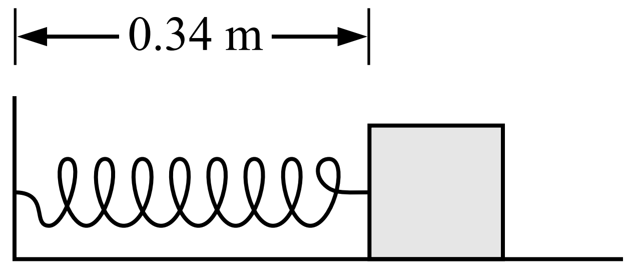
SPRING FORCE & HOOKE'S LAW



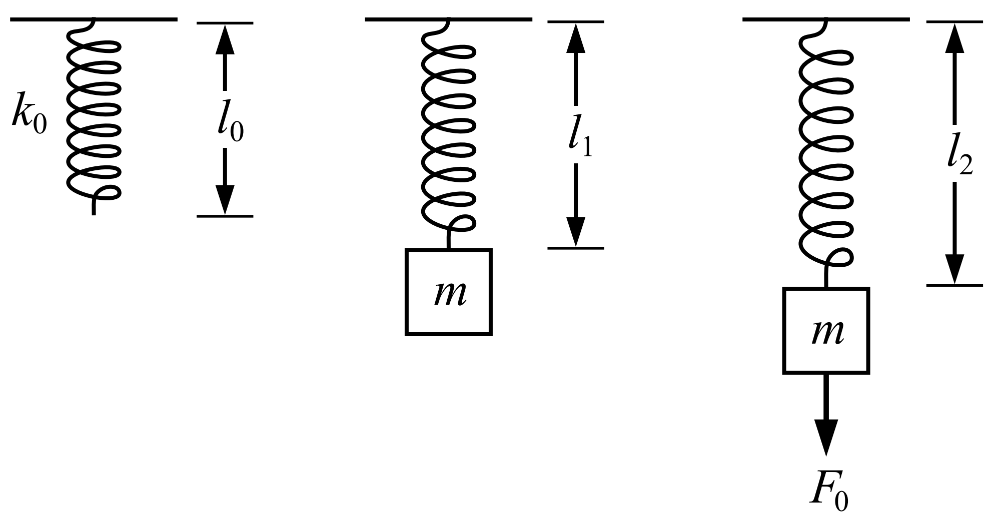
1. A block is attached to a spring which has an original unstretched length of 0.28 m. The other end of the spring is attached to a wall. The block is pulled away from the wall and released, and the block oscillates left and right. Which of the following shows the direction of the spring force acting on the block when it is in the position shown in the figure above?

   (A) 

   (B) 

   (C) 

   (D) The magnitude of the spring force is zero



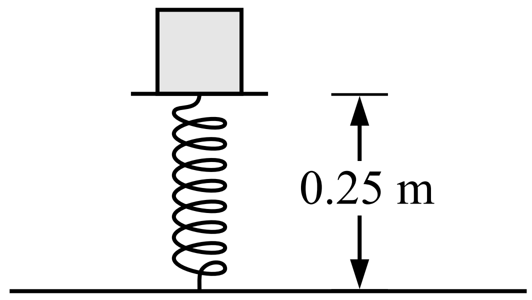
2. A spring with a spring constant of k_0 and an unstretched length of l_0 is suspended from the ceiling as shown in the figure above. A block with a mass of m is then attached to the bottom end of the spring and the block is at rest when the spring has a length of l_1. A force with a magnitude of F_0 then pulls down on the block so that the spring has a length of l_2 and the block is at rest. The moment that the force F_0 is removed, the acceleration of the block is

   (A) $k_0(l_2 - l_1)$

   (B) $\dfrac{k_0(l_2 - l_1)}{m} - g$

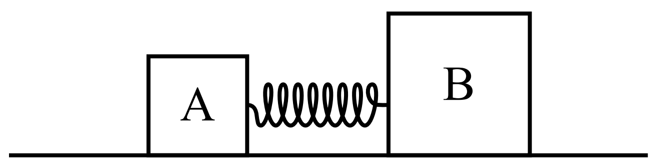
   (C) $\dfrac{k_0(l_2 - l_0)}{m} - g$

   (D) $k_0(l_2 - l_0)$



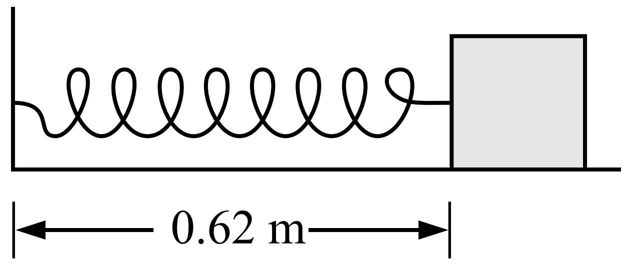
3. A block sits at rest on a spring which has a spring constant of 400 N/m and an unstretched length of 0.30 m. The block is compressing the spring as shown in the figure above. The mass of the block is most nearly

