Name: ___________________________ Date: _____________

1. A simple pendulum consists of a small ball tied to a string and set in oscillation. As the pendulum swings the tension force of the string is:

A) constant
B) a sinusoidal function of time
C) the square of a sinusoidal function of time
D) the reciprocal of a sinusoidal function of time
E) none of the above

2. A block attached to a spring oscillates in simple harmonic motion along the *x* axis. The limits of its motion are x = 10 cm and x = 50 cm and it goes from one of these extremes to the other in 0.25 s. Its amplitude and frequency are:

A) 40 cm, 2 Hz
B) 20 cm, 4 Hz
C) 40 cm, 2 Hz
D) 25 cm, 4 Hz
E) 20 cm, 2 Hz

3. The table below gives the values of the spring constant k, damping constant b, and mass m for a particle in damped harmonic motion. Which of these takes the longest time for its mechanical energy to decrease to one-fourth of its initial value?

	k	b	m
A	k_0	b_0	m_0
B	$3k_0$	$2b_0$	$m_0 1$
C	$k_0/2$	$6b_0$	$2m_0$
D	$4k_0$	b_0	$2m_0$
E	k_0	b_0	$10m_0$

A) A
B) B
C) C
D) D
E) E

4. An oscillator is subjected to a damping force that is proportional to its velocity. A sinusoidal force is applied to it. After a long time:

A) its amplitude is an increasing function of time
B) its amplitude is a decreasing function of time
C) its amplitude is constant
D) its amplitude is a decreasing function of time only if the damping constant is large
E) its amplitude increases over some portions of a cycle and decreases over other portions

5. The displacement of an object oscillating on a spring is given by $x(t) = X \cos(\omega t + \phi_0)$. If the object is initially displaced in the negative x direction and given a negative initial velocity, then the phase constant ϕ_0 is between:

A) 0 and $\pi/2$ rad
B) $\pi/2$ and π rad
C) π and $3\pi/2$ rad
D) $3\pi/2$ and 2π rad
E) none of the above (ϕ_0 is exactly 0, $\pi/2$, π, or $3\pi/2$ rad)

6. A sinusoidal force with a given amplitude is applied to an oscillator. To maintain the largest amplitude oscillation the frequency of the applied force should be:

A) half the natural frequency of the oscillator
B) the same as the natural frequency of the oscillator
C) twice the natural frequency of the oscillator
D) unrelated to the natural frequency of the oscillator
E) determined from the maximum speed desired

7. It is impossible for two particles, each executing simple harmonic motion, to remain in phase with each other if they have different:

A) masses
B) periods
C) amplitudes
D) spring constants
E) kinetic energies

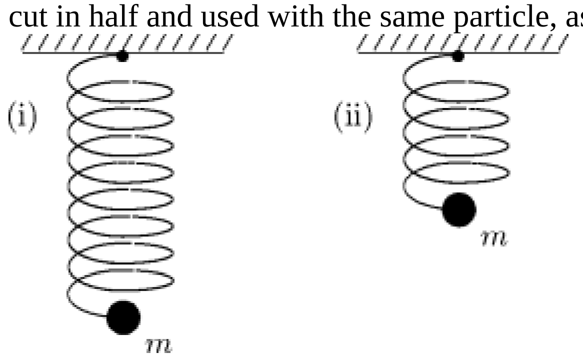
8. A block on a spring is subjected to a damping force that is proportional to its velocity and to an applied sinusoidal force. The energy dissipated by damping is supplied by:

A) the potential energy of the spring
B) the kinetic energy of the mass
C) gravity
D) friction
E) the applied force

9. In simple harmonic motion, the restoring force must be proportional to the:

A) amplitude
B) frequency
C) velocity
D) displacement
E) displacement squared

10. A simple harmonic oscillator consists of an particle of mass *m* and an ideal spring with spring constant *k*. The particle oscillates as shown in (i) with period *T*. If the spring is cut in half and used with the same particle, as shown in (ii), the period will be:



A) $2T$
B) $\sqrt{2}T$
C) $T/\sqrt{2}$
D) T
E) $T/2$

11. Let U be the potential energy (with the zero at zero displacement) and K be the kinetic energy of a simple harmonic oscillator. $\langle U \rangle$ and $\langle K \rangle$ are the average values over a cycle. Then:

