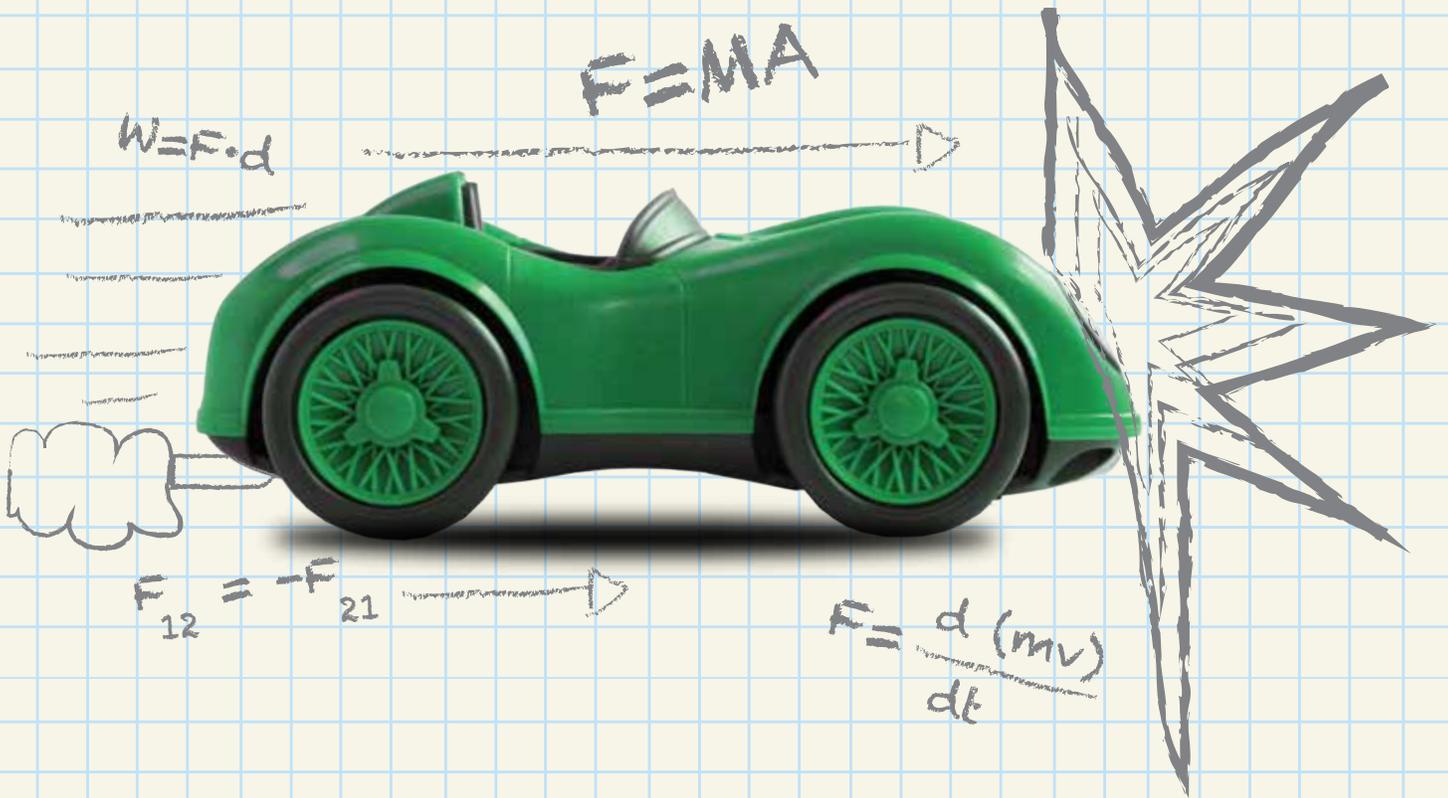




4-H
NATIONAL
YOUTH
SCIENCE DAY

MOTION

COMMOTION



YOUTH GUIDE

4-H PLEDGE

I PLEDGE MY **HEAD** TO CLEARER THINKING,
MY **HEART** TO GREATER LOYALTY,
MY **HANDS** TO LARGER SERVICE, AND
MY **HEALTH** TO BETTER LIVING,
FOR MY CLUB, MY COMMUNITY, MY COUNTRY,
AND MY WORLD.



