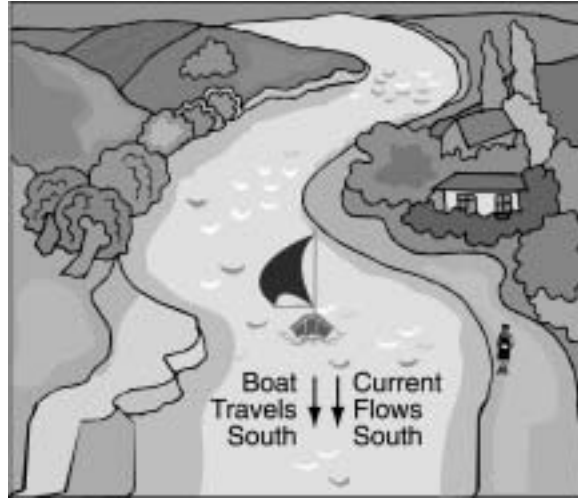


BENCHMARK SC.C.1.4.1

Strand	C	Force and Motion
Standard	1	The student understands that types of motion may be described, measured, and predicted.
Benchmark	SC.C.1.4.1	The student knows that all motion is relative to whatever frame of reference is chosen and that there is no absolute frame of reference from which to observe all motion.
Item Type(s)		MC, GR
Benchmark Clarification		The student identifies that the speed of an object is dependent on the observer's point of view.
Content Limits		Items will NOT address aspects of Einstein's general theory of relativity.
Stimulus Attributes		Items may use diagrams or pictures to illustrate the direction of travel of moving objects.
Response Attributes		Items will describe units in which the answer is to be given.
Sample MC Item		<p>Pat is the passenger on a large boat off the Florida coast. The boat is traveling at a speed of 30 kilometers per hour (km/hr). Pat is walking from the front to the back of the boat at a speed of 5 km/hr. Which of the following is Pat's speed relative to the water?</p> <p>A. 6 km/hr *B. 25 km/hr C. 35 km/hr D. 150 km/hr</p>

Sample GR Item

A river's current flows south at a speed of 5 meters per second (m/s) relative to the ground. Tomás is standing on the riverbank and observes a boat going south at 8 m/s relative to the ground.



What is the speed, in m/s, of the boat relative to the water?

Answer

3

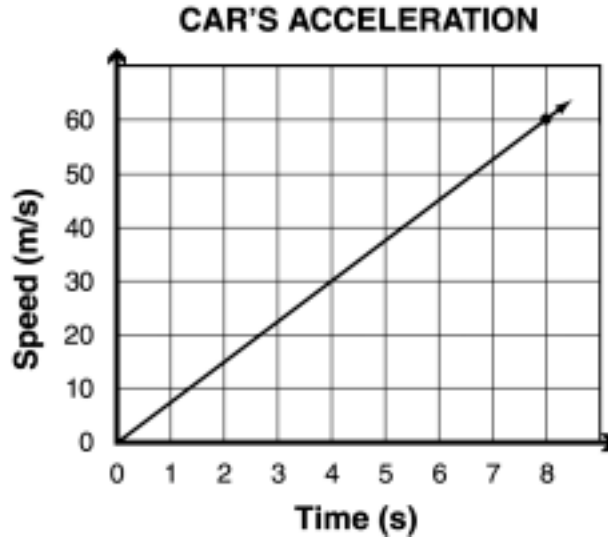
	0	1	2	3
	4	5	6	7
	8	9		

BENCHMARK SC.C.1.4.2

Strand	C	Force and Motion
Standard	1	The student understands that types of motion may be described, measured, and predicted.
Benchmark	SC.C.1.4.2	The student knows that any change in velocity is an acceleration.
Item Type(s)		MC, GR
Benchmark Clarification		None specified.
Content Limits		Items may require the student to calculate or apply a positive or negative acceleration.
Stimulus Attributes		Items may use charts, diagrams, graphs, or tables with values of velocities, times, and accelerations.
Response Attributes		Items will describe units in which the answer is to be given. Items may require responses in the form of charts or graphs.
Sample MC Item		<p>Jack is driving his car westward on a long, straight highway. If he wants to have a negative acceleration rate over the next kilometer (km), what should be Jack's next action?</p> <p>A. Stop the car immediately.</p> <p>B. Increase his speed over the next kilometer.</p> <p>*C. Slowly reduce the car's speed over the next kilometer.</p> <p>D. Quickly turn around and travel east at his original speed.</p>

Sample GR Item

A car accelerates in a straight line from zero meters per second (m/s) to 60 m/s in 8 seconds (s).



