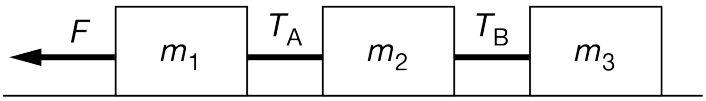
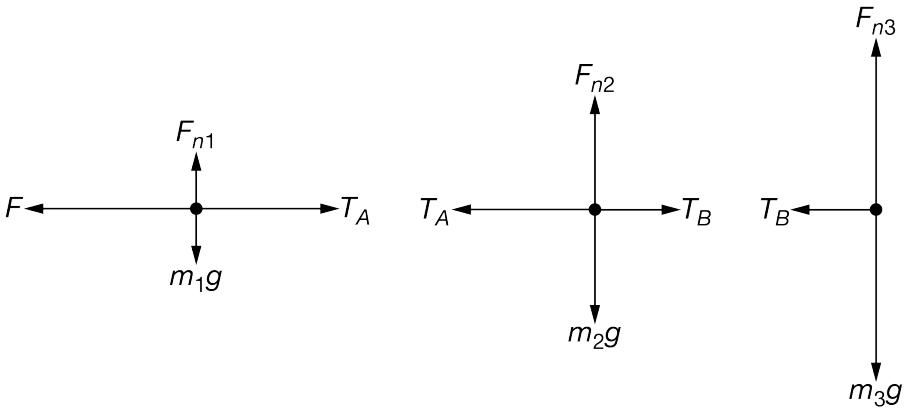
Unit 2 Progress Check: MCQ Part B



Three boxes are pulled to the left by strings with negligible mass on a horizontal surface, as shown above. The masses of the boxes are m_1, m_2, and m_3, where $m_3 > m_2 > m_1$. Friction between the boxes and the surface is negligible. The figure below shows force diagrams for each box.



1. Given that $m_3 > m_2 > m_1$, how do the force F and string tensions T_A and T_B compare?

(A) $T_\text{B} < T_\text{A} < F$ ✓

(B) $T_\text{B} = T_\text{A} < F$

(C) $T_\text{B} = T_\text{A} = F$

(D) $F < T_\text{A} < T_\text{B}$

2. Which of the following is a correct ranking of the normal forces F_{n1}, F_{n2}, and F_{n3} exerted on the boxes?

(A) $F_{n1} = F_{n2} = F_{n3}$

(B) $F_{n1} > F_{n2} > F_{n3}$

(C) $F_{n3} > F_{n2} > F_{n1}$ ✓

(D) The answer cannot be determined without knowing the masses of the boxes.

3. A student is trying to determine the tensions in the strings connecting the boxes. If the acceleration of the system and the pulling force F are known, which of the following pairs of equations could be used to find the tensions?

(A) $m_3 a_3 = T_\text{B}$ and $m_2 a_2 = T_\text{A}$

(B) $m_3 a_3 = T_\text{B}$ and $m_2 a_2 = T_\text{A} - T_\text{B}$ ✓

(C) $m_3 a_3 = F$ and $m_1 a_1 = F - T_\text{A}$

(D) $m_1 a_1 = F - T_\text{A}$ and $m_2 a_2 = T_\text{A}$

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4. Students attach a force probe in the middle of string A to measure T_A and then use a different force probe to provide the applied force F to the box of mass m_1. With the box of mass m_3 held in place by one student, a second student pulls to the left on the force probe that provides the applied force F. As the second student pulls with a steady force, and with the boxes remaining at rest, the following pairs of readings from the two force probes are recorded at different times.

Time	$F(N)$	$T_A(N)$
t_1	10.6	11
t_2	10.4	10
t_3	10.2	10
t_4	10.8	11
t_5	10.6	11

Based on the measurements above, how do the magnitudes of the two force quantities compare?

(A) The two quantities exactly agree numerically.

(B) The two quantities agree within experimental uncertainty but do not exactly agree numerically. ✓

(C) The two quantities disagree by an amount that is larger than the experimental uncertainty.

(D) The two quantities cannot be compared because the two force probes have different levels of precision.

A hockey player uses a hockey stick to hit a puck such that the stick provides an applied force on the puck. The puck travels for distance of $0.85\ \text{m}$ while experiencing the force from the stick. The puck leaves the stick with a speed of $8.0\ \text{m/s}$ and travels at constant speed in a straight line along the horizontal ice for a distance of $12\ \text{m}$. The frictional force between the puck and the ice surface is negligible.

