Newton's Laws of Motion

Major Topic: Newton's Laws of Motion

Science SOLS PS1d,g,h,j PS.10b

Length of Unit: 5 -90 minute classes

Understanding Goals

The students will

- use scientific reasoning, logic, and the nature of science to plan and conduct investigations which will help them develop an understanding of force, motion, acceleration, and Newton's laws of motion.

Essential Questions:

- Describe real-life situations that illustrate each of Newton's laws of motion.
- How can you compare mass and weight, and how do they differ?
- How could you use the relationship, F = ma, to determine force, mass, and acceleration?

Bloom's Taxonomy Skills	**21st Century Learning Skills**
• Creating • Analyzing • Understanding • Remembering • Applying	• Critical Thinking • Problem Solving • Creativity & Innovation • Collaboration • Information & Media • Contextual Learning

Assessment Evidence

Performance Tasks:

The student will

- use simulations to conduct experiments.
- use and identify dependent and independent variables.
- use and interpret data tables
- use experimental results to make valid conclusions after analyzing the data.
- investigate and understand Newton's Laws of Motion.

Evidences from formative assessment:

- Discussion

Lesson Contributed by: Carmen Harper
Funded through 2012 Mathematics and Science Partnership Grant, INSPIRS

- Class Participation
- Teacher Observations
- Writing assignments
- Laboratory assignments/reports
- Group Work

Technology Computers, Internet Connection, Probeware, Laptop, Projector

Internet Resources:

- BrainPop Teacher Account (optional)
- Newton's First Law Video: http://science360.gov/obj/video/70fadaa8-c3d4-4132-ba1f-c98be5caeb14/science-nfl-football-newtons-first-law-motion
- Forces & Motion PhET Lab: http://phet.colorado.edu/en/contributions/view/3423
- Forces & Motion PhET simulation: http://phet.colorado.edu/en/simulation/forces-and-motion
- Newton's Second Law Video: http://science360.gov/obj/video/58e62534-e38d-430b-bfb1-c505e628a2d4/science-nfl-football-newtons-second-law-motion
- Newton's Second Law Lab:http://www.vernier.com/experiments/psv/39/newtons_second_law/
- Newton's Third Law Video: http://science360.gov/obj/video/d0e16d27-05d4-4511-9394-2758aa066981/science-nfl-football-newtons-third-law-motion

Supplies/Materials:

- Handouts
- Toy Truck
- Meter Stick
- 200 g mass
- Calculator
- Color pencils
- Computer Paper
- Notebook Paper
- Index Cards

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- String
- Paper cups
- Sand
- Balance
- Motion Detector

Lesson 1: Sports in Motion (2- 90 minute periods)

Engage:

- Students are shown "Newton's Laws of Motion" from BrainPop (account needed) or another short video about each Law of Motion.
- Briefly discuss the three laws and what makes them laws.
- Students are shown a video from science360 (http://science360.gov/obj/video/70fadaa8-c3d4-4132-ba1f-c98be5caeb14/science-nfl-football-newtons-first-law-motion).
- After viewing the clip students, are asked the following questions and discuss their answers as a class:
  - Why is motion important to football?
  - What was Newton's first law about?
  - How does it relate to football?

Explore:

- Students will work in pairs to complete Part 1 of the Forces and Motion Lab (http://phet.colorado.edu/en/contributions/view/3423) using the Forces and Motion simulation (http://phet.colorado.edu/en/simulation/forces-and-motion).

Explain:

- As a class, discuss the answers and how this applies to Newton's First Law of Motion.

Elaborate:

- Teacher will explain the unit's projects by reviewing the project information page and rubrics (attached). One project will include making a book (varying styles should be explained and encouraged – i.e. digital, folded paper). The second project will be a choice of a variety of mediums (the four options are described on the Newton's Laws of Motion project – attached).
- The students will complete the Newton's First Law of Motion section of their projects and books.

Evaluate:

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- Questioning of students during the *engagement* and their recorded lab data.

Lesson 2: Wait a Second (2-90 minute periods)

Engage:

- Students are shown a video from science360 (http://science360.gov/obj/video/58e62534-e38d-430b-bfb1-c505e628a2d4/science-nfl-football-newtons-second-law-motion).
- After viewing the clip students, are asked the following questions and discuss their answers as a class:
  - What was Newton's second law about?
  - How does it relate to football?

Explore:

- Students complete Vernier's Newton's Second Law Lab.

Explain:

- Students answer the "Processing the Data" section of the lab and we discuss them as a class.

Elaborate:

- Students complete the Newton's second Law of Motion section of their projects.

Evaluate:

- Questioning of students during the *engagement* and lab recordings.

Lesson 3: May the Force Be with You (2-90 minute periods)

Engage:

- Students are shown a video from science360 (http://science360.gov/obj/video/d0e16d27-05d4-4511-9394-2758aa066981/science-nfl-football-newtons-third-law-motion).
- After viewing the clip students, are asked the following questions and discuss their answers as a class:
  - What was Newton's third law about?
  - How does it relate to football?

Explore:

- Students complete the "Forces-Equal and Opposite" lab as a class using 2 Vernier duel range force probes (attached lab).

Explain:

- Students answer the analysis questions and we then discuss them as a class.

Elaborate:

- Students complete the Newton's Third Law of Motion section of their projects.