A) $\langle K \rangle$ is greater than $\langle U \rangle$
B) $\langle K \rangle$ is less than $\langle U \rangle$
C) $\langle K \rangle$ is equal to $\langle U \rangle$
D) $K = 0$ when $U = 0$
E) $K + U = 0$

12. Two uniform spheres are pivoted on horizontal axes that are tangent to their surfaces. The one with the longer period of oscillation is the one with:

A) the larger mass
B) the smaller mass
C) the larger rotational inertia
D) the smaller rotational inertia
E) the larger radius

13. A mass-spring system is oscillating with amplitude X. The kinetic energy will equal the potential energy only when the displacement is:

A) zero
B) $\pm X/4$
C) $\pm X/\sqrt{2}$
D) $\pm X/2$
E) anywhere between $-X$ and $+X$

14. The amplitude of any oscillator can be doubled by:

A) doubling only the initial displacement
B) doubling only the initial speed
C) doubling the initial displacement and halving the initial speed
D) doubling the initial speed and halving the initial displacement
E) doubling both the initial displacement and the initial speed

15. A 0.25-kg block oscillates on the end of the spring with a spring constant of 200 N/m. If the oscillation is started by elongating the spring 0.15 m and giving the block a speed of 3.0 m/s, then the maximum speed of the block is:

A) 0.13 m/s
B) 0.18 m/s
C) 3.7 m/s
D) 5.2 m/s
E) 13 m/s

16. In simple harmonic motion:

A) the acceleration is greatest at the maximum displacement
B) the velocity is greatest at the maximum displacement
C) the period depends on the amplitude
D) the acceleration is constant
E) the acceleration is greatest at zero displacement

17. A particle is in simple harmonic motion along the x axis. The amplitude of the motion is X. At one point in its motion its kinetic energy is $K = 5$ J and its potential energy (measured with $U = 0$ at $x = 0$) is $U = 3$ J. When it is at $x = X$, the kinetic and potential energies are:

A) $K = 5$ J and $U = 3$ J
B) $K = 5$ J and $U = -3$ J
C) $K = 8$ J and $U = 0$
D) $K = 0$ and $U = 8$ J
E) $K = 0$ and $U = -8$ J

18. In simple harmonic motion, the magnitude of the acceleration is:

A) constant
B) proportional to the displacement
C) inversely proportional to the displacement
D) greatest when the velocity is greatest
E) never greater than g

19. An object on the end of a spring is set into oscillation by giving it an initial velocity while it is at its equilibrium position. In the first trial the initial velocity is v_0 and in the second it is $4v_0$. In the second trial:

A) the amplitude is half as great and the maximum acceleration is twice as great
B) the amplitude is twice as great and the maximum acceleration is half as great
C) both the amplitude and the maximum acceleration are twice as great
D) both the amplitude and the maximum acceleration are four times as great
E) the amplitude is four times as great and the maximum acceleration is twice as great

20. The amplitude and phase constant of an oscillator are determined by:

A) the frequency
B) the angular frequency
C) the initial displacement alone
D) the initial velocity alone
E) both the initial displacement and velocity

21. A 0.20-kg object attached to a spring whose spring constant is 500 N/m executes simple harmonic motion. If its maximum speed is 5.0 m/s, the amplitude of its oscillation is:

A) 0.0020 m
B) 0.10 m
C) 0.20 m
D) 25 m
E) 250 m

22. The amplitude of oscillation of a simple pendulum is increased from 1° to 4°. Its maximum acceleration changes by a factor of:

A) 1/4
B) 1/2
C) 2
D) 4
E) 16

23. A simple pendulum is suspended from the ceiling of an elevator. The elevator is accelerating upwards with acceleration *a*. The period of this pendulum, in terms of its length *L*, *g*, and *a* is:

A) $2\pi\sqrt{L/g}$
B) $2\pi\sqrt{L/(g+a)}$
C) $2\pi\sqrt{L/(g-a)}$
D) $2\pi\sqrt{L/a}$
E) $(1/2\pi)\sqrt{g/L}$

24. A certain spring elongates 9.0 mm when it is suspended vertically and a block of mass *M* is hung on it. The natural angular frequency of this block-spring system:

A) is 0.088 rad/s
B) is 33 rad/s
C) is 200 rad/s
D) is 1140 rad/s
E) cannot be computed unless the value of *M* is given

25. An object attached to one end of a spring makes 20 vibrations in 10 s. Its frequency is:

A) 2 Hz
B) 10 s
C) 0.05 Hz
D) 2 s
E) 0.50 s

Answer Key

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