5. How does the magnitude of the force exerted by the stick on the puck $F_{\text{puck, stick}}$ compare to the magnitude of the force exerted by the puck on the stick $F_{\text{stick, puck}}$ at the time interval in which the stick is in contact with the puck?

(A) $F_{\text{puck, stick}} < F_{\text{stick, puck}}$

(B) $F_{\text{puck, stick}} > F_{\text{stick, puck}}$

(C) $F_{\text{puck, stick}} = F_{\text{stick, puck}}$ ✓

(D) It cannot be determined because the masses of the puck and stick are unknown.

6. Which of the following statements best describes the force or forces exerted on the puck after it is hit by the stick and slides on the ice?

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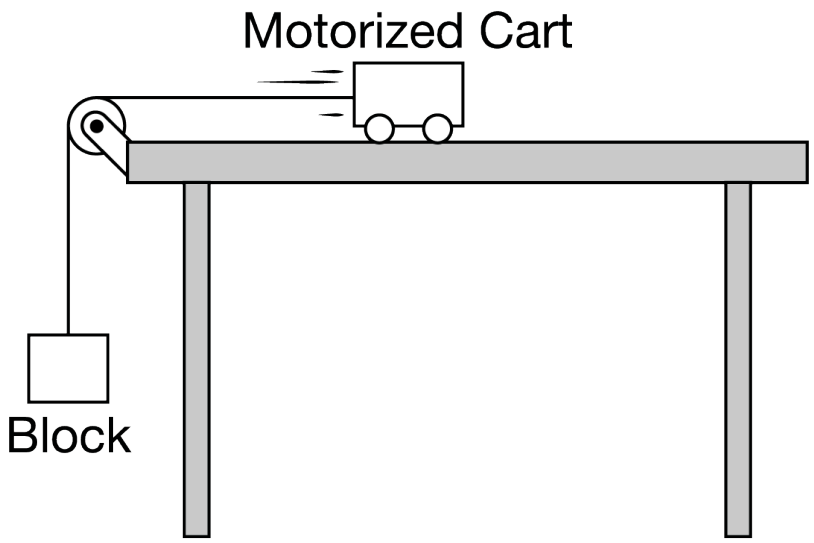
(A) The applied force from the stick is still exerted on the puck during this time.

(B) Since the puck's acceleration is zero, there are no forces exerted on the puck during this time.

(C) Since there is no frictional force exerted on the puck, a normal force is not exerted on the puck, but the gravitational force is exerted on the puck.

(D) There is no frictional force exerted on the puck, and the gravitational force and normal force are exerted on the puck and are equal in magnitude. ✓

7.



A motorized cart is attached to a string that passes over a pulley. The other end of the string is attached to a hanging block. In the figure shown above, the cart is accelerating to the right. Which of the following best represents the forces acting on the cart at the instant shown?

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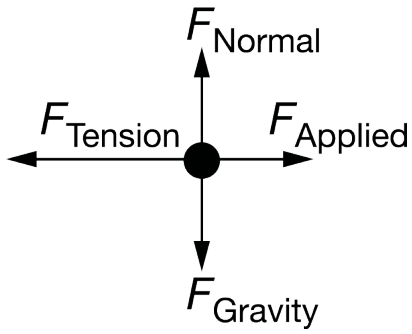
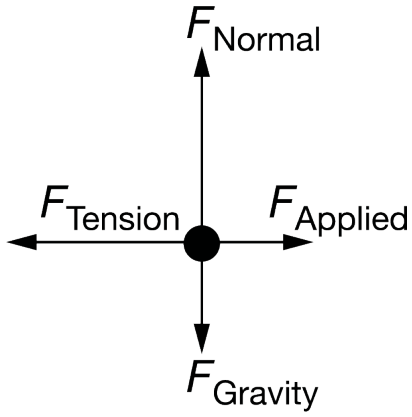
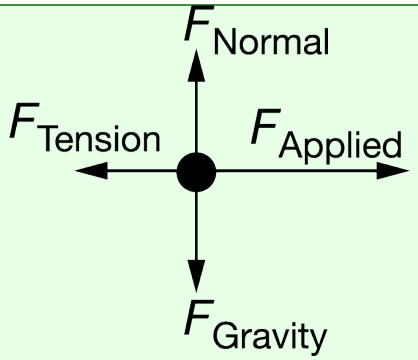
(A)