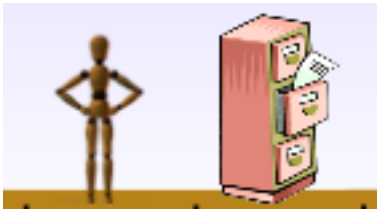
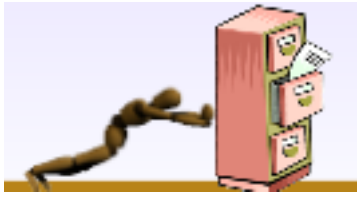
Evaluate:

- Questioning of students during the *engagement* and lab recordings , final projects (assessed with project rubrics) and test (attached) will show their understanding.

Name_____
Grade_____

Forces and Motion Pre Lab (Lesson 1)

Joe needs to push a file cabinet across the room. He begins by just looking at it. (**Scene 1**)
He then begins pushing on the file cabinet. At first, the file cabinet does not move. (**Scene 2**) Then the file cabinet begins to slide. (**Scene 3**)

Scene 1: **Joe not pushing**	**Scene 2:** **Joe pushing but cabinet not moving**	**Scene 3:** **Joe pushing and cabinet moving**
		

a. Use words and pictures to describe all the **forces** you think are acting on the cabinet in each scene.

b. Why do you think the file cabinet moves in **scene 3** but not in **scene 1** or **2**?

c. If the floor is covered with ice, how would the motion of the cabinet change?

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Name_____
Grade_____

Forces and Motion

Learning Objectives:

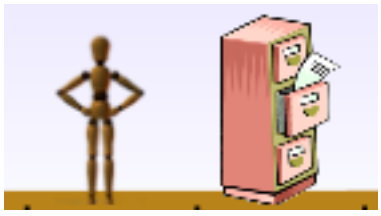
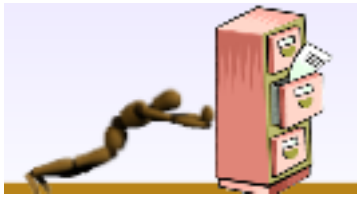
- Be able to identify when an object is being acted upon by unbalanced forces.
- Be able to predict the change in motion when a force is applied to an object.

Part 1: Understanding balanced and unbalanced forces

1. Open the **Forces and Motion Simulation** by clicking the icon on your computer's screen.

2. Play with the first tab of the sim for about 5 minutes. **What do you find?**

3. Using the simulation for help, draw pictures showing Joe, the file cabinet and **force arrows**.

Scene 1: **Joe not pushing**	**Scene 2:** **Joe pushing but cabinet not moving**	**Scene 3:** **Joe pushing and cabinet moving**
		

4. **Describe** what is necessary to start the file cabinet moving.

5. **Compare** the Applied Force arrow and the Friction Force arrow.

   a. What is similar?

   b. What is different?

6. Use your answers to #5 to say whether the forces are **balanced or unbalanced** in each scene.

Part 2: Understanding Applied, Friction and Total Force

7. How can you make the **Friction Force** arrow longer?

8. Apply enough force to **move the cabinet**.

    a. What do you think happens to the Friction Force arrow when you stop applying force (no Applied Force arrow)?

    b. What do you think happens to the Friction Force once the cabinet stops moving?

9. How would you...

    a. ...describe Friction Force?

    b. ...describe Applied Force?

Teacher led discussion: Compare applied and friction forces.

10. Have Joe move a new object. How is moving this object different from moving the file cabinet?

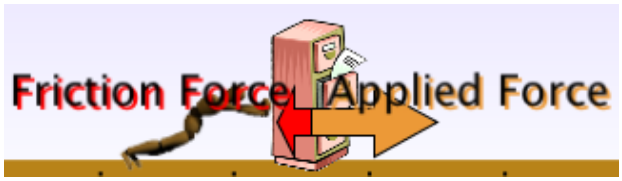
11. In the table, draw the **Total Force arrow** for the different cases:

Scene 1: **Joe not pushing**	**Scene 2:** **Joe pushing but dog not moving**	**Scene 3:** **Joe pushing and dog moving**
		

12. Can you find 3 different ways to make the **Total Force arrow** change?
    List them here:

13. In your own words, what is **Total Force**?

14. For each case, draw the **Total Force arrow**. Write which direction you think the object is moving and whether it will speed up or slow down.

a. 

b. 

c. 

Part 3: Understanding Force and Change in Speed

15.

a. Give the sleepy dog  a **little push**...

...how much does the dogs speed change?

b. Give the sleepy dog a **big push**...

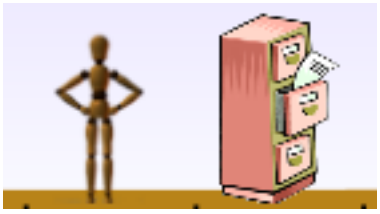
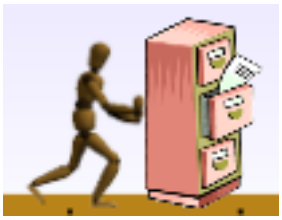
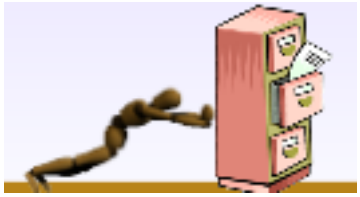
...how much does the dogs speed change?

