SCIENCE CURRICULUM OVERVIEW

The goal of the Lincoln Public Schools science program is to help all students develop an understanding of the natural world and how humans utilize and impact the environment. The curriculum is based on the Nebraska State Science Standards and the National Science Standards. The program stresses hands-on activities to develop inquiry and thinking skills, as well as science process skills. The program is structured to help students realize that science is part of every day life and affects all individuals.

Elementary—The four themes studied in elementary schools are living things, the physical world, space/earth, and STS (science, technology, and society)/environment. Students experiment and do hands-on-activities to learn to value curiosity, openness, inquiry, and critical thinking skills in science as a part of every day living.

Middle School—The middle school science curriculum focuses on topics from life science, physical science, space/earth science, and STS (science, technology, and society)/environment. Some of the specific units include cells and heredity, electricity and magnetism, weather, astronomy, and the environment. The science curriculum helps students explore science questions and discover how science is meaningful to their lives.

High School—The high school science curriculum focuses on higher-level problem solving skills. Environmental issues, daily applications, and connections to other fields are stressed. Core courses include geoscience, physical science, biology, chemistry, and physics. Electives vary from school to school and may include anatomy/physiology, environmental studies, forensic science, and zoology. In order to graduate from high school in 2009–10, two-years of high school science will be required that includes one course in life science, earth science, and physical science.
Questions for Science Exploration

These questions are intended for teachers to pose as they interact with students engaged in inquiry processes.

1. What does this make you think of?
2. In what ways are these different?
3. In what ways are these the same?
4. What materials did you use?
5. What would happen if you ...
6. What might you try instead?
7. Tell me about your ...
8. What does it look like?
9. What does it remind you of?
10. What does it feel like?
11. What can you do next time?
12. What can you tell me about it?
13. Tell me what happened.
14. What could you do instead?
15. Which one do you have more of?
16. Is one object longer/shorter than another?
17. What do you call the things you are using?
18. What can you tell me about the things you have?
19. Tell me what it looks like.
20. How are you going to do that?
21. What do you feel, see, hear, taste, smell?
22. How did you do that?
23. What will you do next after you finish that?
24. Is there anything else you could do/use?
25. How do you know?
26. What are some different things you could try?
27. What is it made of?
28. Show me what you could do with it?
MOTION

While moving objects are very common in our daily lives, measuring the motion of an object is a very sophisticated notion. In these activities, students will be introduced to three useful ways of measuring and describing motion:

- speed, velocity and acceleration.

Students will be able to:
- explain when an object is in motion and how motion is relative to a reference point
- calculate an object’s speed and velocity using SI units of distance
- graph motion showing changes in distance as a function of time
- describe what happens to the motion of an object as it accelerates
- calculate the acceleration of an object and graph changing speed and distance of an accelerating object
- measure distance and time accurately
- record data in lists or tables
- apply concepts learned in class to calculate speed
- communicate their Data by using the Scientific Method
Lincoln Public Schools Science Objectives:
8.3 Forces, Motion and Energy - By the end of 8th grade, students will investigate and understand facts, concepts, principles, and laws related to force, motion, and energy.

8.3.1 Investigate and measure motion
a. Describe and measure motion
b. Calculate speed, velocity, and acceleration using metric measurement

8.3.2 Recognize and compare forces
a. Explain how balanced and unbalanced forces are related to motion
b. Investigate Newton’s 1st and 3rd Laws of Motion through experimentation
c. Explain how force and mass are related to acceleration 8.1.3b

Nebraska State Science Standards:
8.2 SCIENCE AS INQUIRY

8.2.1 By the end of eighth grade, students will develop the abilities needed to do scientific inquiry.
Example indicators:
- Identify questions and form hypotheses that can be examined through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Given evidence, develop descriptions, explanations, predictions, and models.
- Show the relationship between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
Lesson Title: Motion and YOU

Suggested Grade: 7th Grade or 8th Grade (Fits into LPS 8th Grade Curriculum)

Plan of Action:
- Class Discussion on topics of Force and Motion. Establish what the students prior knowledge is and what misconceptions they hold. Give a Pretest.
- Short Readings from Textbook to gain new information
- PowerPoint Presentation with Discussion/Student Notes
- Explore Activities: Newton’s Challenge
- Review Scientific Method
- Lab: Bubble Gum Physics
- Activity: Bubble Gum Trivia
- Lab: Speed Challenge
- Lab: Hot Wheelin’ Physics
- Lab: Speed Machines
- Lab: Play in Traffic
- Evaluate: Student and Teacher Rubrics

Data Set Used:
- LPS Science Curriculum, Prentice Hall: Motion, Forces and Energy
- Discovery Video: Force and Motion
- Data from MATC Traffic on Vine Street
- Data from MATC Speed Gun measurement
Standards Taught:

Lincoln Public Schools Science Objectives:
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   Given evidence, develop descriptions, explanations, predictions, and models.
   Show the relationship between evidence and explanations.
   Recognize and analyze alternative explanations and predictions.
   Communicate scientific procedures and explanations.
Handouts, Assignments, and Supporting Materials:
- PowerPoint Presentation
- PowerPoint Note Pages
- Lab/Activity Worksheets
- www.matc.unl.edu/
- Student and Teacher Scoring Rubrics

Prep Period:
- 30 – 45 minutes to start for Material Review and Planning
- Daily Preparation 10-15 minutes
- Copy Time for Handouts

Implementation Period (# days for lessons in classroom):
- 10 – 12 days depending on the experience and knowledge base of your students
- Class Periods are 50 minutes or After School Program is 1 Hour
- PowerPoint takes 2 days for all Slides and Discussion
- Labs/Activities take 1 Class Period or about 1 Hour
- Extra Days for Discussion and Debriefing Labs/Activities
- Play in Traffic with MATC equipment 2 Hours

Materials Needed and/or Provided:
- PowerPoint Presentation with Notes pages
- Suggested Readings: Motion, Forces and Energy
- Newton’ Challenge: Worksheets, washers, clothespin, string, fishing line, index cards, meter sticks, toy cars, straws, balloons
- Speed Challenge: Worksheets, stopwatch, meter sticks, masking tape, markers
- Hot Wheelin’ Physics: Worksheets, toy cars, race track, stopwatch, meter sticks
- Speed Machines: Worksheets, calculators
- Play in Traffic: Worksheets, MATC visit with Speed guns, measuring tape, Van with traffic camera
Learning Expectations:
- While moving objects are very common in our daily lives, measuring the motion of an object is a very sophisticated notion. In these activities, students will be introduced to three useful ways of measuring and describing motion: speed, velocity and acceleration.

Students will be able to:
- Explain when an object is in motion and how motion is relative to a reference point
- Calculate an object’s speed and velocity using SI units of distance
- Graph motion showing changes in distance as a function of time
- Describe what happens to the motion of an object as it accelerates
- Calculate the acceleration of an object and graph changing speed and distance of an accelerating object
- Measure distance and time accurately
- Record data in lists or tables
- Apply concepts learned in class to calculate speed
- Communicate their Data by using the Scientific Method

Science and Math Implications:

Nebraska State Math Standards:

8.3.2 By the end of eighth grade, students will convert units within measurement systems using standard and metric, given conversion factors.
Example indicators:
Convert between various units of area and various units of volume (square foot to square yards and cubic decimeters to liters, etc.).
Check solutions to problems using unit analysis (feet/second to miles/hour).

8.5 DATA ANALYSIS, PROBABILITY, AND STATISTICAL CONCEPTS
8.5.1 By the end of eighth grade, students will collect, construct, and interpret data displays and compute mean, median, and mode.
Example indicator: Select appropriate representations of data when constructing data displays (graphs, tables, or charts).
8.5.2 By the end of eighth grade, students will read and interpret tables, charts, and graphs to make comparisons and predictions.

8.5.3 By the end of eighth grade, students will conduct experiments or simulations to demonstrate theoretical probability and relative frequency.
   Example indicator:
   Compare the results of a simulation (relative frequency) to the theoretical probability (a three color spinner or a coin).

8.5.4 By the end of eighth grade, students will identify statistical methods and probability for making decisions.
   Example indicators:
   Identify the use of appropriate sampling techniques.
   Identify the use of appropriate charts and graphs.
   Identify the use of measures of central tendency (mean, median, and mode) appropriately.

8.6.3 By the end of eighth grade, students will describe and represent relations, using tables, graphs, and rules.
   Example indicator:
   Use variables to recognize and describe patterns.

Evaluations, Assessments, and Grading Rubric:
   ▶ Self Assessment of Performance as a Group Member
   ▶ Group Assessment of Laboratory Activities
   ▶ Teacher Independent Investigation Rubric

Unexpected Results:
We can hardly wait for the MATC team to return!
We used my Lesson plans with our after school program, Project Nexus.
My Team of Teachers was very pleased with the final product.
The students were engaged the entire time, which is a difficult task for a group of 6th, 7th and 8th graders from 3:15 until 5:15pm. We really generated excitement for our after school program. Our student numbers
are over 50 (over 10% of our population) on a regular basis for an after school program.
The 8th grade Science teachers will use my materials during 3rd Quarter to teach Motion, Forces and Energy. They are pleased that I planned their 3rd Quarter of Instruction with fresh, innovative ideas.
What is Motion?

Diamond a cloud moving in the sky
Diamond an acorn falling from an oak tree
Diamond a sprinter moving down a track
Diamond a feather falling to earth
Diamond water level rising in a bath tub
Diamond minute hand moving on a clock

Which example will be easy to measure?
Which example will be challenging to measure?

