Lesson 5.1 Motion

This lesson will help you practice working with concepts related to motion, momentum, and momentum conservation. Use it with core lesson 5. 1 Motion to reinforce and apply your knowledge.

Key Concept

Objects are in motion all around us. Motion can be described by speed, velocity, and acceleration. A moving object has momentum, which can be transferred between objects during a collision.

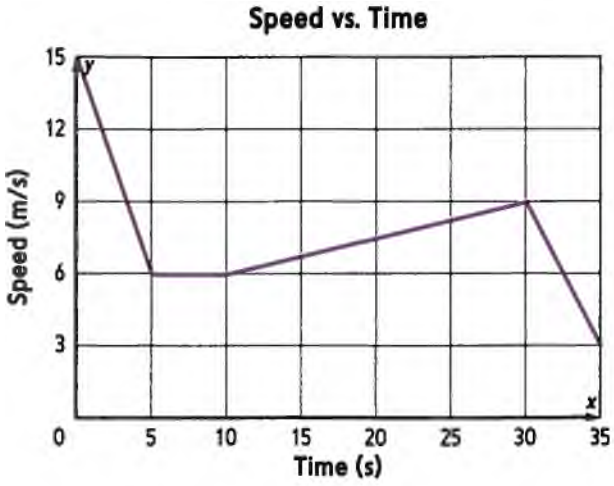
Core Skills & Practices

- Express Scientific Information or Findings Numerically or Symbolically
- Interpret Graphs and Functions

Describing Motion

Motion can be described in terms of position, speed, velocity, and acceleration.

Directions: Use the graph below to answer questions 1-3.



1. The graph shows the change in speed of a car over time as the car moves along a straight street. At which time is the car's speed 7. 8 m/s?

A 2s

B. 10 s

C. 22 s

D. 34 s

2. During which time intervals does the car undergo deceleration?

A. 0-5 s and 5-10 s

B. 0-5 s and 30-35 s

C. 5-10 s and 10-30 s

D. 10-30 s and 30-35 s

3. What is the magnitude of the car's acceleration between 10 s and 30 s?

$$\text{acceleration} = \frac{(\text{final velocity} - \text{initial velocity})}{(\text{final time} - \text{initial time})}$$

A. 0. 15 m/s^2

B. 0. 60 m/s^2

C. 0. 90 m/s^2

D. 1. 50 m/s^2

Directions: Answer the questions below.

4. A plane flying east travels 75 km in 9. 0 min. What is the plane's velocity?

$$\text{velocity} = \frac{(\text{final position} - \text{initial position})}{(\text{final time} - \text{initial time})}$$

A. 2. 3 m/s, east

B. 0. 3 m/s, east

C. 139 km/h, east

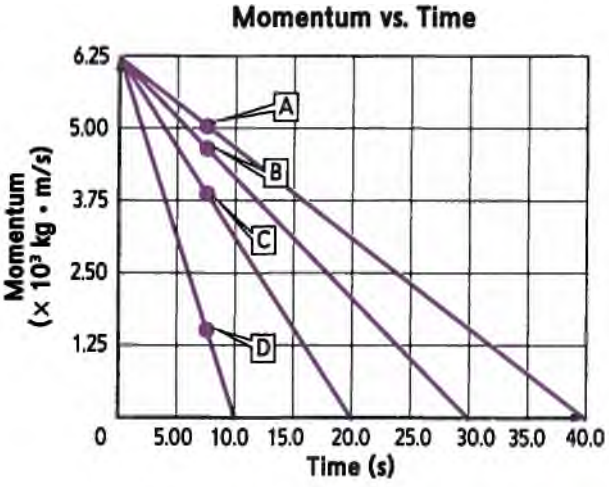
D. 500 km/h, east

5. A rolling grocery cart has no acceleration. Knowing just this, what information about velocity and speed can you infer about the cart's motion? What would be different if the cart were at rest?

Momentum

Momentum is defined as the product of an object's mass and velocity.

Directions: Use the graph below to answer questions 6-7.



6. Suppose you are designing a device that safely reduces the momentum associated with an impact, such as what a safety helmet or airbag does for cyclists and motorists. From the graph shown, what can you infer about any design that uses a given amount of force to decrease momentum?