Disclaimer: Reference in this publication to any specific commercial products, processes, or services, or the use of any trade, firm, or corporation name is for general informational purposes only and does not constitute an endorsement, recommendation, or certification of any kind by Oregon State University. Persons using such products assume responsibility for their use in accordance with current directions of the manufacturer.

INTRODUCTION

In October 2015, you will become part of the biggest youth science event in the nation: **4-H National Youth Science Day (NYSD)**. With the help of thousands of volunteers and educators from the nation's 109 land-grant universities, you and millions of other youth will become 4-H physicists for the day as you engage in the **National Science Experiment**.



The **2015 National Science Experiment, Motion**

Commotion, explores the science of motion—how things move through space and time. You will discover how human factors, such as reaction time, affect your own body's motion and your ability to stay safe.





WHY MOTION?

The world is constantly in motion. From riding the bus to school to crossing a busy street to playing sports after school, we encounter motion every day. What we may not realize is how science is a part of each of these activities.

In science, **motion** is defined as how something moves through space and time. Take, for example, a baseball speeding toward a batter at home plate. It isn't only the ball that is in motion. As the pitcher throws the ball toward home plate, his body is in motion. So are the trees swaying in the breeze and the mascot who is entertaining spectators. So is the crowd as they perform a "wave" – standing, raising their arms, then returning to their seats. All of that – and so much more – is motion.

Professional scientists, including physicists, engineers, and safety analysts, study all types of motion and implement technologies to keep us safe. They research and develop solutions to problems. These types of STEM careers are projected to remain in high demand. Project-based, hands-on experience with **STEM** activities like the 4-H National Science Experiment helps us build the skills we need to innovate, achieve, and succeed.

JOBS IN SCIENCE

Take a look at the different types of jobs available in science, technology, engineering and math.



Meet Matt!

Matt Anthes-Washburn
Software Product Owner at HealthSpa

Matt got his first computer at age 8, and it immediately became one of his favorite things. He enjoys figuring out how computers work and helping others use them.

If there is a job to be done, leave it to Matt to suggest a way to do it with technology. As a physics teacher, Matt encouraged his students to use computers to record their thoughts and present their ideas.

Today, Matt works with software developers to make apps that are easy to use. Whether you are learning physics or trying to find a good doctor, Matt thinks there ought to be “an app for that,” and he is doing his part to help make them.



Meet Fran!

Fran Poodry
Physics Educational Technology Specialist at Vernier Software & Technology

Fran was interested in science from an early age. She was particularly inspired by the Voyager I and II flybys of Saturn and Jupiter in 1979 and 1980, which revealed a previously unknown, rocky ring around Jupiter. Despite her brief infatuation with biology in high school, Fran went on to study physics in college, becoming a high school physics teacher after graduation.

Why teach physics? “I got to play with all the toys!” says Fran. Her classes featured bowling balls, toy cars, balancing games, and building projects such as hot-air balloons and miniature submarines.

Her favorite way to gain momentum? Fran enjoys the sport of curling and going for runs in her neighborhood.



Meet Dani!

Dani Annala
4-H Youth Development Faculty, Oregon State University Extension, Hood River County, Oregon

As a 4-H County Agent in Oregon, Dani finds ways to engage kids in science, technology, engineering, and mathematics through hands-on experiments. With strong ties to agriculture, Dani shares her passion with 4-H by teaching after-school programs, training volunteers, writing curriculum and designing publications to help educate all ages about agriculture, science, and youth development.

Dani enjoys small-town rural American life, living on an orchard, raising chickens, gardening, running and riding her horse.