16. Using your answers to Question #15, what general statement can you make about the **relationship between the applied force and how fast an object changes its speed.**

Name_____
Grade_____

Forces and Motion Post Lab

1. Joe needs to push a file cabinet across the room. He begins by just looking at it. (**Scene 1**)
He then begins pushing on the file cabinet. At first, the file cabinet does not move. (**Scene 2**) Then the file cabinet begins to slide. (**Scene 3**)

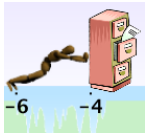
Scene 1: **Joe not pushing**	**Scene 2:** **Joe pushing but cabinet not moving**	**Scene 3:** **Joe pushing and cabinet moving**
		

a. Use words and pictures to describe all the **forces** you think are acting on the cabinet in each scene.

b. Why do you think the file cabinet moves in **scene 3** but not in **scene 1** or **2**?

c. What do you think Joe could do to make the cabinet move faster?

d. If the floor is covered with ice, how would the motion of the cabinet change?



e. What would be different if Joe was moving a book, instead of a file cabinet.

2. How ***useful for your learning*** was this science activity, compared to other science class activities? (circle)

   More useful About the same Less useful

   How ***enjoyable*** was this science class activity, compared to other science class activities? (circle)

   More enjoyable About the same Less enjoyable

   Why did you or did you not find it useful or enjoyable?

   _____
   _____
   _____
   _____

Forces and Motion Teachers Guide: Notes added below in RED (Lesson 1)

Name_____
Grade_____

Pre Lab

Joe needs to push a file cabinet across the room. He begins by just looking at it. (**Scene 1**)
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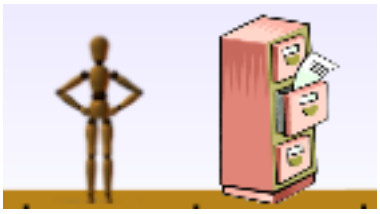	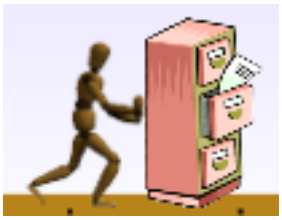	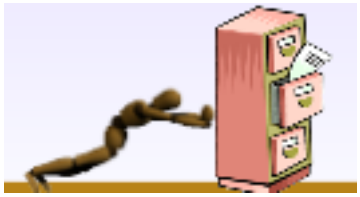

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b. Why do you think the file cabinet moves in **scene 3** but not in **scene 1** or **2**?

c. If the floor is covered with ice, how would the motion of the cabinet change?

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Name_____
Grade_____

Forces in 1D

Learning Objectives:

- Be able to identify when an object is being acted upon by unbalanced forces.
- Be able to predict the change in motion when a force is applied to an object.

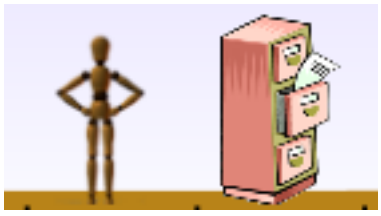
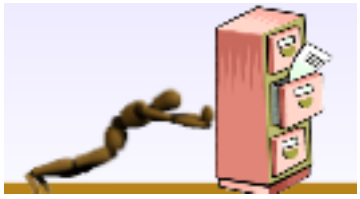
Part 1: Understanding balanced and unbalanced forces

1. Open the **Forces and Motion Simulation** by clicking the icon on your computer's screen.

2. Play with the first tab of the sim for about 5 minutes. **What do you find?**

I encourage the students to spend at least a few minutes just playing with the sim at the beginning of an activity. This helps students orient to tools available, develop ownership over controlling the simulation and gets some of the giggles out of the way so they can focus on the activity when open play is done.

3. Using the simulation for help, draw pictures showing Joe, the file cabinet and **force arrows**.

Scene 1: **Joe not pushing**	**Scene 2:** **Joe pushing but cabinet not moving**	**Scene 3:** **Joe pushing and cabinet moving**
		

4. **Describe** what is necessary to start the file cabinet moving.

5. **Compare** the Applied Force arrow and the Friction Force arrow.

   a. What is similar?

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6. Use your answers to #5 to say whether the forces are **balanced or unbalanced** in each scene.

Part 2: Understanding Applied, Friction and Total Force

7. How can you make the **Friction Force** arrow longer?

8. Apply enough force to **move the cabinet**.

    a. What do you think happens to the Friction Force arrow when you stop applying force (no Applied Force arrow)?

    b. What do you think happens to the Friction Force once the cabinet stops moving?

9. How would you...

    a. ...describe Friction Force?

    b. ...describe Applied Force?

Teacher led discussion: Compare applied and friction forces.

This would be a time for students to say what they thought the friction and applied force arrows meant. The friction force arrow can be difficult for the students, as it's harder to imagine the ground pushing back. This discussion time be used as an opportunity to briefly discuss friction and even compare what happens with and without friction (ground as ice or wood).

10. Have Joe move a new object. How is moving this object different from moving the file cabinet?

11. In the table, draw the **Total Force arrow** for the different cases:

Scene 1: **Joe not pushing**	**Scene 2:** **Joe pushing but dog not moving**	**Scene 3:** **Joe pushing and dog moving**
		

12. Can you find 3 different ways to make the **Total Force arrow** change?
    List them here:

13. In your own words, what is **Total Force**?

14. For each case, draw the **Total Force arrow**. Write which direction you think the object is moving and whether it will speed up or slow down.

a. 

b. 

c. 