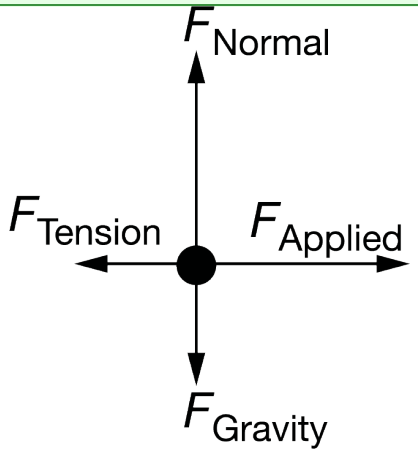
(B)



(C) ✓



(D)



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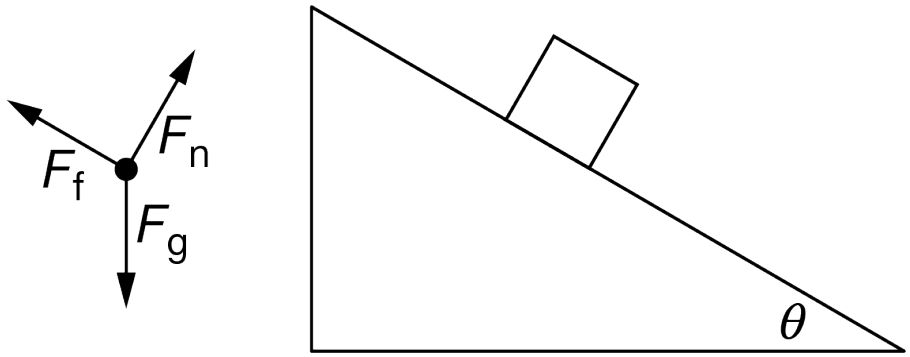
8.



A block slides with constant velocity down a rough inclined plane that makes an angle of θ with the horizontal. It experiences three forces: gravitational (F_g), normal (F_N), and frictional (F_f). Which of the following gives the magnitude of the net force on the block?

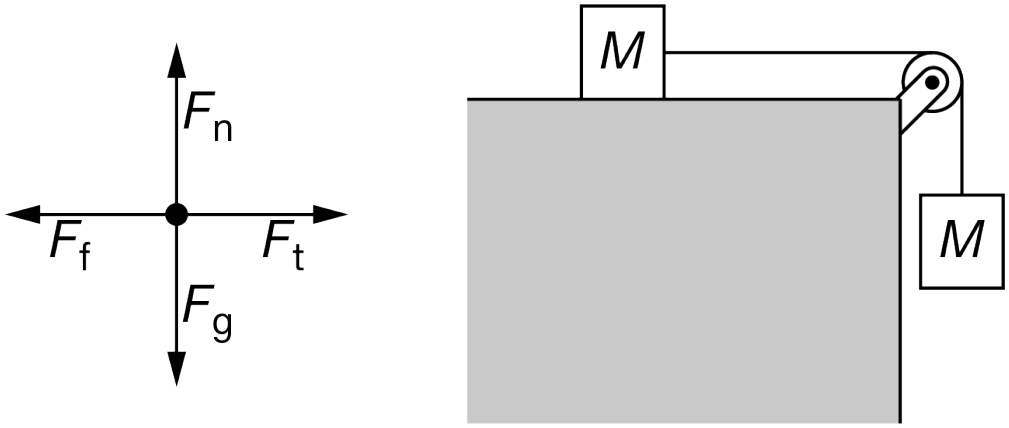
(A) Zero ✓

(B) $F_f + F_N - F_g$

(C) $F_g \cos\theta - F_f$

(D) $F_g \sin\theta + F_N \cos\theta - F_f$

9.