How can we describe different types of motion?

Diamond measure distance and time
Diamond create a map showing various positions

Imagine that you have traveled thousands of miles to visit the tropics of South America. Suddenly vivid reds and blues brighten the green of the rain forest as a group of macaws swoop down and perch about you in the nut tree. They squawk at each other and crack nuts with their powerful beaks and eat the meat. In a few minutes they spread their wings to take off and vanish from sight. The macaws cracking nuts, flapping their wings and flying through the forest are all examples of motion. Your plane flight to South America is another.
WHAT IS AN OBJECT IN MOTION?

An object is in motion when its distance from another object is changing.

At the same time that you think you are sitting still, you are actually moving about 30 kilometers every second. At that speed you could travel from New York City to Los Angeles in about 2 minutes! You are moving because you are on Planet Earth which is orbiting the Sun. The Earth moves about 30 kilometers every second, so you and everything else on Earth are moving at that speed as well.

Whether or not an object is moving depends on your point of view. A REFERENCE POINT is a place or object used for comparison to determine if something is in motion. An object is in motion if it changes position relative to a reference point. You assume that the reference point is stationary or not moving.

To describe motion, you need to use units of measurement. Scientists all over the world use the same system of units so that they can communicate information clearly. This system is called the International System of Units. SI is based on the number 10. The SI basic unit of length is the meter.
Scientists use SI units to describe the distance an object travels. A car for example might travel 90 kilometers. An ant may travel 2 centimeters. If you know the distance an object travels in a certain amount of time, you know the speed of the object. The speed of an object is the distance the object travels in one unit of time. Speed is a type of rate. A rate tells you the amount of something that occurs or changes in one unit of time.

To calculate the speed of an object, divide the distance the object travels by the amount of time it takes to travel that distance.

\[
\text{Speed} = \frac{\text{Distance}}{\text{Time}}
\]

Speed measurements consist of a unit of distance by a unit of time. If you measure in meters and time in seconds you express the speed in meters per second (m/s) (the slash means “per”). If you measure in kilometers and time in hours, you express the speed in kilometers per hour (km/hr).

**Constant Speed**

If the speed of an object does not change, the object is traveling at a constant speed. When an object travels at a constant speed, you know that its speed is the same at all times during its motion.
AVERAGE SPEED

Most objects do not move at constant speeds for very long. To find average speed, divide the total distance traveled by the total time.

Knowing the speed at which something travels does not tell you everything about its motion. For example if a weather forecaster announces that a severe storm is traveling 25 km/hr would you prepare for the storm? Storms usually travel from west to east. If you live to the west of the storm and the storm is traveling to the east, you probably don’t have to worry. It is important to know not only the speed of the storm but also its direction. When you know both the speed and direction of an object’s motion, you know the velocity of the object. Speed in a given direction is called velocity. If you know the velocity at which an object is moving, you know two different things about the object’s motion -- it’s speed and direction.

- weather forecasters need to know velocities for tracking the weather
- air traffic controllers need to know velocities of the aircrafts’ to avoid collisions between airplanes
- stunt pilots need to know velocities to stay in formation and to avoid collisions with other planes
Graphing Motion

You can show the motion of an object on a line graph in which you plot distance against time. A point on the graph represents the location of an object at a particular time. x-axis shows time and y-axis represents distance. A straight line represents motion at a constant speed. The steepness of the slope (slant of the line) depends on how quickly or slowly an object is moving. The faster the motion, the steeper the slope, because the object moves a greater distance in a given amount of time. A horizontal line represents an object that is not moving at all.
ACCELERATION

The pitcher winds up. She throws. The ball speeds to the batter and crack off the bat it goes. It’s going, it’s going, it’s gone....a home run!!

Before falling over the fence, the softball went through several changes in motion. It started moving from the pitcher’s hand, sped up, stopped moving at the bat, changed direction and eventually slowed down. Most examples of motion involve similar changes. It is rare for any motion to stay the same for very long. You can describe changes in motion in much the same way as you did when you learned how to describe motion in terms of speed and velocity.

Consider a car at a red light. When the light changes to green, the driver of the car gently steps on the accelerator. So the car speeds up or accelerates. In everyday language, acceleration means “speeding up”.

Acceleration is a more precise definition in Science. **Acceleration** is the rate at which velocity changes. Recall that velocity has 2 components (SPEED and DIRECTION). Acceleration involves a change in either of these components. In Science, acceleration refers to increasing speed, decreasing speed or changing direction.
Increasing Speed
If the speed of an object increases, the object experiences acceleration.

Examples of acceleration
- a pitcher throws a softball
- a bat hits a softball
- a car moves forward at a stop light
- a runner sprints down a track
- you try to catch the bus for school

Decreasing Speed
Just as objects can speed up, they can also slow down. Motion in which speed decreases is also considered acceleration in Science. This change in speed is sometimes called deceleration or negative acceleration.

Examples of deceleration
- a softball rolls to a stop
- a car brakes to a stop at a red light
- a jet lands on a runway
- a diver completes their dive into the water

Changing Direction
Velocity involves both speed and direction. An object can be accelerating even if its speed is constant.

Examples of constant speed/direction change
- a car rounding a curve in the road
- a skater rounds a turn on the track
- a moving Ferris wheel at an Amusement Park
- the Moon revolving around the Earth
Calculating Acceleration
Acceleration describes the rate at which velocity changes.
To determine the acceleration of an object, you must calculate the change in velocity during each unit of time.

$$\text{Acceleration} = \frac{\text{Final velocity} - \text{Initial velocity}}{\text{Time}}$$

Remember units of measure...
Velocity is measured in distance / time
Time is measured in units of time
So units for Acceleration is in distance/time/time.
Therefore Acceleration has two units of time. Written: 

$$2 \text{ Distance/time}$$

If an object’s speed and direction change by the same amount during each unit of time, the acceleration at any time during its motion is the same. If however, the acceleration varies, you can describe only the average acceleration.

For an object moving without changing direction, the acceleration of the object is the change in its speed during one unit of time.

Consider for example a small airplane moving on a runway. The speed of the airplane at the end of each of the first five seconds of motion is shown below:
Change in Speed over Time

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>32</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
</tr>
</tbody>
</table>

To calculate the acceleration of the airplane, you must first subtract the initial speed (0 m/s) from the final speed (40 m/s). This gives the change in speed, 40 m/s. Then divide the change in speed by the time, 5 seconds.

\[
\text{ACCELERATION} = \frac{40 \text{ m/s} - 0 \text{ m/s}}{5 \text{ seconds}} = 8 \text{ m/s}^2
\]

The acceleration tells you how the speed of the airplane in the Table changes during each second. Notice that after each interval of one second, the speed of the airplane is 8 m/s greater than during the previous interval. So after one second, its speed = 8 m/s.

After two seconds, its speed = 8 m/s + 8 m/s = 16 m/s

Since the acceleration of the airplane does not change during the five seconds, you can use this formula for any time interval during the five seconds. Try it.
Graphing Acceleration
You can use a graph to analyze the motion of an object that is accelerating.

You can graph Speed vs. Time.

If acceleration is constant, for every increase in unit of time the speed increases in the same amount the graph will be a straight line.

If the object accelerated by a different amount each unit of time, the graph would not be a straight line.

You can graph Distance vs. Time

This graph is a curved line. The distance traveled by an accelerating object varies each second. As speed increases, the graph curves upward.
DESCRIBING and MEASURING MOTION

KEY IDEAS

◆ The motion of an object is determined by its change of position relative to a reference point.

◆ Speed is the distance an object travels in one unit of time. If an object moves at constant speed, its speed can be determined by dividing the distance it travels by the time taken. If an object’s speed varies, then dividing distance by time gives you the object’s average speed.

◆ When you state both the speed of an object and the direction in which it is moving, you are describing the object’s velocity.

ACCELERATION

KEY IDEAS

◆ Acceleration is the rate at which velocity changes. It involves increasing speed, decreasing speed or changing direction.

◆ Acceleration can be calculated by dividing the change in velocity by the amount of time it took that change to occur.
MOTION AND YOU
<table>
<thead>
<tr>
<th>ACCELERATION</th>
<th>ACORN</th>
<th>CLOCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLOUD</td>
<td>DECREASING SPEED</td>
<td>DISTANCE</td>
</tr>
<tr>
<td>DIVINGINTOPOOL</td>
<td>EARTH</td>
<td>FEATHER</td>
</tr>
<tr>
<td>FERRISWHEEL</td>
<td>INCREASING SPEED</td>
<td>MAP</td>
</tr>
<tr>
<td>MINUTEHAND</td>
<td>MOTION</td>
<td>MOVEMENT</td>
</tr>
<tr>
<td>OAKTREE</td>
<td>POINTOFREFERENCE</td>
<td>POINTOFVIEW</td>
</tr>
<tr>
<td>SPEED</td>
<td>SPEEDEQUATION</td>
<td>TIME</td>
</tr>
<tr>
<td>TRAFFIC</td>
<td>UNITOFMEASURE</td>
<td>VELOCITY</td>
</tr>
<tr>
<td>WATERLEVEL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

25 of 25 words were placed into the puzzle.

