional to,

a. applied force b. amplitude c. displacement d. restoring force

2) Any type of vibratory motion is called,

a. oscillatory motion b. translatory motion
c. rotator motion d. simple harmonic motion

3) The maximum distance of the vibrating body from the mean position when the body is executing S.H.M. is called,

a. frequency b. time period c. displacement d. amplitude

4) A body executing S.H.M. has displacement equal to,

a. $x_0 \sin\omega t$ b. $x_0 \cos\omega t$ c. $x_0 \sin^2\omega t$ d. $x_0 \cos^2\omega t$

5) In S.H.M. the velocity of the particle is maximum at,

a. extreme position b. mean position
c. intermediate position d. none of these

6) The acceleration of the projection on the diameter for a particle moving along a circle is,

a. $\omega^2 x$ b. ωx^2 c. $-\omega^2 x$ d. $-\omega x^2$

7) The maximum velocity v_0 of mass attached to one end of the elastic spring is.

a. $v_0 = x_0\sqrt{\frac{k}{m}}$ b. $v_0 = x_0\sqrt{\frac{k}{m}}$ c. $v_0 = x\sqrt{\frac{m}{k}}$ d. $v_0 = x_0\sqrt{\frac{m}{k}}$

8) Time period of a simple pendulum is.

a. $2\pi\sqrt{\frac{l}{g}}$ b. $\frac{1}{2\pi}\sqrt{\frac{l}{g}}$ c. $2\pi\sqrt{\frac{g}{l}}$ d. $\frac{1}{2\pi}\sqrt{\frac{g}{l}}$

9) The time period of a simple pendulum is.

a. 1 second b. 2 second c. 3 second d. 4 second

10) The length of the second's pendulum is,

a. 98 cm b. 99 cm c. 99.2 cm d. 100 cm

11) If length of simple pendulum becomes four times then the time period will become,

a. two times b. four times
c. remains the same d. none of these

12) The force responsible for the vibratory motion of the simple pendulum is,

a. $mg\cos\theta$ b. $mg\sin\theta$ c. $mg\sec\theta$ d. $mg\tan\theta$

13) If the mass of the bob of a simple pendulum is double, its time period,

a. becomes one half b. becomes double
c. becomes four times d. remains same

14) The time period of the simple pendulum is independent of the,

a. mass b. length
c. acceleration due to gravity d. restoring force

15) If the mass attached to the spring increases, then its time period,

a. increases b. decreases
c. remains constant d. none of these

16) Simple harmonic motion is a type of,

a. rectilinear motion b. circular motion
c. angular motion d. rotational motion

17) When the bob of the simple pendulum is at the extreme position, it has,

a. K.E. b. P.E.
c. both P.E. & K.E. d. none of these

18) When the bob of the simple pendulum is at the mean position, the value of the P.E. is,

a. zero b. minimum c. maximum d. infinite

19) Total energy of a particle executing S.H.M. at any displacement x is given by,

a. kx b. ½ kx c. kx_0 d. ½ kx_0^2

20) The frequency of a body of mass m attached to a spring constant k is given by,

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

21) Angular frequency ω is given by the expression,

a. $\omega = \frac{v}{r}$ b. $\omega = \frac{2\pi}{T}$
c. $\omega = \sqrt{\frac{k}{m}}$ d. all of these

22) In microwave oven, the heating is produced by the phenomenon of,

a. damped oscillations b. resonance
c. forced oscillations d. free oscillations

23) The vibrations of a factory floor caused by the running of the factory of a heavy machinery is,

a. due to uneven floor b. due to rough surface of the floor
c. forced oscillations d. due to bad construction

24) When damping is small, the amplitude of vibration at resonance will be,

a. small b. large c. unchanged d. none of these

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