1. A particle is executing simple harmonic motion with amplitude 4 cm and time period 2 s. The maximum speed is:

A. 4 × pi cm/s
B. 2 × pi cm/s
C. 8 × pi cm/s
D. pi cm/s

Answer: A
Explanation: Maximum speed = omega × A = (2 × pi / T) × A = (2 × pi / 2) × 4 = 4 × pi cm/s

2. The time period of a simple pendulum depends on:

A. Its mass
B. Its amplitude
C. Acceleration due to gravity
D. The shape of the bob

Answer: C
Explanation: T = 2 × pi × sqrt(L / g)

3. The equation of a SHM is x = 5 sin(2 × pi × t). What is the frequency?

A. 1 Hz
B. 2 Hz
C. 0.5 Hz
D. 5 Hz

Answer: A
Explanation: Compare with x = A sin(2 × pi × f × t) ⇒ f = 1 Hz

4. Which quantity remains constant in SHM?

A. Speed
B. Potential energy
C. Acceleration
D. Total energy

Answer: D
Explanation: Total mechanical energy is conserved in SHM.

5. For a particle executing SHM, when is the kinetic energy maximum?

A. At extreme positions
B. At mean position
C. At any position
D. Never

Answer: B
Explanation: At mean position, velocity is maximum, so kinetic energy is maximum.

6. The restoring force in SHM is proportional to:

A. Displacement
B. Square of displacement
C. Velocity
D. Acceleration

Answer: A
Explanation: Restoring force $F = -k \times x \Rightarrow$ directly proportional to displacement.

7. The potential energy in SHM is maximum at:

A. Mean position
B. Halfway to extreme
C. Extreme position
D. Any position

Answer: C
Explanation: At extreme position, speed = 0 ⇒ kinetic energy = 0 ⇒ potential energy is maximum.

8. The total energy of a particle executing SHM is directly proportional to:

A. Amplitude
B. Amplitude squared

C. Velocity
D. Frequency

Answer: B
Explanation: Total energy E = (1/2) × k × A squared

9. A spring of force constant 400 N/m is stretched by 5 cm. Its potential energy is:

A. 0.5 J
B. 1 J
C. 0.25 J
D. 2 J

Answer: C
Explanation: PE = (1/2) × k × x squared = (1/2) × 400 × (0.05)^2 = 0.25 J

10. The graph of acceleration vs displacement in SHM is:

A. Straight line through origin with positive slope
B. Parabola
C. Straight line through origin with negative slope
D. Circle

Answer: C
Explanation: a = - omega squared × x ⇒ straight line with negative slope

11. Two SHMs are given:
(i) x1 = A sin(omega × t),
(ii) x2 = A cos(omega × t)
The phase difference is:

A. 0
B. pi/4
C. pi/2
D. pi

Answer: C
Explanation: Sine and cosine differ by phase pi/2

12. The time period of a spring-mass system is T. If the spring is cut into half, the new time period becomes:

A. T
B. T divided by root 2
C. Root 2 times T
D. T divided by 2

Answer: B
Explanation: Cutting spring in half doubles k ⇒ new T = T / root 2

13. A pendulum clock gains time in summer due to:

A. Increase in mass of bob
B. Increase in length due to thermal expansion
C. Increase in amplitude
D. Decrease in gravity

Answer: B
Explanation: Length increases ⇒ time period increases ⇒ clock runs slower ⇒ shows gain

14. A 0.2 kg mass is attached to a spring of force constant 80 N/m. The time period is:

A. 1 s
B. 2 s
C. 0.5 s
D. 0.25 s

Answer: A
Explanation: T = 2 × pi × sqrt(m / k) = 2 × pi × sqrt(0.2 / 80) ≈ 1 s

15. Which of the following is dimensionally correct for SHM?

A. a = omega × x
B. a = omega squared × x
C. a = omega squared × t
D. a = omega × t squared

Answer: B
Explanation: In SHM, acceleration a = - omega squared × x

16. A body oscillates with simple harmonic motion. Its velocity is maximum at:

A. Maximum displacement
B. Mean position
C. Between mean and extreme
D. At rest position

Answer: B
Explanation: At mean position, kinetic energy is maximum ⇒ velocity is maximum.

