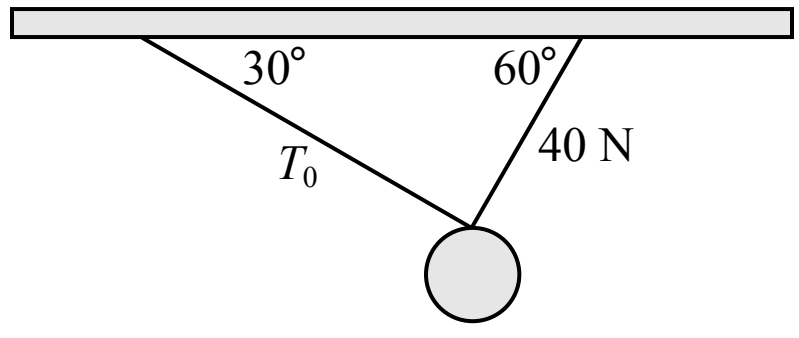
TENSION & PULLEY SYSTEMS



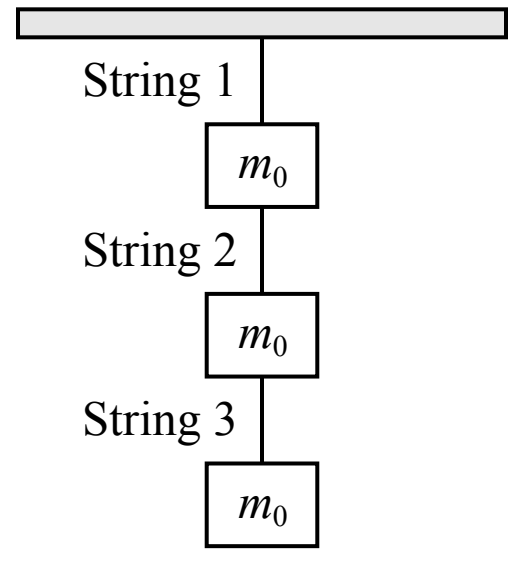
1. A ball is suspended from two cables as shown in the figure above. The ball is at rest and the tension in the cable on the right is 40 N. The tension T_0 in the cable on the left is most nearly

   (A) 20 N

   (B) 69 N

   (C) 23 N

   (D) 40 N



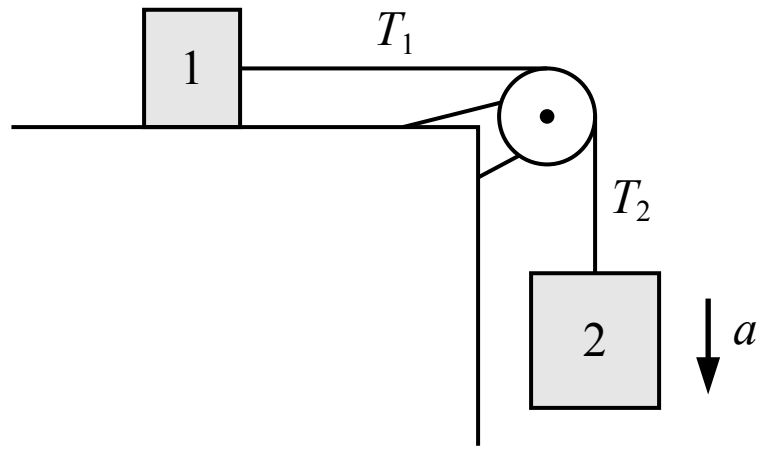
2. Three blocks with equal mass are suspended from the ceiling using three strings as shown in the figure above. If string 1 is cut, which of the following is an expression for the tension in string 2?