GETTING STARTED: LET'S TALK PHYSICS

Physics is the branch of science that studies matter and its interactions. It provides us with a framework—language, equations, and observations—to explore and discuss motion. One of the first types of motion that physicists studied was the motion of planets in our solar system.

In 1687, physicist and mathematician Sir Isaac Newton described the motion we observe and experience on Earth. His three laws of motion help us understand *why* and *how* objects move.



In this experiment, we will focus on Newton's first and second laws.

Newton's first law of motion addresses how objects move. Newton concluded that an object at rest stays at rest. In order for that object to start or stop moving – or change direction – it must be **interacting** with something. We call that interaction a **force**.

Picture the baseball as it reaches home plate. The force applied by a swinging bat will cause the baseball to change its **trajectory** toward the field. If the batter misses the ball, the force of the catcher's mitt will stop the ball, ending its motion. Newton's second law of motion describes **how** forces change the motion of an object.

1. Newton's First Law:
An object at rest will remain at rest unless acted on by an unbalanced force. An object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

2. Newton's Second Law:
Acceleration is produced when a force acts on a mass. The greater the mass (of the object being accelerated) the greater the amount of force needed (to accelerate the object).

3. Newton's Third Law:
For every action there is an equal and opposite reaction. Action and reaction refer to forces, which are simultaneous interactions between objects. The force of one object on a second object has equal strength and opposite direction compared to the force from the second object on the first object.

Talk About It

Have you experienced one of Newton's Laws of Motion?

Give an example.



HOW IS MOTION MEASURED?

Speed is the measure of motion. To determine an object's speed, we measure the distance the object travels through space in a certain amount of time. Fast objects cover a larger distance in a given time compared to slow objects that cover a shorter distance in that same amount of time.

For example, if a baseball's speed were 100 mph, it would travel a distance of 100 miles during the time duration of one hour.

