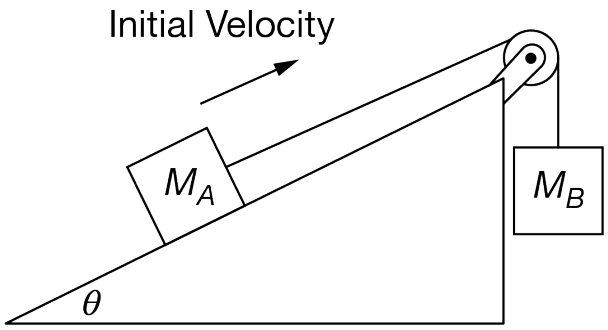
Unit 2 Progress Check: MCQ Part A

Block A is placed on a rough surface inclined at an angle θ above the horizontal. A taut string connects block A over a pulley to block B, which hangs from the string, as shown below. The masses of blocks A and B are M_A and M_B, respectively. At time $t = 0$, block A is sliding up the slope as block B falls, and the blocks are both slowing down. Assume that the mass and friction of the pulley are negligible.



1. If the mass of block B is 2kg, the gravitational force exerted on block B is most nearly which of the following?

(A) 0.2N

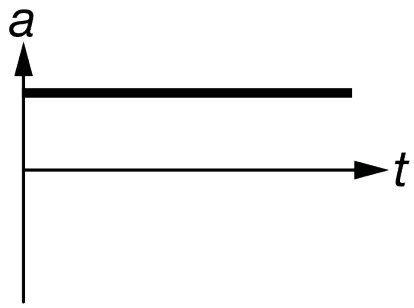
(B) 2N

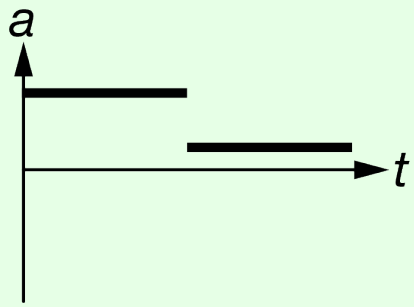
(C) 20N ✓

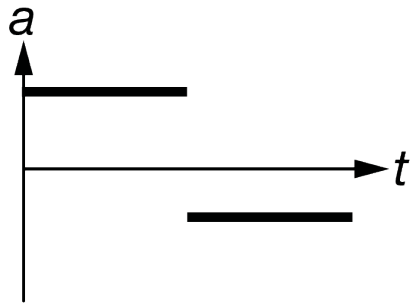
(D) It is impossible to determine without knowing the mass of block A.

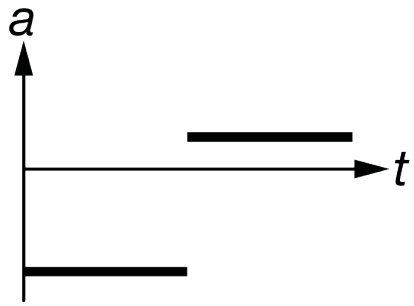
2. The two blocks eventually stop and reverse direction. Which of the following graphs best predicts the acceleration of block A as it moves up and down the rough, inclined surface? Assume that the positive direction points down the slope.

Unit 2 Progress Check: MCQ Part A

(A)


(B) ✓


(C)


(D)


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3. A $5\ \text{kg}$ object is released from rest near the surface of a planet such that its gravitational field is considered to be constant. The mass of the planet is unknown. After $2\ \text{s}$, the object has fallen $30\ \text{m}$. Air resistance is considered to be negligible. What is the gravitational force exerted on the $5\ \text{kg}$ object near the planet's surface?

(A) $5\ \text{N}$

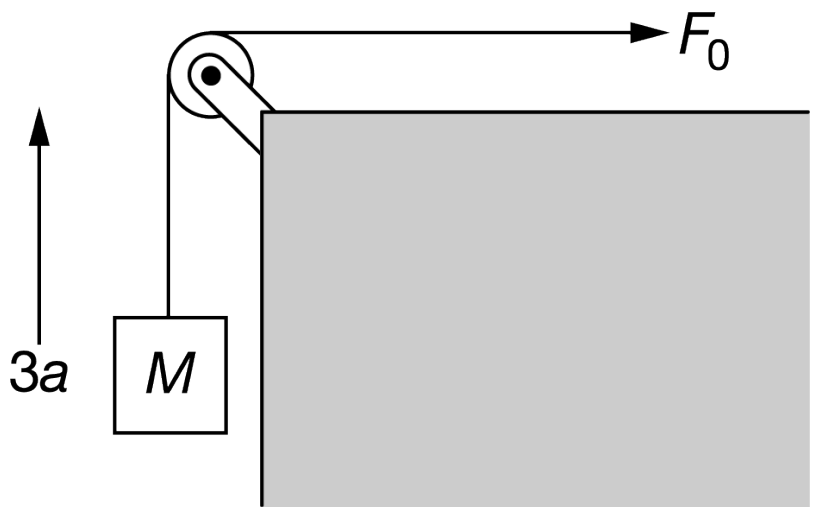
(B) $15\ \text{N}$

(C) $37.5\ \text{N}$

(D) $75\ \text{N}$ ✓

Unit 2 Progress Check: MCQ Part A

4.



