1. If the length of a simple pendulum is doubled but the mass remains constant, its period is multiplied by a factor of

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

   B) $\frac{1}{\sqrt{2}}$

   C) 1

   D) $\sqrt{2}$

   E) 2

2. A mass oscillating on a spring has a period of *T*. What is the ratio of the maximum velocity of the mass to the maximum displacement?

   A) *T*

   B) $\frac{T}{2\pi}$

   C) 1

   D) $\frac{2\pi}{T}$

   E) $\frac{1}{T}$

3. A simple pendulum has a period of oscillation of approximately 2.0 s. When the length of the pendulum is doubled, the period of oscillation is most nearly

   A) 0.5 s

   B) 1.0 s

   C) 1.4 s

   D) 2.0 s

   E) 2.8 s

4. The length of a simple pendulum with a period of 6 seconds on earth is most nearly

   A) 4.5 m

   B) 8.9 m

   C) 18 m

   D) 36 m

   E) 90 m

5. A simple pendulum has a period of 3.0 seconds on earth. On the moon, where the acceleration due to gravity is approximately one-sixth of its value on earth, its period would be most nearly

   A) 0.50 s

   B) 1.2 s

   C) 3.0 s

   D) 7.3 s

   E) 18 s

6. A simple pendulum of mass *M* swings with a period of 20 seconds on Earth. This pendulum is brought to a planet with an acceleration due to gravity 4 times that of the earth. What is the period of the pendulum on this planet?

   A) 20 s

   B) 10 s

   C) 15 s

   D) 200 s

   E) 2 s

7. A pendulum swings in simple harmonic motion with period T and angular displacement θ. If the same pendulum is instead raised to an initial displacement of 3θ, the new period will be

   A) $\frac{T}{9}$

   B) $\frac{T}{3}$

   C) T

   D) $3T$

   E) $9T$

8. A simple pendulum in simple harmonic motion on the Earth's surface has a period of 1 s. If the same pendulum is undergoing simple harmonic motion on the Moon, with an acceleration due to gravity $\frac{1}{6}$ that of the Earth, under which of the following modifications would the pendulum have the same period?

   A) Increase the length of the pendulum by a factor of 6.

   B) Decrease the length of the pendulum by a factor of 6.

   C) Increase the length of the pendulum by a factor of `6.

   D) Decrease the length of the pendulum by a factor of `6.

   E) No change would be necessary.

9. A simple harmonic oscillator has a frequency of 2 Hz and an amplitude of 0.04 m. What is the period of the oscillations?

   A) 0.5 s

   B) 0.2 s

   C) 2 s

   D) 5 s

   E) 10 s

10. A simple harmonic oscillator has a period of 5 s and an amplitude of 1.2 m. What is the frequency of the oscillations?

    A) 0.1 Hz

    B) 0.2 Hz

    C) 0.5 Hz

    D) 1 Hz

    E) 5 Hz

Base your answers to questions **11** through **13** on the following situation.

A simple pendulum undergoes harmonic motion as it oscillates through small angles. The maximum angular displacement of the pendulum is θ_{max}. The displacement of the pendulum is θ.

11. At which values of θ is the speed of the pendulum maximized?

    A) $\theta = \theta_{max}/4$ and $\theta = -\theta_{max}/4$.

    B) $\theta = \theta_{max}/2$ and $\theta = -\theta_{max}/2$.

    C) $\theta = \theta_{max}$ and $\theta = -\theta_{max}$.

    D) $\theta = \theta_{max}$, $\theta = -\theta_{max}$, and $\theta = 0$.

    E) $\theta = 0$ only.

12. At which values of θ is the potential energy of the pendulum maximized?

    A) $\theta = \theta_{max}/4$ and $\theta = -\theta_{max}/4$.

    B) $\theta = \theta_{max}/2$ and $\theta = -\theta_{max}/2$.

    C) $\theta = \theta_{max}$ and $\theta = -\theta_{max}$.

    D) $\theta = \theta_{max}$, $\theta = -\theta_{max}$, and $\theta = 0$.

    E) $\theta = 0$ only.

13. At which values of θ is the restoring force of the pendulum maximized?

A) $\theta = \theta_{max}/4$ and $\theta = -\theta_{max}/4$.

B) $\theta = \theta_{max}/2$ and $\theta = -\theta_{max}/2$.

