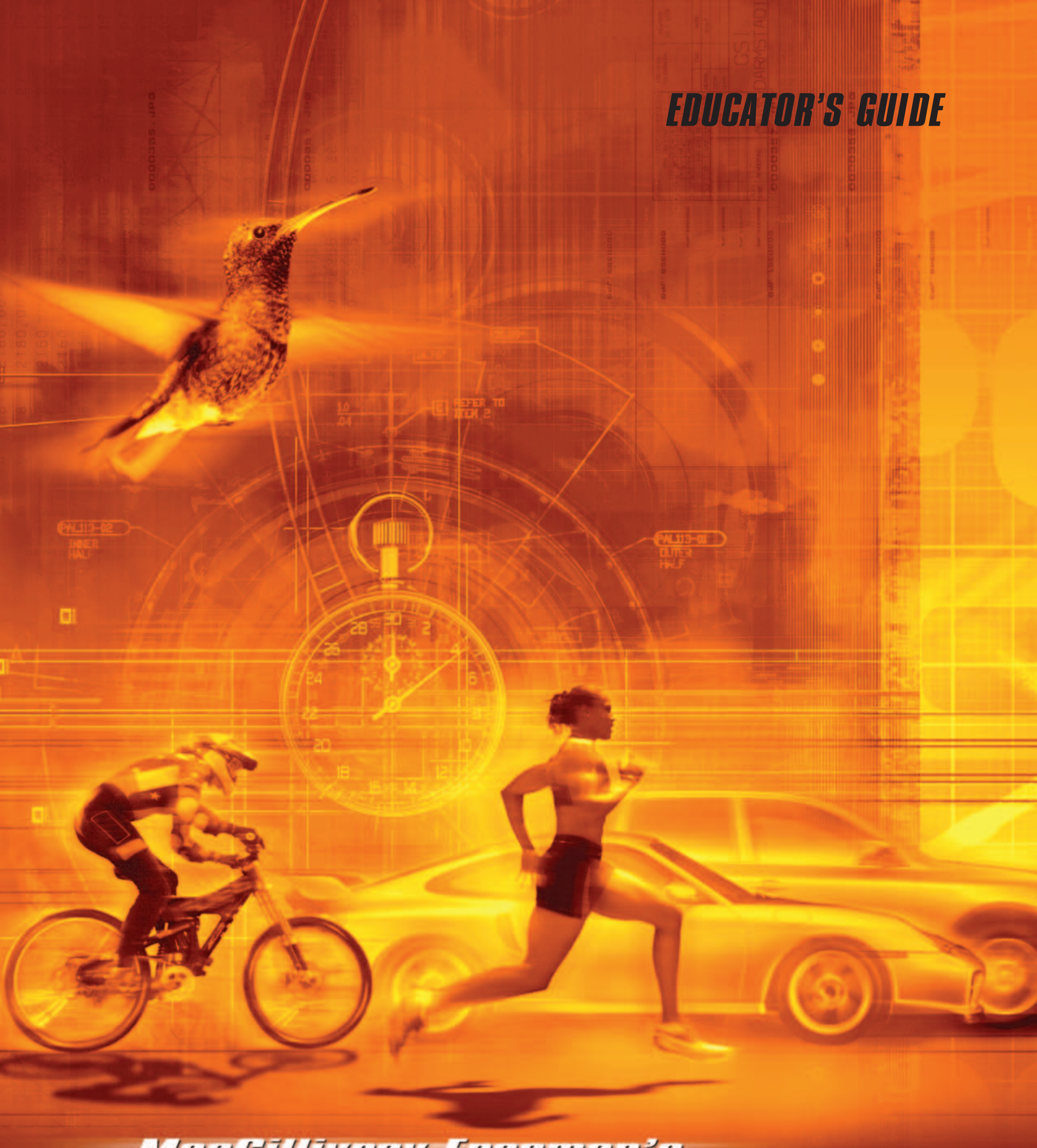
EDUCATOR'S GUIDE



MacGillivray Freeman's

TOP SPEED

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MacGillivray Freeman's TOP SPEED