A block of mass M is attached to a modified Atwood machine and is accelerated upward at $3a$ by a constant force F_0. What is the weight of the block?

(A) $F_0 - Mg$

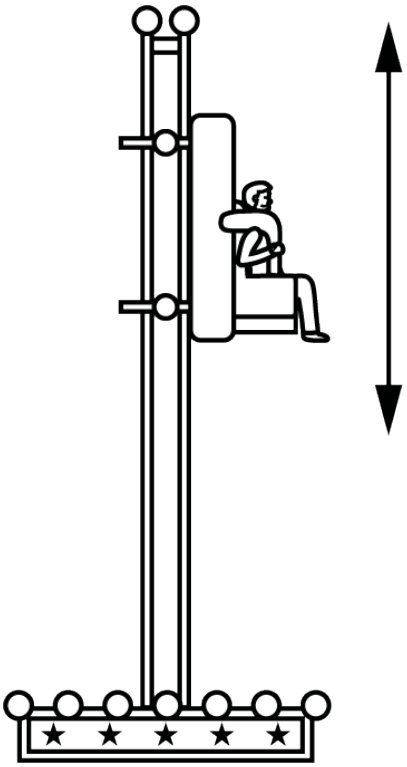
(B) $3Mg$

(C) $2Mg$

(D) Mg ✓

Unit 2 Progress Check: MCQ Part A

5.



The amusement park ride shown above takes riders straight up a tall tower and then releases an apparatus holding seats. This apparatus free-falls back to Earth and is stopped safely right above the ground. Which of the following indicates the magnitude of the gravitational force exerted on a rider of mass m on the way up and on the way down?

Unit 2 Progress Check: MCQ Part A

(A)

Way Up	Way Down
Zero	Zero

(B)