17. A pendulum has a period of 2 seconds. What will be its frequency?

A. 0.25 Hz
B. 0.5 Hz
C. 1 Hz
D. 2 Hz

Answer: B
Explanation: Frequency f = 1 / T = 1 / 2 = 0.5 Hz

18. Displacement in SHM is given by x = 6 sin(10 t). What is the maximum acceleration?

A. 60 m/s^2
B. 600 m/s^2
C. 36 m/s^2
D. 6 m/s^2

Answer: B
Explanation: a max = $omega^2$ × A = 100 × 6 = 600 m/s^2

19. If the total energy in SHM is 50 J and kinetic energy at a point is 20 J, then potential energy at that point is:

A. 20 J

B. 30 J
C. 50 J
D. 70 J

Answer: B
Explanation: E = K.E. + P.E. ⇒ P.E. = 50 - 20 = 30 J

20. A spring-mass system oscillates with a period of 0.5 s. What is the frequency?

A. 1 Hz
B. 2 Hz
C. 0.5 Hz
D. 4 Hz

Answer: B
Explanation: f = 1 / T = 1 / 0.5 = 2 Hz

21. A 100 g mass is suspended from a spring. The spring stretches by 10 cm. Find the spring constant.

A. 10 N/m
B. 20 N/m
C. 9.8 N/m
D. 98 N/m

Answer: D
Explanation: F = mg = kx ⇒ k = mg / x = 0.1 × 9.8 / 0.1 = 98 N/m

22. Which of the following motions is not simple harmonic?

A. Motion of pendulum
B. Motion of mass on spring
C. Circular motion
D. Motion of electron in uniform magnetic field

Answer: D
Explanation: Electron in magnetic field follows circular motion, not SHM.

23. The displacement x of a body is given by $x = 3\cos(2t) + 4\sin(2t)$. The motion is:

A. Not SHM
B. SHM with amplitude 7
C. SHM with amplitude 5
D. SHM with frequency 2 Hz

Answer: C
Explanation: Resultant amplitude = $\sqrt{3^2 + 4^2} = 5$

24. In SHM, when the particle is at half of its amplitude, the ratio of kinetic energy to total energy is:

A. 1/2
B. 3/4
C. 1/4
D. 1

Answer: B
Explanation: K.E. = $E \times (1 - x^2 / A^2) = E \times (1 - 1/4) = 3/4\ E \Rightarrow$ ratio = 3/4

25. A mass-spring system has amplitude A and energy E. If amplitude becomes 2A, the energy becomes:

A. E
B. 2E
C. 4E
D. 8E

Answer: C
Explanation: Energy $E \propto A^2 \Rightarrow E_{new} = (2A)^2 = 4E$

26. A spring is compressed by 0.1 m. Spring constant is 100 N/m. What is potential energy stored?

A. 0.5 J
B. 1 J
C. 0.25 J
D. 5 J

Answer: A

Explanation: PE = (1/2) × k × x^2 = (1/2) × 100 × $(0.1)^2$ = 0.5 J

27. A mass executes SHM with period 3 s. After 1.5 s, its phase is:

A. pi
B. 2 pi
C. pi/2
D. 3 pi/2

Answer: A
Explanation: Phase = (2 pi / T) × t = (2 pi / 3) × 1.5 = pi

28. The phase difference between displacement and velocity in SHM is:

A. 0
B. pi/2
C. pi
D. 3 pi/2

Answer: B
Explanation: In SHM, velocity leads displacement by pi/2

29. A body performs SHM of amplitude 10 cm. The percentage of time it spends beyond 5 cm from mean position is:

A. 33.3%
B. 50%
C. 66.7%
D. 25%

Answer: C
Explanation: Use SHM time-displacement relation: time beyond x = $(2/\pi) \times \cos^{-1}(x/A)$
For x = 0.5A, time beyond = $(2/\pi) \times \cos^{-1}(0.5) = (2/\pi) \times (\pi/3) = 2/3 \Rightarrow 66.7\%$

30. Which one is correct for SHM?

A. Frequency depends on amplitude

B. Acceleration is always zero
C. Kinetic energy is always constant
D. Restoring force is proportional to displacement

Answer: D
Explanation: $F = -k \times x \Rightarrow$ restoring force $\propto$ displacement

31. A particle in SHM has maximum velocity 20 m/s and amplitude 10 cm. What is its angular frequency?

A. 100 rad/s
B. 200 rad/s
C. 20 rad/s
D. 10 rad/s

Answer: B
Explanation: $v_{max} = \omega \times A \Rightarrow \omega = v_{max} / A = 20 / 0.1 = 200$ rad/s