(A) 20 kg
(B) 12 kg
(C) 10 kg
(D) 2 kg



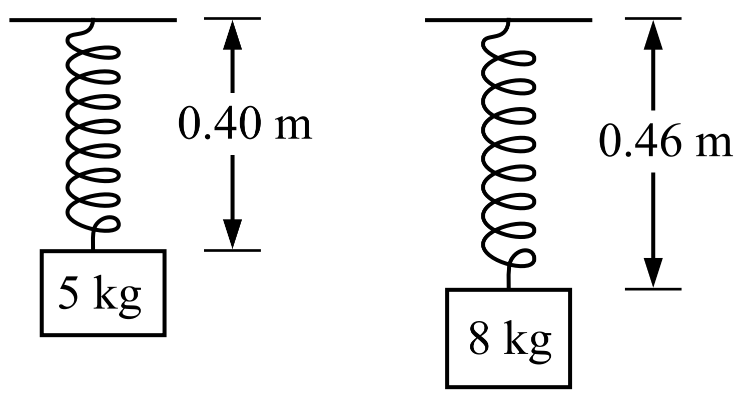
4. Two blocks are on a frictionless surface and are connected by a spring as shown in the figure above. The mass of block B is greater than the mass of block A. The blocks are held in place so that the spring is compressed. Which of the following is true at the moment the blocks are released?

(A) The magnitude of the spring force on block A is equal to the magnitude of the spring force on block B
(B) The magnitude of the spring force on block A is greater than the magnitude of the spring force on block B
(C) The magnitude of the spring force on block A is less than the magnitude of the spring force on block B
(D) The magnitude of the spring force on both blocks is zero



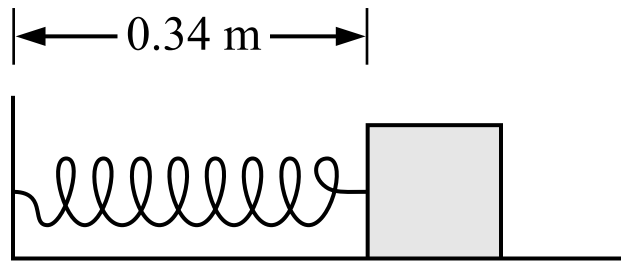
5. A block is attached to a spring which has an unstretched length of 0.68 m. The block is held in the position shown in the figure above. If the block is moved 0.10 m to the right, the magnitude of the spring force on the block

(A) will be greater than the magnitude of the spring force at the position shown
(B) will be less than the magnitude of the spring force at the position shown
(C) will be the same as the magnitude of the spring force at the position shown
(D) cannot be compared to the magnitude of the spring force at the position shown



6. A 5 kg block is suspended from a spring attached to the ceiling. When the block is at rest the spring is 0.40 m long. The 5 kg block is removed and replaced with an 8 kg block. When the new block is at rest the spring is 0.46 m long. The spring constant of the spring is most nearly

(A) 125 N/m
(B) 1333 N/m
(C) 174 N/m
(D) 500 N/m



1. A block is attached to a spring which has an original unstretched length of 0.28 m. The other end of the spring is attached to a wall. The block is pulled away from the wall and released, and the block oscillates left and right. Which of the following shows the direction of the spring force acting on the block when it is in the position shown in the figure above?

(A) 

(B) 

(C) 