Solution

Created by Puzzlemaker at DiscoverySchool.com
Describing and Measuring Motion

An object is in motion when its distance from another object is changing. Whether an object is moving or not depends on your point of view. For example, a woman riding on a bus is not moving in relation to the seat she is sitting on, but she is moving in relation to the buildings the bus passes. A reference point is a place or object used for comparison to determine if something is in motion. An object is in motion if it changes position relative to a reference point. You assume that the reference point is stationary, or not moving.

Units of measurement are used to describe an object's motion. The system of measurement used by scientists all over the world is called the International System of Units, or in French, Système International (SI). The SI system is based on the number 10.

The basic SI unit of length is the meter (m). A meter is a little longer than a yard. To measure the length of an object smaller than a meter, scientists use the metric unit called the centimeter (cm). There are 100 centimeters in a meter. Meters and centimeters can be used to describe the distance an object travels.

Rate is the amount of something that occurs or changes in one unit of time. Speed is a type of rate. The speed of an object is the distance the object travels in one unit of time. To calculate the speed of an object, divide the distance the object travels by the amount of time it takes to travel that distance. Speed measurements consist of a unit of distance divided by a unit of time, such as meters per second.

\[
\text{Speed} = \frac{\text{Distance}}{\text{Time}}
\]

When an object travels at a constant speed, its speed at any point during its motion is the same as it is at every other point. Most objects do not move at constant speeds. To find the average speed of an object, divide the total distance traveled by the total time. An object's speed tells how fast it is moving, but not the direction of the motion. When you know both the speed and direction of an object's motion, you know the velocity of the object. Speed in a given direction is called velocity.

A line graph in which distance is plotted against time can show the motion of an object. A straight line represents motion at a constant speed. The steepness of the line's slope depends on the speed of the object. A horizontal line represents an object that is not moving at all.
SECTION 1-1 REVIEW AND REINFORCE

Describing and Measuring Motion

♦ Understanding Main Ideas

Use the following paragraph and graph to answer questions 1 through 5. Write your answers on a separate sheet of paper. Remember to include units in your answers.

On Saturday, Ashley rode her bicycle to visit Maria. Maria's house is directly east of Ashley's. The graph shows how far Ashley was from her house after each minute of her trip.

1. Ashley rode at a constant speed for the first 4 minutes of her trip. What was her constant speed?
2. What was her average speed for the entire trip?
3. What was her average velocity for the entire trip?
4. Ashley stopped to talk with another friend during her trip. How far was she from her house when she stopped?
5. Ashley's brother rode beside her for several minutes. During this time, was he moving relative to Ashley?

♦ Building Vocabulary

From the list below, choose the term that best completes each sentence. Write your answers on the line provided.

<table>
<thead>
<tr>
<th>motion</th>
<th>International System of Units</th>
<th>foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>reference point</td>
<td>yard</td>
<td>meter</td>
</tr>
<tr>
<td>average</td>
<td>velocity</td>
<td>speed</td>
</tr>
</tbody>
</table>

6. Scientists around the world use the ____________, a system of measurement based on the number ten.

7. An object is in ____________ when its distance from a(n) ____________ is changing.

8. Speed in a given direction is ____________.

9. ____________ can be calculated if you know the distance that an object travels in one unit of time.

10. The basic SI unit of length is the ____________.
Exploring Reference Points

Depending on the reference point you choose, the same object can seem to be moving or standing still. Furthermore, even if an object seems moving from two different reference points, observers at those points might disagree about its speed and direction.

Here is a simple example: In the diagram below, a crow is flying along at a constant speed, carrying a shiny marble. Suddenly, it accidentally drops the marble and watches it fall. The diagram shows the position of the crow and the marble at five points in time, one second apart. A person standing still on the ground also watches the marble fall.

Answer the following questions on a separate sheet of paper.

1. From the reference point of the crow, in what direction is the marble falling? Does it appear to follow a curved or straight path?
2. How many seconds does it take the marble to fall to the ground?
3. The sides of the grid squares in the diagram are 5 meters long. Using this, calculate the average speed of the marble during its fall from the point of view of the crow. About how fast was it traveling during the last second of its fall from this perspective?
4. From the reference point of the person on the ground, does the marble appear to fall in a straight or curved path?
5. Measure the distance that the marble traveled while falling from the perspective of the person. What was its average speed? About how fast was it traveling during the last second of its fall from this perspective? (Hint: You will need a ruler to answer this.)
Slow Motion on Planet Earth

If you look at a map of the world, you can see that the landmasses seem to fit together like a giant jigsaw puzzle. Earth's upper layer consists of more than a dozen major pieces called plates. Scientists use the concept of plates to explain how landmasses have changed over time. According to their explanation, known as the theory of plate tectonics, Earth's plates move ever so slowly in various directions. Some small plates can move as much as several centimeters per year, whereas others move only a few millimeters per year.

Knowing how far a plate moves in a certain amount of time enables scientists to calculate the average speed of the plate. The average speed lets them predict how far a plate will move in the future. To calculate the distance a plate will move, rearrange the speed formula:

\[
\text{Distance} = \text{Speed} \times \text{Time}
\]

If you know that a plate moves 5 cm/yr, and you want to predict the distance it will move in 1,000 years, multiply the speed by the time during which the plate travels.

\[
\text{Distance} = \frac{5 \text{ cm}}{1 \text{ yr}} \times 1,000 \text{ yr} = 5,000 \text{ cm}
\]

To convert this distance from centimeters to meters, recall that there are 100 centimeters in 1 meter. Divide by 100 by moving the decimal to the left two places: 5,000 cm = 50.00 m. The plate will move 5,000 centimeters, or 50 meters, in 1,000 years.

You can convert from one unit of measurement to another by using a conversion factor, a fraction in which the numerator and denominator are equal. For example, to convert the speed of the plate from centimeters per year to centimeters per day, you will need a conversion factor.

\[
\frac{5 \text{ cm}}{1 \text{ yr}} \times \frac{1 \text{ yr}}{365 \text{ d}} = 0.0137 \text{ cm/d}
\]

So you can describe the speed of the plate as 5 cm/yr or 0.0137 cm/d.
Slow Motion on Planet Earth

♦ Understanding Main Ideas

Study the map below. Answer the following questions on the back of this sheet or on a separate piece of paper. Remember to include units in your answers as needed.

1. Which plate is moving the fastest?
2. Which plate is moving the slowest?
3. If the Juan de Fuca Plate continues to move away from the Pacific Plate at the same speed as shown on the graph, how many meters will it move in 10,000 years?
4. About how many centimeters does the Nazca Plate move in one year?

♦ Building Vocabulary

Write your answer to the following question on a separate sheet of paper.
5. Briefly describe the theory of plate tectonics. Include in your answer the definition of plates.
Acceleration

Acceleration is the rate at which velocity changes. Recall that velocity has two components—direction and speed. Acceleration involves a change in either of these components. In science, acceleration refers to increasing speed, decreasing speed, or changing direction.

Any time the speed of an object changes, the object experiences acceleration. That change can be an increase or decrease. A decrease in speed is sometimes called deceleration, or negative acceleration.

An object that is changing direction is also accelerating, even if it is moving at a constant speed. A car moving around a curve or changing lanes at a constant speed is accelerating because it is changing direction.

Many objects continuously change direction without changing speed. The simplest example of this type of motion is circular motion, or motion along a circular path. The moon accelerates because it is continuously changing direction as it revolves around Earth.

Acceleration describes the rate at which velocity changes. To determine the acceleration rate of an object, you must calculate the change in velocity during each unit of time. This is summarized by the following formula.

\[
\text{Acceleration} = \frac{\text{Final velocity} - \text{Initial velocity}}{\text{Time}}
\]

If velocity is measured in meters/second and time is measured in seconds, the unit of acceleration is meters per second per second, which is written as m/s².

If an object is accelerating by the same amount during each unit of time, the acceleration at every point in its motion is the same. If the acceleration varies, however, only the average acceleration can be calculated. For an object moving without changing direction, the acceleration is the change in its speed during one unit of time.

A line graph can be used to analyze acceleration by showing speed versus time. When a graph shows speed versus time as a straight line, the acceleration is constant. If an object accelerates by a different amount each time period, a graph of its acceleration will not be a straight line. A graph of distance versus time for an accelerating object is curved.
Acceleration

◆ Understanding Main Ideas

If the statement is true, write true. If it is false, change the underlined word or words to make the statement true.

1. If a train is slowing down, it is accelerating.

2. To find the acceleration rate, you must calculate the change in distance during each unit of time.

3. A Ferris wheel turning at a constant speed of 5 m/s is not accelerating.

4. An airplane is flying west at 200 km/h. Two hours later, it is flying west at 300 km/h. Its average acceleration is 100 km/h².

5. Graph A plots a race car's speed for 5 seconds. The car's rate of acceleration is 6 m/s².

6. Graph B plots the same car's speed for a different 5-second interval. The car's acceleration during this interval is 12 m/s².

◆ Building Vocabulary

From the list below, choose the term that best completes each sentence. Write your answers on the line provided.

acceleration velocity speed distance

7. ___________ occurs when the velocity of an object changes.

8. When you say that a race car travels northward at 100 km/h, you are talking about its _____________.

Motion, Forces, and Energy
CHAPTER 1

SKILLS LAB

Measuring

Inclined to Roll

In this lab, you will practice the skills of measuring time and distance to find the speed of a moving object.

◆ Problem  How does the steepness of a ramp affect how fast an object moves across the floor after it rolls down the ramp?