Way Up	Way Down
Less than mg	Equal to mg

(C) ✓

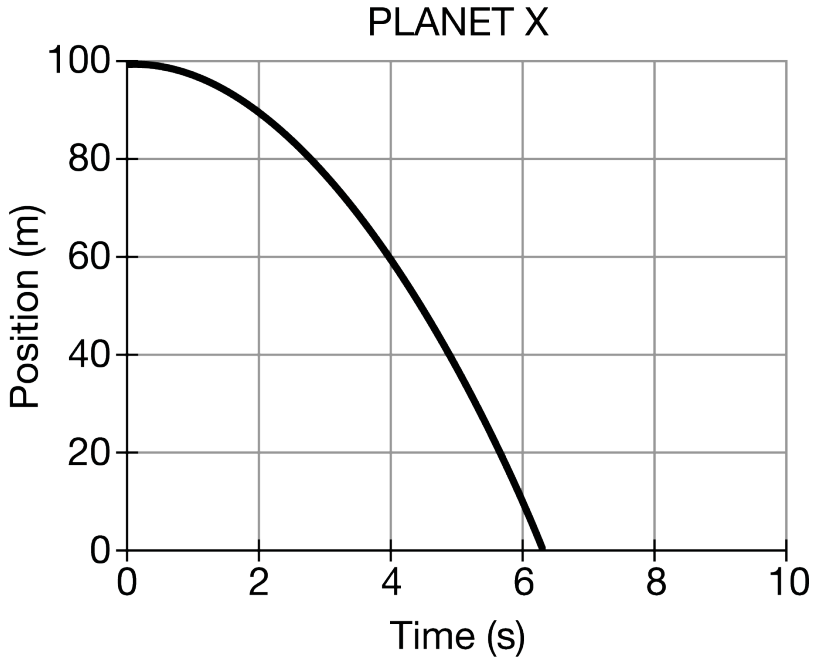
Way Up	Way Down
Equal to mg	Equal to mg

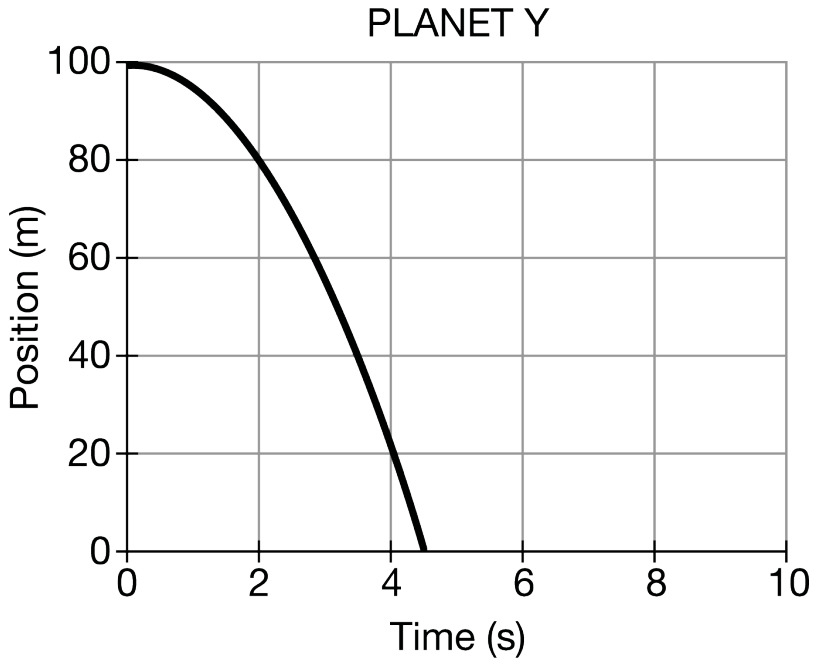
(D)

Way Up	Way Down
Greater than mg	Zero

Unit 2 Progress Check: MCQ Part A

6.





Identical spheres are dropped from a height of $100\ \text{m}$ above the surfaces of both Planet X and Planet Y. The position of the spheres as a function of time is recorded as the spheres fall. These data are shown in the graphs above. Which planet exerts a greater gravitational force on the sphere, and what evidence supports this conclusion?

Unit 2 Progress Check: MCQ Part A

(A) Planet X, because the object's final speed is greater.

(B) Planet X, because the object's time of fall is greater.

(C) Planet Y, because the area under the curve is smaller.

(D) Planet Y, because the magnitude of the slope of the curve increases at a faster rate. ✓

7. Two identical blocks, block A and block B, are placed on different horizontal surfaces. Block A is initially at rest on a smooth surface, while block B is initially at rest on a rough surface. A constant horizontal force of magnitude F_0 is exerted on each block. After the force has been applied for a time Δt, the speeds of blocks A and B are v_A and v_B, respectively. Which of the following claims indicates the correct relation between v_A and v_B and provides the best justification for the relation?

(A) $v_A < v_B$. The forces between the atoms in a block and the atoms in a surface oppose the motion of the block and are greater, on average, for block A.

(B) $v_A < v_B$. The forces between the atoms in a block and the atoms in a surface oppose the motion of the block and are greater, on average, for block B.

(C) $v_A > v_B$. The forces between the atoms in a block and the atoms in a surface oppose the motion of the block and are greater, on average, for block A.

(D) $v_A > v_B$. The forces between the atoms in a block and the atoms in a surface oppose the motion of the block and are greater, on average, for block B. ✓

8. Which of the following experiments could be used to determine the inertial mass of a block?

(A) Place the block on a rough horizontal surface. Lift one end of the surface up and measure the angle the surface makes with the horizontal at the moment the block begins to slide.

(B) Drop the block from different heights and measure the time of fall from each height.

(C) Place the block on a rough horizontal surface. Give the block an initial velocity and then let it come to rest. Measure the initial velocity and the distance the block moves in coming to rest.

(D) Use a spring scale to exert a force on the block. Measure the acceleration of the block and the applied force. ✓

9. A $1500\ \mathrm{kg}$ car traveling along a road is hit by a $0.1\ \mathrm{kg}$ rock that creates a small crack in the car's windshield. Which of the following describes the interaction between the windshield and the rock?

(A) The car exerts a force on the rock, but the rock does not exert a force on the car.

(B) The rock exerts a force on the car, but the car does not exert a force on the rock.

(C) The car exerts a force on the rock, and the rock exerts a force on the car. The two forces are not equal in magnitude.

(D) The car exerts a force on the rock, and the rock exerts a force on the car. The two forces are equal in magnitude. ✓

10. Two objects, X and Y, move toward one another and eventually collide. Object X has a mass of $2M$ and is moving at a speed of $2v_0$ to the right before the collision. Object Y has a mass of M and is moving at a speed of v_0 to the left before the collision. Which of the following describes the magnitude of the forces F the objects exert on each other when they collide?

