ConcepTest 14.5a Energy in SHM I

A mass on spring oscillates in simple harmonic motion with amplitude A. If the mass is doubled, but the amplitude is not changed, what will happen to the total energy of the system?

A) total energy will increase
B) total energy will not change
C) total energy will decrease

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A) total energy will increase

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The total energy is equal to the initial value of the elastic potential energy, which is $PE_s = \frac{1}{2}kA^2$. This does not depend on mass, so a change in mass will not affect the energy of the system.

Follow-up: What happens if you double the amplitude?

ConcepTest 14.5b Energy in SHM II

If the amplitude of a simple harmonic oscillator is doubled, which of the following quantities will change the most?

A) frequency
B) period
C) maximum speed
D) maximum acceleration
AB) total mechanical energy

ConcepTest 14.5b Energy in SHM II

If the amplitude of a simple harmonic oscillator is doubled, which of the following quantities will change the most?

A) frequency
B) period
C) maximum speed
D) maximum acceleration
AB) total mechanical energy

Frequency and period do not depend on amplitude at all, so they will not change. Maximum acceleration and maximum speed do depend on amplitude, and both of these quantities will double. (You should think about why this is so.) The total energy equals the initial potential energy, which depends on the square of the amplitude, so that will quadruple.

Follow-up: Why do maximum acceleration and speed double?

ConcepTest 14.9 Grandfather Clock

A grandfather clock has a weight at the bottom of the pendulum that can be moved up or down. If the clock is running slow, what should you do to adjust the time properly?

A) move the weight up
B) move the weight down
C) moving the weight will not matter
D) call the repairman

ConcepTest 14.9 Grandfather Clock

A grandfather clock has a weight at the bottom of the pendulum that can be moved up or down. If the clock is running slow, what should you do to adjust the time properly?

A) move the weight up

B) move the weight down

C) moving the weight will not matter

D) call the repairman

The period of the grandfather clock is too long, so we need to decrease the period (increase the frequency). To do this, the length must be decreased, so the adjustable weight should be moved up in order to shorten the pendulum length.

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

ConcepTest 14.10a Pendulum in Elevator I

A pendulum is suspended from the ceiling of an elevator. When the elevator is at rest, the period is *T*. What happens to the period when the elevator is moving upward at constant speed?

A) period will increase
B) period will not change
C) period will decrease

ConcepTest 14.10a Pendulum in Elevator I

A pendulum is suspended from the ceiling of an elevator. When the elevator is at rest, the period is *T*. What happens to the period when the elevator is moving upward at constant speed?

A) period will increase
B) period will not change
C) period will decrease

Nothing changes when the elevator moves at constant speed. Neither the length nor the effective value of *g* has changed, so the period of the pendulum is the same.

ConcepTest 14.10b Pendulum in Elevator II

A pendulum is suspended from the ceiling of an elevator. When the elevator is at rest, the period is *T*. What happens to the period when the elevator is accelerating upward?

A) period will increase

B) period will not change

C) period will decrease

ConcepTest 14.10b Pendulum in Elevator II

A pendulum is suspended from the ceiling of an elevator. When the elevator is at rest, the period is *T*. What happens to the period when the elevator is accelerating upward?

A) period will increase
B) period will not change
C) period will decrease

When the elevator accelerates upward, the hanging mass feels "heavier"—this means that the effective value of *g* has increased due to the acceleration of the elevator. Because the period depends inversely on *g*, and the effective value of *g* increased, then the period of the pendulum will decrease (*i.e.*, its frequency will increase and it will swing faster).

ConcepTest 14.10c Pendulum in Elevator III

A swinging pendulum has period *T* on Earth. If the same pendulum were moved to the Moon, how does the new period compare to the old period?

A) period increases

B) period does not change

C) period decreases

ConcepTest 14.10c Pendulum in Elevator III

A swinging pendulum has period *T* on Earth. If the same pendulum were moved to the Moon, how does the new period compare to the old period?

A) period increases

B) period does not change

C) period decreases

The acceleration due to gravity is smaller on the Moon. The relationship between the period and *g* is given by:

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

therefore, if *g* gets smaller, *T* will increase.

Follow-up: What can you do to return the pendulum to its original period?

ConcepTest 14.11 Damped Pendulum

After a pendulum starts swinging, its amplitude gradually decreases with time because of friction.

What happens to the period of the pendulum during this time ?

A) period increases

B) period does not change

C) period decreases

ConcepTest 14.11 Damped Pendulum

After a pendulum starts swinging, its amplitude gradually decreases with time because of friction.

What happens to the period of the pendulum during this time ?

A) period increases

B) period does not change

C) period decreases

The period of a pendulum does not depend on its amplitude, but only on its length and the acceleration due to gravity.

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

Follow-up: What is happening to the energy of the pendulum?