◆ Materials
  skateboard  meter stick  flat board, about 1.5 m long
  protractor  masking tape  small piece of sturdy cardboard
  supports to prop up the board (books, boxes)
  2 stopwatches or wristwatches with a stopwatch function

◆ Procedure

1. You will record your results in the data table on page 30.

2. Lay the board flat on the floor. Using masking tape, mark a starting line in the middle of the board. Mark a finish line on the floor 1.5 m beyond the other end of the board. Place a barrier after the finish line.

3. Prop up the other end of the board to make a slight incline. If necessary, tape a piece of cardboard between the end of the board and the floor to make a smooth joint with the floor.

4. Use a protractor to measure the angle that the board makes with the ground. Record the angle in the data table.

5. Working in groups of three, have one person hold the skateboard so that its front wheels are even with the starting line.

6. As the holder releases the skateboard, the other two students should start their stopwatches.

7. One timer should stop his or her stopwatch when the front wheels of the skateboard reach the end of the incline. The second timer should stop his or her stopwatch when the front wheels of the skateboard reach the finish line.

8. Repeat steps 5–7 two more times. If your results aren’t consistent (the three times measured on a given watch should be within 0.2 seconds of each other), carry out more trials. Record all times in the data table.

9. Repeat Steps 3–8 four times, making the ramp gradually steeper each time.

10. For each angle of the incline, complete the following calculations and record them in the data table.

   a. Find the average time the skateboard takes to get to the bottom of the ramp (Time 1).

   b. Find the average time the skateboard takes to get to the finish line (Time 2).

   c. Subtract the average Time 1 from the average Time 2.
SKILLS LAB (continued)

◆ Data Table

Complete the data table on the back of this sheet or on a separate sheet of paper.

<table>
<thead>
<tr>
<th>Angle (degrees)</th>
<th>Trial Number</th>
<th>Time 1 (to bottom) (s)</th>
<th>Time 2 (to finish) (s)</th>
<th>Avg Time 1 (s)</th>
<th>Avg Time 2 (s)</th>
<th>Avg Time 2 – Avg Time 1 (s)</th>
<th>Avg Speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>3</td>
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</tr>
</tbody>
</table>

◆ Analyze and Conclude

Write your answers on the back of this sheet or on a separate sheet of paper.

1. How can you find the average speed of the skateboard for each angle of incline? Determine the average speed for each angle and record it in the data table.

2. Which is your manipulated variable and which is your responding variable in this experiment? Explain why.

3. On a graph, plot the speed of the skateboard (on the y-axis) against the angle of the ramp (on the x-axis). Connect the points on your graph.

4. What does the shape of your graph show about the relationship between the speed and the angle of the ramp?

5. Think About It Do you think your method of timing was accurate? Suggest other strategies so that you can be sure the timers start their stopwatches exactly when the skateboard is released and stop them exactly when the wheels reach the appropriate point.

◆ Design an Experiment

A truck driver transporting new cars needs to roll the cars off the truck. You offer to design a ramp to help with the task. What measurements might you make that would be useful? Design an experiment to test your ideas.
REAL-WORLD LAB (continued)

♦ Part II Stopping Distance

5. On the school field or in the gymnasium, mark off a distance of 25 m.

6. Have your partner time how long it takes you to run the course at full speed. **CAUTION: Be sure to remove any obstacles from the course.** After you pass the 25-m mark, come to a stop as quickly as possible and remain standing. You must not slow down before the mark. Have your partner measure the distance from the 25-m mark to your final position. This is the distance you need to come to a complete stop. Enter your time and distance into the class data table.

7. Reverse roles with your partner. Enter your partner’s time and distance into the class data table.

♦ Class Data Table

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Reaction Time (s)</th>
<th>Running Time (s)</th>
<th>Stopping Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>
REAL-WORLD LAB (continued)

♦ Analyze and Conclude

Answer the following questions on the back of this sheet or on a separate sheet of paper.

1. How can you calculate the average speed of the student who ran the 25-m course the fastest? Find this speed.

2. Multiply the speed of the fastest student (the speed calculated in Question 1) by the slowest reaction time listed in the class data table. Why would you be interested in this product?

3. Add the distance calculated in Question 2 to the longest stopping distance in the class data table. What does this total distance represent?

4. Explain why it is important to use the fastest speed, the slowest reaction time, and the longest stopping distance in your calculations.

5. What other factors should you take into account to get results that apply to a real basketball court?

6. Apply Suppose the distance between the out-of-bounds line and the wall in a playground or gymnasium is, according to your calculations, too short for safety. Suggest some strategies that could be used (other than moving the wall) for making that playground safer.

♦ Getting Involved

Visit a local playground and examine it from the viewpoint of safety. Use what you learned about stopping distance as one of your criteria, but also try to identify other potentially unsafe conditions. Write a letter to the department of parks or to the officials of your town informing them of your findings.
Converting Units for Speed Measurements

As you make speed calculations, you'll choose measurement units that are convenient for that particular measurement. If you want to compare two different speeds, it's more convenient to convert one or both measurements so that both units are the same. Work through the examples and complete the table to practice converting measurement units.

♦ Example 1

Peyton calculated the speed of a windup toy to be 7 m/min and the speed of a grain of sand dropping through water to be 11 cm/s. He wanted to convert both of these measurements to the same units so that he could compare them.

Peyton can convert the speed of the windup toy from m/min to cm/s, or he can convert the speed of the grain of sand from cm/s to m/min. In this example, he converts the speed of the grain of sand from cm/s to m/min.

\[
\frac{11 \text{ cm}}{1 \text{ s}} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{60 \text{ s}}{1 \text{ min}} = 6.6 \text{ m/min}
\]

The grain of sand moves at 6.6 m/min, somewhat slower than the windup toy.

♦ Example 2

Kacy estimated that her bean plant grew about 2 centimeters per day. She wants to know how fast that is in meters per year. She does the following calculation:

\[
\frac{2 \text{ cm}}{1 \text{ day}} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{365 \text{ days}}{1 \text{ year}} = 7.3 \text{ m/yr}
\]

Here's how she would find the growth rate of the bean plant in centimeters per hour:

\[
\frac{2 \text{ cm}}{1 \text{ day}} \times \frac{1 \text{ day}}{24 \text{ h}} = 0.083 \text{ cm/h}
\]

♦ Conversions to Do

Complete the table. The first two rows are done for you.

<table>
<thead>
<tr>
<th>Start with this</th>
<th>Convert the units to</th>
<th>Multiply original measurement by</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0065 m/day</td>
<td>mm/d</td>
<td>(\frac{1000 \text{ mm}}{1 \text{ m}})</td>
<td>6.5 mm/d</td>
</tr>
<tr>
<td>25 m/s</td>
<td>km/h</td>
<td>(\frac{60 \text{ s}}{1 \text{ min}} \times \frac{60 \text{ min}}{1 \text{ h}} \times \frac{1 \text{ km}}{1000 \text{ m}})</td>
<td>90 km/h</td>
</tr>
<tr>
<td>8,900 mm/s</td>
<td>m/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 cm/d</td>
<td>m/yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.9 km/yr</td>
<td>m/d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 m/yr</td>
<td>km/yr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 1 PROJECT  WORKSHEET 1

The Art of Measuring Speed

♦ Measuring More Than Once

1. Keisha wanted to measure the running speed of her dog, Marvin. She marked off 20 meters in her backyard, told Marvin to stay at the starting point, and then positioned herself at the finish point with a stopwatch. She started the stopwatch and called Marvin, who faithfully came running. Before calculating Marvin's speed, Keisha repeated the measurement three more times. Her four measurements were: 5.6 s, 4.3 s, 4.1 s, and 4.4 s.

a. Give possible explanations why the first measurement might be so different from the other three. Why is it a good idea to repeat a measurement several times rather than just taking the first piece of data you get?

b. The first measurement was over a second longer than the other three. Give reasons for including and for excluding the first measurement from the average.

♦ Measuring the Distance Around a Circle

2. Cara's gerbil Clancy was running in a treadmill. Cara remembered that the circumference of a circle is \( \pi \times \) the diameter of the circle. \( (\pi \approx 3.14) \)

a. Calculate how far Clancy runs for each revolution of the treadmill.

b. The radius of a bicycle wheel is 34.5 cm. How far does your bicycle travel for each revolution of the wheel? (Hint: The diameter of a circle is equal to twice its radius.)
Newton's Challenge

Newton's 1st Law Lab
In this basic (and less costly) version of the "pull the tablecloth" magic trick, I use standard clothespin taped to film vials filled with sand. You will need to prepare the stand apparatus, gather a few pennies, and make "platforms". For the platforms, cut 2 small circles (4 -5 inches in diameter) from index cards. Attach a 10 cm strand of fishing line to the edge of one circle with tape and leave the last one plain.

First, students are instructed to balance a penny on a circle with a string on top of the clothespin. The challenge is to pull the circle out from under the penny to leave it balanced on the pencil. Second, students need to place the penny on top of a plain circle (no string) on the pencil. This time they should use their finger to "flick" the index card circle out from under the penny leaving it balanced on the pencil. Third, the challenge is to balance the penny and circle on the end of the finger. The student should try to flick the index card circle out from under the penny to leave it balanced on their finger.

Newton's 2nd Law Lab
For this experiment, students set up simple ramps (between 20 – 30 cm in height) using books and three meter sticks (side by side) taped together. The students experiment with varying amounts of mass (washers) to determine the distance the car will roll. I use toy cars (a little larger than Hot Wheels) and 3/8 inch washers. Complete instructions can be found on the student worksheet. You can also challenge the students to conduct experiment with different ramp heights while keeping the mass constant.