Unit 2 Progress Check: MCQ Part A

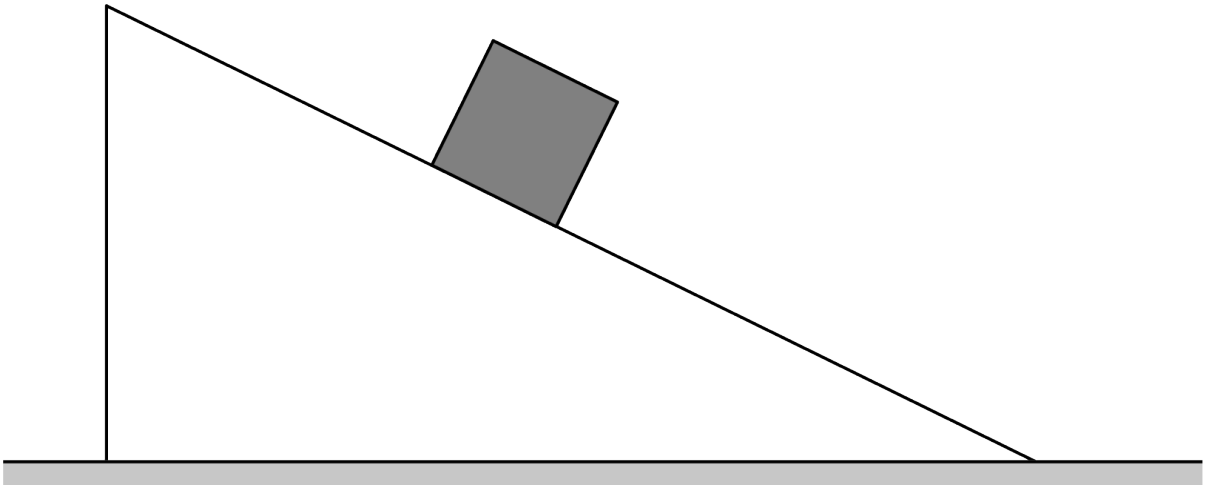
(A) The force exerted by X on Y is $4F$ to the right, and the force exerted by Y on X is F to the left.

(B) The force exerted by X on Y is $2F$ to the right, and the force exerted by Y on X is F to the left.

(C) The force exerted by X on Y is F to the right, and the force exerted by Y on X is F to the left. ✓

(D) The force exerted by X on Y is F to the left, and the force exerted by Y on X is F to the right.

11.



A block is placed on an inclined plane and remains stationary, as shown in the figure above. A student claims, "The block remains stationary because as gravity tries to pull the block down the ramp, the block exerts an equal and opposite force on itself up the ramp." Is the student's claim correct? Justify your answer.

(A) Yes. Newton's first law states the block must remain stationary unless pushed.

(B) Yes. Newton's third law states the block must exert a force equal and opposite to gravity.

(C) No. Newton's first law states the block's inertia must cause it to move down the ramp.

(D) No. Newton's third law states the block cannot exert a force on itself. ✓

12. Students connect a spring scale to a block on a rough horizontal surface. The students use the spring scale to measure the magnitude of the horizontal force needed to pull the block at a constant speed. Which of the following statements explains why two forces exerted between objects are equal in magnitude?

(A) The gravitational and normal forces exerted on the block, because they are a Newton's third-law pair.

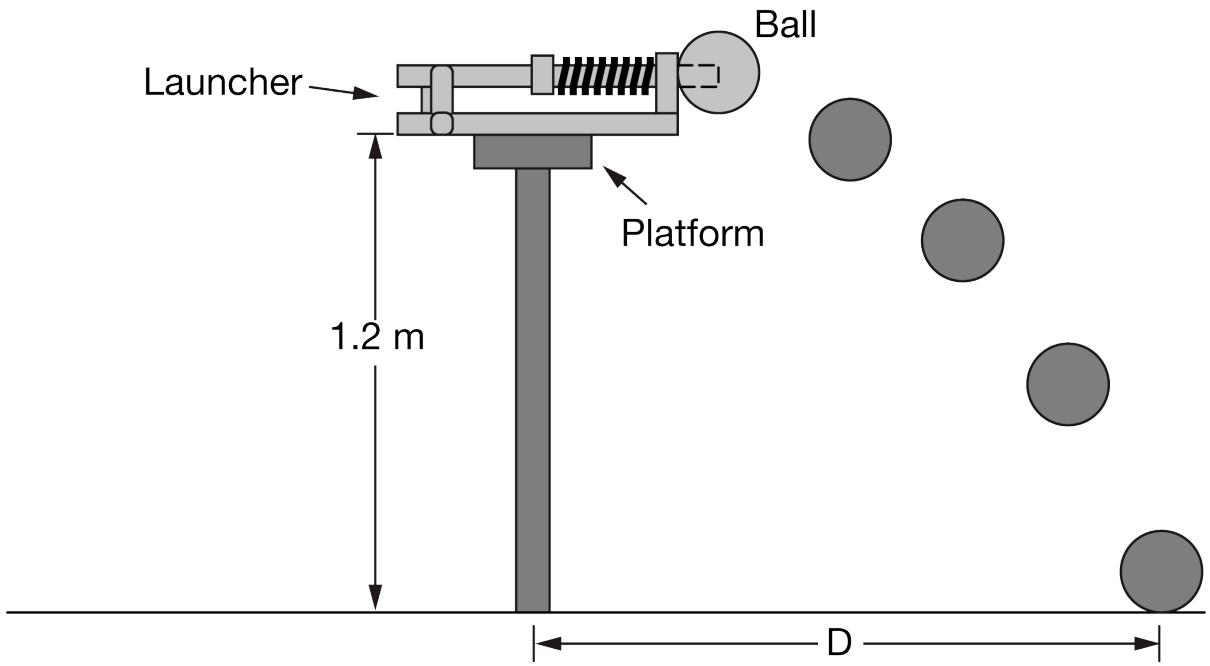
(B) The frictional force and force exerted by the spring scale on the block, because they are a Newton's third-law pair.