An Educational Resource for Teachers

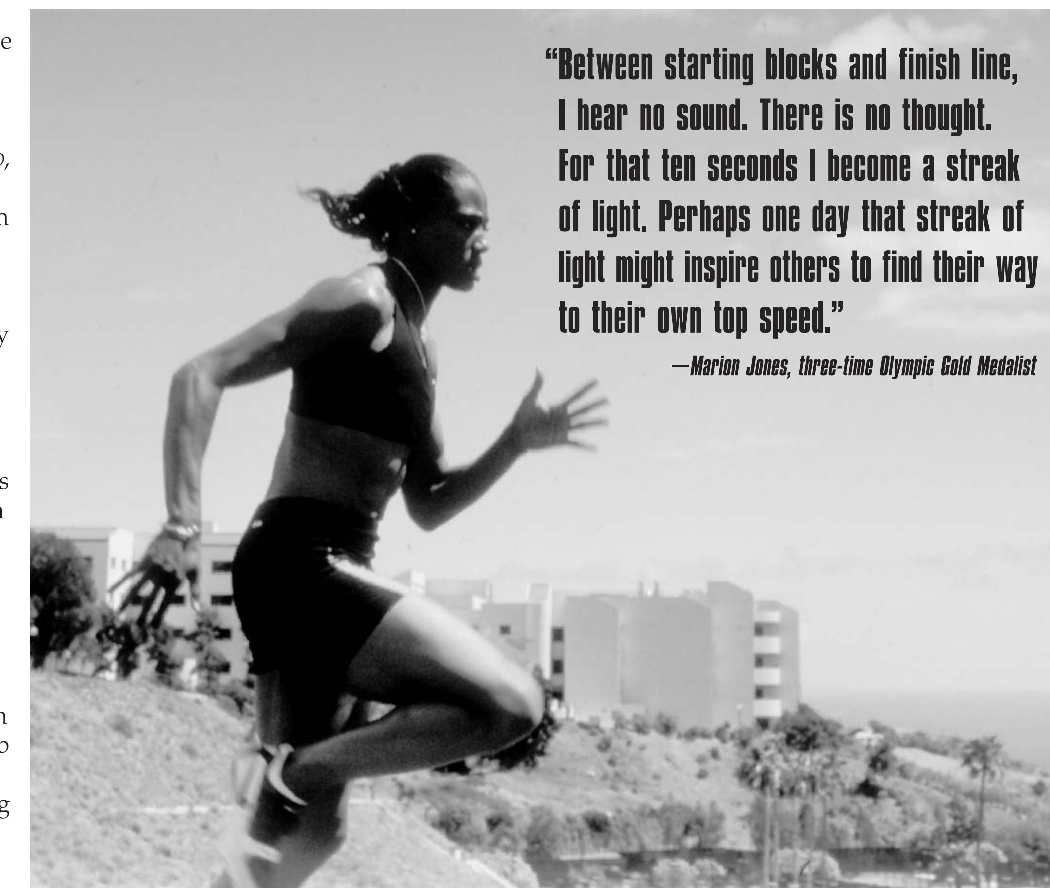
Introduction

Speed is relative. A garden snail moving at .03 miles per hour (0.05 kilometers/hour) zips by his inchworm buddies, crawling along at 43 inches per hour (109 cm). A housecat can outpace a human running at 27 miles per hour (43 km/hr), but cannot keep up with its cousin, the cheetah, racing by at 63 miles per hour (101 km/hr). The speed of sound (at sea level) seems incredibly fast at 770 miles per hour (1,239 km/hr), yet is only a small fraction of the 670,616,629 miles per hour (1,079,252,848 km/hr) that light travels.

In the film, *Top Speed*, we learn that humans begin their love affair with speed at an early age. In fact, it begins as soon as we overcome our fear of falling. We master gravity when we take our first few steps.

Marion Jones, an Olympic Medalist, demonstrates that there's more to this sport than a good start and "running like mad." Starting out in "phases" such as the response phase and the drive phase, Marion accelerates all the way to and through the finish line. Her body is in superb physical condition. She spends time strengthening not only the legs, but shoulders, abdominals, and back so she can sprint down the track at maximum speed, all muscle groups coordinated in graceful unison. It works. Marion is known as the fastest woman alive and was the first female track and field athlete to win five medals at a single Olympics.

In *Top Speed*, you will experience Marion's anticipation first-hand, by being in her shoes—a sensation that only a large format film can create. You will appreciate Marion's composed focus, and ultimately the tremendous explosion of energy she undergoes when running a world-class 100 meter (109 yard) race against the top female sprinters in the world.



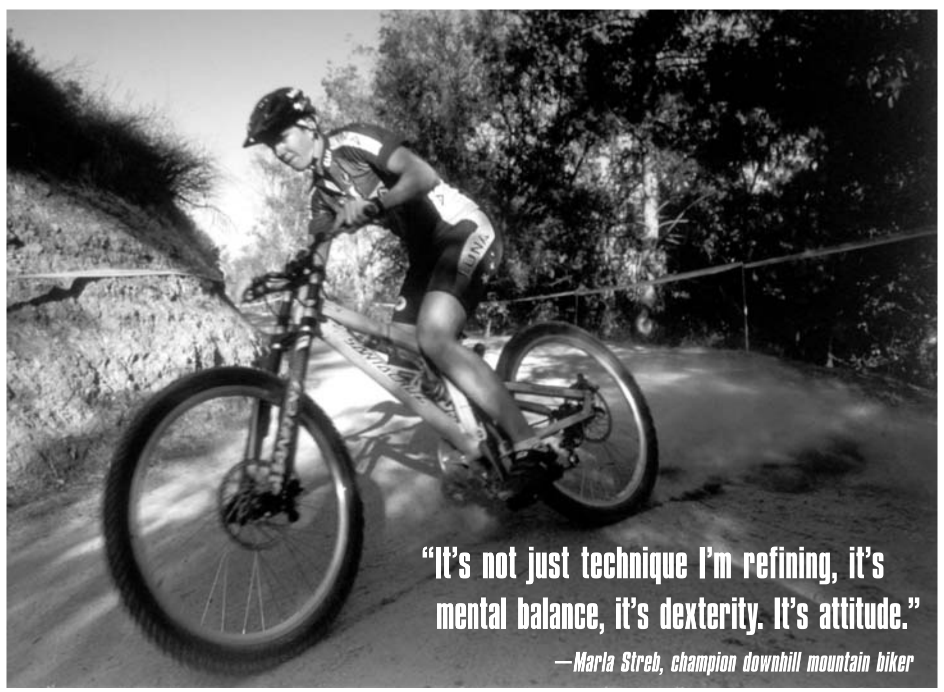
By definition, the word speed means the distance traveled divided by the time of travel. To travel farther faster than a person could run, add two wheels and a bit of courage. In the film, downhill mountain biker, Marla Streb, demonstrates

"There can be no fear. If you are afraid, you shouldn't be racing. I don't even like to talk about fear —I don't want it in my head at all."