Newton's 3rd Law Lab
Students use straws and balloons to investigate Newton's 3rd Law. By experimenting with several variations (angles), students construct their own understanding of this law. Complete instructions can be found on the student worksheet.

Student Worksheet : Newton's Laws
Newton’s First Law of Motion

What is Newton’s First Law of Motion?

Part A: Wacky Washers
To prepare for this experiment, stack 4 washers one on top of the other so that you form a tower of washers. Place the stack of washers on top of your textbook or on the floor so that you have a smooth, slick surface.

Aim one washer at the bottom of the stack of four washers and give it a good hard flick with your finger or hand. What happens?

Flick a stack of two washers into a stack of four washers. What happens?

Flick a stack of four washers into a stack of four washers. What happens?

Explain your observations in terms of Newton’s 1st Law.

Part B: Tricky Tricks
Now that you are an expert at Newton’s First Law of Motion, try these tricks. Without inertia, they would not be possible!

Set up the situation shown in the top diagram. The goal is to remove the circle by pulling on the string, but the penny must remain in place on top of the clothespin. Can you do it? Keep trying until you are able to do it!

Try the experiment again using the plain circle (no string). Can you flick the circle out from under the penny and keep the penny on the end of the clothespin? Keep trying until you are able to do it!

Balance the penny on a circle (string or no string) on the tip of you finger as shown in the second diagram. Try to remove the paper circle to leave the penny balanced on your finger. Can you do it?

How does this activity relate to the “pull the tablecloth” trick used by magicians?
Newton’s Second Law of Motion

What is Newton’s Second Law of Motion?

Newton’s Race

Step 1: Set up a ramp using meter sticks and several books. Place one end of the ramp on the books and line up the other end with a piece of masking tape on the floor.

Step 2: Place the vehicle at the top of your meterstick and roll it down the ramp. Use a meter stick to measure how far the vehicle rolls. Repeat this step for Trials 2 & 3.

Step 3: Add five washers to the vehicle and repeat the process from Step 2. Record your measurements in the chart. Be sure all the washers remain on the vehicle! Repeat this step for Trials 2 & 3.

Step 4: Add ten washers to the vehicle and repeat the process from Step 2. Record your measurements in the chart. Be sure all the washers remain on the vehicle! Repeat this step for Trials 2 & 3.

<table>
<thead>
<tr>
<th># of Washers</th>
<th>Distance (cm)</th>
<th>Average Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
<td>Trial 2</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How does increasing mass (adding more washers) affect the force of objects in motion (the distance the vehicle rolls)? Explain your answer using data from the chart.

What would happen if you added fifteen washers to the car? Predict how far the car would roll.

Explain the results of your experiment in terms of Newton’s 2nd Law.
Newton’s Third Law of Motion

What is Newton’s Third Law of Motion?

Balloon Rally

Step 1: Attach a balloon to the end of a flexible straw with tape. Choose the end that is furthest away from the bend.

Step 2: Push a straight pin through the straw about halfway between the balloon and the bend in the straw. Fasten the pin in the eraser of a pencil.

Blow up the balloon and bend your straw to a $90^\circ$ angle before allowing the air to escape. What happens?

Blow up the balloon and bend your straw to a $45^\circ$ angle before allowing the air to escape. What happens?

Blow up the balloon, but leave your straw straight ($180^\circ$ angle). Release the air in the balloon. What happens?

Remove the pin and hold on to the straw as you blow up the balloon. Release the straw. What happens?

Explain your observations in terms of Newton’s 3rd Law.
Hot Wheelin’ Physics

Follow your teacher's directions to complete this lab activity.
Be sure to record your lab results in the charts!

<table>
<thead>
<tr>
<th>Trial 1:</th>
<th>Trial 2:</th>
<th>Trial 3:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point</td>
<td>Distance</td>
<td>Time</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Point</th>
<th>Distance</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Speed = Distance \div Time

1. Calculate the speed for each trial using the total time and total distance. Show your work!
   - Trial 1: 
   - Trial 2: 
   - Trial 3: 

2. Calculate the speed from **Point B** to **Point C** for each trial. Show your work!
   - Trial 1: 
   - Trial 2: 
   - Trial 3: 

3. Calculate the speed from **Point D** to **Point E** for each trial. Show your work!
   - Trial 1: 
   - Trial 2: 
   - Trial 3: 

Name ____________________________
4. Construct a graph to show your results. Be sure to label each graph!

Trial 1:  

Trial 2:  

Trial 3:  

5. Do your graphs represent a constant speed or an average speed?

6. Are your results reliable? Explain.
Scientific Method

**What is the scientific method?** It is a process that is used to find answers to questions about the world around us.

**Is there only one “scientific method”?** No, there are several versions of the scientific method. Some versions have more steps, while others may have only a few. However, they all begin with the identification of a problem or a question to be answered based on observations of the world around us and provide an organized method for conducting and analyzing an experiment.

**What is a hypothesis?** It is an educated guess based on observations and your knowledge of the topic.

**What is data?** It is information gathered during an experiment.

---

**Identify the Problem**
What do you want to know or explain? Use observations you have made to write a question that addresses the problem or topic you want to investigate.

**Form a Hypothesis**
What do you think will happen? Predict the answer to your question or the outcome of the experiment.

**Create an Experiment**
How will you test your hypothesis? Develop a procedure for a reliable experiment and address safety rules.

**Perform an Experiment**
Follow the steps in your procedure to perform your experiment. Record data and observations!

**Analyze the Data**
Is the data reliable? Does your data and observations from the experiment support your hypothesis?

- **Yes**
  - Is your data inaccurate or the experiment flawed?
  - **Yes**
    - **Modify the Experiment**
      - Rewrite your procedure to address the flaws in the original experiment.
  - **No**

- **No**
  - Write a conclusion that summarizes the important parts of your experiment and the results.

---

*T. Trimpe 2003  http://sciencespot.net/*
Scientific Method

What is the scientific method? It is a ___________ that is used to find ___________ to questions about the world around us.

Is there only one “scientific method”? No, there are several versions of the scientific method. Some versions have more ___________, while others may have only a few. However, they all begin with the identification of a ___________ or a ___________ to be answered based on observations of the world around us and provide an ___________ method for conducting and analyzing an experiment.

What is a hypothesis? It is an ___________ ___________ based on observations and your knowledge of the topic.

What is data? It is ___________ gathered during an experiment.

What do you want to know or explain? Use observations you have made to write a question that addresses the problem or topic you want to investigate.

What do you think will happen? Predict the answer to your question or the outcome of the experiment.

How will you test your hypothesis? Develop a procedure for a reliable experiment and address safety rules.

Follow the steps in your procedure to perform your experiment. Record data and observations!

Is the data reliable? Does your data and observations from the experiment support your hypothesis?

Yes

Is your data inaccurate or the experiment flawed?

Yes

Rewrite your procedure to address the flaws in the original experiment.

No

No

Write a conclusion that summarizes the important parts of your experiment and the results.

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Bubble Gum Physics

Obtain a piece of bubble gum from your teacher and start chewing to get ready for the experiments!

Part A: Chomper Challenge

(1) For this experiment, you will conduct five trials to determine the number of chomps you can do in 30 seconds. A chomp is defined as a “big chew”, or the kind that usually causes you to get caught with gum.

(2) Use a timer to determine the number of chomps you can do in 30 seconds. Record your data in the chart. Repeat the same process for the other trials.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Chomps</th>
<th>Time</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<td>3</td>
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<td>4</td>
<td></td>
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<td></td>
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<tr>
<td>5</td>
<td></td>
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</tr>
</tbody>
</table>

Speed = # of Chomps ÷ Time
Round speeds to the nearest hundredth!

(3) What is your average speed? Round answers to the hundredth. _______ chomps/second

(4) Based on your average chomping speed, how many chomps could you do in five minutes, one hour, or one day? Show your work!

5 min = _______ chomps 1 hour = _______ chomps 1 day = _______ chomps

Part B: Speedy Chompers

(1) Use a timer to determine the number of chomps you can do in 1 minute. As the time reaches each point, record the number of chomps you have completed. Do not stop the timer as you record your data. You may want to practice a few times before running an “official” trial.

<table>
<thead>
<tr>
<th>Time</th>
<th>Chomps</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 sec</td>
<td></td>
</tr>
<tr>
<td>40 sec</td>
<td></td>
</tr>
<tr>
<td>60 sec</td>
<td></td>
</tr>
</tbody>
</table>

T. Trimpe 2001
(2) Calculate your chomping speed at each point (20 sec, 40 sec, and 60 sec) using the data from your experiment. Show your work! Round all answers to the nearest hundredth!

\[
\text{Speed at } T = 20 \text{ sec} = \frac{\text{_______}}{20 \text{ sec}} = \frac{\text{_______}}{\text{chomps/sec}}
\]

\[
\text{Speed at } T = 40 \text{ sec} = \frac{\text{_______}}{40 \text{ sec}} = \frac{\text{_______}}{\text{chomps/sec}}
\]

\[
\text{Speed at } T = 60 \text{ sec} = \frac{\text{_______}}{60 \text{ sec}} = \frac{\text{_______}}{\text{chomps/sec}}
\]

(3) Did you maintain a constant rate? Explain.

**Think About It!**

Write a paragraph to summarize the results of your experiments.