Calculate the average acceleration of the car in meters per second squared (m/s^2).

Answer

7.5

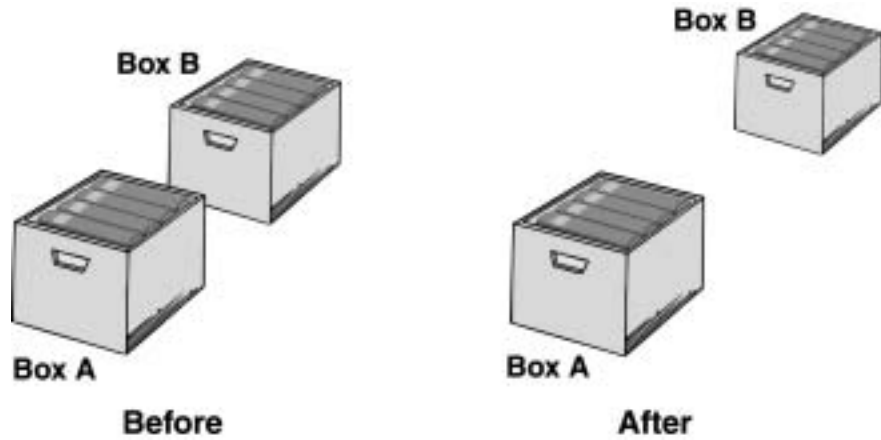
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BENCHMARK SC.C.2.4.1

Strand	C	Force and Motion
Standard	2	The student understands that the types of force that act on an object and the effect of that force can be described, measured, and predicted.
Benchmark	SC.C.2.4.1	The student knows that acceleration due to gravitational force is proportional to mass and inversely proportional to the square of the distance between the objects.
Item Type(s)		MC, GR
Benchmark Clarification		The student identifies and calculates the relative force or acceleration due to gravity or other forces acting between two objects.
Content Limits		Items may connect force relationships to acceleration and distance. Items may address the continuous nature of the force of gravity as an explanation for the acceleration of falling objects.
Stimulus Attributes		Items will provide an equation when a calculation is required if the equation is not provided on the reference sheet. Items may provide the student with data in drawing or picture form.
Response Attributes		Items will describe units in which the answer is to be given.

Sample MC Item

Andre has two boxes of equal mass that are two meters (m) apart. He moves Box B so that it is four meters away from Box A.



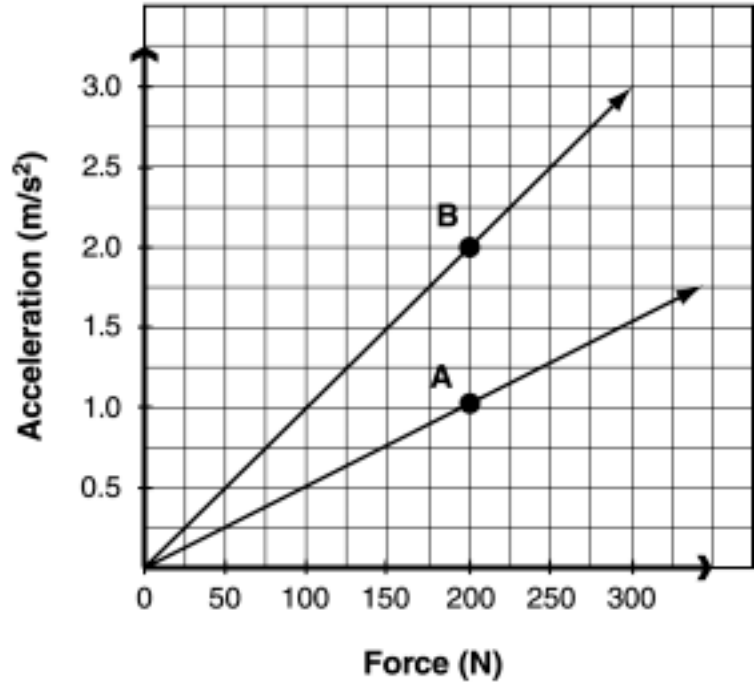
In order for the gravitational force between the boxes to remain the same before and after moving the boxes, what must happen to the weight of each box?