—Lucas Luhr, professional racecar driver

the art and science of this sport as she rides through stunning red rock country in the west. As one of the top three female downhill mountain bike racers in the world, Marla gave up her life as a biologist to become a professional cyclist. Why choose this male-dominated sport? According to Marla, it is because it is hair-raising, and requires the most amount of courage to win.

Marla uses her science background to structure her training and organize her approach to racing. "Sometimes science helps me to twist legitimate theories around in order to rationalize some crazy jump or risk, like knowing that the gyroscopic motion of my turning wheels will stabilize me, but only with increasing speed, or that space-time is relative the faster that you travel!"



From two wheels and courage the film speeds up to four wheels and nail-biting nerve. Lucas Luhr is currently one of the top German GT racecar drivers in the world. You'll climb inside his Porsche GT and ride with him, zipping through heavy race traffic at speeds in excess of 200 miles per hour (322 km/hr)! Hold your breath and feel the adrenaline rush as you come within inches of a devastating multi-car pile-up.

Racecar driving takes more than nerve—it requires concentration, stamina and some basic science understanding. Lucas knows well the force of gravity as he pulls over two-G's when cornering and braking in hard turns. This means his body weighs twice what it normally does and requires quick reflexes, and tremendous upper body strength.

In addition to a driver's own fitness, he must understand his vehicle well and the physics behind its motion. For instance, it could be calculated that his car must push 52 million pounds (23.6 kg) of air out of the way during a race. Lucas also knows that without traction, or adhesive friction, the angular momentum would rip him and his car from the track.

Auto designer, Stephen Murkett, deals with science, too. He must design cars able to overcome the invisible resistance of air to keep turbulence to a mininum as it flows around the vehicle.

For all three athletes, the big challenge is maintaining razor-sharp focus. For Marla, it's important to "hard-wire" the line in her head before attempting to ride it. For Lucas, he must concentrate for long periods of time, rewiring his neural network faster than any computer. And Marion's goal is to run with machine-like precision, with mind and body in perfect sync. Their ability to do these things is what makes them champions.

Racy Writing

ACTIVITY ONE

Objective: Students will create Science Notebooks for noting observations, reflections, conclusions, questions and comments about the film *Top Speed*.

In the Film: Sports coaches and trainers record important facts about their athlete's performances—Marion Jones' coach keeps a log of her start times and her finish speeds as well as other important information that is reviewed later. Lucas Luhr relies on notations about weather conditions and data from the aerodynamics tests conducted on the car each time he sits in the driver's seat. This information helps him make snap decisions during a race.

Materials:
- black and white cover essay books—one per student
- pencils and pens

Teacher Prep Notes: Students come to class with varied experiences, which will influence their reactions to *Top Speed*. Some of their experiences will aid in discussions about major themes of the film, and students should be encouraged to share. While students may be familiar with the topic, they often do not have the correct scientific knowledge to comprehend the concepts. Scientific content will need to be addressed by the teacher, but there often are many things that the students already know. Writing in science notebooks offers the teacher a chance to assess what students know.

Give students a chance to voice their thoughts, and hear those of their peers, before, during and after investigations. The types of notebooks recommended in this activity will offer students a convenient location for noting thoughts in an organized fashion. While essay notebooks are recommended, spiral notebooks can be used as well.

Science notebooks illustrate the learning processes being used by the students and are also effective assesssment tools. *Note:* Science notebooks will be needed for all activities in this guide.

Background: In order to promote sound science training, it is necessary for students to realize the importance of lab notebooks or journals. Researchers use lab books or journals to record their observations, findings, thoughts and even drawings about their work. Whether they are noting the number of insect species in the rainforest or the colors/smells of chemical reactions in the laboratory, lab notebooks are what scientists use to record information. Scientists like Thomas Edison and Leonardo da Vinci used lab notebooks to record thoughts, diagrams and notes that eventually led them to major scientific breakthroughs.

To Do: Give each student a notebook to decorate with icons and/or drawings that illustrate what *Top Speed* means to them. Then have students spend 10 minutes writing as many words or thoughts that describe "speed" as they can. Lists, slogans, drawings and any creative writing are acceptable, as long as they relate to the topic of "speed." Some students may have negative feelings about this topic and it is acceptable for them to share those feelings in their notebooks.