Part 3: Understanding Force and Change in Speed

This section is asking students to notice acceleration (how fast an object changes speed). While it's not necessary that they know the term 'acceleration', from using the simulation they may be able to make some qualitative observations about how objects change speed. (A greater force causes greater acceleration, while a smaller force causes less acceleration). If the concept of acceleration is not something you want to introduce, take out Part 3. Depending on your learning objectives, you might want to delve deeper into this concept, and maybe even go to the third tab and have students plot acceleration.

15.

a. Give the sleepy dog  a **little push**...

...how much does the dogs speed change?

b. Give the sleepy dog a **big push**...

...how much does the dogs speed change?

16. Using your answers to Question #15, what general statement can you make about the **relationship between the applied force and how fast an object changes its speed.**

Name_____
Grade_____

Post Lab

1. Joe needs to push a file cabinet across the room. He begins by just looking at it. (**Scene 1**)
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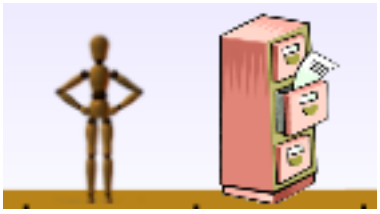	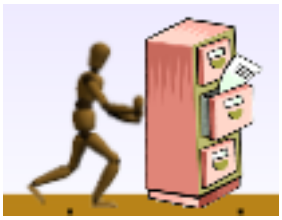	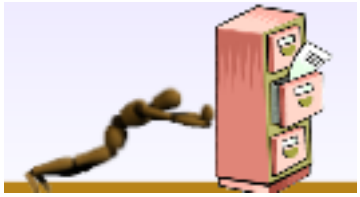

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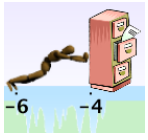

e. What would be different if Joe was moving a book, instead of a file cabinet.

2. How ***useful for your learning*** was this science activity, compared to other science class activities? (circle)

   More useful About the same Less useful

   How ***enjoyable*** was this science class activity, compared to other science class activities? (circle)

   More enjoyable About the same Less enjoyable

   Why did you or did you not find it useful or enjoyable?

   _____
   _____
   _____
   _____

Newton's Laws of Motion Project

You will be choosing from ONE of the following assignments to create a project that explains Newton's Laws of Motion in a creative and relevant way.

- **Option 1**
  You will create a Facebook page (on paper, not on the computer) that explain the laws, give real life applications to each law, and includes explanations of any important terms, formulas, and facts that apply each law.

- **Option 2**
  You will create a diary that explains the laws, give real life applications to each law, and includes explanations of any important terms, formulas, and facts that apply to each law.

- **Option 3**
  You will create a trading card for each of the three laws that explain the law, give real life applications to the law, and include explanations of any important terms, formulas, and facts that apply that law.

- **Option 4**
  You will create an ESPN SportCenter show that uses sporting events to explain the three laws, give real life applications to each, and include explanations of any important terms, formulas, and facts that apply to each law.

The *minimal* important terms/formulas/facts that apply to each law are:

- Law 1: inertia, unbalanced forces
- Law 2: F = M x A
- Law 3: Action = Reaction

This will be taken as a **quiz grade**.

The following rubric will be used to grade your project:

Category	Excellent	Good	Needs Work
Law 1	Goes above and beyond the requirements in a creative and attractive way. (30 Points)	Includes the law, its explanation, its real life applications, and explanations of any important terms, formulas, and facts. (25 Points)	Is missing part of the requirements or contains incorrect information. (20 Points)
Law 2	Goes above and beyond the requirements in a creative and attractive way. (30 Points)	Includes the law, its explanation, its real life applications, and explanations of any important terms, formulas, and facts. (25 Points)	Is missing part of the requirements or contains incorrect information. (20 Points)
Law 3	Goes above and beyond the requirements in a creative and attractive way. (30 Points)	Includes the law, its explanation, its real life applications, and explanations of any important terms, formulas, and facts. (25 Points)	Is missing part of the requirements or contains incorrect information. (20 Points)

Name _____ Period _____

Book of Laws Rubric

Category	Excellent	Good	Needs Work
Cover	Includes all the requirements and is creative and attractive. (10 Points)	Includes the title, your name, and class period. (5 Points)	Is missing part of the requirements. (3 Points)
Law 1	Includes all the requirements in a creative and attractive way. (30 Points)	Includes the law, its definition, and an example. (25 Points)	Is missing part of the requirements or contains incorrect information. (20 Points)
Law 2	Includes all the requirements in a creative and attractive way. (30 Points)	Includes the law, its definition, and an example. (25 Points)	Is missing part of the requirements or contains incorrect information. (20 Points)
Law 3	Includes all the requirements in a creative and attractive way. (30 Points)	Includes the law, its definition, and an example. (25 Points)	Is missing part of the requirements or contains incorrect information. (20 Points)

Name _____ Period _____

Book of Laws Rubric

Category	Excellent	Good	Needs Work
Cover	Includes all the requirements and is creative and attractive. (10 Points)	Includes the title, your name, and class period. (5 Points)	Is missing part of the requirements or contains incorrect information. (20 Points)
Law 1	Includes all the requirements in a creative and attractive way. (30 Points)	Includes the law, its definition, and an example. (25 Points)	Is missing part of the requirements or contains incorrect information. (20 Points)
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Law 3	Includes all the requirements in a creative and attractive way. (30 Points)	Includes the law, its definition, and an example. (25 Points)	Is missing part of the requirements or contains incorrect information. (20 Points)

Name _____ Period _____

Forces – Equal and Opposite Lab (Lesson 3)

Pre Lab

Newton's Third Law is usually stated as follows: "For every action, there is an equal and opposite reaction." For instance, when you push on a wall, the wall pushes back with an equal force in the opposite direction. The **net** force is zero at the point of contact, because the two applied force — you pushing, and the wall pushing back — exactly cancel. If it weren't, the wall would move.