(C) The normal force and the frictional force exerted on the block, because objects always exert forces of equal magnitude on each other.

(D) The frictional forces that the block and the surface exert on each other, because objects always exert forces of equal magnitude on each other. ✓

Unit 2 Progress Check: MCQ Part A

13.



A spring-loaded launcher has a mass of $0.60\ \text{kg}$ and is placed on a platform $1.2\ \text{m}$ above the ground. The force of friction is negligible between the platform and the launcher. The launcher fires a $0.30\ \text{kg}$ ball that lands a distance D to the right of the platform, as shown in the diagram above. Which of the following explanations is true?

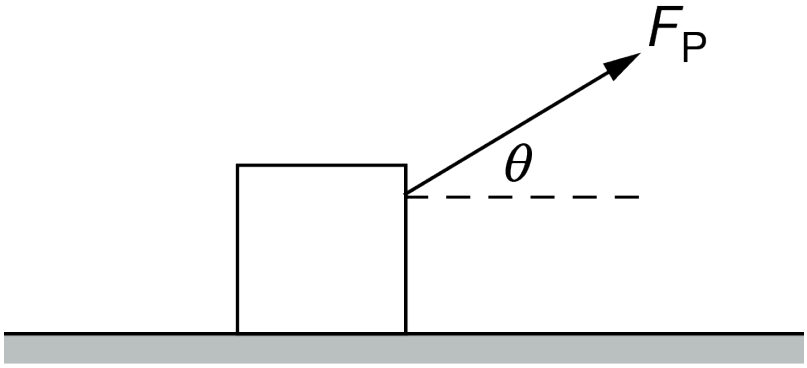
(A) The launcher will not fall off the platform because only the ball receives an applied force.

(B) The launcher will fall off the platform and land $\frac{\text{D}}{3}$ to the left of the platform because the mass of the system is three times the mass of the ball.

(C) The launcher will fall off the platform and land $\frac{\text{D}}{2}$ to the left of the platform because the launcher is twice the mass of the ball. ✓

(D) The launcher will fall off the stand and land D to the left of the stand because the force is the same on both objects.

14.



A student pulls a block over a rough surface with a constant force F_P that is at an angle θ above the horizontal, as shown above. If F_P remains constant but the angle θ is increased, which of the following is true at some later time?

Unit 2 Progress Check: MCQ Part A

(A) The force of friction between the block and surface will increase.

(B) The force of friction between the block and surface will decrease. ✓

(C) The weight of the block will increase.

(D) The weight of the block will decrease.

15. A satellite orbits Earth. The only force on the satellite is the gravitational force exerted by Earth. How does the satellite's acceleration compare to the gravitational field at the location of the satellite? Select two answers.

A The gravitational field strength is unrelated to the acceleration.

B The gravitational field strength is smaller than the acceleration.

C The gravitational field and the acceleration point in the same direction. ✓

D The magnitudes of the acceleration and the gravitational field strength are equal. ✓

16. An object is at rest on the ground. The object experiences a downward gravitational force from Earth. Which of the following predictions is correct about why the object does not accelerate downward? Select two answers. Justify your selections.

A The bonded molecules of the object are repelled upward by the bonded molecules of the ground with the same magnitude as the gravitational force downward on the object. ✓

B The normal force is exerted upward on the object from the ground with the same magnitude as the gravitational force downward on the object. ✓

C The bonded molecules of the object are attracted downward by the bonded molecules of the ground with the same magnitude as the gravitational force downward on the object.

D The force of friction is exerted upward on the object from the ground with the same magnitude as the gravitational force downward on the object.

17.

Trial Number	Force Sensor Reading (N)
1	0.0
2	8.5

A student uses an electronic force sensor to study how much force the student's finger can apply to a specific location. The student uses one finger to apply a force on the sensor, and data collected from two trials are shown in the table. During which trial, if any, does the student's finger experience the greatest electromagnetic force?