KEY WORDS

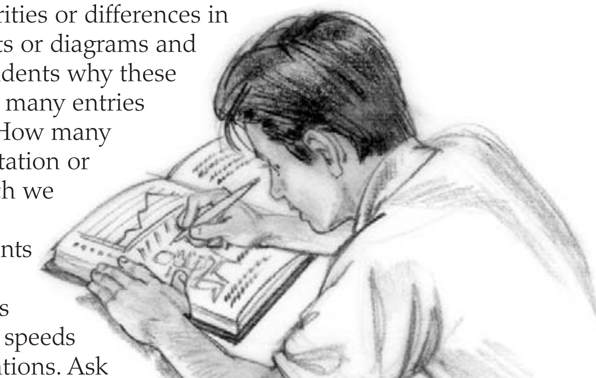
Research – Careful systematic study and investigation in some field of knowledge.

Observation – The noting and recording of facts for research.

Diagram – A sketch or plan that explains something, as by outlining its parts.

Label – To classify and to indicate contents or parts.

When students have completed the writing exercise, ask for volunteers to verbally share writing entries. Polite listening skills should be encouraged. Students may not feel comfortable bringing their personal thoughts from their notebook entries to a group. Do not force students to share entries. Discuss any similarities or differences in the words, thoughts or diagrams and discuss with all students why these were chosen. How many entries related to sports? How many related to transportation or other ways in which we think about speed?



Now ask students to move outside to observe two objects moving at different speeds and record observations. Ask students to record how far each of their objects moves in five seconds, or as long at it takes them to count "one, one-hundred, two, one-hundred… five, one-hundred." Ask students to make notations in their notebooks about how many times faster the faster moving object moves than the slower moving object. Have students share reflections on this activity in pairs or in a large group.

See Your Acceleration!

ACTIVITY TWO

Objective: Students will construct an accelerometer to measure changes in the rate of velocity and inertia of an object.

In the Film: Viewers really experience what high acceleration feels like as racecars zip around the slippery track. The cars are moving fast but the scream of the engines and the squeal of the tires as they peel out toward the finish line enhance your perception of speed in the film.

Materials:

- ☐ science notebooks
- ☐ large 1 gallon (3.8 liters) clear glass jar
- ☐ string
- ☐ water
- ☐ scissors
- ☐ matches
- ☐ candle
- ☐ lead sinker (can be purchased where fishing supplies are sold) or a large machine nut (sold in hardware stores) approximately 1½ inches (2.5 cm) in diameter
- ☐ access to a large area for walking (indoor or outdoor)

KEY WORDS
Accelerate – To increase speed or, or more generally, change the velocity.
Velocity – The speed of an object in a given direction.
Inertia – The tendency of an object in motion to remain in motion.
Force – An action that causes an object to accelerate.

Teacher Prep Notes: This activity can be done as a demonstration, but depending on the age of the students, it can be done with small groups as well. Teachers may choose to make the accelerometers in advance and then have students perform the activity.

Note: Direct supervision is required for students using matches, candles and hot wax.

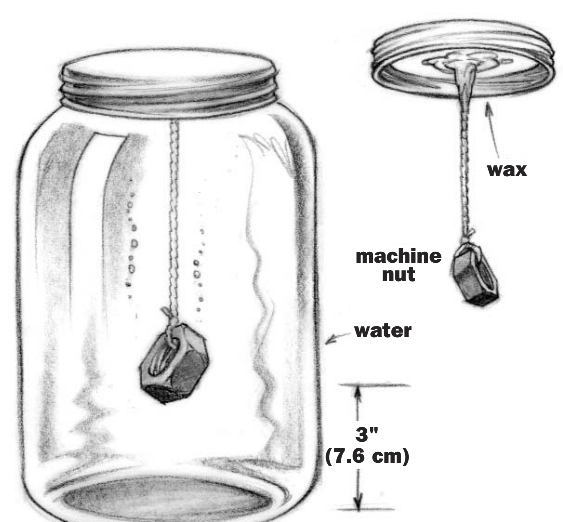
Background: When referring to motion, the rate of change in velocity of an object is known as acceleration. If we use a roller coaster to think about this, the acceleration we experience comes from the rate of speed at which we travel (racing down hills) and the direction in which we are traveling (around the track). We feel acceleration when the coaster car begins to move downhill, as it changes from a still position to forward motion with increased speed.

Acceleration continues in this manner until a change in speed or direction occurs. When that happens, ie: when the coaster car reaches the bottom of the hill, we feel the de-celeration or change in direction and speed (car now moving uphill at a slower speed). When the car reaches the bottom of the hill and begins to climb the next hill, both the direction of movement (from down to up) and the speed at which the car is traveling changes and we feel acceleration once more.

To Do: Cut a piece of string that will allow the nut or sinker to be suspended in the jar approximately 3 inches (7.6 cm) from the bottom of the jar. Tie the nut/sinker to one end of the string and place the other end on the center of the bottom of the jar lid. Carefully drip hot melted wax over the end of the string, covering it completely. Allow the wax to harden. Once the wax is hard, turn the lid over and check to make sure the nut/sinker swings freely without coming off the lid. If the string is not fully secure, drip more hot wax onto the string. Fill the jar with water, completely to the top. It is important that there are no air bubbles in the jar, once it is sealed. Drop the nut/sinker into the water and twist the top of the jar on tightly. See diagram of completed accelerometer.