In the setup shown in the figure, two blocks of equal mass M are at rest but are just about to slip. Also shown is a free-body diagram for the block on top of the table. In this setup, the coefficient of static friction between the table and the block resting upon it must be

(A) 0

(B) between 0 and 0.5

(C) between 0.5 and 1.0

(D) at least 1.0 ✓

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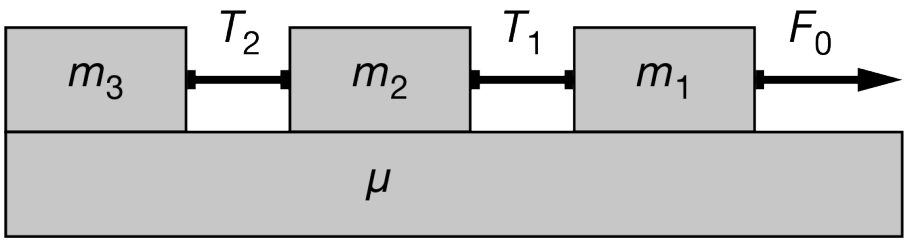
10.



Three blocks with masses m_1, m_2, and m_3 are attached by strings, as shown in the figure above. The coefficient of friction between each of the blocks and the horizontal surface is μ. The tension in the left and right strings is T_2 and T_1, respectively. If the acceleration of the blocks is a, which of the following expressions is equal to T_2 ?

(A) $T_1 + m_2a - \mu m_2g$

(B) $T_1 - m_2a - \mu m_2g$ ✓

(C) $T_1 - m_2a + \mu m_2g$

(D) $T_1 + m_2a + \mu m_2g$

11. A falling skydiver opens his parachute. A short time later, the weight of the skydiver-parachute system and the drag force exerted on the system are equal in magnitude. Which of the following statements predicts the motion of the skydiver at this time?

(A) The skydiver is at rest.

(B) The skydiver is moving downward with constant speed. ✓

(C) The skydiver is moving downward with an upward acceleration.

(D) The skydiver is moving downward with a downward acceleration.

12. The following figures each show vectors representing the forces exerted on an object that is initially at rest. In which case will the object remain at rest?