(A) Trial 1, because the student's finger did not apply a force to the sensor.

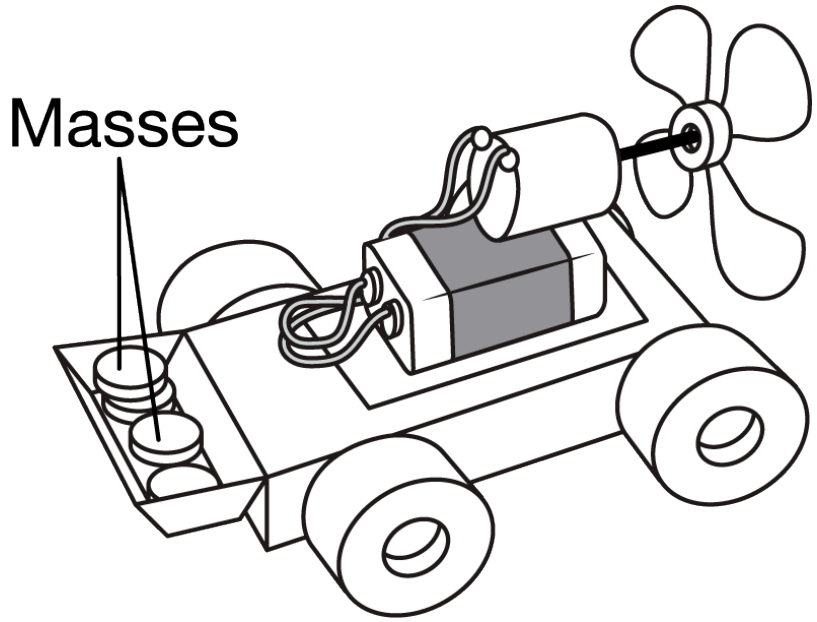
(B) Trial 2, because the student's finger applied the largest force to the sensor. ✓

(C) An electromagnetic force is not exerted on the student's finger for any trial because the sensor does not apply any force to the student's finger.

(D) An electromagnetic force is not exerted on the student's finger for any trial because the only force that the sensor applies to the student's finger is a normal force.

Unit 2 Progress Check: MCQ Part A

18.



A toy car has a battery-powered fan attached to it such that the fan creates a constant force that is exerted on the car so that it is propelled in the opposite direction in which the fan blows air. The car has a carriage that allows a student to attach objects of different masses, as shown above. The fan has only one speed setting. All frictional forces are considered to be negligible. Which of the following procedures could be used to determine how the mass of the fan-car-object system affects the acceleration of the system?

(A) Measure the mass of the system using a balance, activate the fan, measure the distance traveled by the system at a known time by using a stopwatch, and repeat the experiment for several trials with different objects added to the carriage. ✓

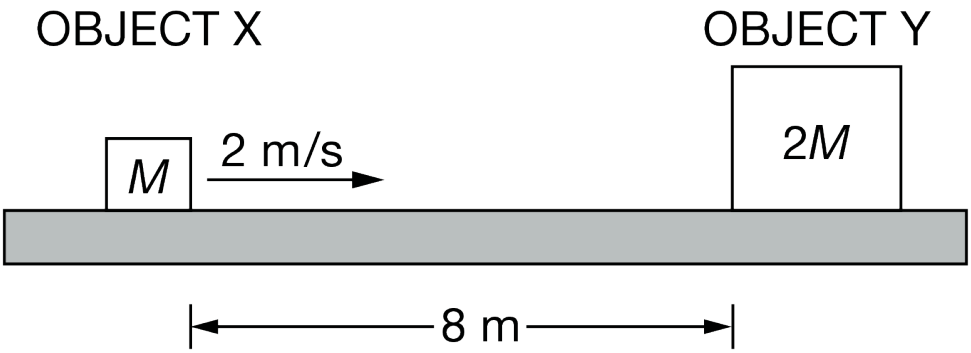
(B) Measure the mass of the system using a balance, activate the fan, use a meterstick and stopwatch to measure the initial and final speeds of the system, and repeat the experiment for several trials with different objects added to the carriage.

(C) Measure the mass of the system using a balance, connect a spring scale to the back of the car, measure the amount of force required to hold the system at rest, and repeat the experiment for several trials with different objects added to the carriage.

(D) Measure the mass of the system using a balance, activate the fan, use a stopwatch to record the time it takes for the system to travel before the battery of the fan no longer works, and repeat the experiment for several trials with different objects added to the carriage.