Have students observe the motion of the nut/sinker on the string as it begins to settle. The nut/sinker will act as an indicator in the accelerometer to measure changes in direction and speed.

Select a student to carefully hold the accelerometer. Ask the student to begin walking in a large circle at a normal walking pace. Ask the other students to walk in a slightly larger circle in the opposite direction of the student holding the accelerometer to get a close look at the indicator in the jar and record its position in their notebooks. Students should record as much observational information as possible. (Things like estimated walking speed, type of walking, dimension of the walking path, position of the accelerometer, etc.) It is very important that the students observing the accelerometer do not touch it or impact the path of the student walking with the device.



Once all students have made observations about the accelerometer and the location of the indicator, have the students in the larger circle increase the speed of their walk. The student holding the accelerometer should also increase speed to a fast pace but follow the same path as before. Again, have the other students make observations about the accelerometer, the location of the indicator, etc. Have them record all observations in their notebooks.

Ask the students to stop walking. Ask the student holding the jar to stop walking and put the jar on the ground. Allow the student holding the accelerometer to make observations in his or her notebook while the accelerometer's indicator slows. Offer all students a few minutes to review the data they collected from their observations and ask them each to develop an experiment that they can do with the device to make the indicator move in a way that it did not in the experiment. Students can use prior knowledge and what they have learned in their recorded data, based on their notebook entries. Experiments planned by students need to be realistic and if possible, demonstrable in class.

The following questions can be used to prompt students for experiment ideas:

- What direction will you need to move the accelerometer in order to make the indicator move vertically (up and down)?
- What is the reaction of the indicator when the accelerometer moves faster than it did in this experiment?
- What role does the direction or movement of the accelerometer play in how the indicator behaves?

Ask for volunteers to share their experiment ideas with the class. Group students with similar ideas for experiments together and allow them to demonstrate their experiment to the class. The findings from this experiment can be recorded in the science notebooks and may give others insight into experiment ideas. If time permits, allow each group of students to share their experiments with the class.

What's Going On & Why?
In this activity, as the student moved from a resting position to a forward medium speed walking motion, the indicator moves backwards in the jar. But then, as the student walks at a steady speed, the indicator moves back to the center (the same position it was in when the student was resting). It does not matter what the velocity is— there is no acceleration unless the velocity changes. If the student holding the accelerometer walked in a straight line, at a slow speed, the indicator would remain in the vertical position until the speed increased, or the direction changed. As the walking speed is decreased and the person stops, the indicator should move forward. The reason for this movement is because it has inertia. That is, the indicator tends to keep moving at the same speed and in the same direction it was moving. In essence, the indicator does not "know" the person carrying the jar has stopped —it just wants to keep going in the same direction! As the walking motion changes from a straight line to go around the curve of a circular path, the indicator will move toward the outside of the jar (toward the outside of the circle). Again this happens because of inertia. The indicator tends to keep moving in the same direction. When the student (and the jar) turns, the indicator tends to keep moving in a straight line, and thus moved toward the outside of the jar (opposite the direction of the turn). Again, the indicator does not "know" the person carrying the jar has turned— it just wants to keep going straight! This tendency of a moving object to keep moving in the same direction at the same speed unless acted upon by a force, is known as Newton's first law of motion.

Can You Stand the Cold?

ACTIVITY THREE

Objectives: Students will focus their concentration skills on one task while being distracted by something else.

In The Film: Talented athletes train their bodies to move at top speed. They ensure every muscle of the body is up to the challenge of the performance. They also train their minds to be able to focus on their sport. These athletes often reach inside themselves to find a deep level of concentration that keeps them focused on their actions. Some call it "flow," others call it "Zen," but they are describing the mental state or visualization necessary to get to the finish line first.

KEY WORDS

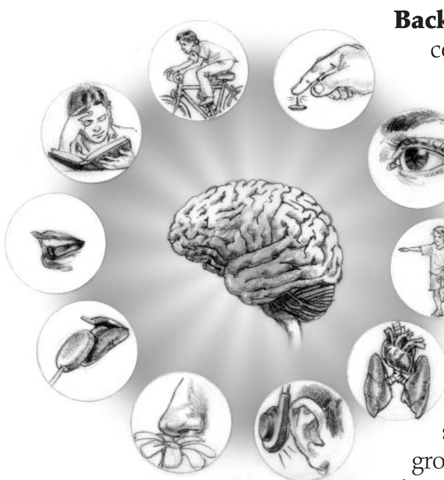
Cerebrum – The largest part of the brain where learning, intelligence and judgment occur. It also controls all voluntary activities of the body.

Cerebellum – The second largest part of the brain that coordinates the actions of the muscles to maintain balance.

Medulla – Connects the brain to the spinal cord and controls involuntary actions such as heartbeat, breathing and blood pressure.

Materials:

- ☐ small metal coffee cans with tight fitting lids (one per group of two to three students)
- ☐ ice (enough to fill each can)
- ☐ paper towels for clean up
- ☐ science notebooks
- ☐ pencils and pens
- ☐ stopwatch or clock with secondhand



Background: The brain is the control center of the body and is made up of billions of cells called neurons. The human brain has three main parts, which are grouped into lobes (cerebrum, cerebellum and medulla). Each lobe and part of the brain controls different brain and body functions and contain neurons needed to control aspects of what we do.