1. Think of another example where two forces cancel each other and there is no motion and write it below.

2. We will be trying scenarios using two force sensors. Predict in each case whether the force sensor 1 will read that same as, or different from, the force sensor 2.

    a. 1 pulls and 2 stays still.

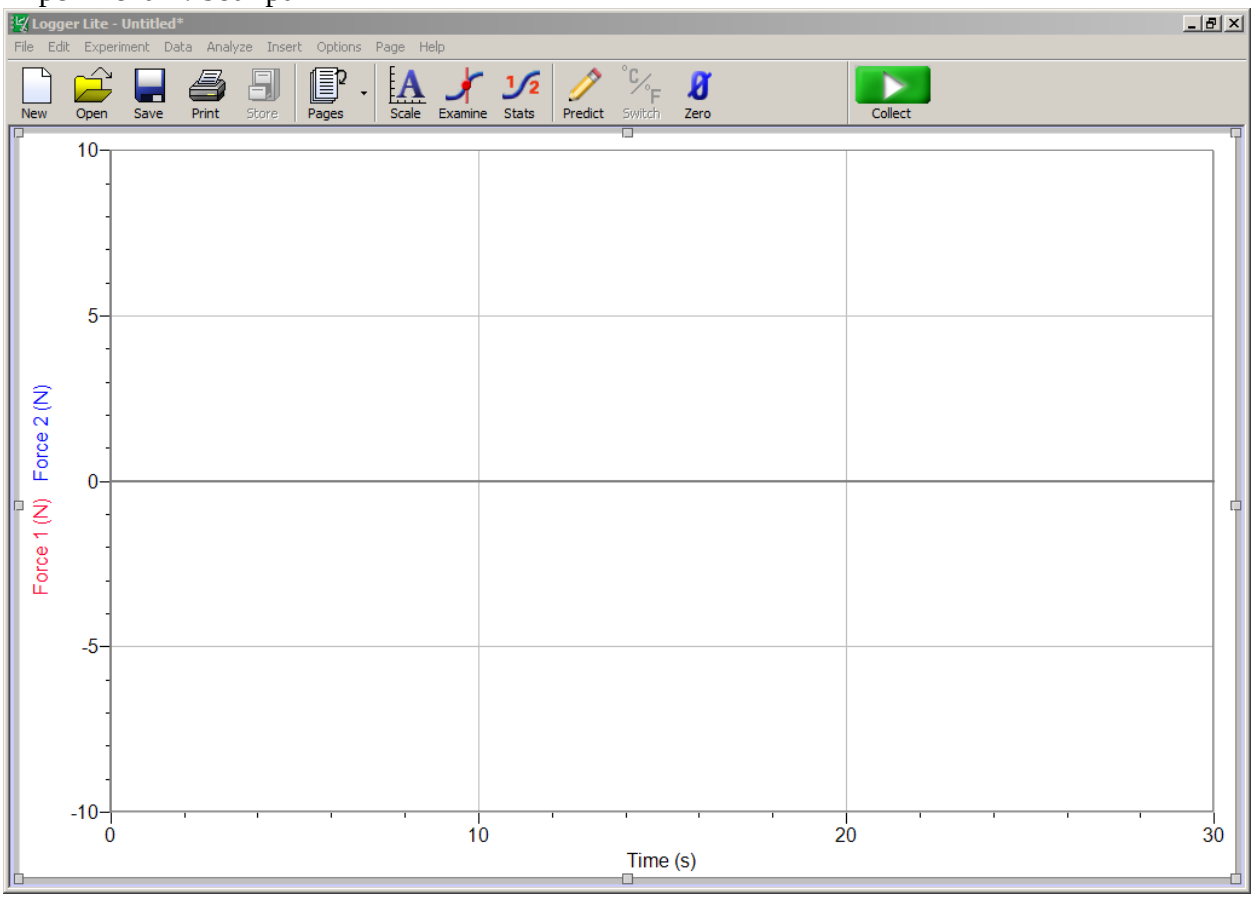
    b. 2 pulls and 1 stays still.

    c. Both sensors pull at the same time.

Data/Observations

1. Now we will take data with two force sensors (1 and 2). Record the data for each of the experiments.

- Experiment A: both still
- Experiment B: 1 is still 2 pulls
- Experiment C: 2 is still and 1 pulls
- Experiment D: both pull



2. In each of the experiments which were the action force and which was the reactions force?

A.

B.

C.

D.