- *A. The weight of each box must be doubled.
- B. The weight of each box must be quadrupled.
- C. The weight of each box must be reduced by half.
- D. The weight of each box must be reduced by a quarter.

Sample GR Item

The diagram below illustrates the relationship between the net force and resulting acceleration of two objects. Object A has a mass of 200 kilograms (kg).

ACCELERATION OF TWO OBJECTS



What is the mass, in kilograms, of Object B?

Answer

100

	0	1	2
	3	4	5
	6	7	8
	9		

BENCHMARK SC.C.2.4.3

Strand	C	Force and Motion
Standard	2	The student understands that the types of force that act on an object and the effect of that force can be described, measured, and predicted.
Benchmark	SC.C.2.4.3	The student describes how magnetic force and electrical force are two aspects of a single force. This benchmark also assesses SC.C.2.4.2. ⁵
Item Type(s)		MC
Benchmark Clarification		The student identifies how moving electric charges create a magnetic field and how a changing magnetic field causes electric charges to move.
Content Limits		Items will NOT require the student to perform calculations.
Stimulus Attributes		None specified.
Response Attributes		None specified.
Sample MC Item		<p>An electromagnet is created when an electric current is passed through a coil of copper wire. When the current is turned off, the electromagnet will not attract steel paper clips. When the current is turned on, the electromagnet will attract steel paper clips. Why are the paper clips attracted only part of the time?</p> <p>A. The copper wire is a permanent magnet. B. The steel paper clips create the magnetic force. *C. Moving electric charges in the wire create the magnetic force. D. Stationary electric charges in the wire create the magnetic force.</p>

⁵ The complete text for SC.C.2.4.2 is “The student knows that electrical forces exist between any two charged objects.”

BENCHMARK SC.C.2.4.4

Strand	C	Force and Motion
Standard	2	The student understands that the types of force that act on an object and the effect of that force can be described, measured, and predicted.
Benchmark	SC.C.2.4.4	The student knows that the forces that hold the nucleus of an atom together are much stronger than electromagnetic force and that this is the reason for the great amount of energy released from the nuclear reactions in the sun and other stars.
Item Type(s)		MC
Benchmark Clarification		The student demonstrates an understanding of the relative strength of fundamental forces.
Content Limits		Items will require the student to differentiate between a strong nuclear force and a weak nuclear force.
Stimulus Attributes		None specified.
Response Attributes		None specified.
Sample MC Item		<p>Daphne is studying the forces in the universe. She reads that each force works at different distances and under different conditions. In the small space of an atomic nucleus, which force is the greatest?</p> <ul style="list-style-type: none">A. electromagneticB. gravitational*C. strong nuclearD. weak nuclear

BENCHMARK SC.C.2.4.5

Strand	C	Force and Motion
Standard	2	The student understands that the types of force that act on an object and the effect of that force can be described, measured, and predicted.
Benchmark	SC.C.2.4.5	The student knows that most observable forces can be traced to electric forces acting between atoms or molecules.
Item Type(s)		MC
Benchmark Clarification		None specified.
Content Limits		Items will NOT require the student to quantify electric forces.
Stimulus Attributes		Items will provide the student with data in a real-world context.
Response Attributes		None specified.
Sample MC Item		Sometimes when Jackie brushes her dog's hair, the brush will attract the hair and cause it to stand up. Which force is responsible for the attraction between the dog's hair and the brush? A. centripetal *B. electrical C. frictional D. gravitational

BENCHMARK SC.C.2.4.6

Strand	C	Force and Motion
Standard	2	The student understands that the types of force that act on an object and the effect of that force can be described, measured, and predicted.
Benchmark	SC.C.2.4.6	The student explains that all forces come in pairs commonly called action and reaction.
Item Type(s)		MC
Benchmark Clarification		None specified.
Content Limits		None specified.
Stimulus Attributes		Items requiring calculations will contain the formula in the stimulus.
Response Attributes		Items may require responses in the form of vectors.
Sample MC Item		Each crew member in the boat shown below is pulling back on the paddles. They are each completing one stroke on the same side of the boat before switching to the other side. The boat is moving in the direction of the arrow.



Which statement explains the movement of the boat?

- A. The boat moves in the same direction as friction.
- B. The boat moves in the same direction as the applied force.
- *C. The boat moves in a direction opposite to the force of the crew.
- D. The boat moves in a direction similar to the induced water currents.