As your body grows, so does your brain and as it grows, one side becomes dominant. In fact, by the age of 10, one side of your brain is more dominant (in control) than the other for certain functions. This is when you find that you are good at some things, and not so good at others, depending on which side of your brain has developed dominance.

Because of the way the nerve fibers cross in and out of the brain, the left side generally controls the right side of the body and the right side of the brain controls the left side of the body. This means that if you are right handed, your brain is left-side dominant and if you are left-handed, the right side of your brain is dominant. In addition, studies have shown that the left side of the brain generally specializes in tasks that require logic and language (writing, numerical skills, scientific skills and reasoning). The right side of the brain specializes in creative things such as music, art appreciation, the use of symbols and patterns. People who are good at specific sports use the side of their brain dominant for that sport. Because the brain is not actually cut into separate halves there are complex activities in which both sides of the brain work together.

Studies show that when people are taught to focus brainpower away from less dominant actions and toward dominant ones, their performance can increase in certain tasks. Focusing brainpower to accommodate brain dominance is one tool athletes can use to excel. Concentration skills are required to focus all of an athlete's attention away from all other simulations (the crowd, the weather, fear, etc.) allowing them to focus all brainpower on training and performing.

To Do: Begin this activity by asking students to use their science notebooks to reflect and record all information they can about the warmest place they can remember visiting. Ask them how the place smelled, how their body felt, how the place looked, what they ate or drank while there, or were they wearing any special clothes. These ideas will be used later in the activity.

Give each group of 2 students a can with a tight-fitting lid and ask them to fill each can to the top with ice, tightly securing the lid when the can is full. Use towels for spills or drips. Keep towels on desks for condensation during the activity.

Ask one person from each pair to sit comfortably in a chair, holding the can full of ice with one hand. Make sure they hold the can with their entire hand and that the palm and all fingers have contact with the cold metal. (See diagram.)

While the person holds the can, ask them to concentrate on the warmest place they remember. This student may look at the notes they have recorded in their notebooks if needed, but should

concentrate on the warm thoughts they had at the start of the activity. Encourage students to concentrate on these "warm" thoughts, trying to ignore increasing cold from the can. Students should hold on to the can for as long as possible.

The other student in the group will record observations about the person holding the cold can into their notebooks. They should record facial expressions, body language and whether or not the person holding the can needed to review their notes often. Recording students will also need to keep track and record the amount of time their teammate could hold onto the can. They should use a stopwatch or a clock with a second hand for this and record this data in their notebooks.

Repeat the process until all students have had a chance to hold onto the can. Once this is complete, ask students to reflect in their notebooks about their feelings during the experience. Have them reflect on how long it took them before they pulled their hand away from the can. Were they successful at concentrating on the warm things to increase the time they were able to hold onto the cold can? What concentration techniques were the most effective? Were students able to vary the times they could hold the can based on the amount of time spent focusing on the warm thoughts? Can any correlation be made between the body language and the amount of time holding the can? Can any correlation be made between classroom athletes and their ability to concentrate during this activity? Did students who play musical instruments or work a specific job hold the can longer?

What's Going On & Why? In this activity the metal can became increasingly cold because of the ice inside. Extreme cold is an uncomfortable sensation for us and prolonged exposure can be very hard to endure. As students took turns holding the can they put themselves into a situation where they were asked to overcome the discomfort of the cold and focus all of their thoughts away from the cold. Students who were able to focus their thoughts and attention away from the cold were able to hold onto the can longer. These students demonstrated that some things can be overcome with the idea of "mind over matter" visualization.

Pushy Pushy!

ACTIVITY FOUR

Objective: Students will study the relationship between force, mass and acceleration in relation to Newton's second and third laws of motion.

In the Film: Lucas Luhr surpasses human limits by strapping himself into his powerful racecar to win grueling races like the Le Mans 24-hour endurance series. His body is constantly feeling the effects of Newton's laws of motion as he races. His head is jolted side-to-side as he strains to maintain head posture despite the pulling of his fast acceleration. He is constantly working the car to overcome the friction forces which can slow his time. In the end, when he is victorious, we know he has used skill and training to battle the forces of physics.

KEY WORDS

Force – An action that causes an object to accelerate or decelerate (go fast or slow).

Mass – The mass (size) of an object is proportional to its weight.

Accelerate – To increase speed or, more generally, to change velocity.

Friction – Resistance generated when two surfaces rub past each other.

Materials:

- ☐ science notebooks
- ☐ tape measure
- ☐ helmets and pads
- ☐ colored masking tape
- ☐ rolling chairs, skateboards or roller blades/skates (one pair needed if activity is to be done as a demo)
- ☐ access to large area having a flat, smooth floor (school hallway)
- ☐ access to a large area having a flat, carpeted floor

Teacher Prep Notes:
This activity can be done as a demonstration, but depending on the age of the students, it can be done effectively in small groups. Make sure that all students participating in the activity wear helmets and protective wrist, elbow and kneepads to prevent injury.