   (A) 0

   (B) $m_0 g$

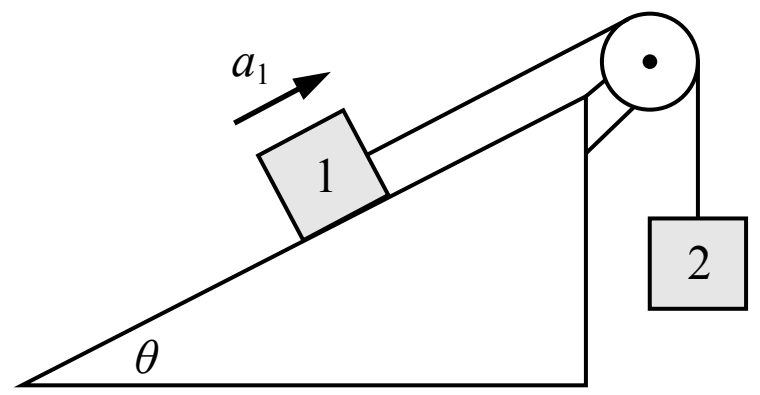
   (C) $2\,m_0 g$

   (D) $3\,m_0 g$



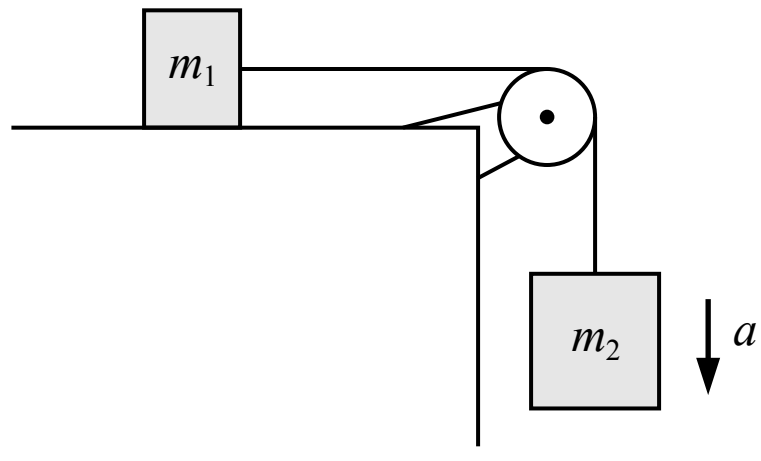
3. Two blocks are connected by a cable with negligible mass which passes over a pulley with negligible mass and negligible friction as shown in the figure above. There is friction between block 1 and the surface. The mass of block 2 is greater than the mass of block 1 and the blocks accelerate. Which of the following correctly compares the tensions in the two sections of the cable?

(A) $T_1 = T_2$
(B) $T_1 < T_2$
(C) $T_1 > T_2$
(D) A comparison between the tensions cannot be determined



4. Two blocks are connected by a cable with negligible mass which passes over a pulley with negligible mass and negligible friction as shown in the figure above. There is negligible friction between block 1 and the incline. If the acceleration of block 1 is a_1, which of the following is an expression for the magnitude of the acceleration of block 2?

(A) g
(B) a_1
(C) $a_1 \cos(\theta)$
(D) $a_1 \sin(\theta)$



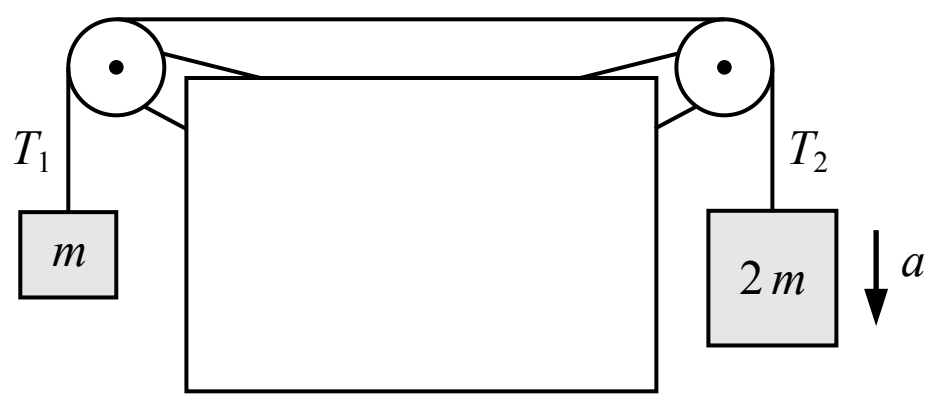
5. Two blocks are connected by a string with negligible mass which passes over a pulley with negligible mass and negligible friction as shown in the figure above. There is negligible friction between the block of mass m_1 and the surface. Which of the following is an expression for the magnitude of the acceleration of the lower block?

(A) g

(B) $\dfrac{m_2 g}{m_1}$

(C) $\dfrac{(m_1 + m_2)g}{m_1 + m_2}$

(D) $\dfrac{m_2 g}{m_1 + m_2}$



6. Two blocks are connected by a string with negligible mass which passes over two pulleys with negligible mass and negligible friction as shown in the figure above. One block has twice the mass of the other block and accelerates downwards. Which of the following correctly relates the tensions in the two segments of the string?