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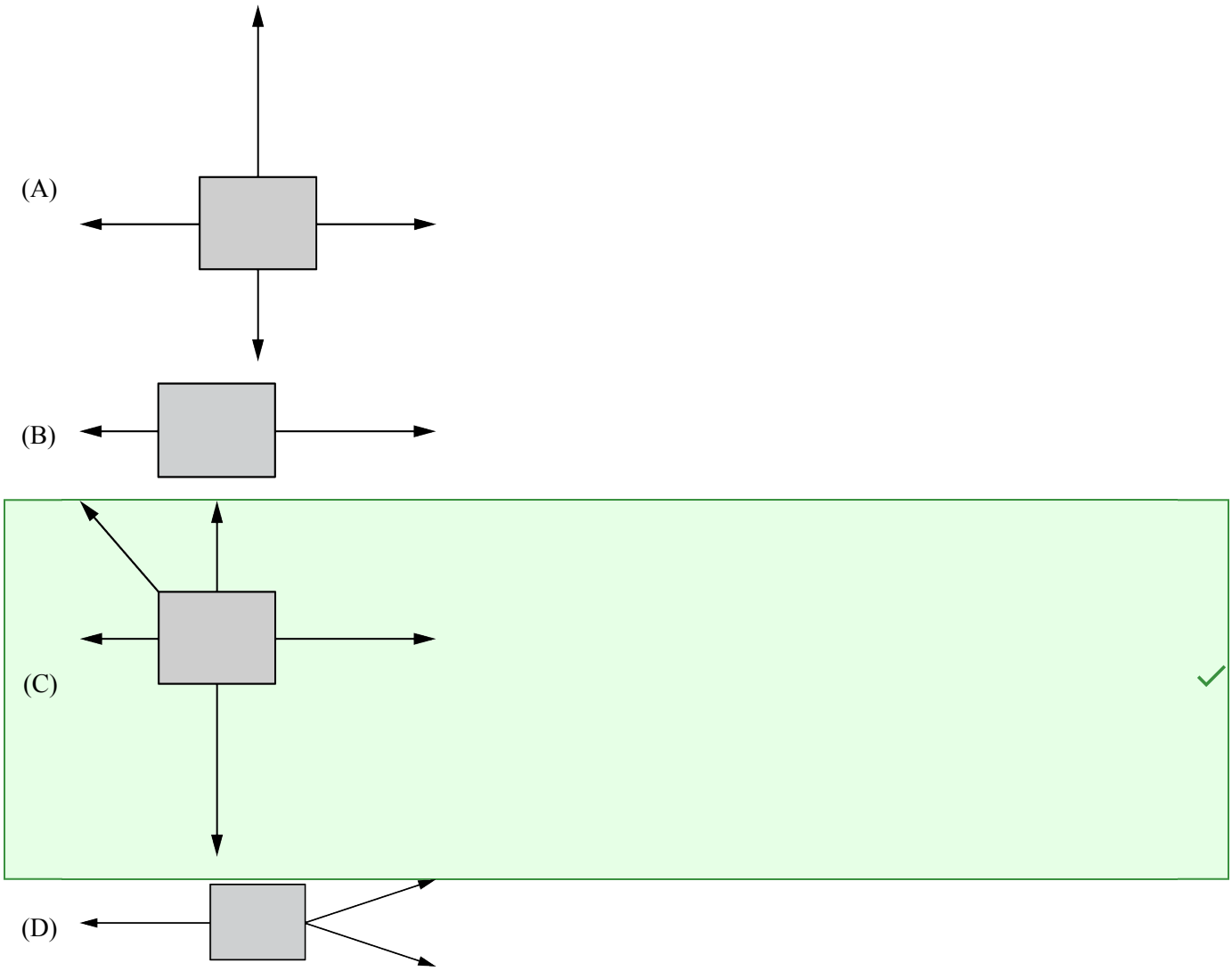
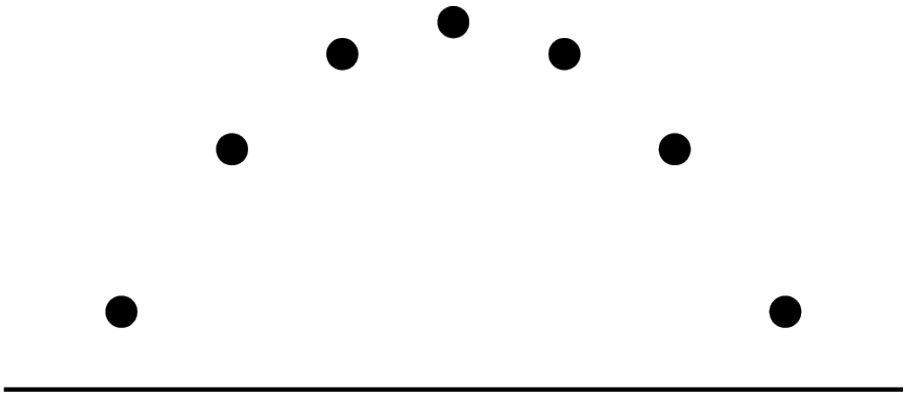


13.



A person kicks a ball into the air with a force F_0. The figure shows the position of the ball at various times. What is the net force on the ball and its acceleration at the highest point shown?

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(A)

Force	Acceleration
Zero	Zero

(B) ✓

Force	Acceleration
mg	g

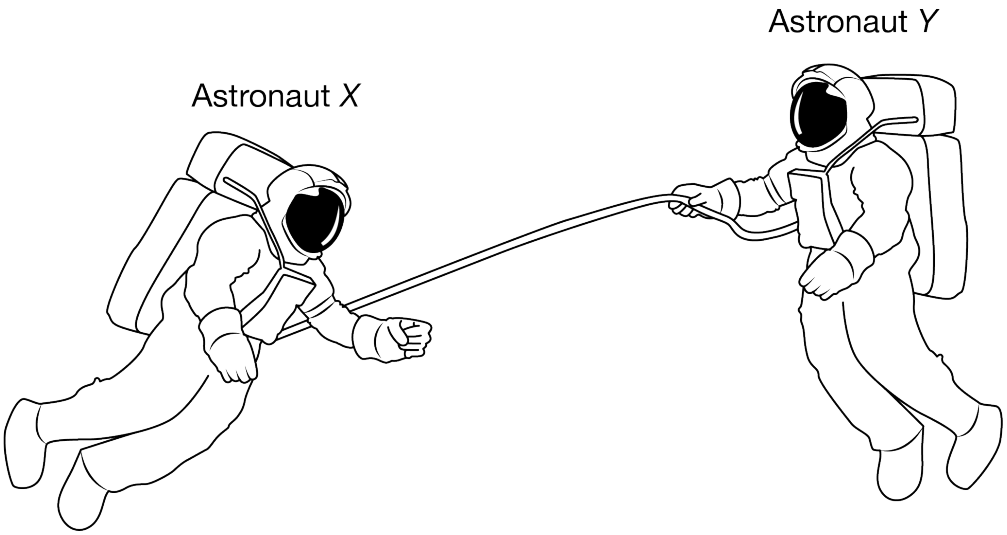
(C)

Force	Acceleration
$mg + F_0$	g

(D)

Force	Acceleration
$mg + F_0$	Greater than g

14.