(D) The magnitude of the spring force is zero

A Incorrect

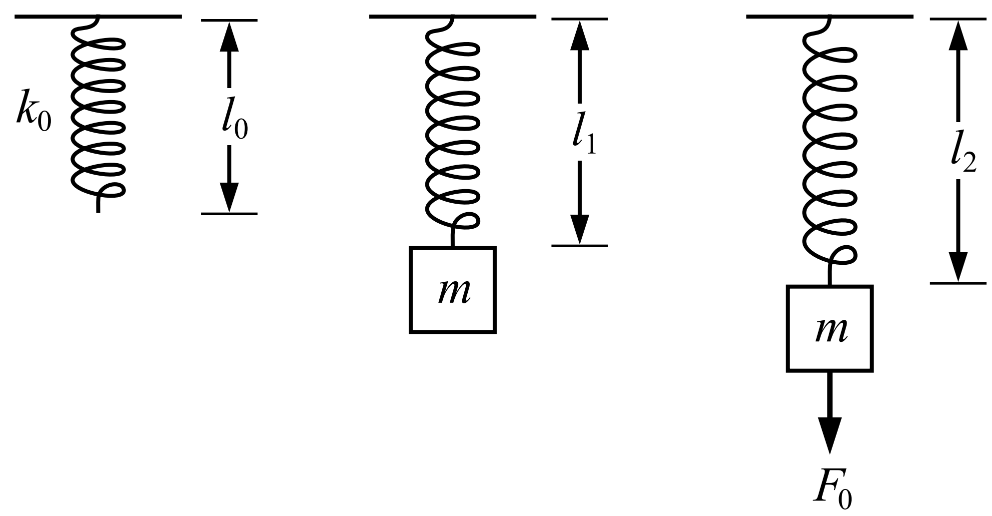
B Incorrect

C Correct

The magnitude of the spring force is equal to the spring constant multiplied by the change in length from the original unstretched length (see the equation below). The spring is stretched longer than the original length so the spring applies a pulling force (not a pushing force) on the block, which acts in the left direction.

$F_{sp} = k\Delta x$

D Incorrect



2. A spring with a spring constant of k_0 and an unstretched length of l_0 is suspended from the ceiling as shown in the figure above. A block with a mass of m is then attached to the bottom end of the spring and the block is at rest when the spring has a length of l_1. A force with a magnitude of F_0 then pulls down on the block so that the spring has a length of l_2 and the block is at rest. The moment that the force F_0 is removed, the acceleration of the block is

(A) $k_0(l_2 - l_1)$

(B) $\dfrac{k_0(l_2 - l_1)}{m} - g$

(C) $\dfrac{k_0(l_2 - l_0)}{m} - g$

(D) $k_0(l_2 - l_0)$

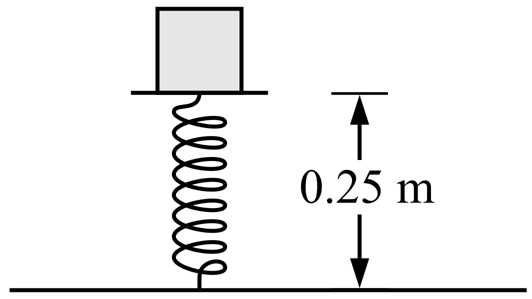
A Incorrect
This answer would be the spring force acting on the block but it also incorrectly uses l_1 instead of l_0 for the change in length of the spring.

B Incorrect
This answer incorrectly uses l_1 instead of l_0 for the change in length of the spring.

C **Correct**
The moment that the force F_0 is removed, there is an upwards spring force and a downwards weight force acting on the block. The spring force depends on the change in length from the original unstretched length of the spring l_0, not from the equilibrium length when the block is attached l_2.
$F_{sp} = k\Delta x = k_0(l_2 - l_0)$

$$\Sigma F_y = F_{sp} - F_g = m a_y \qquad k_0(l_2 - l_0) - mg = m a_y \qquad a_y = \frac{k_0(l_2 - l_0)}{m} - g$$

D Incorrect
This answer is the spring force acting on the block.



3. A block sits at rest on a spring which has a spring constant of 400 N/m and an unstretched length of 0.30 m. The block is compressing the spring as shown in the figure above. The mass of the block is most nearly

(A) 20 kg

(B) 12 kg

(C) 10 kg

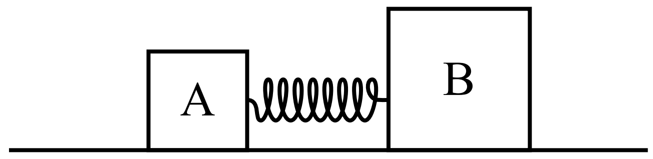
(D) 2 kg

A Incorrect
This answer is the spring force acting on the block (20 N) using the unit of kg for mass.

B Incorrect
This answer incorrectly uses 0.30 m for the change in length of the spring.

C Incorrect
This answer incorrectly uses 0.25 m for the change in length of the spring.

D **Correct**
The block is at rest and not accelerating so the net force on the block is zero. The spring is compressed and there is an upwards spring force and a downwards weight force acting on the block.
$\Sigma F_y = F_{sp} - F_g = m(0\text{ m/s}^2)$ $\quad k\Delta x = mg$ $\quad (400\text{ N/m})(0.30\text{ m} - 0.25\text{ m}) = mg$ $\quad m = 2\text{ kg}$



4. Two blocks are on a frictionless surface and are connected by a spring as shown in the figure above. The mass of block B is greater than the mass of block A. The blocks are held in place so that the spring is compressed. Which of the following is true at the moment the blocks are released?

