# *ConcepTest 14.6a* Period of a Spring I

**A glider with a spring attached to each end oscillates with a certain period. If the mass of the glider is doubled, what will happen to the period?**

**1) period will increase**

**2) period will not change**

**3) period will decrease**

# *ConcepTest 14.6a* Period of a Spring I

A glider with a spring attached to each end oscillates with a certain period. If the mass of the glider is doubled, what will happen to the period?

1) period will increase
2) period will not change
3) period will decrease

The period is proportional to the square root of the mass. So an increase in mass will lead to an increase in the period of motion.

$$T = 2\pi \sqrt{(m/k)}$$

**Follow-up: What happens if the amplitude is doubled?**

## *ConcepTest 14.6b* Period of a Spring II

A glider with a spring attached to each end oscillates with a certain period. If identical springs are added in parallel to the original glider, what will happen to the period?

1) period will increase
2) period will not change
3) period will decrease

# ConcepTest 14.6b Period of a Spring II

A glider with a spring attached to each end oscillates with a certain period. If identical springs are added in parallel to the original glider, what will happen to the period?

1) period will increase
2) period will not change
3) period will decrease

We saw in the last section that two springs in parallel act like a stronger spring. So the spring constant has been effectively increased, and the period is inversely proportional to the square root of the spring constant, which leads to a decrease in the period of motion.

$$T = 2\pi \sqrt{(m/k)}$$

# *ConcepTest 14.7a* Spring in an Elevator I

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

1) period will increase
2) period will not change
3) period will decrease

# ConcepTest 14.7a Spring in an Elevator I

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

1) period will increase
2) period will not change
3) period will decrease

Nothing at all changes when the elevator moves at constant speed. The equilibrium elongation of the spring is the same, and the period of simple harmonic motion is the same.

# *ConcepTest 14.7b* Spring in an Elevator II

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

1) period will increase
2) period will not change
3) period will decrease

# *ConcepTest 14.7b* Spring in an Elevator II

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

1) period will increase
2) period will not change
3) period will decrease

When the elevator accelerates upward, the hanging mass feels "heavier" and the spring will stretch a bit more. Thus, the equilibrium elongation of the spring will increase. However, the period of simple harmonic motion does not depend upon the elongation of the spring – it only depends on the mass and the spring constant, and neither one of them has changed.

# *ConcepTest 14.7c* Spring on the Moon

A mass oscillates on a vertical spring with period *T*. If the whole setup is taken to the Moon, how does the period change?

1) period will increase
2) period will not change
3) period will decrease

# ConcepTest 14.7c Spring on the Moon

A mass oscillates on a vertical spring with period *T*. If the whole setup is taken to the Moon, how does the period change?

1) period will increase
2) period will not change
3) period will decrease

The period of simple harmonic motion only depends on the mass and the spring constant and does not depend on the acceleration due to gravity. By going to the Moon, the value of *g* has been reduced, but that does not affect the period of the oscillating mass-spring system.

**Follow-up: Will the period be the same on any planet?**

# *ConcepTest 14.8a* Period of a Pendulum I

Two pendula have the same length, but different masses attached to the string. How do their periods compare?

1) period is greater for the greater mass
2) period is the same for both cases
3) period is greater for the smaller mass

One person swings on a swing and finds that the period is 3.0 s. Then a second person of equal mass joins him. With two people swinging, the period is

1. 1.5 s.
2. <3.0 s but not necessarily 1.5 s.
3. 3.0 s.
4. >3.0 s but not necessarily 6.0 s.
5. 6.0 s.

One person swings on a swing and finds that the period is 3.0 s. Then a second person of equal mass joins him. With two people swinging, the period is

1. 1.5 s.
2. <3.0 s but not necessarily 1.5 s.
3. **3.0 s.**
4. >3.0 s but not necessarily 6.0 s.
5. 6.0 s.

# *ConcepTest 14.8a* Period of a Pendulum I

**Two pendula have the same length, but different masses attached to the string. How do their periods compare?**

1) period is greater for the greater mass
2) period is the same for both cases
3) period is greater for the smaller mass

**The period of a pendulum depends on the length and the acceleration due to gravity, but it does not depend on the mass of the bob.**

$$T = 2\pi \sqrt{(L/g)}$$

**Follow-up: What happens if the amplitude is doubled?**

# *ConcepTest 14.8b* Period of a Pendulum II

Two pendula have different lengths: one has length *L* and the other has length 4*L*. How do their periods compare?