Unit 2 Progress Check: MCQ Part A

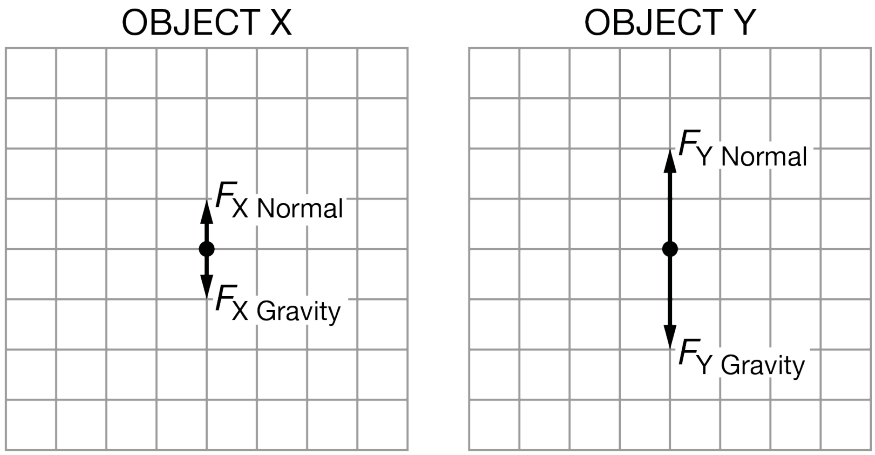
19.



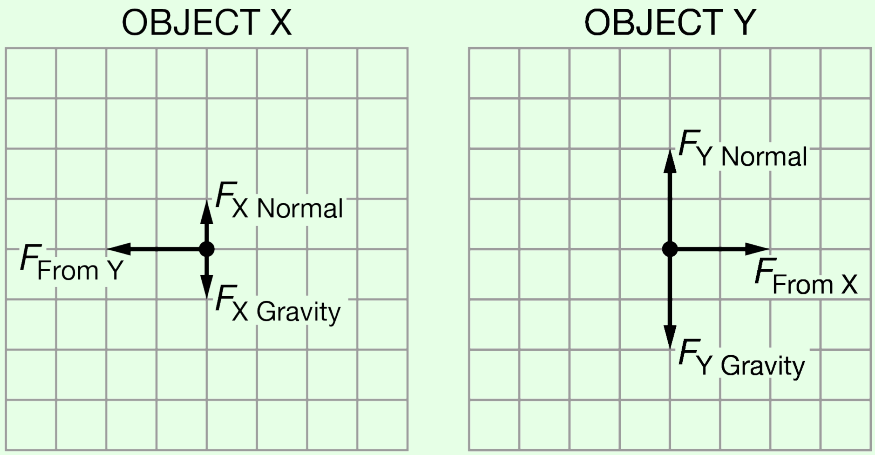
At time $t = 0\text{s}$, object X of mass M travels at a constant speed of $2\,\text{m/s}$ to the right toward object Y of mass $2M$ that is a distance of 8m away from object X while at rest, as shown above. Both objects are on a horizontal surface, where the frictional forces may be considered negligible. Which of the following pairs of force diagrams represents the forces exerted on object X and object Y at $t = 4\,\text{s}$?

Unit 2 Progress Check: MCQ Part A

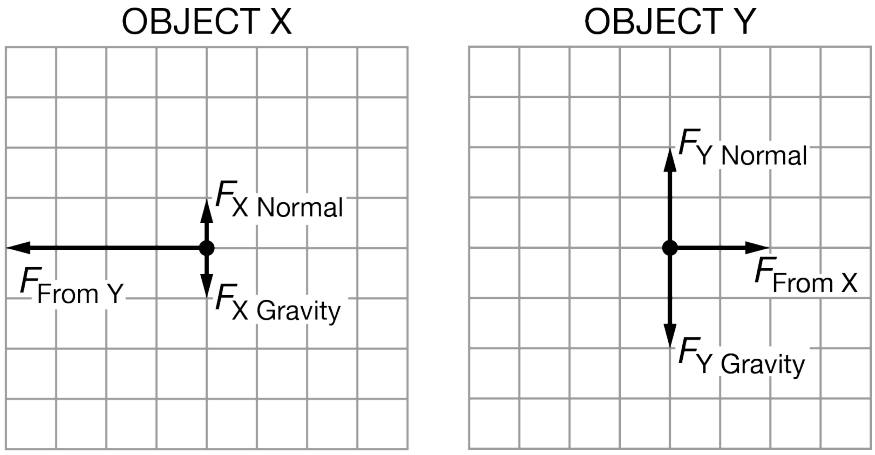
(A)