A. The materials of which the device is made need to be made as rigid as possible.

B. The materials of which the device is made need to be made as flexible as possible.

C. The time over which momentum decreases needs be made as large as possible.

D. The time over which momentum decreases needs be made as small as possible.

7. Which point on the graph indicates a momentum with magnitude of about 4, 700 kg • m/s after 7. 50 s have elapsed?

A. Point A

B. Point B

C. Point C

D. Point D

Test-Taking Tip

When completing a "hot spot" activity in a computer-based exam, only certain points or regions on the diagram will be active. You must click on the point or region to answer the question. Identifying the possible hot spots will help narrow the possibilities for the answer.

Directions: Answer the questions below.

8. What is the momentum of an ice skater with a mass of 52. 0 kg, and who is sliding with a velocity of4. 5 m/s to the south?

momentum = mass x velocity

A. 116 kg • m/s, south

B. 11. 6 kg • m/s, south

C. C. 234 kg • m/s, south

D. D. 2, 340 kg • m/s, south

9. A student stands on a skateboard with a bucket full of water. Everything is initially at rest The student then tosses the water out of the bucket If the student/bucket/skateboard/water system has a total mass of 80. 0 kg, and the water has a mass of 10. 0 kg and an initial velocity of 2. 50 m/s, south, what is the final velocity of the student, skateboard, and bucket?

momentum = mass x velocity

A. 0. 313 m/s, north

B. 0. 313 m/s, south

C. 0. 357 m/s, north

D. 0. 357 m/s, south

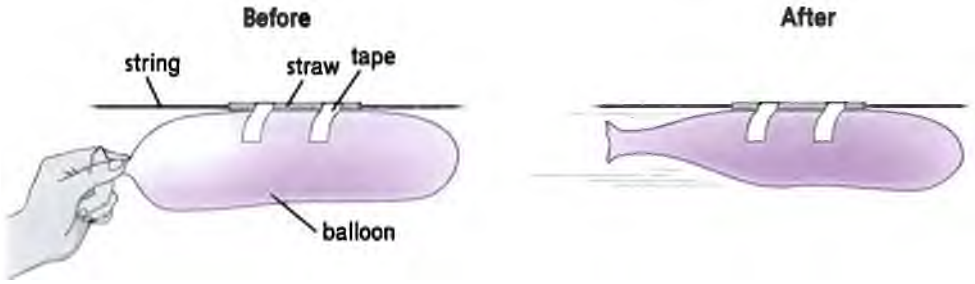
Law of Conservation of Momentum

Momentum is conserved in all collisions, provided no force is applied to the system of colliding objects.

Directions: Use the reading passage and diagram below to answer questions 10-11.

What happens when an object exerts a force on a second object? Imagine what happens when a child kicks a door shut. The foot exerts a force on the door. At the same instant, the foot feels a reaction force from the door. When an object exerts a force on a second object, the second object exerts an equal force in the opposite direction on the first object Another way of expressing this is with the law of conservation of momentum. The total momentum of the system (the door and foot) is the same before and after a collision.

A balloon rocket demonstrates momentum conservation. The difference in air pressure causes the air inside the balloon to move to the left rapidly. Its momentum is equal to the mass of the air and the velocity with which it escapes. The balloon moves with a momentum that is equal in magnitude to that of the air and is in the opposite direction (to the right in the diagram below). The total momentum of the air-balloon system before the air is released equals the total momentum afterward.



10. Suppose the mass of the balloon equals 0. 010 kg, and the balloon moves to the right with a uniform speed of 0. 10 m/s. The total momentum (momentum = mass x velocity) of the balloon-air system is 0 kg • m/s. How does the definition of momentum conservation tell you how this problem can be solved?

_____

_____

_____

11. Suppose the balloon-air system has an initial momentum toward the right. Which statement correctly describes how the system behaves after the air has been released from the balloon?