Are your results accurate and reliable? Why or why not?

What other experiments could you do with bubble gum?
Bubble Gum Trivia Challenge

Test your knowledge of bubble gum!

1. How many sticks of gum does the average American chew in a year?
   A. 200    B. 300    C. 400

2. How many tons of gum are chewed every year?
   A. 50,000   B. 75,000   C. 100,000

3. If all the five-chunk packs of Bubble Yum ever chewed in the U.S. since its introduction in 1975 were laid end-to-end, how many times would it circle the earth at the equator?
   A. 2   B. 5   C. 7

4. San Luis Obispo, California, is the home of 'Bubble Gum Alley'. What is it?
   A. An alley with brick walls covered with ABC (already-been-chewed) gum wads.
   B. The place where bubble gum was invented.
   C. The home of the largest collection of bubble gum machines.

5. Richard Walker holds the record for the Chomp Title by chewing 135 sticks of gum for the longest time. How long did he chomp?
   A. 5 hours   B. 6 hours   C. 8 hours

6. The Topps company holds the record for having made the largest single piece of bubble gum. How many pieces of normal-sized Bazooka did it equal?
   A. 5000   B. 8000   C. 10,000

7. The 1952 Mickey Mantle rookie card is the most valuable Topps Company card. How much did it sell for at auction?
   A. $75,000   B. $120,000   C. $1,000,000

8. What is the Official Gum of Major League Baseball?
   A. Bubble Yum   B. Bazooka   C. Topps

9. When was the first successful bubble gum invented?
   A. 1891   B. 1906   C. 1928

10. Susan Mont"Gum"ery Williams is the Guinness Record Holder Of the Worlds Largest Gum Bubble. How big was it?
    A. 19 inches   B. 23 Inches   C. 27 inches

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Bubble Gum Trivia Challenge

Answer Key

1. How many sticks of gum does the average American chew in a year? Answer: B. 300

2. How many tons of gum are chewed every year? Answer: C. 100,000

3. If all the five-chunk packs of Bubble Yum ever chewed in the U.S. since it's introduction in 1975 were laid end-to-end, how many times would it circle the earth at the equator? Answer: C. 7 (and a little more!)

4. San Luis Obispo, California, USA is the home of 'Bubble Gum Alley'. What is it? Answer: A. An alley with brick walls covered with ABC (already BEEN-chewed) gum wads.

5. Richard Walker holds the record for the Chomp Title by chewing 135 sticks of gum for the longest time. How long did he chomp? Answer: C. 8 hours

6. The Topps company holds the record for having made the largest single piece of bubble gum. How many pieces of normal-sized Bazooka did it equal? C. 10,000

7. The 1952 Mickey Mantle rookie card is the most valuable Topps Company card. How much did it sell for at auction? Answer: B. $120,000

8. What is the Official Gum of Major League Baseball? Answer: A. Bubble Yum

9. When was the first successful bubble gum invented? Answer: C. 1928

10. Susan Mont'Gum'ery Williams is the Guinness Record Holder Of the Worlds Largest Gum Bubble. How big was it? Answer: B. 23 Inches

Many of the facts for the questions were found at Bubble Gum Fact page at http://mmwww.northville.k12.mi.us/STUDENTS/2005/dugganla/Hpage4.htm.

T. Trimpe 2001
Speed Challenge

Challenge your students with this fun activity exploring speed! Students work together to collect data related to distance and time for four tasks: hopping, walking backwards, walking (regular rate), and speed walking. They use the data to calculate speeds for each task and solve related problems. We also discuss the variables that would affect their experiment and determine if their results are accurate and reliable.

Student Worksheet: Speed Challenge
Name ______________________

Speed Challenge

Get Ready!
Step 1: Gather your materials!
Each team needs 2 timers, 1 meterstick, 1 roll of masking tape, and 1 marker.

Step 2: Create your “race” track!
Find a spot in the hallway and measure off a 10 meter race track. Use three pieces of tape to mark the beginning, middle, and end of your track. Mark each distance (0 m, 5 m, and 10 m) on the tape with a marker.

Step 3: Go for it!
Each team member will need to perform the following tasks for each distance: hopping, walking backwards, walking (regular rate), and speed walking. Your team will need people with timers or stopwatches at the 5 meter and 10 meter points. Record the time it takes to perform each task.

NOTE: Speed walking is going as fast as you can without jogging or running!

Collect That Data!
Record your data from the experiment in the chart, then use the information to calculate the speed for each task and distance.

<table>
<thead>
<tr>
<th>TASK</th>
<th>DISTANCE</th>
<th>TIME</th>
<th>SPEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOPPING</td>
<td>5 Meters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOPPING</td>
<td>10 Meters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WALK BACKWARD</td>
<td>5 Meters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WALK BACKWARD</td>
<td>10 Meters</td>
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<tr>
<td>WALK REGULAR</td>
<td>5 Meters</td>
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<td>5 Meters</td>
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<tr>
<td>SPEED WALK</td>
<td>10 Meters</td>
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</tr>
</tbody>
</table>
Think About It!

1. Which task and distance resulted in the fastest speed?
   Task = ________  Distance = ________
   Speed = ________

2. Which task and distance resulted in the slowest speed?
   Task = ________  Distance = ________
   Speed = ________

3. How far could you speed walk in 10 minutes based on your speed for the 10 meter trial? Show your work!

4. How long would it take you to hop 30 meters based on your speed for the 5 meter trial? Show your work!

5. How far could you travel walking backwards in 15 minutes based on your results for the 5 meter trial?
   Show your work!

6. How long would it take you to walk (regular rate) 1 kilometer (or 1,000 m) based on your speed for the 10 meter trial? Show your work.

7. Are your results accurate? Why or why not?
Speed Challenge

Get Ready!

Step 1: Gather your materials!
Each team needs 2 timers, 1 meterstick, 1 roll of masking tape, and 1 marker.

Step 2: Create your “race” track!
Find a spot in the hallway and measure off a 10 meter race track. Use three pieces of tape to mark the beginning, middle, and end of your track. Mark each distance (0 m, 5 m, and 10 m) on the tape with a marker.

Step 3: Go for it!
Each team member will need to perform the following tasks for each distance: hopping, walking backwards, walking (regular rate), and speed walking. Your team will need people with timers or stopwatches at the 5 meter and 10 meter points. Record the time it takes to perform each task.

NOTE: Speed walking is going as fast as you can without jogging or running!

Collect That Data!
Record your data from the experiment in the chart, then use the information to calculate the speed for each task and distance. Round answers to the nearest hundredth if needed. Label your answers!

<table>
<thead>
<tr>
<th>Task</th>
<th>Distance</th>
<th>Time</th>
<th>Speed</th>
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<tr>
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<td></td>
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<td>5 m</td>
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<td>Backwards</td>
<td>10 m</td>
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<td>Speed</td>
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<td>10 m</td>
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</tbody>
</table>

T. Trimpe 2001
Think About It!

1. Which task and distance resulted in the fastest speed?
   Task = ______________  Distance = ______________  Speed = ____________

2. Which task and distance resulted in the slowest speed?
   Task = ______________  Distance = ______________  Speed = ____________

3. How far could you **speed walk** in 10 minutes based on your speed for the 10 meter trial? Show your work!

4. How long would it take you to **hop** 30 meters based on your speed for the 5 meter trial? Show your work!

5. How far could you travel **walking backwards** in 15 minutes based on your results for the 5 meter trial? Show your work!

6. How long would it take you to **walk (regular rate)** 1 kilometer (or 1,000 m) based on your speed for the 10 meter trial? Show your work!

7. Are your results accurate? Why or why not?
Speed Challenge Answer Key

1. Which task and distance resulted in the fastest speed?  **Answers will vary**

2. Which task and distance resulted in the slowest speed?  **Answers will vary**

3. How far could you speed walk in 10 minutes based on your speed for the 10 meter trial? Show your work!  **Answers will vary. Students should use their results to calculate a distance using the formula S=D÷T. The speed would be equal to the speed from the speed walking 10 meter trial and time should be 10 minutes. Students will need to multiply the speed by the time to find the distance.**

4. How long would it take you to hop 30 meters based on your speed for the 5 meter trial? Show your work!  **Answers will vary. Students should use their results to calculate a distance using the formula S=D÷T. The speed would be equal to the speed from the hopping 5 meter trial and distance should be 30 meters. Students will need to divide the distance by the speed to find the time.**

5. How far could you travel walking backwards in 15 minutes based on your results for the 5 meter trial? Show your work!  **Answers will vary. Students should use their results to calculate a distance using the formula S=D÷T. The speed would be equal to the speed from the walking backwards 5 meter trial and time should be 15 minutes. Students will need to multiply the speed by the time to find the distance.**

6. How long would it take you to walk (regular rate) 1 kilometer (or 1,000 m) based on your speed for the 10 meter trial? Show your work!  **Answers will vary. Students should use their results to calculate a distance using the formula S=D÷T. The speed would be equal to the speed from the walking 10 meter trial and distance should be 1000 meters. Students will need to divide the distance by the speed to find the time.**

7. Are your results accurate? Why or why not?  **Answers will vary.**

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Formula Challenge

What do the following units represent? Use D for distance, T for time, S for speed, or A for acceleration.