3. Now we will experiment with pushing. For each of the experiments record who moves and how much.

E. Student 1 pushes and student 2 is still.

F. Student 2 pushes and student 1 is still.

G. Both students push.

Processing the Data

1. How do experiments A-D demonstrate Newton's third law?

2. How do experiments E-G demonstrate Newton's third law?

3. How would Newton's third law apply to rockets?

4. How would Newton's third law apply to a seesaw?

Unit Test: Forces and Motion

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

____ 1. When an object's distance from another object is changing,
a. it is in motion.
b. it is speeding.
c. it has a high velocity.
d. it is accelerating.

____ 2. A place or object used for comparison to determine if something is in motion is called
a. a position.
b. a reference point.
c. a constant.
d. velocity.

____ 3. If you know the distance an object has traveled in a certain amount of time, you can determine
a. the size of the object.
b. the speed of the object.
c. the location of the object.
d. the velocity of the object.

____ 4. If the speed of an object does NOT change, the object is traveling at a(n)
a. constant speed.
b. average speed.
c. increasing speed.
d. decreasing speed.

____ 5. If a bicyclist travels 30 kilometers in two hours, her average speed is
a. 30 km/h.
b. 60 km/h.
c. 15 km/h.
d. 2 km/h.

____ 6. If an object moves in the same direction and at a constant speed for 4 hours, which of the following is true?
a. The object's speed changed during the 4 hours.
b. The object's velocity did not change.
c. The object accelerated during the 4 hours.
d. The object decelerated during the 4 hours.

____ 7. A train that travels 100 kilometers in 4 hours is traveling at what average speed?
a. 50 km/h
b. 100 km/h
c. 2 km/h
d. 25 km/h

____ 8. You can show the motion of an object on a line graph in which you plot distance against
a. velocity.
b. time.
c. speed.
d. direction.

____ 9. In graphing motion, the steepness of the slope depends on
a. how quickly or slowly the object is moving.
b. how far the object has moved.

c. when the object began moving.
d. the direction the object is moving.

____ 10. On a graph showing distance versus time, a horizontal line represents an object that is
a. moving at a constant speed.
b. increasing its speed.
c. decreasing its speed.
d. not moving at all.

____ 11. It is rare for any motion to
a. stay the same for very long.
b. change quickly.
c. increase in velocity.
d. decrease in speed.

____ 12. The rate at which velocity changes is called
a. speed.
b. direction.
c. acceleration.
d. motion.

____ 13. Which of these is an example of deceleration?
a. a bird taking off for flight
b. a baseball released by a pitcher
c. a car approaching a red light
d. an airplane following a straight flight path

____ 14. The moon accelerates because it is
a. in a vacuum in space.
b. continuously changing direction.
c. a very large sphere.
d. constantly increasing its speed of orbit.

____ 15. In an acceleration graph showing speed versus time, a straight line shows the acceleration is
a. decreasing.
b. increasing.
c. changing.
d. constant.

____ 16. In physical science, a push or a pull is called a(n)
a. force.
b. acceleration.
c. inertia.
d. motion.

____ 17. When two equal forces act on the same object in opposite directions, the net force is
a. smaller than either force.
b. equal to each of the forces.
c. zero.
d. greater than either force.

____ 18. What happens when two forces act in the same direction?
a. They cancel each other out.
b. The stronger one prevails.
c. They add together.
d. Their sum divided by two is the total force.

____ 19. The tendency of an object to resist any change in its motion is known as
a. mass.

b. inertia.
c. force.
d. balance.

____ 20. The amount of matter in an object is called its
a. weight.
b. mass.
c. force.
d. balance.

____ 21. The greater the mass of an object,
a. the easier the object starts moving.
b. the greater its inertia.
c. the more balanced it is.
d. the more space it takes up.

____ 22. Force equals mass times
a. speed.
b. motion.
c. acceleration.
d. inertia.

____ 23. One way to increase acceleration is by
a. increasing mass.
b. decreasing mass.
c. decreasing force.
d. increasing both force and mass proportionally.

____ 24. The force that one surface exerts on another when the two rub against each other is called
a. friction.
b. acceleration.
c. inertia.
d. gravity.

____ 25. Which of the following is an example of increasing friction intentionally?
a. waxing skis
b. adding grease to gears on a bike
c. throwing sand on an icy driveway
d. oiling a squeaky door

____ 26. When the only force acting on a falling object is gravity, the object is said to be
a. stationary.
b. decelerating.
c. in free fall.
d. a projectile.

____ 27. The force that pulls falling objects toward Earth is called
a. gravity.
b. free fall.
c. acceleration.
d. air resistance.

____ 28. The force of gravity on a person or object at the surface of a planet is known as
a. mass.
b. inertia.
c. air resistance.
d. weight.

____ 29. Objects falling through air experience a type of friction called

a. terminal velocity.
b. air resistance.
c. inertia.
d. rolling friction.

____ 30. According to Newton's third law of motion, when a hammer strikes and exerts force on a nail, the nail
a. creates a friction with the hammer.
b. disappears into the wood.
c. exerts an equal force back on the hammer.
d. moves at a constant speed.

____ 31. Which law can explain how gases released from burning fuel in a rocket produce thrust?
a. Newton's first law of motion
b. Newton's second law of motion
c. Newton's third law of motion
d. the law of conservation of momentum

____ 32. What is required for a rocket to lift off into space?
a. thrust that is greater than Earth's gravity
b. mass that is greater than Earth's mass
c. very little air resistance
d. more velocity than friction

____ 33. An object that travels around another object in space is called a
a. projectile.
b. rocket.
c. mass.
d. satellite.