A. The balloon will move to the left.

B. The balloon will move faster to the right.

C. The balloon will move slower to the right.

D. The balloon's motion will not be affected.

Forces and Newton's Laws of Motion Lesson 5.2

This lesson will help you practice working with concepts related to forces and Newton's Laws of Motion and to understand how they affect the motion of everyday objects. Use it with core lesson 5. 2 Forces and Newton's Laws of Motion to reinforce and apply your knowledge.

Key Concept

Newton's Laws describe the motion of objects. Newton's law of universal gravitation relates the mass and distance between two objects to the force of gravity between two objects. These laws can be used to predict the motion of everyday objects.

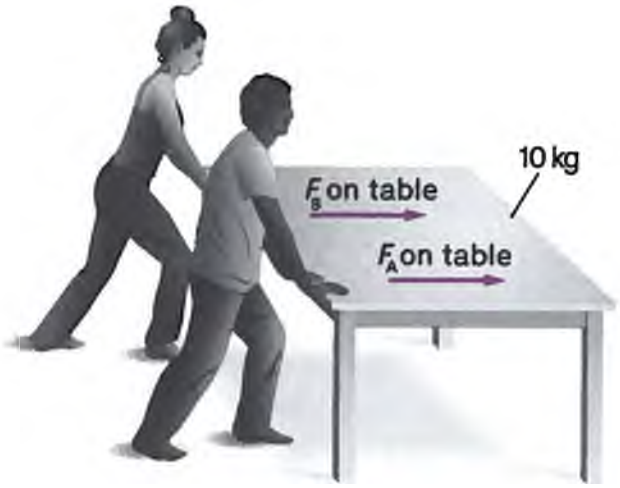
Core Skills & Practices

* **Apply Formulas from Scientific Theories**
* **Solve Linear Equations**

Newton's Laws of Motion

Newton's Laws of Motion can be used to predict the motion of objects in response to forces.

Directions: Use the diagram below to answer questions 1-2.



1. The man exerts a force of 40 N on the table (F_A), while the woman exerts a force of 60 N (F_B). The net force (F_{net}) acting on the table is_____

2. Assume that the man and the woman each exert a force of 60 N on the table in the same direction. In response to this force, the table moves a total distance of 5 meters. What is the acceleration of the table?

A. 5 m/s

B. 5 m/s^2

C. 12 m/s^2

D. 50 N/s

Test-Taking Tip

Some multiple choice questions will require you to make calculations. When answering such questions, remember to check the units in your final answer.

Directions: Answer the questions below.

3. Four people are pushing grocery carts in a supermarket. Which cart has the greatest inertia?

A. an 8-kg cart being pushed by a child

B. a full grocery cart with a mass of 10 kg

C. an empty grocery cart with a mass of 5 kg

D. a half-full grocery cart with a mass of 20 kg

4. As a person rows a boat, the force exerted on the oars is transferred as an action force to the water. Why does the boat begin to move through the water rather than remain in one place? Use Newton's third law of motion to justify your response.

5. What is the average acceleration of a 30-kg box that is pushed with 15 N and 30 N of force?

A. 0. 5 m/s^2

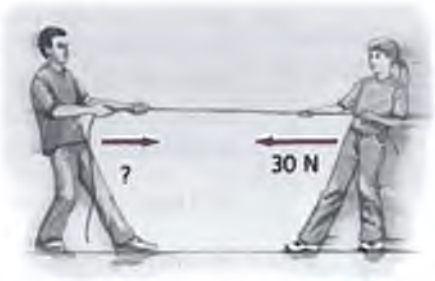
B. 1. 0 m/s^2

C. 1. 5 m/s^2

D. 0. 75 m/s^2

6. How are the forces of gravity and magnetism different from that of friction?

Directions: Use the diagram below to answer questions 7-8.



7. The people shown are having a tug-of-war. The person on the left is exerting a pulling force of 30 N on the rope toward the left. If the rope is moving toward the person on the left, what can you conclude about the force being exerted on the rope by the person on the right? Explain your answer.

8, What conclusion can be drawn if the rope in the tug-of-war game shown does not move toward either the right or the left?