_____ 1. 14 km  _____ 4. 6 hours  _____ 7. 14 mi  _____ 10. 1.4 m
_____ 2. 30 m/s  _____ 5. 12 cm/s²  _____ 8. 3.2 sec  _____ 11. 6 cm/min/sec
_____ 3. 34 min  _____ 6. 150 mph  _____ 9. 25 ft  _____ 12. 3 km/hr/sec

Solve each problem! Be sure to show your work!

13. Goldie Goldfish, a speed swimmer, loves to race around the park's pond, which is 0.5 miles around. If she can swim 20 laps around the track in 2 hours, what is her average speed?

14. It takes Stu, a slimy slug, 20 minutes to travel from his favorite bush to the local trash can (a trip of 30 meters), how far can he travel in 1 hour (60 minutes)?

15. At exactly 2:00 pm, Speedy the Snail crawls onto a meter stick at the 10 cm mark. If he reaches the 65 cm mark at exactly 2:10 pm, what is his speed?

16. If it takes Leaping Louie 5 minutes to jump 3 blocks, how long will it take for him to jump 15 blocks?

17. If Bert the Bat travels eastward at 40 mph with a tail wind of 6 mph, what is his actual speed?

18. Toon Train is traveling at the speed of 10 m/s at the top of a hill. Five seconds later it reaches the bottom of the hill and is moving at 30 m/s. What is the rate of acceleration of Toon Train?

19. Pete the Penguin loves to sled down his favorite hill. If he hits a speed of 50 m/s after 5 seconds, what is his rate of acceleration? Hint: He starts at 0 m/s at the top of the hill.

20. Monster Mike's truck decelerates from 72 m/s to 0 m/s in 6 seconds. What is his rate of deceleration?
Formula Challenge Answer Key

D 1. 14 km  
S 2. 30 m/s  
T 3. 34 min

T 4. 6 hours  
A 5. 12 cm/s²  
S 6. 150 mph

D 7. 14 mi  
T 8. 3.2 sec  
D 9. 25 ft

D 10. 1.4 m  
A 11. 6 cm/min/sec  
A 12. 3 km/hr/sec

Solve each problem! Be sure to show your work!

13. Goldie Goldfish, a speed swimmer, loves to race around the park’s pond, which is 0.5 miles around. If she can swim 20 laps around the track in 2 hours, what is her average speed?

\[20 \times 0.5 = 10 \text{ miles} \div 2 \text{ hours} = 5 \text{ mph}\]

14. It takes Stu, a slimy slug, 20 minutes to travel from his favorite bush to the local trash can (a trip of 30 meters). How far can he travel in 1 hour (60 minutes)?

\[30 + 20 = 1.5 \text{ m/min} \times 60 \text{ min} = 90 \text{ m}\]

15. At exactly 2:00 pm, Speedy the Snail crawls onto a meter stick at the 10 cm mark. If he reaches the 65 cm mark at exactly 2:10 pm, what is his speed?

\[65 \text{ cm} - 10 \text{ cm} = 55 \text{ cm} \div 10 \text{ min} = 5.5 \text{ cm/min}\]

16. If it takes Leaping Louie 5 minutes to jump 3 blocks, how long will it take for him to jump 15 blocks?

\[3 \text{ blocks} \div 5 \text{ min} = 0.6 \text{ blocks/min} \quad 15 \text{ blocks} \div 0.6 \text{ blocks/min} = 25 \text{ min}\]

17. If Bert the Bat travels eastward at 40 mph with a tail wind of 6 mph, what is his actual speed?

\[40 \text{ mph} + 6 \text{ mph} = 46 \text{ mph}\]

18. Toon Train is traveling at the speed of 10 m/s at the top of a hill. Five seconds later it reaches the bottom of the hill and is moving at 30 m/s. What is the rate of acceleration of Toon Train?

\[30 \text{ m/s} - 10 \text{ m/s} = 20 \text{ m/s} \div 5 \text{ s} = 4 \text{ m/s}^2\]

19. Pete the Penguin loves to sled down his favorite hill. If he hits a speed of 50 m/s after 5 seconds, what is his rate of acceleration? Hint: He starts at 0 m/s at the top of the hill.

\[50 \text{ m/s} - 0 \text{ m/s} = 50 \text{ m/s} \div 5 \text{ s} = 10 \text{ m/s}^2\]

20. Monster Mike’s truck decelerates from 72 m/s to 0 m/s in 6 seconds. What is his rate of deceleration?

\[0 \text{ m/s} - 72 \text{ m/s} = -72 \text{ m/s} \div 6 \text{ s} = -12 \text{ m/s}^2\]
Hot Wheelin' Physics

During this lab, students investigate the motion of toy cars. They may use Hot Wheel cars, wind-up cars, or remote control vehicles. To perform the tests, create a "race track" and position five students armed with stop watches at various points along the track. I use a 5 meter track with students at 1, 2, 3, 4, and 5 meter positions. As the car passes each point, the students should record the time in their data charts.

Once the three trials are complete, we head back to the classroom and use the data collected to analyze the speed of the vehicle between various points and overall speed. Students use the data to create graphs and analyze the reliability of their experiment. The main challenges we face during this lab are keeping the car on the track, making sure it travels the complete distance, and making accurate time readings. These are points for discussion as we determine if our tests are reliable.

Student Worksheet: Hot Wheelin' Physics
Hot Wheelin’ Physics

Follow your teacher’s directions to complete this lab activity. Be sure to record your lab results in the charts!

Trial 1: 

<table>
<thead>
<tr>
<th>Point</th>
<th>Distance</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
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<tr>
<td>B</td>
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<tr>
<td>D</td>
<td></td>
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<tr>
<td>E</td>
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Trial 2: 

<table>
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Trial 3: 

<table>
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<tbody>
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<td>D</td>
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<td></td>
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<tr>
<td>E</td>
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</tr>
</tbody>
</table>

Speed = Distance ÷ Time

1. Calculate the speed for each trial using the total time and total distance. Show your work!
   Trial 1: _______  Trial 2: _______  Trial 3: _______

2. Calculate the speed from Point B to Point C for each trial. Show your work!
   Trial 1: _______  Trial 2: _______  Trial 3: _______

3. Calculate the speed from Point D to Point E for each trial. Show your work!
   Trial 1: _______  Trial 2: _______  Trial 3: _______
4. Construct a graph to show your results. Be sure to label each graph!

Trial 1: 

Trial 2: 

Trial 3: 

5. Do your graphs represent a constant speed or an average speed?

6. Are your results reliable? Explain.
Speed Machines

In this activity, students relate speed to some of the fastest machines on Earth. Students solve problems related to fast cars, boats, trains, and airplanes. The second half of the activity related speed to their own world as they compute the time it would take for each vehicle to travel a specific distance (i.e. from Havana, IL to Springfield, IL.)

Student Worksheet: Speed Machines
FORMULA:  SPEED = Distance ÷ Time
Round answers to the nearest tenth (one decimal place)!

1. Nascar driver, Jeff Gordon, has a car that is one of the fastest on the circuit. If it travels 600 miles in 4 hours, what is his cruising speed?

2. The fastest car on Earth, a German-made Thrust SSC, would win every Nascar race in America. If it takes 0.5 hours (30 minutes) to travel 380 miles, what is its speed?

3. The fastest train on Earth, the TGV from France, can travel at faster speeds than trains in the United States. During a speed test, the train traveled 800 miles in 2.5 hours. What is its speed?

4. *Spirit of Australia*, a hydroplane boat, made speed records by traveling 239 miles in 0.75 hours (45 minutes). What is its record-breaking speed?

5. The fastest plane ever made, the *Lockheed SR71*, was able to travel 2200 miles per hour. Based on this speed, how far could it travel in:
   a. 2 hours?   
   b. 3 hours?   
   c. 5 hours?

Challenge: Out of all the machines on this worksheet, which one is the fastest?

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6. Fill in the boxes and use a calculator to determine how long it would take each machine to get to travel 60 miles.

Round answers in shaded boxes!

A. Jeff Gordon’s Car = _______ mph

\[ \frac{60 \text{ miles}}{\text{Speed}} = \_ \_ \_ \times 60 \text{ minutes} = \_ \_ \_ \_ \_ \_ \_ \_ \text{minutes} \]

B. Thrust SSC Car = _______ mph

C. TGV (France) Train = _______ mph

D. Spirit of Australia Boat = _______ mph

E. Lockheed SR71 Airplane = _______ mph
Speed Machine Answers:
1. $600 \div 4 = 150$ mph
2. $380 \div .5 = 760$ mph
3. $800 \div 2.5 = 320$ mph
4. $239 \div .75 = 318.67$ mph
5. a. $2200 \times 2 = 4400$ miles, b. $2200 \times 3 = 6600$ miles, c. $2200 \times 5 = 11,000$ miles
Challenge: Lockheed SR71
6. A. 24.0 minutes, B. 4.7 minutes, C. 11.3 minutes, D. 11.3 minutes, E. 1.6 minutes
play in traffic

While moving objects are very common in our daily lives, measuring the motion of an object is a very sophisticated notion. In these activities, students will be introduced to three useful ways of measuring and describing motion:

- speed, velocity and acceleration.

Students will be able to:

- explain when an object is in motion and how motion is relative to a reference point
- calculate an object’s speed and velocity using SI units of distance
- graph motion showing changes in distance as a function of time
- describe what happens to the motion of an object as it accelerates
- calculate the acceleration of an object and graph changing speed and distance of an accelerating object
- measure distance and time accurately
- record data in lists or tables
- apply concepts learned in class to calculate speed
- communicate their Data by using the Scientific Method
In this Lab you will design the experiment. You will use the information that you have acquired in the previous labs to design your own experiment.