(B) ✓

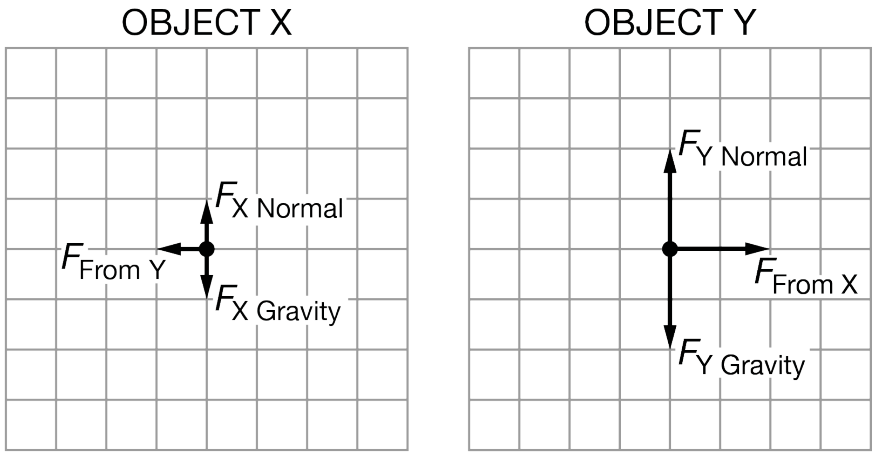


(C)

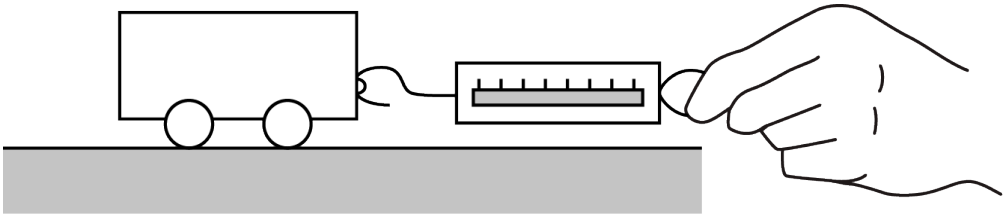


Unit 2 Progress Check: MCQ Part A

(D)



20.

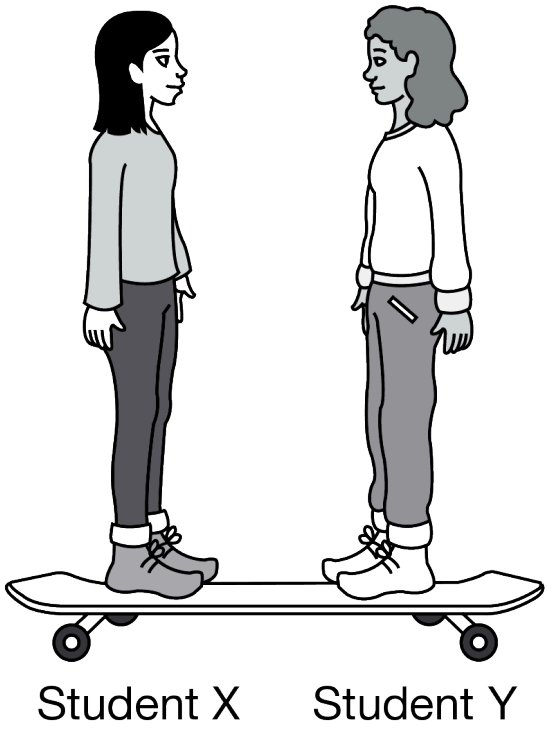


A student sets up an experiment to determine the inertial mass of a cart. The student has access to the following measurement equipment: a spring scale, a meterstick, and a stopwatch. The student uses the spring scale to pull the cart starting from rest along a horizontal surface such that the reading on the spring scale is always constant. All frictional forces are negligible. In addition to the spring-scale reading, which two of the following quantities could the student measure with the available equipment and then use to determine the inertial mass of the cart? Select two answers.

- A The total distance traveled by the cart after it has been in motion ✓
- B The average speed of the cart while in motion
- C The acceleration of the cart while in motion
- D The time during which the cart is in motion ✓

Unit 2 Progress Check: MCQ Part A

21.



Two students, Student X and Student Y, stand on a long skateboard that is at rest on a flat, horizontal surface, as shown. In order to get the student-student-skateboard system to accelerate, Student X claims that Student Y should apply a force on Student X while both students stand on the skateboard. Which of the following statements is true regarding the claim made by Student X?

(A) The claim is correct because Newton's second law states that an object will accelerate if a net force is applied to the object.

(B) The claim is correct because Student Y can apply a force that is greater in magnitude than the frictional forces that are exerted on the student-student-skateboard system

(C) The claim is incorrect because Student Y cannot apply a force that is greater in magnitude than the frictional forces that are exerted on the student-student-skateboard system

(D) The claim is incorrect because both students are internal to the student-student-skateboard system, and internal forces within a system cannot cause the system to accelerate. ✓