____ 34. Any force that causes an object to move in a circle is called a(n)
a. balanced force.
b. unbalanced force.
c. gravitational force.
d. centripetal force.

____ 35. What did Galileo propose about objects that fall toward the Earth?
a. All objects fall at the same rate, regardless of their mass, when gravity is the only force acting on them.
b. Objects of greater mass will accelerate more than objects of lesser mass.
c. Objects are not affected by air resistance.
d. Objects that have greater surface area will accelerate faster than objects with lesser surface area.

____ 36. Imagine that a car is being driven with cruise control on, so it is going at a constant speed. Which of the following statements is true?
a. There are no forces acting on the car.
b. Only gravity is acting on the car.
c. The force of friction is less than the force required to accelerate the car.
d. The forces acting on the car are balanced.

____ 37. Which of the following is an example of an action/reaction pair?
a. You push down on a book, and the book pushes back on you.
b. You sit in a chair, and the chair pushes down on the floor.
c. You push down on a book, and the book pushes down on the desk.
d. A book pushes down on a desk, and the floor pushes up on the desk.

____ 38. On the moon, a hammer and a feather dropped at the same time, from the same height, will hit the ground at the same time. Which of the following best explains why?
a. The moon has no gravity.
c. The moon has less gravity than the Earth.

b. The moon has no air.

d. The hammer and feather have the same mass.

____ 39. Recalling what you know about inertia, what driving and stopping advice would you give to someone who has never before driven a dump truck?

a. It takes less force to stop the truck when it is empty.

c. No one can predict whether or not a filled dump truck brakes differently from an empty one.

b. It takes more force to stop the truck when it is empty.

d. It takes the same amount of force to stop regardless of whether or not the truck is filled or empty.

____ 40. You and your much smaller friend are facing each other on a flat sidewalk. You are both wearing in-line skates. You push against each other with equal force, and you both begin to roll back. Who has greater acceleration?

a. You both have the same acceleration.

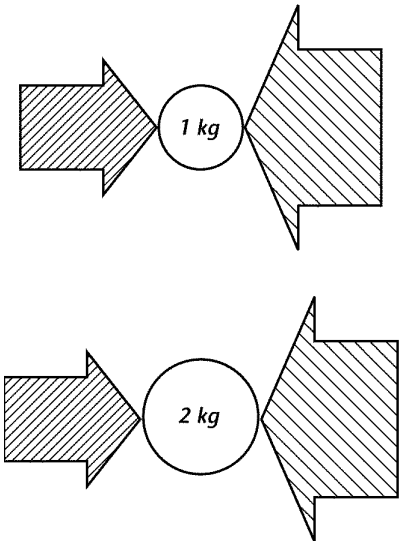
c. Your friend is smaller and has greater acceleration.

b. You are bigger and have greater acceleration.

d. You would need more information to answer this question.

Short Answer

Forces on Two Objects



41. What does the head of each arrow indicate?

42. What does the width of each arrow represent?

43. In what direction is the net force acting on each object?

44. In what direction must a force be applied so that the forces on each object are balanced?

45. Given that the net force acting on each of the two objects is the same, which object will accelerate the most? Explain your answer.

Unit Test: Forces and Motion
Answer Section

MULTIPLE CHOICE

1. ANS: A PTS: 1 DIF: 2=Low/Mid
   OBJ: Physical Ch. 9.1.1—Explain when an object is in motion and how motion is relative to a reference point. STA: PS.10.a
2. ANS: B PTS: 1 DIF: 2=Low/Mid
   OBJ: Physical Ch. 9.1.1—Explain when an object is in motion and how motion is relative to a reference point. STA: PS.10.a
3. ANS: B PTS: 1 DIF: 3=Mid/High
   OBJ: Physical Ch. 9.1.2—Calculate an object's speed and velocity using SI units of distance.
   STA: PS.10.a
4. ANS: A PTS: 1 DIF: 2=Low/Mid
   OBJ: Physical Ch. 9.1.2—Calculate an object's speed and velocity using SI units of distance.
   STA: PS.10.a
5. ANS: C PTS: 1 DIF: 2=Low/Mid
   OBJ: Physical Ch. 9.1.2—Calculate an object's speed and velocity using SI units of distance.
   STA: PS.10.a
6. ANS: B PTS: 1 DIF: 3=Mid/High
   OBJ: Physical Ch. 9.1.2—Calculate an object's speed and velocity using SI units of distance.
   STA: PS.10.a
7. ANS: D PTS: 1 DIF: 3=Mid/High
   OBJ: Physical Ch. 9.1.2—Calculate an object's speed and velocity using SI units of distance.
   STA: PS.10.a
8. ANS: B PTS: 1 DIF: 3=Mid/High
   OBJ: Physical Ch. 9.1.3—Graph motion showing changes in distance as a function of time.
   STA: PS.10.a
9. ANS: A PTS: 1 DIF: 3=Mid/High
   OBJ: Physical Ch. 9.1.3—Graph motion showing changes in distance as a function of time.
   STA: PS.10.a
10. ANS: D PTS: 1 DIF: 3=Mid/High
    OBJ: Physical Ch. 9.1.3—Graph motion showing changes in distance as a function of time.
    STA: PS.10.a
11. ANS: A PTS: 1 DIF: 3=Mid/High
    OBJ: Physical Ch. 9.3.1—Describe what happens to the motion of an object as it accelerates.
    STA: PS.10.a
12. ANS: C PTS: 1 DIF: 2=Low/Mid
    OBJ: Physical Ch. 9.3.1—Describe what happens to the motion of an object as it accelerates.
    STA: PS.10.a
13. ANS: C PTS: 1 DIF: 2=Low/Mid
    OBJ: Physical Ch. 9.3.1—Describe what happens to the motion of an object as it accelerates.
    STA: PS.10.a
14. ANS: B PTS: 1 DIF: 3=Mid/High
    OBJ: Physical Ch. 9.3.1—Describe what happens to the motion of an object as it accelerates.
    STA: PS.10.a