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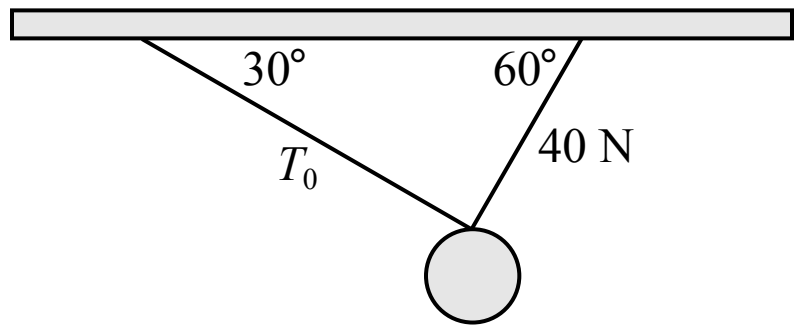

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(A) 20 N

(B) 69 N

(C) 23 N

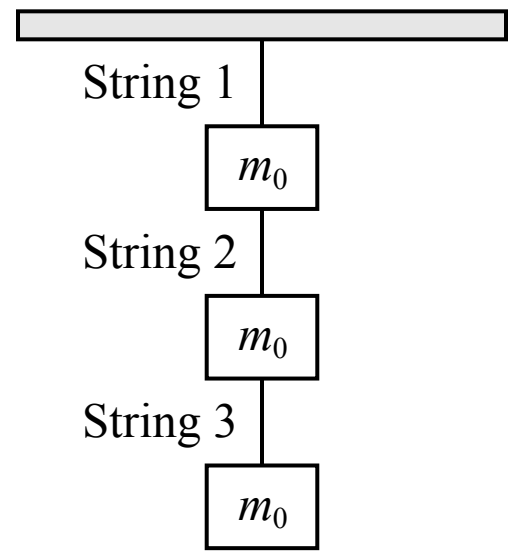
(D) 40 N

A Incorrect
This answer may incorrectly assume that the tension in the left cable is half of the tension in the right cable because the angle of the left cable with the horizontal is half of the angle of the right cable.

B Incorrect
This answer incorrectly uses $\sin(\theta)$ instead of $\cos(\theta)$ for the components of the tension forces that are equal in magnitude.

C **Correct**
The ball is at rest so the net force on the ball is zero. There is a downwards weight force acting on the ball and two tension forces acting on the ball in the direction of each cable. The net horizontal force on the ball is zero so the horizontal components of the two tension forces must be equal in magnitude and opposite in direction.
$\Sigma F_x = (40\text{ N})\cos(60°) - T_0\cos(30°) = m(0\text{ m/s}^2) \qquad T_0 = 23.1\text{ N}$

D Incorrect
This answer incorrectly assumes the tensions in both cables are the same.



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(A) 0

(B) $m_0 g$

(C) $2\,m_0 g$

(D) $3\,m_0 g$

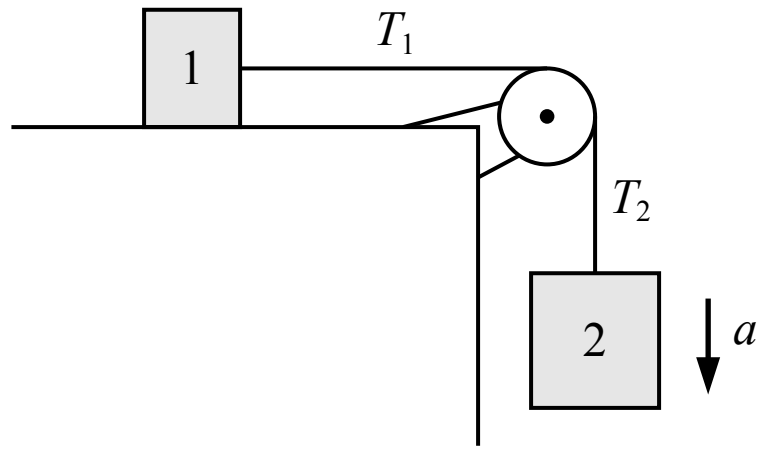
A **Correct**

When string 1 is cut the tension in string 1 becomes zero and there is no upwards force acting on the top block, or the system of the three blocks. The three blocks will be in free fall and accelerate downwards together at g, 9.8 m/s². If each individual block accelerates downwards at g then the net force acting on each block is only the weight force on that block, and there are no tension forces acting on the blocks (the tension in strings 2 and 3 is zero). If there were tension in strings 2 and 3, the top block would accelerate downwards faster than g and the bottom block would accelerate downwards slower than g and the blocks would move towards each other and compress or buckle the strings and there could not be tension in the strings.