(A) The magnitude of the spring force on block A is equal to the magnitude of the spring force on block B

(B) The magnitude of the spring force on block A is greater than the magnitude of the spring force on block B

(C) The magnitude of the spring force on block A is less than the magnitude of the spring force on block B

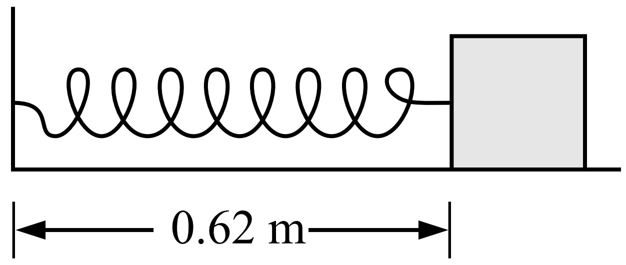
(D) The magnitude of the spring force on both blocks is zero

A **Correct**
The magnitude of the force acting at both ends of a spring are always equal. This is an assumption we always make for ideal (massless) springs.

B Incorrect

C Incorrect

D Incorrect
The magnitude of the spring force is not zero because the spring is compressed, and the spring force is proportional to the change in length of a spring.



5. A block is attached to a spring which has an unstretched length of 0.68 m. The block is held in the position shown in the figure above. If the block is moved 0.10 m to the right, the magnitude of the spring force on the block

(A) will be greater than the magnitude of the spring force at the position shown

(B) will be less than the magnitude of the spring force at the position shown

(C) will be the same as the magnitude of the spring force at the position shown

(D) cannot be compared to the magnitude of the spring force at the position shown

A Incorrect

B **Correct**

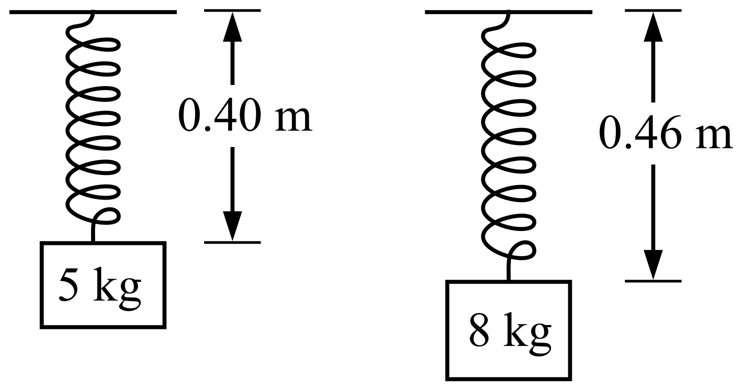
The magnitude of the spring force acting on the block depends on the change in length of the spring from its original length of 0.68 m.

When the block is at the position shown: $F_{sp} = k\Delta x = k(0.68\text{ m} - 0.62\text{ m}) = k(0.06\text{ m})$ (to the right)

When the block is moved 0.10 m to the right: $F_{sp} = k\Delta x = k(0.72\text{ m} - 0.68\text{ m}) = k(0.04\text{ m})$ (to the left)

C Incorrect

D Incorrect



6. A 5 kg block is suspended from a spring attached to the ceiling. When the block is at rest the spring is 0.40 m long. The 5 kg block is removed and replaced with an 8 kg block. When the new block is at rest the spring is 0.46 m long. The spring constant of the spring is most nearly

   (A) 125 N/m
   (B) 1333 N/m
   (C) 174 N/m
   (D) 500 N/m

A Incorrect
This answer incorrectly solves for the spring constant using only the 5 kg block and 0.40 m for Δx.

B Incorrect
This answer incorrectly solves for the spring constant using the 8 kg block and 0.06 m for Δx.

C Incorrect
This answer incorrectly solves for the spring constant using only the 8 kg block and 0.46 m for Δx.

D **Correct**
When the blocks are at rest the net vertical force on each block is zero (Newton's 1st law) so the upwards spring force is equal in magnitude to the downwards weight force on the block. The spring force is equal to the spring constant multiplied by the change in length of the spring from its original unstretched length (which is not known). A system of two equations and two unknowns (the spring constant k and the original length of the spring L_0) can be set up and solved using substitution.

Each block: $\Sigma F_y = m a_y \qquad F_{sp} - F_g = m(0) \qquad F_{sp} = F_g \qquad k\Delta x = mg$

5 kg block: $k\Delta x = (5\text{ kg})g \qquad k(0.40\text{ m} - L_0) = (5\text{ kg})g \qquad L_0 = 0.40\text{ m} - \dfrac{(5\text{ kg})g}{k}$

8 kg block: $k\Delta x = (8\text{ kg})g \qquad k(0.46\text{ m} - L_0) = (8\text{ kg})g \qquad k\left(0.46\text{ m} - \left(0.40\text{ m} - \dfrac{(5\text{ kg})g}{k}\right)\right) = (8\text{ kg})g$

$k = 500\text{ N/m}$