1) period of 4*L* is four times that of *L*
2) period of 4*L* is two times that of *L*
3) period of 4*L* is the same as that of *L*
4) period of 4*L* is one-half that of *L*
5) period of 4*L* is one-quarter that of *L*

# *ConcepTest 14.8b* Period of a Pendulum II

Two pendula have different lengths: one has length *L* and the other has length 4*L*. How do their periods compare?

1) period of 4*L* is four times that of *L*
2) period of 4*L* is two times that of *L*
3) period of 4*L* is the same as that of *L*
4) period of 4*L* is one-half that of *L*
5) period of 4*L* is one-quarter that of *L*

The period of a pendulum depends on the length and the acceleration due to gravity. The length dependence goes as the square root of *L*, so a pendulum 4 times longer will have a period that is 2 times larger.

$$T = 2\pi \sqrt{(L/g)}$$

# 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?

1) move the weight up
2) move the weight down
3) moving the weight will not matter
4) 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?

1) move the weight up
2) move the weight down
3) moving the weight will not matter
4) 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.

$$T = 2\pi \sqrt{(L/g)}$$

# *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?

1) period will increase
2) period will not change
3) 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?

1) period will increase
2) period will not change
3) period will decrease

Nothing at all 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?

1) period will increase
2) period will not change
3) 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?

1) period will increase
2) period will not change
3) 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. Since 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?

1) period increases
2) period does not change
3) 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?

1) period increases
2) period does not change
3) 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 ?

1) period increases
2) period does not change
3) 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 ?

1) period increases
2) period does not change
3) period decreases

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

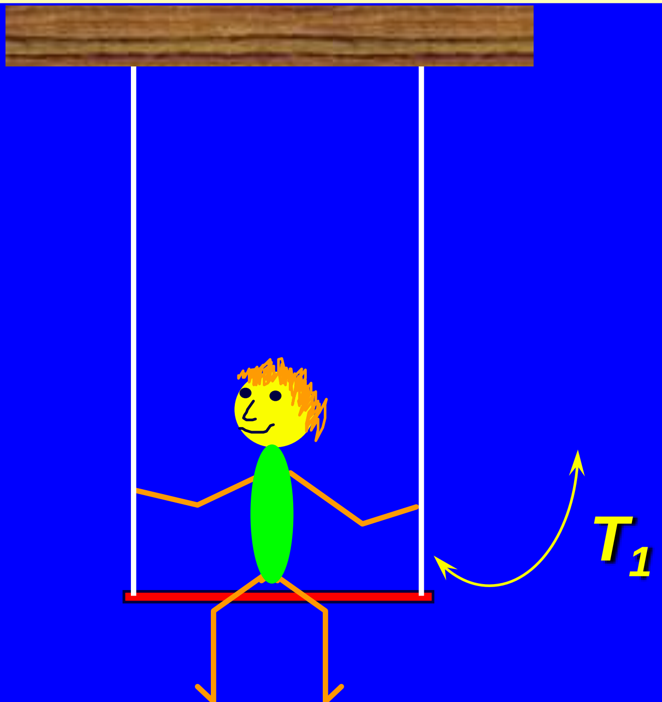
$$T = 2\pi\sqrt{\frac{L}{g}}$$

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

## *ConcepTest 14.12* Swinging in the Rain

You are ***sitting*** on a swing. A friend gives you a push, and you start swinging with period $T_1$. Suppose you were ***standing*** on the swing rather than sitting. When given the same push, you start swinging with period $T_2$. Which of the following is true?

1) $T_1 = T_2$
2) $T_1 > T_2$
3) $T_1 < T_2$



# ConcepTest 14.12 Swinging in the Rain

You are *sitting* on a swing. A friend gives you a push, and you start swinging with period $T_1$. Suppose you were *standing* on the swing rather than sitting. When given the same push, you start swinging with period $T_2$. Which of the following is true?

1) $T_1 = T_2$
2) $T_1 > T_2$
3) $T_1 < T_2$

Standing up raises the **Center of Mass** of the swing, making it shorter !! Since $L_1 > L_2$ then $T_1 > T_2$

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