B Incorrect

C Incorrect

D Incorrect



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(A) $T_1 = T_2$

(B) $T_1 < T_2$

(C) $T_1 > T_2$

(D) A comparison between the tensions cannot be determined

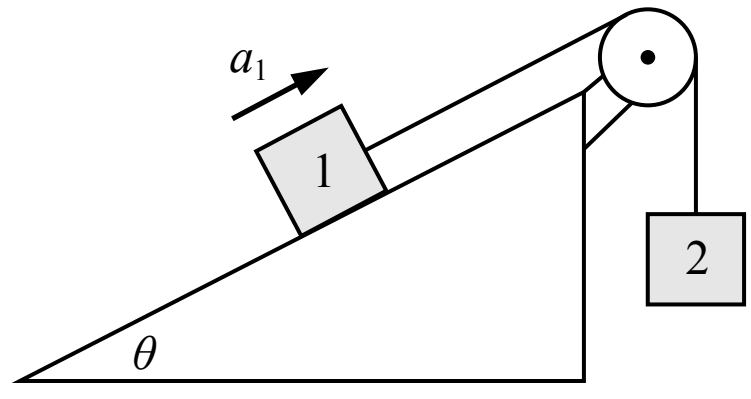
A **Correct**

The pulley has negligible mass and negligible friction so the tension is the same everywhere in the cable.

B Incorrect

C Incorrect

D Incorrect



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(A) g

(B) a_1

(C) $a_1 \cos(\theta)$

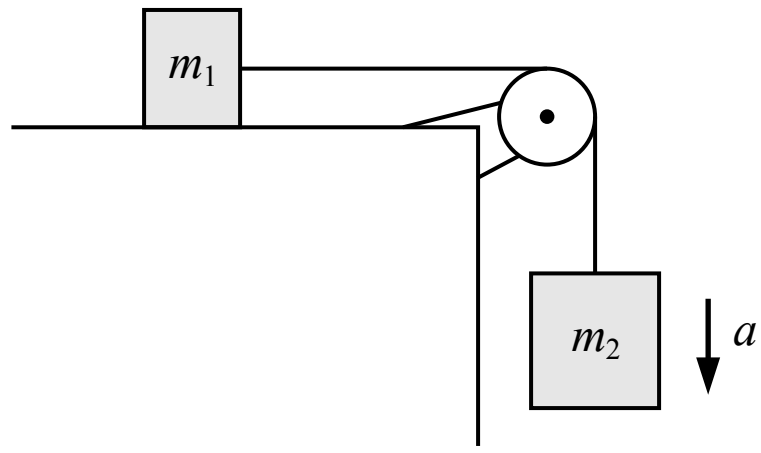
(D) $a_1 \sin(\theta)$

A Incorrect
There is an upwards tension force on block 2 so the acceleration of block 2 is not g.

B Correct
It is assumed that the cable does not change length so the magnitudes of the displacement, velocity and acceleration of each block is the same.

C Incorrect
This answer is the horizontal component of the a_1 vector which is not relevant to the question.

D Incorrect
This answer is the vertical component of the a_1 vector which is not relevant to the question.



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(A) g

(B) $\dfrac{m_2 g}{m_1}$

(C) $\dfrac{(m_1 + m_2)g}{m_1 + m_2}$

(D) $\dfrac{m_2 g}{m_1 + m_2}$

A Incorrect

B Incorrect

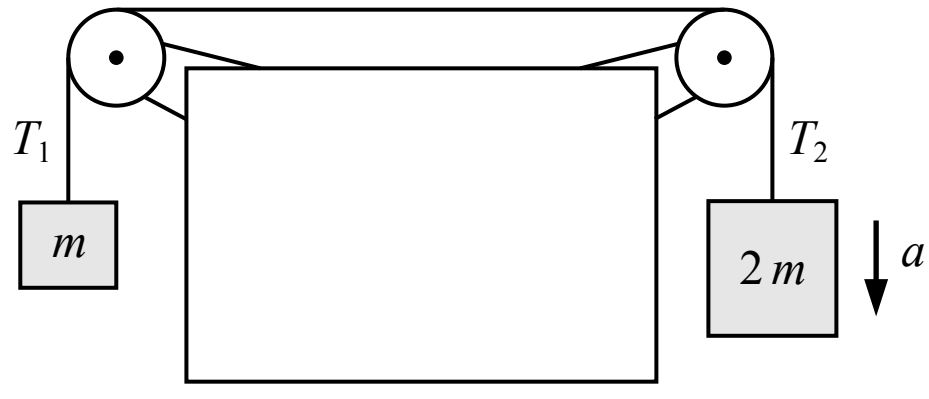
C Incorrect

D Correct

Newton's 2nd law can be applied to each block to get a system of two equations. The magnitude of the tension forces (T) and the accelerations of each block (a) are the same. If right and down are positive:

Block 1: $\Sigma F_x = T = m_1 a$

Block 2: $\Sigma F_y = m_2 g - T = m_2 a \qquad m_2 g - (m_1 a) = m_2 a \qquad m_2 g = m_1 a + m_2 a \qquad a = \dfrac{m_2 g}{m_1 + m_2}$



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A Incorrect

B Incorrect

C Correct

The pulleys have negligible mass and negligible friction so the tension is the same everywhere in the string.

D Incorrect