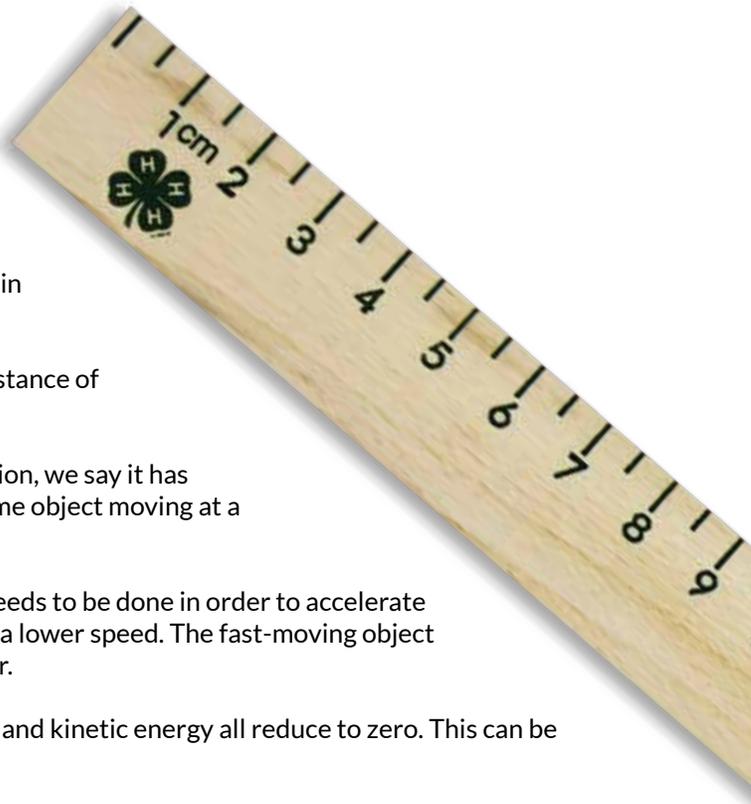
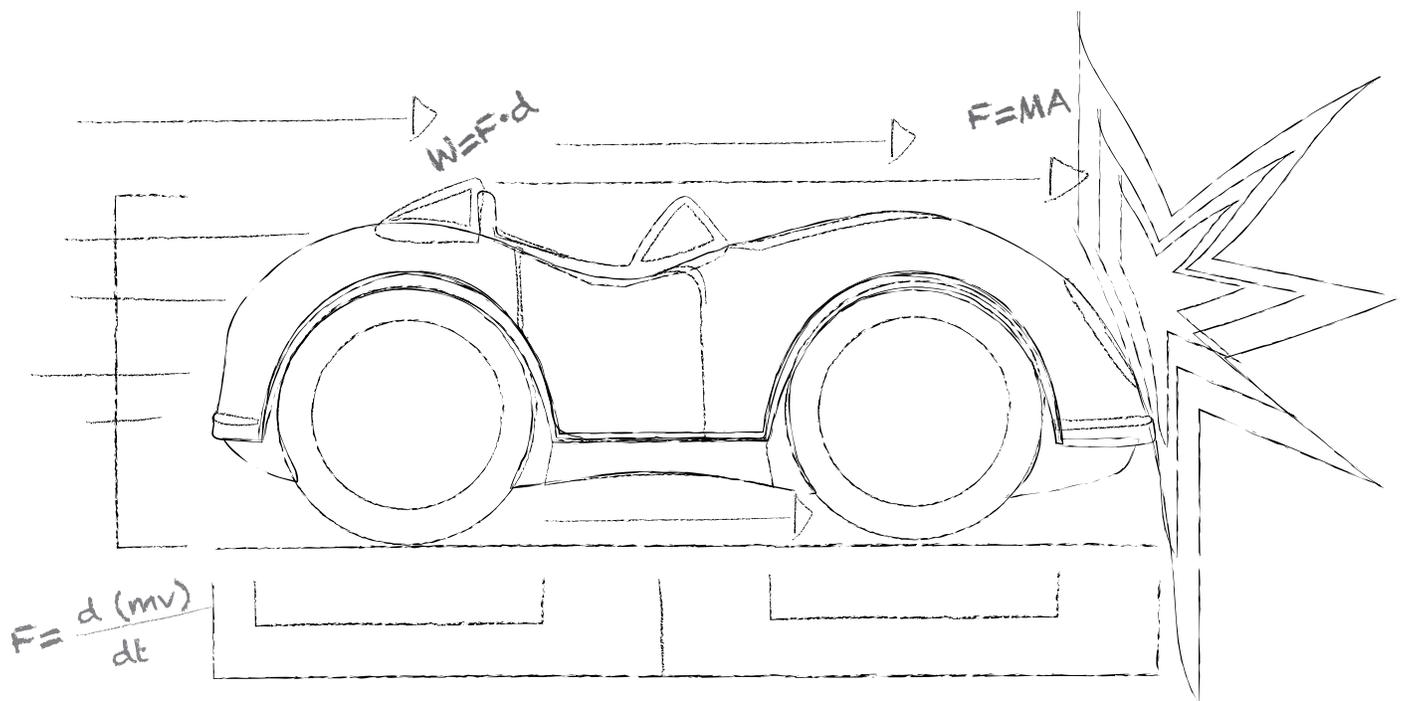
When an object with mass and speed is moving in a particular direction, we say it has **momentum**. A fast-moving object has more momentum than the same object moving at a slower speed.

A moving object also has **kinetic energy**, meaning that some work needs to be done in order to accelerate that **mass** from a lower speed to a higher speed or a higher speed to a lower speed. The fast-moving object has more kinetic energy compared to the same object moving slower.

What happens when an object stops moving? Its speed, momentum, and kinetic energy all reduce to zero. This can be gradual or sudden.

Lets use physics to investigate!

Have you ever felt the difference between slowing to a stop and slamming on the brakes? What physical factors influence how fast an object can stop? Do human factors play a role? Let's use physics to investigate!