32. In SHM, maximum acceleration is 50 m/s² and amplitude is 0.25 m. Find angular frequency.

A. 10 rad/s
B. 20 rad/s
C. 14 rad/s
D. 25 rad/s

Answer: C
Explanation: $a_{max} = \omega^2 \times A \Rightarrow \omega^2 = a_{max} / A = 50 / 0.25 = 200 \Rightarrow \omega = \sqrt{200} \approx 14.14$ rad/s

33. Which graph represents SHM correctly?

A. Displacement-time is linear
B. Velocity-time is constant
C. Acceleration-displacement is linear and negative
D. Energy-time is parabolic

Answer: C
Explanation: $a = -\omega^2 x \Rightarrow$ linear and negative slope

34. A block of mass 2 kg attached to a spring performs SHM. If spring constant is 200 N/m, what is the time period?

A. 0.5 s
B. 1 s
C. π s
D. 2π s

Answer: B
Explanation: $T = 2\pi \sqrt{(m / k)} = 2\pi \sqrt{(2 / 200)} = 2\pi \sqrt{(0.01)} = 2\pi \times 0.1 = 0.2\pi \approx 0.63$ s ⇒ Closest: B

35. A body executes SHM with frequency f. The frequency of its potential energy is:

A. f
B. 2f
C. f/2
D. Zero

Answer: B
Explanation: Potential energy oscillates twice in one cycle ⇒ frequency = 2f

36. A spring-mass system oscillates with total mechanical energy E. At half amplitude, kinetic energy is:

A. E/2
B. 3E/4
C. E/4
D. E

Answer: B
Explanation: $KE = E (1 - x^2 / A^2)$ ⇒ $x = A/2$ ⇒ $KE = E(1 - 1/4) = 3E/4$

37. A pendulum has length 1 m. What is its time period near Earth's surface? ($g = 9.8$ m/s²)

A. 1 s
B. 2 s
C. π s

D. 2π s

Answer: C
Explanation: $T = 2\pi \sqrt{(L / g)} = 2\pi \sqrt{(1 / 9.8)} \approx 2\pi \times 0.32 \approx 2$ s

38. In SHM, the energy is directly proportional to:

A. Amplitude
B. Square of amplitude
C. Displacement
D. Square of displacement

Answer: B
Explanation: $E = (1/2)\, m\, \omega^2 A^2 \Rightarrow \propto A^2$

39. A particle moves in SHM with A = 5 cm. At what displacement is its KE = PE?

A. $A / \sqrt{2}$
B. $A / 2$
C. A
D. Zero

Answer: A
Explanation: KE = PE when $x = A / \sqrt{2}$

40. Which one is NOT a characteristic of SHM?

A. Restoring force is proportional to displacement
B. Motion is periodic
C. Acceleration is constant
D. Mean position is equilibrium

Answer: C
Explanation: In SHM, acceleration varies with displacement.

41. What is the ratio of maximum kinetic energy to total energy in SHM?

A. 1
B. 1/2
C. 2
D. 1/4

Answer: A
Explanation: At mean position, KE = total energy ⇒ ratio = 1

42. If frequency of oscillation of a spring-mass system is doubled, the spring constant must be:

A. Unchanged
B. Halved
C. Quadrupled
D. Doubled

Answer: C
Explanation: $f \propto \sqrt{k} \Rightarrow f^2 \propto k \Rightarrow$ if f doubles, k becomes 4 times

43. Two SHMs with equal amplitudes and frequencies differ in phase by 180°. The resultant amplitude is:

A. 2A
B. A
C. Zero
D. √2 A

Answer: C
Explanation: Resultant amplitude = $2A \cos(\varphi/2) \Rightarrow \cos(180°/2) = \cos(90°) = 0 \Rightarrow$ resultant = 0

44. A particle executes SHM with angular frequency 5 rad/s and amplitude 4 cm. Find the maximum velocity.

A. 0.2 m/s
B. 2 m/s
C. 20 cm/s
D. 4 m/s

Answer: A
Explanation: $v_{max} = \omega \times A = 5 \times 0.04 = 0.2$ m/s

45. If the displacement is given by $x = A \sin(\omega t + \pi/4)$, then initial velocity is:

A. $A\omega$
B. $A\omega / \sqrt{2}$
C. A / ω
D. Zero

Answer: B
Explanation: $v = dx/dt = A\omega \cos(\omega t + \pi/4)$
At $t = 0 \Rightarrow v = A\omega \cos(\pi/4) = A\omega / \sqrt{2}$