15. ANS: D PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 9.3.2—Calculate the acceleration of an object and graph changing speed and distance of an accelerating object. STA: PS.1.j | PS.10.a
16. ANS: A PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 10.1.1—Explain how balanced and unbalanced forces are related to motion.
STA: PS.10.c
17. ANS: C PTS: 1 DIF: 3=Mid/High
OBJ: Physical Ch. 10.1.1—Explain how balanced and unbalanced forces are related to motion.
STA: PS.10.b | PS.10.c
18. ANS: C PTS: 1 DIF: 3=Mid/High
OBJ: Physical Ch. 10.1.1—Explain how balanced and unbalanced forces are related to motion.
STA: PS.10.c
19. ANS: B PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 10.1.2—State Newton's first law of motion and define inertia.
STA: PS.10.b | PS.10.c
20. ANS: B PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 10.1.2—State Newton's first law of motion and define inertia.
STA: PS.10.b | PS.10.c
21. ANS: B PTS: 1 DIF: 3=Mid/High
OBJ: Physical Ch. 10.1.2—State Newton's first law of motion and define inertia.
STA: PS.10.b | PS.10.c
22. ANS: C PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 10.2.1—State Newton's second law of motion and explain how force and mass are related to acceleration. STA: PS.10.a | PS.10.b
23. ANS: B PTS: 1 DIF: 3=Mid/High
OBJ: Physical Ch. 10.2.1—State Newton's second law of motion and explain how force and mass are related to acceleration. STA: PS.10.a
24. ANS: A PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 10.3.1—Describe friction and identify the factors that determine the friction force between two surfaces. STA: PS.10.c
25. ANS: C PTS: 1 DIF: 3=Mid/High
OBJ: Physical Ch. 10.3.1—Describe friction and identify the factors that determine the friction force between two surfaces. STA: PS.10.c
26. ANS: C PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 10.3.4—Describe the effects of gravity and air resistance on an object in free fall.
STA: PS.10.c
27. ANS: A PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 10.3.4—Describe the effects of gravity and air resistance on an object in free fall.
STA: PS.10.c
28. ANS: D PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 10.3.2—Explain how mass differs from weight.
STA: PS.10.c
29. ANS: B PTS: 1 DIF: 3=Mid/High
OBJ: Physical Ch. 10.3.4—Describe the effects of gravity and air resistance on an object in free fall.
STA: PS.10.c
30. ANS: C PTS: 1 DIF: 3=Mid/High
OBJ: Physical Ch. 10.4.1—State Newton's third law of motion.
STA: PS.10.b
31. ANS: C PTS: 1 DIF: 2=Low/Mid

OBJ: Physical Ch. 10.5.1—Explain how a rocket lifts off the ground.
STA: PS.10.a | PS.10.b

32. ANS: A PTS: 1 DIF: 3=Mid/High
OBJ: Physical Ch. 10.5.1—Explain how a rocket lifts off the ground.
STA: PS.10.a | PS.10.b
33. ANS: D PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 10.5.2—Describe the forces that keep a satellite in orbit.
STA: PS.10.c
34. ANS: D PTS: 1 DIF: 3=Mid/High
OBJ: Physical Ch. 10.5.2—Describe the forces that keep a satellite in orbit.
STA: PS.10.c
35. ANS: A PTS: 1
36. ANS: D PTS: 1
37. ANS: A PTS: 1
38. ANS: B PTS: 1
39. ANS: A PTS: 1
40. ANS: C PTS: 1

SHORT ANSWER

41. ANS:
The head indicates the direction of the force.

PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 10.1.1—Explain how balanced and unbalanced forces are related to motion.
STA: PS.10.c
42. ANS:
The width represents the size, or magnitude, of the force.

PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 10.1.1—Explain how balanced and unbalanced forces are related to motion.
STA: PS.10.c
43. ANS:
to the left

PTS: 1 DIF: 2=Low/Mid
OBJ: Physical Ch. 10.1.1—Explain how balanced and unbalanced forces are related to motion.
STA: PS.10.c
44. ANS:
to the right

PTS: 1 DIF: 3=Mid/High
OBJ: Physical Ch. 10.1.1—Explain how balanced and unbalanced forces are related to motion.
STA: PS.10.c
45. ANS:
The acceleration of the 1-kg object is twice the acceleration of the 2-kg object.

PTS: 1 DIF: 3=Mid/High
OBJ: Physical Ch. 10.2.1—State Newton's second law of motion and explain how force and mass are related

to acceleration. STA: PS.10.c