A. The forces acting on the rope are unbalanced.

B. A net force of 30 N to the right is acting on the rope.

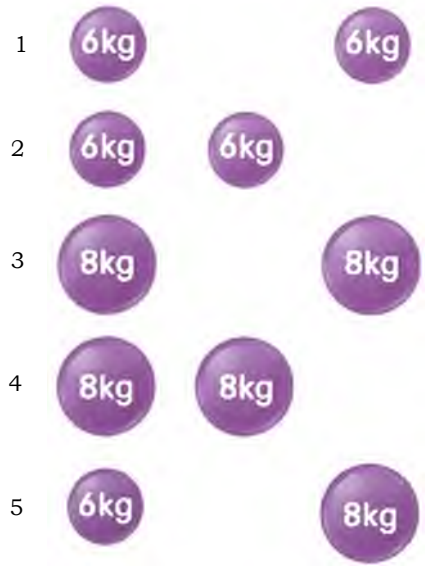
C. A force less than of 30 N is pulling the rope toward the right.

D. The forces acting on the rope are balanced and the net force is 0.

The Law of Universal Gravitation

The universal law of gravitation explains how gravity exerts a force between any two objects that have mass.

Directions: Use the diagram below to answer questions 9-10.



9. The diagram shows five pairs of balls. The gravitational force is weakest between the balls shown in pair number_____ and strongest between the balls shown in pair number _____.

10. Currently the balls in pairs 1, 3, and 5 are the same distance apart. If the distance between the balls in each of these three pairs is doubled, then the force of gravity exerted on the balls in each pair will [1 Select . . .]. If the mass of only one ball in pair 1, 3, or 5 were doubled, the force of gravity acting upon the balls in each pair would [2 Select . . .].

[1 Select . . .]

A. remain the same

B. increase by one-half

C. decrease by one-half

D. decrease by one-fourth

[2 Select . . .]

A. double

B. remain the same

C. increase by one-half

D. decrease by one-half

Directions: Use the formula $W = mg$ to answer the questions below.

11. If a person has a mass of 50 kg, what is this person's weight?

A. 5. 1 N

B. 50 kg

C. 490 N

D. 490 kg

12. A person on Earth has a weight of 539 N. On Jupiter, this person's weight is 1, 273. 8 N. Which correctly identifies both the mass of the individual and the acceleration due to gravity on Jupiter?

A. 55 N; 9. 8 m/s^2

B. 55 kg; 9. 8 m/s^2

C. 55 N; 23. 16 m/s^2

D. 55 kg; 23. 16 m/s^2

Lesson 5.3 **Work and Simple Machines**

This lesson will help you practice working with concepts related to work and simple machines. Use it with core lesson 5. 3 Work and Simple Machines to reinforce and apply your knowledge.

Key Concept

When forces move an object over a distance, work has been done. Simple machines are used to make work easier by reducing either the force or the distance. Compound machines are made of more than one simple machine.

Core Skills & Practices

- Identify and Refine Hypotheses for Scientific Investigations
- Follow a Multistep Procedure and Analyze the Results

Work and Power

Work is done when a force moves an object some distance in the same direction as the force is exerted.

Directions: Answer the questions below.

1. Which of the following measurements might represent an amount of work done on an object?

A. 14. 2 J

B. 68. 0 N

C. 71. 3 W

D. 95. 6 m/s^2

2. A horizontal force causes an object with a mass of 10 kg to accelerate at 4 m/s^2 and move a distance of 30 m horizontally. How much work is done by the force?

F = ma W = Fd

A. 40 J

B. 70 J

C. 300 J

D. 1, 200 J

3. Several students took turns exerting a horizontal force on a desk initially resting on the floor. The force (F) and the horizontal distance (d) the desk moved as a result of that force are listed for each student. Write the names of the students in the boxes to order them from the least to the greatest amount of work done on the desk.

W = Fd

Sarina	Carlos	Sameel	Trey
F **=** 10 N; d=9m	***F*** **=** 8 N; ***d*** **=** 12 m	***F*** **=** 15 N; d=5m	***F*** **=** 20 N; ***d*** **=** 3 m

LEAST →			GREATEST
1.	2.	3.	4.