**PROBLEM:** In this lab we will calculate and test the speed of the traffic on Vine Street. This is important information to have so we can assist the City of Lincoln with the Pedestrian Crosswalk Issues. Do we have enough time to safely cross the street given the speed of the traffic? It will be up to you to design a plan to measure the speed of the traffic on Vine Street.

**REMEMBER THAT**

**SPEED = DISTANCE/TIME**

You will complete the independent investigation form as your written lab report.

We will run the tests on the Traffic Speed for the next two days. You will only have 2 Periods to gather your data. We will have Controllers who will use a SPEED GUN to find the ACTUAL SPEED so we can determine how close you are in your calculations.

**GOOD LUCK**
Independent Investigation Guidelines

Step 1: Create a Question
➤ What do you want to find out?
➤ Does your question relate to the topic?
➤ Can you develop an experiment to answer your question?
➤ Does your question make sense? Is it confusing?

Step 2: Hypothesis
➤ What do you think will happen?
➤ BE SPECIFIC!
➤ Use complete sentences.

Step 3: Procedure
➤ What steps will you follow to find an answer?
  ✔ BE SPECIFIC! Label your steps using 1, 2, 3, etc.
  ✔ Would someone else be able to follow your directions?
➤ How will you collect your data?
➤ How will you ensure reliable results?
➤ What safety issues need to be addressed?

Step 4: Experiment & Data
➤ Be sure to display your data in an organized manner. Use a table or chart to help you show your results. Don't forget to label!
➤ Include enough data to prove or disprove your hypothesis.

Step 5: Analysis/Conclusion
➤ What happened during your experiment?
➤ Did your results support your hypothesis?
➤ Write a summary of what you learned during your experiment and address your results.
➤ Explain any unexpected results.
➤ Are your results reliable?
➤ Did you use complete sentences?
play in traffic

PROBLEM: In this lab we will calculate and test the speed of the traffic on Vine Street. This is important information to have so we can assist the City of Lincoln with the Pedestrian Crosswalk Issues. Do we have enough time to safely cross the street given the speed of the traffic? It will be up to you to design a plan to measure the speed of the traffic on Vine Street.

REMEMBER THAT

\[ \text{SPEED} = \frac{\text{DISTANCE}}{\text{TIME}} \]

<table>
<thead>
<tr>
<th></th>
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</table>
Personal Image Use

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Date ____________________________

Signature ________________________

Printed Name ____________________

Street Address ____________________

City, State, Zip ________________

If applicable, parent or guardian of: ________________________________
## Independent Investigation

<table>
<thead>
<tr>
<th>Question</th>
<th>Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you want to find out?</td>
<td>What do you think will happen?</td>
</tr>
</tbody>
</table>

### Procedure

Design your experiment! Write the steps for your experiment in the space below.

### Safety Rules

What safety rules do you need to follow during your experiment?
Data
Create a table, chart, or graph to record your data.

Conclusion/Analysis
What did you find out? Did your results support your hypothesis? Are your results reliable?
## Checklist of Laboratory Procedures

<table>
<thead>
<tr>
<th>Activity</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructions followed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety precautions observed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment handled correctly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment cleaned thoroughly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment stored properly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lab area kept clean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spills cleaned promptly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical disposed of properly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperation with others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvisation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appropriate use of time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations noted and recorded</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Independent Investigation Rubric

<table>
<thead>
<tr>
<th>Category/Value</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Needs Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question/</td>
<td>The purpose of the lab or the question to be answered during the lab is</td>
<td>The purpose of the lab or the question to be answered during the lab</td>
<td>The purpose of the lab or the question to be answered during the lab</td>
<td>The purpose of the lab or the question to be answered during the lab is incorrect or irrelevant.</td>
</tr>
<tr>
<td>Purpose</td>
<td>clearly identified and stated.</td>
<td>is identified, but is stated in a somewhat unclear manner.</td>
<td>is partially identified, and is stated in an unclear manner.</td>
<td></td>
</tr>
<tr>
<td>_____ x 1 =</td>
<td></td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>_____ pts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedures</td>
<td>Procedures are listed in a logical order. Each step is numbered and is</td>
<td>Procedures are listed in a logical order, but steps are not numbered</td>
<td>Procedures are listed but are not in a logical order or are difficult to follow.</td>
<td>Procedures do not accurately list the steps of the experiment.</td>
</tr>
<tr>
<td>_____ x 2 =</td>
<td>a complete sentence.</td>
<td>and/or are not in complete sentences.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_____ pts</td>
<td></td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Data</td>
<td>Accurate representation of the data in tables and/or graphs. Charts,</td>
<td>Fair representation of the data in tables and/or graphs. Charts,</td>
<td>Provides representation of the data in written form, but no charts,</td>
<td>Data are not shown OR are inaccurate.</td>
</tr>
<tr>
<td>_____ x 1 =</td>
<td>graphs and tables are labeled and titled.</td>
<td>graphs and tables lack labels and/or titles.</td>
<td>graphs, or tables are presented.</td>
<td></td>
</tr>
<tr>
<td>_____ pts</td>
<td></td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Conclusion/</td>
<td>Conclusion includes whether the findings supported the hypothesis,</td>
<td>Conclusion includes whether the findings supported the hypothesis</td>
<td>Conclusion includes what was learned from the experiment.</td>
<td>No conclusion was included in the report OR shows little effort and reflection.</td>
</tr>
<tr>
<td>Analysis</td>
<td>possible sources of error, and what was learned from the experiment.</td>
<td>and what was learned from the experiment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_____ x 2 =</td>
<td></td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>_____ pts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participation</td>
<td>Used time well in lab and focused attention on the experiment.</td>
<td>Used time well and stayed focused on the experiment most of the time.</td>
<td>Did the lab but did not appear very interested. Focus was lost on several occasions.</td>
<td>Participation was minimal or none.</td>
</tr>
<tr>
<td>_____ x 1 =</td>
<td></td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>_____ pts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Points Possible = 28   Points Earned = _____   Final Grade = _____ %   A B C D F

Rubric created from a template at [http://rubistar.4teachers.org/](http://rubistar.4teachers.org/).
Group Self-Assessment of Laboratory Activities

<table>
<thead>
<tr>
<th>Group</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Activity

Use these descriptors to assess how effectively your group performed a specific activity. Choose one or several numbers from the list of criteria.

1 = yes  
2 = no  
3 = we think so  
4 = needs improvement  
5 = satisfactory  
6 = excellent

<table>
<thead>
<tr>
<th>Things to consider</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Did we develop a clear plan before we began?</td>
<td></td>
</tr>
<tr>
<td>Did each group member have specific things to do?</td>
<td></td>
</tr>
<tr>
<td>Were we able to work together as a team?</td>
<td></td>
</tr>
<tr>
<td>Did we discuss the purpose for doing the activity?</td>
<td></td>
</tr>
<tr>
<td>Was a hypothesis developed and recorded?</td>
<td></td>
</tr>
<tr>
<td>How well did we predict what took place?</td>
<td></td>
</tr>
<tr>
<td>Were instructions followed correctly?</td>
<td></td>
</tr>
<tr>
<td>How well did we use equipment and materials?</td>
<td></td>
</tr>
<tr>
<td>Did we observe all safety precautions?</td>
<td></td>
</tr>
<tr>
<td>Were measurements made accurately?</td>
<td></td>
</tr>
<tr>
<td>How well were data recorded?</td>
<td></td>
</tr>
<tr>
<td>Did we clean up thoroughly after the activity?</td>
<td></td>
</tr>
<tr>
<td>Were the data examined closely to search for meaning?</td>
<td></td>
</tr>
<tr>
<td>Did we use accepted techniques for data analysis?</td>
<td></td>
</tr>
<tr>
<td>Were the conclusions consistent with the data?</td>
<td></td>
</tr>
<tr>
<td>Did we re-examine our initial hypothesis?</td>
<td></td>
</tr>
<tr>
<td>Did we account for experimental error?</td>
<td></td>
</tr>
<tr>
<td>Was relevant research used to support our work?</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>
# Self-Assessment of Performance as a Group Member

<table>
<thead>
<tr>
<th>Your name</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Members</td>
<td>Date</td>
</tr>
</tbody>
</table>

Circle the following on working within the group. Additional written responses may be included.

1. I encouraged others.        | Seldom | Sometimes | Often |
2. I shared ideas and information. | Seldom | Sometimes | Often |
3. I checked to make sure that others in the group knew what they were doing. | Seldom | Sometimes | Often |
4. I was willing to help others. | Seldom | Sometimes | Often |
5. I accepted responsibility for completing the work properly and on time. | Seldom | Sometimes | Often |
6. I was willing to listen to others in the group. | Seldom | Sometimes | Often |
7. I was willing to receive help from others in the group. | Seldom | Sometimes | Often |
8. I offered encouragement and support to others in the group. | Seldom | Sometimes | Often |
9. Others in the group shared ideas and information. | Seldom | Sometimes | Often |
10. The group checked with the teacher to make sure we knew what we were supposed to be doing. | Seldom | Sometimes | Often |
11. All members of the group contributed equally to this project. | Seldom | Sometimes | Often |

Answer the following questions about working in a group.

12. How did you distribute the workload within your group?
13. What problems, if any, arose within your group?
14. What would you do differently next time?
15. How is working in a group different from working by yourself?