ACTIVITY 1: STOP & GO SCIENCE

Time required: 15 minutes

Objective:

In this experiment, you will observe collisions and investigate the physical factors that govern safety.

Materials each team will need:

Included in the 2015 NYSD Science Kit:

- Modeling clay (225 g) 
- Vinyl baseboard material (120 cm) 

- 1 toy car 

Not included in the kit: 5-6 books



Step 1: Set up the experiment

To set up a ramp for rolling the car, stack five or six books or any object(s) that can elevate and support the ramp about 20 cm high. Unroll the ramp material and set it up on the books to form the ramp. The car should have a clear area to roll. It may be helpful to secure the ramp by tucking the edge of the ramp material into the stack of books.

Make a figure out of the clay that will sit in the seat of the car. Place a book or heavy object at the bottom of the ramp. This object will be used for your first collision.

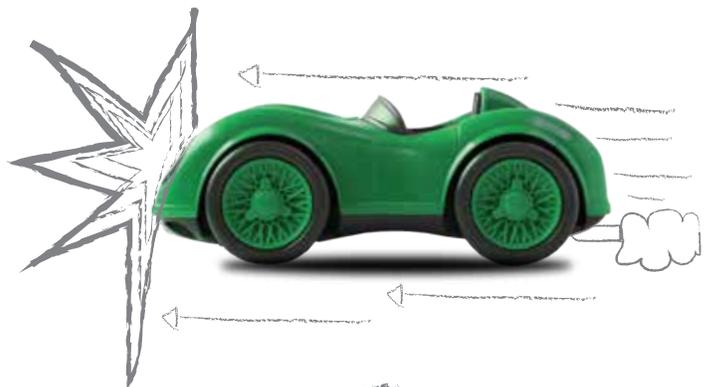


Step 2: Create a collision

Position the car at the top of the ramp. Prepare to release the car and observe the crash. Let the car go and observe as it collides with the obstacle.

- What happens to the clay figure?
- What might happen to a person in a crash like this?

Experiment with other obstacles. Try a tissue box. How is this collision different? Record what you observe.



$$F_{12} = -F_{21}$$

$$W = F$$



Step 3: Discuss what you observed

There are many ways to measure the difference between the two collisions. Describe how the following factors are different in the two collisions:

- The distance the *car* travels after the crash
- The distance the *figure* travels after the crash
- The distance the *obstacle* moves

What can you conclude about the physical factors that influence a car's ability to stop? How did the car's speed affect the collisions? How did the obstacle's mass affect the collision?

Another way to describe the two collisions is to consider the amount of *time* it takes for the car to stop.

- *How does this parameter differ for the two collisions?*
- *How does time relate to safety?*



Step 4: Make connections

We just examined the motion of a toy car and a clay figure.

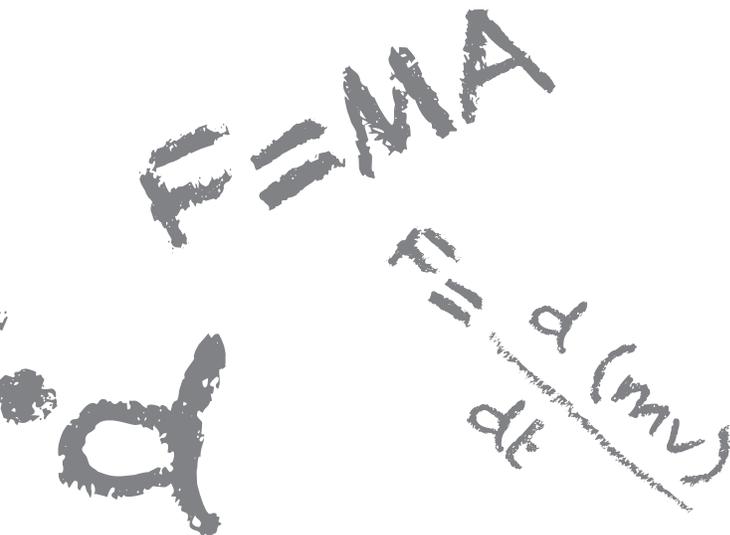
- How is this motion similar to other activities like skateboarding or riding a bike?
- How are these activities different?
- Do the same physical factors such as speed and mass influence our body's motion?
- What are some other factors to take into account when considering outcomes of a collision?