Test-Taking Tip

When a test requires you to put items in an order sequence, it is sometimes helpful to start with the first and last answers. Find the last item or the final result. Then find the first item or the first result. Continue until you have all the items placed in order. Then look at the items from the first item to the last to make sure that each item would cause the next item to happen.

Machines

Machines make work easier to do by either reducing the amount of force that must be exerted or decreasing the distance over which the force is exerted.

Directions: Answer the questions below.

4. Which pair of simple machines is most closely related?

A. levers and wedges

B. wedges and screws

C. screws and pulleys

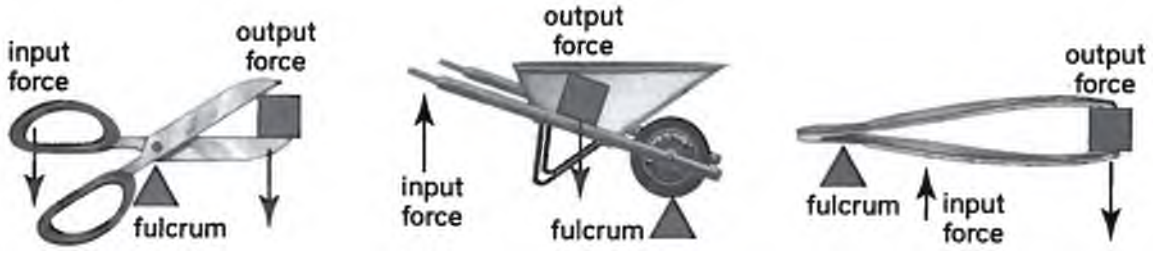
D. inclined planes and wheels and axles

5. A group of students conducts an investigation using a ramp and a box. They begin with the hypothesis that the amount of work they need to do to lift the box to a shelf 0. 5 m above the ground will decrease as the length of the ramp increases. They lift the box with a spring scale and record the distance they pull it and the force they use. Their data are summarized in the table.

Distance	Force
0. 5 m	20. 0 N
0. 8 m	12. 5 N
1. 0 m	10. 0 N
1. 5 m	6. 67 N

How should they revise their hypothesis based on their results? Explain your reasoning.

Directions: Use the diagram below to answer questions 6-7.



6. The illustration shows three types of levers. Explain two ways the levers are alike.

7. Circle the type of lever that always magnifies the distance over which a force is exerted.

Analyze Machine Use

The mechanical advantage of a machine is the ratio of the output force to the input force.

Directions: Answer the questions below.

8. A carpenter applies a force of 60 N to pry a nail out of a wooden beam. The hammer applies a force of 720 N to the nail. What is the mechanical advantage of the hammer?

MA = output force / input force

A. 12 C. 640

B. 56 D. 780

9. What is true about the mechanical advantage of a machine that increases the distance over which a force must be exerted to complete a task?

A. MA = 0 C. MA < 1

B. MA = 1 D. MA > 1

10. A pair of students designs an investigation to test a hypothesis. They attach a weight to the end of a wooden beam and allow it to pivot around a rock. The students attach a spring scale to the free end and pull down on the scale to lift the weight. The students hypothesize that the closer the rock is to the spring scale, the lower the force they measure will be. The average force over several trials for each setup is listed in the table.

Setup	Force
A	53 N
B	71N
C	98N

The students' hypothesis was not supported by the data. If the distance between the weight and the fulcrum is x and the distance between the fulcrum and the spring scale is y, the students should revise their hypothesis to which of the following based on their results?

A. If the ratio of x to y is 1, then the mechanical advantage will be greatest.

B. If the ratio of y to x increases, then the mechanical advantage increases.

C. If the ratio of x to y increases, then the mechanical advantage increases.

D. If the ratio of y to x decreases, then the mechanical advantage increases.

Directions: Use the information below to answer questions 11-12.

A boat mechanic uses a pulley system to lift an engine into place. The mechanic exerts a force of 900 N to lift the 1800 N engine. MA = output force / input force

11. What is the mechanical advantage of the pulley system?

A. 2 C. 9

B. 6 D. 18

12. If the mechanic alters the design of the pulley system, the mechanical advantage becomes 6. The force that will be required to lift the engine will be_____