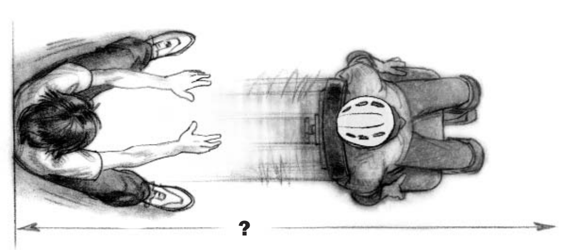
Background: When demonstrating the forces that lead to acceleration, it is convenient to use rolling objects such as wheeled chairs, skateboards or roller skates. These allow us to experiment with the effects of force and mass on acceleration. Everything moving in the real world is subject to friction forces. Friction acts to slow down moving objects as its force acts in the opposite direction of the moving object. How far an object moves is directly related to how much initial force has been exerted on the object.

To Do: Have one student stand with his/her back against a wall in an area with a flat, smooth floor. Ask another student to sit on a rolling chair/skateboard in front of that person. *Note:* Student on the rolling object MUST wear protective gear. Have the student against the wall push the student on rollers away from the wall quickly. Use colored masking tape to mark the distance and the stopping position of the rolling chair/skateboard. Have the students measure the distance traveled and record this information in their science notebooks. Perform these procedures several more times, recording all measurements. Ask students to observe and note the outcome of each test. Students will learn that the harder they push, the faster the acceleration and the farther the distance traveled.

Now perform the same procedures with the same rolling chair/skateboard on a flat carpeted area. Repeat the same number of tests, having students measure the distance traveled in their notebooks. Ask students to compare the distances traveled on a hard floor versus a carpeted floor to discover how friction plays a part in the activity. Data recorded in the notebooks should show evidence of this.

Next, follow the same procedure as before, but this time use two rolling chairs/skateboards and have two similarly sized students hold hands or lock arms (so they are sitting right next to each other, very closely side-by-side). Have one student push BOTH chairs at the same time while standing with their back against the wall, as before. It is important that the student pushes with approximately the same force as was used in the first part of the activity. Make measurements to determine the distance rolled and record this into notebooks again. Data should reflect that the two students (about twice the mass of a single student) should roll only about half the distance of a single student on rollers.

Now have two students of approximately the same weight stand on rollers. *Note*: Skateboards work particularly well for this part of the activity. Make sure students wear protective gear. Place the students on rollers in front of each other and



mark the starting point of each student roller. Have one student push the other student. The other students should make observations entries in their notebooks. Use tape to measure the stopping position of each student. The distances should be recorded in the notebooks. Repeat this part of the activity several more times to get more data and then switch student pushers. Have the student who was pushing switch positions with the person who got pushed. Record data for these tests as well. In both cases, both students should roll about the same distance in opposite directions demonstrating that every force has an equal and opposite reaction force. In this part of the activity the same is true no matter which student exerts the pushing force.

Have students reflect in their notebooks about the following prompts using the data they have collected.

- Why does a person stop rolling? Why don't they keep rolling forever?
- In which direction does friction act? Does it go in the same direction as the push or in the opposite direction? Can a friction force speed up the movement?
- Why did the person in the third part of the activity roll backwards?
- Did the result in this activity depend on the student pushing?
- When the student doing the pushing is leaning against the wall, what happens to the "reaction force" acting in the opposite direction?

What's Going On & Why? In this activity, when the person on the rolling chair/skateboard is pushed, a force is being exerted on them. While they are being pushed they are accelerating. When the pushing stops, friction forces stop the acceleration, causing the rolling to stop. In all cases, the distance traveled gives an indication of the initial force exerted on the object. Friction forces, in this case, the wheels and the floor (technically including the wheels and the wheel bearings) arise when two surfaces rub past each other. Friction forces always act in the opposite direction from those of an object in motion and cause deceleration (slowing down) of the moving object. Without friction, theoretically, the chair/skateboard could roll forever.

When the rolling chair or skateboard moved on a carpeted surface, the friction forces were greater than those on the smooth floor and the distance traveled was less.

Newton's second law tells us that when an object is pushed, the acceleration is proportional to the pushing force. When pushed, heavier objects will move shorter distances because of their mass. In this activity, students may have observed this as different students participated in the test runs.

Newton's third law of motion is illustrated in this activity: For every force exerted there is an opposite and equal force observed. In the part of the activity where two students sat on a rolling chair or skateboard and both students moved apart from one student's push, Newton's third law was tested. One student moved away from the push while the other also moved away from his/her own push. If both students were the same mass, the distance they both moved away from each other should be the same.

FACT BOX

It is amazing to realize that the reaction force in the opposite direction does act upon the student standing against the wall. Not only the student is affected—so is the wall, the building and even the Earth. Because the weight of the Earth is about 100,000,000,000,000,000,000,000 times larger than the weight of the student, the acceleration of the earth is about 100,000,000,000,000,000,000,000 times smaller than the acceleration of the student on the roller, which is hardly a noticeable acceleration!

Speed Into Health

ACTIVITY FIVE

Objective: Students will research and design an obtainable personal fitness program.