Brainstorm examples.

Conclusion

Physicists use the term **model** to describe an investigation like the one above with the toy car. Based on the model, you observed that physical factors such as speed and mass might be factors during a collision.

The toy car's motion is a model for other types of motion. For example, the toy car could represent real-life motion, such as riding your bike or skateboarding. However, the toy car is an over-simplified model. In reality, the motion of humans is much more complex. We have a heart, brain, lungs, and muscles that need to coordinate and function together to move our bodies. This takes more time!



ACTIVITY 2: WE NEED MORE TIME!

Time required: 15 minutes

Objective:

Take your investigation further by exploring the human factors of motion. What is your reaction time?

Materials each team will need:

Included in the 2015 NYSD Science Kit:

- Ruler

Not included in the kit: Calculator or Cell Phone

Step 1: Set up the experiment

Reaction time is the measure of how quickly you can respond to a particular stimulus. To measure your reaction time, you will try to catch a free-falling ruler.

Break up into groups of two. You will take turns being the “Dropper” and the “Grabber.” For large groups, you will need to take turns until everyone has a chance to both drop and grab the ruler.

Step 2: Perform the experiment

Dropper: Hold the ruler lightly between two fingers in a vertical position near the high numbers on the ruler.

Grabber: Position your thumb and forefinger just below the 0 cm mark on the ruler. Get ready to grab. Keep your eyes on the ruler!

Dropper: Without warning, let the ruler fall.

Grabber: When you see the ruler start to fall, grab it as quickly as you can between your thumb and forefinger. Hang onto the ruler and don’t move your fingers yet. Read the position of your fingers on the ruler, in centimeters, and record the value below.

Ruler value: _____ cm



REACTION TIME TABLE

Grabbing Distance (cm)	Reaction Time (s)
1	0.05
2	0.06
3	0.08
4	0.09
5	0.10
6	0.11
7	0.12
8	0.13
9	0.14
10	0.14
11	0.15
12	0.16
13	0.16
14	0.17
15	0.17
16	0.18
17	0.19
18	0.19
19	0.20
20	0.20
21	0.21
22	0.21
23	0.22
24	0.22
25	0.23
26	0.23
27	0.23
28	0.24
29	0.24
30	0.25

Step 3: Calculate your reaction time

Since the ruler began dropping at the 0 cm mark, the value at which you caught the ruler is directly related to the time it took you to catch the ruler. This is your reaction time.

Use the provided table to find the reaction time that corresponds to your distance value and record your reaction time below.

Reaction Time: _____ s

Talk About It

How does your reaction time compare to your team members?

Why might they be different?



Step 4: Distract and react

Repeat the activity. Only this time, ask the “grabber” to simultaneously grab the ruler while typing a value into a calculator or pretending to dial a phone. Record your results below:

Ruler Value (Distracted): _____ cm

Reaction Time (Distracted): _____ s

Step 5: Discuss your findings

Based on your findings:

- How do distractions affect your reaction time?
- Do distractions increase or decrease your reaction time?
- What conclusions can you draw about how human factors such as reaction time affect your body's motion?

Reaction time is a complicated variable—there is no one reaction time that can be applied universally. Every person has a different reaction time depending on the situation and other variables.

- What factors can affect your reaction time?

Want more physics?

Find additional activities at www.4-H.org/NYSDregister

Talk About It

How does your distracted reaction time compare to your undistracted reaction time?



GET THE FACTS

We have observed that both physical and human factors affect our motion. Based on our observations and discussions today, what actions can we take to improve our safety?