Two astronauts of identical mass are connected by a taut cable of negligible mass, as shown in the figure above, and are initially at rest with respect to a nearby space station. Astronaut Y pulls on the cable toward herself with considerable force. Which of the following describes the direction of the velocity of the center of mass of the two astronauts after Astronaut Y pulls on the cable?

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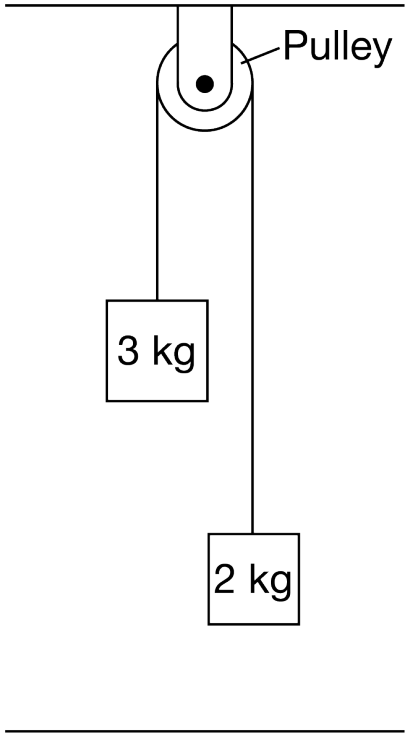
(A) The center of mass moves toward Astronaut Y.

(B) The center of mass moves toward Astronaut X.

(C) The center of mass does not move. ✓

(D) It cannot be determined without more information.

15.



Two blocks of mass $2\ \text{kg}$ and $3\ \text{kg}$ are connected by a light string that passes over a pulley, as shown above. The pulley has negligible mass and friction. The two-block system is released from rest. Which of the following correctly describes the velocity of the two-block system's center of mass?

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(A)

Direction of Velocity	Magnitude of Velocity
Upward	Increasing

(B)

Direction of Velocity	Magnitude of Velocity
Upward	Decreasing

(C) ✓

Direction of Velocity	Magnitude of Velocity
Downward	Increasing

(D)

Direction of Velocity	Magnitude of Velocity
Downward	Decreasing

16. Two ice skaters, Skater X and Skater Y, are at rest on a horizontal surface made of ice. The friction between the ice and the skaters is negligible. Skater X, who has a smaller mass than Skater Y, pushes Skater Y such that Skater Y travels with a speed of $2v_o$ to the right. Which of the following indicates the direction of the velocity of Skater X and the direction of the velocity of the center of mass of the two-skater system after the push?

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(A)

Skater X	Center of Mass
To the left	To the right

(B) ✓

Skater X	Center of Mass
To the left	Zero

(C)

Skater X	Center of Mass
Zero	To the right

(D)

Skater X	Center of Mass
Zero	Zero

17. An object of mass M is dropped near the surface of Earth such that the gravitational field provides a constant downward force on the object. Which of the following describes what happens to the center of mass of the object-Earth system as the object falls downward toward Earth?

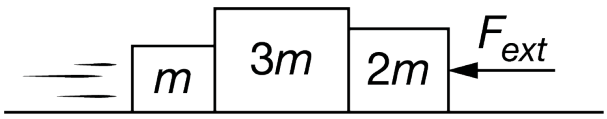
(A) It moves toward the center of Earth.

(B) It moves toward the object.

(C) It does not move. ✓

(D) The answer cannot be determined without knowing the mass of Earth and the distance between the object and Earth's center.

18.



Three blocks are sliding together to the right along a surface of negligible friction when a force with magnitude F_{ext} is exerted to the left on the rightmost block, as shown in the figure. The masses of the blocks are indicated in the figure. If the force is exerted for a time Δt, what is the change in velocity of the center of mass of the three-block system?