C) $\theta = \theta_{max}$ and $\theta = -\theta_{max}$.

D) $\theta = \theta_{max}, \theta = -\theta_{max}$, and $\theta = 0$.

E) $\theta = 0$ only.

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14. A pendulum is released from a height *h*. Halfway through its period, it strikes an object of mass *m* which connects with the pendulum bob. Which of the follow describe the pendulum-object system after to the collision.

I. The kinetic energy of the system increases.
II. The period of the pendulum remains constant.
III. The maximum height the pendulum reaches decreases.

A) I only

B) II only

C) III only

D) II and III only

E) I, II, and III only

15. A pendulum's period is initially *t*. Changes are made to the system so that the new period is 2*t*. What may have been changed?

A) The length of the pendulum was decreased by a factor of 2.

B) The length of the pendulum was increased by a factor of 2.

C) The pendulum was moved to a planet with 2 times the mass of Earth.

D) The length of the pendulum was increased by a factor of 4.

E) The pendulum was moved to a planet with 4 times the mass of earth.

16. A pendulum swinging with a maximum amplitude of p/6 has a period of *T*. What must happen for the period to remain the same if the amplitude of motion is doubled?

A) The length must be increased by a factor of 2.

B) The length must be increased by a factor of 4.

C) The acceleration due to gravity must be increased by a factor of 2.

D) The acceleration due to gravity must be decreased by a factor of 2.

E) The length and acceleration due to gravity must remain the same.

17. A pendulum swinging with a maximum amplitude of p/6 has a period of *T*. If the maximum amplitude is increased to p/3, what is the new period of the pendulum?

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

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

C) T

D) $2T$

E) $4T$

18. Which of the following does NOT exhibit periodic motion?

A) a simple pendulum

B) a spring-mass system

C) an electron moving perpendicularly to a constant, external, magnetic field

D) a standing wave

E) a projectile

19. Which of the following can be related to the period of a simple pendulum?

I. The rotational inertia of the bob
II. The angular momentum of the bob at its lowest point
III. The maximum angular displacement of the bob

A) II only

B) III only

C) I and III only

D) I, II and III

E) None of the above

20. An ideal pendulum hangs stationary at its equilibrium position. Which of the following is true of the string supporting the mass?

A) It is doing work.

B) It is exerting a torque on the mass.

C) The tension in the string is constant.

D) There is no tension in the string.

E) The force provided by the string is greater than the weight of the mass.

21. Which of the following is true for a simple pendulum?

A) The kinetic and potential energies are equal at all times.

B) The kinetic and potential energies are both constant.

C) The maximum kinetic energy is equal to the minimum kinetic energy.

D) The total energy is constant.

E) The total energy is equal to the sum of the maximum kinetic and potential energies.

22. The energy contained in a pendulum depends on its

I. period
II. amplitude
III. mass

A) I only

B) II only

C) I and III only

D) II and III only

E) I, II, and III

23. Which one of the following statements is true concerning an object executing simple harmonic motion?

A) Its velocity is never zero.

B) Its acceleration is never zero.

C) Its velocity and acceleration are simultaneously zero.

D) Its velocity is zero when its acceleration is a maximum.

E) Its maximum acceleration is equal to its maximum velocity.

24. A 5 kg ball hangs from a 10 m string. The ball is swung horizontally outward 90º from its equilibrium position. Assuming the system behaves as a simple pendulum, find the maximum speed of the ball during its swing.

A) 50 m/s

B) 14 m/s

C) 10 m/s

D) 5 m/s

E) 2 m/s

25. A pendulum of length L swings in simple harmonic motion with period T and angular displacement θ about the equilibrium point $\theta = 0$. What is the maximum velocity of the pendulum?

A) $\sqrt{gL(\sin\theta - \cos\theta)}$

B) $\sqrt{2gL(1-\cos\theta)}$

C) $\sqrt{2gL\cos\theta}$

D) $\sqrt{2gL(1-\sin\theta)}$

E) $\sqrt{2gL\sin\theta}$

Answer Key
[New Exam]

1. D
2. D
3. E
4. B
5. D
6. B
7. C
8. B
9. A
10. B
11. E
12. C
13. C
14. D
15. D
16. E
17. C
18. E
19. E
20. C
21. D
22. D
23. D
24. B
25. B

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