Play It Safe!

In a car, on a bike— even when using your own two feet— distractions can have devastating consequences.

Consider the following tips:

- Stay focused – avoid becoming distracted.
- In a car, wear a seatbelt.
- When biking or skateboarding, wear a helmet.
- If you are driving, don't exceed the speed limit.

Get the facts and play it safe!



DISTRACTIONS HAPPEN WHILE...

...Driving

Distracted driving happens when a driver is engaged in an activity that could divert attention away from the primary task of driving. This includes texting, using a cell phone, eating and drinking, or talking with friends.

- In 2011, at least 23% of auto collisions—a total of 1.3 million crashes—involved cell phones.
- Five seconds is the minimum amount of time your attention is taken away from the road when you're texting and driving.
- For someone driving 55 miles per hour, that is the length of a football field!
- Texting while driving makes the possibility of a crash up to 23 times more likely.
- Teens who text while driving spend approximately 10% of the time outside of their lane.
- 48% of kids age 12-17 have been riding in a car while the driver was texting.
- According to AT&T's Teen Driver Survey, 97% of teens agree that texting while driving is dangerous, yet 43% do it anyway.

Did You Know?

Your brain is still developing until your early 20s. Research has shown that the parts of the brain responsible for controlling impulses and planning ahead are among the last to mature—which may affect your decision-making ability.



Being aware of these limitations can help you make safer choices. For more information, see:

The Teen Brain: Still Under Construction
www.nimh.nih.gov/health/publications/the-teen-brain-still-under-construction/index.shtml.

Eyes Up, Phone Down — It's the law!

While no state bans cell phone use altogether, many states have laws restricting how cell phones can be used. This includes restricting texting or using handheld cell phones while driving.

Make the right kind of impact. Check out your own state's laws at www.distraction.gov

...Walking

Teens have the highest pedestrian death rates among children ages 19 and under. And injuries among older teens are on the rise – an increase of 25% over the previous five years. One of the main reasons? Distractions.

- Pedestrian injuries due to cell phone use are up 35% since 2010.
- 1 in 3 pedestrians are distracted by mobile devices while crossing busy intersections.
- Texters are also 4 times more likely to ignore crosswalk lights, cross at the middle of an intersection, or fail to look both ways before crossing the street.



...Cycling

Automobile drivers and pedestrians aren't the only ones who need to keep their eyes on the road. Distracted cycling increases the risk of injuries to riders.

- Bicyclists who text or talk on the phone or with a fellow bicyclist are more than twice as likely to engage in unsafe biking behaviors.
- The use of handheld cell phones while cycling is prohibited in Chicago, Illinois and Flagstaff, Arizona.

Talk About It

What types of distracted driving, walking, or cycling behaviors have you observed?





TAKE ACTION: MAKE A DIFFERENCE

In 4-H, one of our responsibilities is to be a positive force and get involved in our communities. *What steps can you take to share what you have learned and make a difference in your community?*

Take the Pledge!

The fight to end distracted driving starts with you. Make the commitment to promote phone-free driving today.

Distracted driving kills and injures thousands of people each year. I pledge to:

- Protect lives by never texting or talking on the phone while driving.
- Be a good passenger and speak out if the driver in my car is distracted.
- Encourage my friends and family to drive phone-free.

To download the pledge, visit www.distraction.gov

SPEAK UP!

Sometimes it can be difficult or uncomfortable to take a stand. If the driver in your car is distracted, remind them about the facts. As a passenger, you can also offer to send a text for the driver or take a message for them. Be creative! It's your life too.

Additional steps you can take:

- **Organize a safety fair for your community.** Help educate people about the precautions they can take to increase their safety.
- **Run a text-free driving pledge.** Get great materials from www.distraction.gov, the official U.S. government website for distracted driving.
- **Take a closer look at your community.** Observe a busy intersection or road in your town. How many drivers do you see using a cell phone in a given amount of time?
- **Find a local news story related to multitasking with a cell phone.** What can you do to prevent these outcomes?
- **Be a "roll model."** Wear a helmet when biking — and encourage others to do the same!