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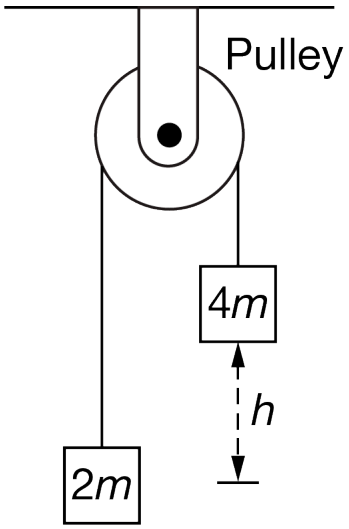
(A) $\frac{F_{ext}}{6m}\Delta t$ ✓

(B) $\frac{F_{ext}}{2m}\Delta t$

(C) $\frac{2F_{ext}}{m}\Delta t$

(D) $\frac{6F_{ext}}{m}\Delta t$

19.



Block A of mass $4m$ is attached by a light string to block B of mass $2m$. The string passes over a pulley with negligible friction and of negligible mass. Block A is held a distance h above the ground, as shown. The blocks are released from rest, and block A reaches the ground two seconds later. The value of h is most nearly

(A) $13.3\ \mathrm{m}$

(B) $6.7\ \mathrm{m}$ ✓

(C) $3.3\ \mathrm{m}$

(D) $2\ \mathrm{m}$

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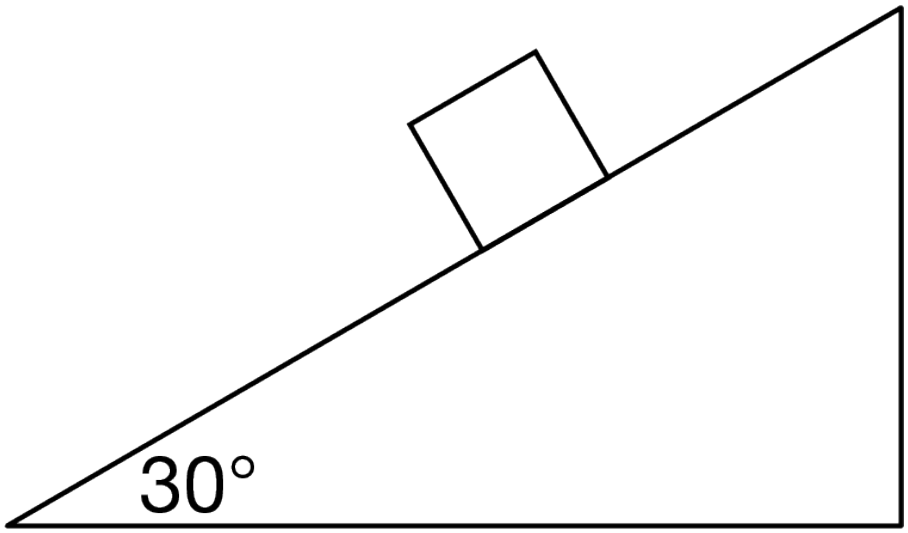
20.



A 1 kg block is placed near the top of an inclined plane that is at an angle of 30 degrees with respect to the ground, as shown above. By correctly determining the effect of gravity, a student predicts that the acceleration of the block will be $5\ \text{m/s}^2$. After allowing the block to slide down the inclined plane, the student finds that the acceleration is actually $4\ \text{m/s}^2$. What type of force did the student most likely not account for when predicting the acceleration of the block, and what is the magnitude of that force?

(A) Force of friction of approximately 0.1 N

(B) Force of friction of approximately 1 N ✓

(C) Normal force of approximately 0.1 N

(D) Normal force of approximately 1 N

21.

Force Label	Magnitude of Force (N)
F_1	30
F_2	6
F_3	24
F_4	30

A 3 kg object experiences a rightward horizontal acceleration of $6\ \text{m/s}^2$ as it slides to the right across a rough, horizontal surface. The table above contains the label and magnitude of four forces exerted to the right or left on the object that represent measurements from an experiment as the object accelerates. Which pair of opposing forces in which directions could be responsible for the acceleration of the object?

(A) F_1 to the right and F_2 to the left

(B) F_3 to the right and F_2 to the left ✓

(C) F_4 to the right and F_1 to the left

(D) F_4 to the right and F_3 to the left