Talk About It

What will YOU do to take action?



Put a lid on it!

No matter what your age or level of experience, whenever you ride a bike, scooter, ski, or engage in other activities during which your head is vulnerable to injury, protect yourself by wearing a helmet.



Bicycle helmets are 85-88% effective in mitigating head and brain injuries, making the use of helmets the single most effective way to reduce head injuries and fatalities resulting from bicycle crashes.

Ready for More?

Continue your physics exploration with additional activities available for download at www.4-H.org/NYSDregister

Take it further with:

- Make it Safe
- Pulse
- Physics Apps from Vernier Software & Technology

GLOSSARY

Collision: The meeting of objects in which each exerts a force upon the other, causing an exchange of energy and momentum

Distraction: Something that prevents someone from giving full attention to something else

Gravity: The mutual attraction of all mass in the universe, and the force that pulls unsupported objects toward the center of Earth

Kinetic energy: Energy that an object possesses due to its motion

Mass: A measure of how much matter is in an object. On Earth, when our mass is under the influence of gravity, we often substitute the term “mass” with “weight”

Model: A representation that allows scientists to predict an outcome based on initial conditions

Momentum: The product of mass and velocity for a moving object or system, sensed by how difficult it is to stop the object or system

Motion: The manner in which a person or object moves through space and time

Obstacle: Something that blocks motion, sight, or progress

Parameter: A measurable quantity that helps define a system, such as height, mass, temperature, etc.

Physics: The study of matter and its interactions

Potential energy: Energy stored in a system based on position(s) of objects

Qualitative: Descriptions of observations or qualities

Quantitative: Numerical data or measurements

Reaction time: The total time it takes our body to react and respond to a stimulus

Speed: The rate at which someone or something is able to move or operate

STEM: Science, Technology, Engineering and Mathematics

Stimulus: Any interaction that an organism responds to

Trajectory: The path an object takes when moving through space

Variable: A parameter that may change, either by human action or by the result of a change in a different parameter

Velocity: Speed of an object in a particular direction

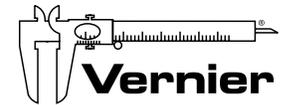


4-H, the nation's largest youth development organization, grows confident young people who are empowered for life today and prepared for career tomorrow. 4-H programs empower nearly **six million young people** across the U.S. through experiences that develop critical life skills. In the U.S., 4-H serves every county and parish through our network of **110 universities** and more than **3000 local offices**. Globally, 4-H collaborates with independent programs to empower **one million youth in 50 countries**. The research-backed 4-H experience grows young people who are four times more likely to contribute to their communities; two times more likely to make healthier choices; two times more likely to be civically active; and two times more likely to participate in STEM programs. 4-H is led by a unique private-public partnership of universities, federal and local government agencies, foundations and professional associations. National 4-H Council is the private sector, non-profit partner of the Cooperative Extension System and 4-H National Headquarters located at the National Institute of Food and Agriculture (NIFA) within the United States Department of Agriculture (USDA). 🍀



United States
Department of
Agriculture

National Institute
of Food and
Agriculture



Learn more about 4-H at www.4-H.org



#4HNYS



4 - H
NATIONAL
YOUTH
SCIENCE DAY

©1902-2015 National 4-H Council. All Rights Reserved. The 4-H Name and Emblem have special protections from Congress, protected by code 18 USC 707. 4-H is the youth development program of our nation's Cooperative Extension System and USDA.

© 2015 Oregon State University. This publication was produced and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties. Oregon State University Extension Service offers educational programs, activities, and materials without discrimination based on age, color, disability, gender identity or expression, marital status, national origin, race, religion, sex, sexual orientation, or veteran's status. Oregon State University Extension Service is an Equal Opportunity Employer.