In the Film: Whether we are talking about race cars, high-tech downhill bicycles or even the human athletes who operate these vehicles, one thing they have in common is finely tuned mechanisms. In the film, car and driver have endured long hours in training. Lucas Luhr is as carefully tuned as his racecar. His balanced diet and demanding fitness routines help him endure the constant braking, extreme heat and noise, and a force of almost 2G's as he reaches top speeds.

KEY WORDS

Isometric Muscle Action – A force produced by muscle without any resulting muscle movement and without any joint motion.

Flexibility – The measure of the range of motion, or the amount of movement possible for a particular joint.

Static Stretching – Techniques that gradually lengthen a muscle to an elongated position (to the point of discomfort) and held in that position for 10-30 seconds.

Materials:
- ☐ science notebooks
- ☐ pens and pencils
- ☐ access to Internet or health-related web sites
- ☐ access to closely related family members (parents, aunts, uncles, and grandparents)
- ☐ access to public library
- ☐ access to workout areas (gym, playing field, track)
- ☐ poster with quote (above right) to be posted in the room for the duration of the activity.

Teacher Prep Notes: Students will be designing personal fitness programs and following them for the duration of the lesson. The lesson can be extended to take a long period of time, even to be done for an entire semester or school year. Encourage students to keep working on their fitness goals but if any health issues arise with the programs developed by students, ask them to change programs or stop. Sports injuries are common if care is not taken to ensure safety.

FACT BOX

Regular physical activity improves more than 50 different physiological, metabolic and psychological aspects of human life!

"As long as you pursue it, your own top speed lives somewhere in your future!"

Background: Physical fitness is often defined as a set of attributes related to one's ability to perform normal physical activity (agility, power, balance, body composition, cardiovascular and muscular endurance, flexibility, and muscle strength). Exercise is often defined as physical activity that is done at a higher than normal level of exertion. Exercise, when done in a systematic routine, duration and frequency, will help increase the level of physical fitness. Research indicates that physical activity level as a child is a good predictor of physical activity level as an adult. Research also shows that regular physical activity, combined with a healthy diet, can combat obesity, coronary disease, high blood pressure and can help in weight control. Many of these risks begin during the childhood years and worsen with age. Physical exercise also boosts self-esteem as we tone our body.

To Do: Have students analyze their personal needs for a fitness program. Ask them to record thoughts and ideas in their science notebooks. What benefits do they expect from a fitness program? What personal fitness goals do they have? Do they want to increase strength? Do they want to lose weight, or increase muscle tone?

Next have students record limitations they may have with exercising. Do they have a disability? Have students record the things they like to do that are physical. Ask them to write as many physical activities that they like to do in their notebooks. Health professionals say that it is much easier to maintain a physical fitness plan if it contains the things we enjoy doing for exercise.

The next step in the creation of a personal fitness plan involves researching family health history and possible health issues that may put you at risk—or give you added motivation to exercise. Ask students to perform 3-5 interviews with family members or their family doctor to determine if there are any health concerns that they should be aware of as they create their fitness plan. Students should develop questions to ask at the interviews and record all responses.

Once they have a list of personal reasons for a plan, students are ready to research a regular fitness routine. They can research types of sports, find clubs or groups that perform exercise, find local areas to work out, join a gym, etc. Have students determine if volunteering at a local fitness club can be helpful in their fitness plan. Do friends or classmates have similar likes or goals? Can exercise equipment be shared?

Time is also a big factor in any fitness program. Make sure students develop their fitness plans with a realistic schedule in mind.

It is also critical that students create realistic goals for their programs. Sports injuries such as shin splints, or runner's knee can occur with over exercising. To avoid these types of injuries, make sure students stretch well, start slowly and build strength gradually to increase the quality of exercise done.

Have students follow the check list below as they create their plans.

- ☐ Start slowly
- ☐ Stretch before and after physical activity
- ☐ Make only one life change at a time
- ☐ Have reasonable expectations for yourself and your fitness program
- ☐ Choose a specific time to exercise and stick with it
- ☐ Exercise with a friend
- ☐ Make exercise a positive habit
- ☐ Keep a record of your progress

After the lesson, encourage students to continue the progress made with the fitness plans. Ask each to reflect about the process and how it relates to the quote posted in the room at the start of the activity.

KEY WORDS

Aerobic Exercise – Any type of exercise, typically performed at moderate levels of intensity for extended periods of time (20-30 minutes or longer), that increases heart rate.

Target Heart Rate – Calculated as a percentage of maximum heart rate (220 minus your age); heart rate (pulse) is taken during aerobic exercise to check if intensity of work out has been achieved.

Balancing Act

ACTIVITY SIX

Objective: Students will experiment with balance as it relates to base, center of gravity, rotation and rotational mass.

In The Film: Marla Streb takes her bike down twisting trails, jumps ravines, speeds across meadows, and rides perfectly balanced on the brink of steep drop-offs as she perfects her skills. In order for Marla to make these maneuvers, she must be aware of her center of gravity and keep it in check to avoid a devastating crash. She must work her bike and body together in order to maintain balance and control while achieving high speeds.

KEY WORDS

Balance – When the force of gravity is cancelled with some equal force in an upward direction.

Center of Gravity – The point in a body around which its weight is evenly balanced.

Materials:

- science notebooks
- meter sticks—one per group of students
- "C" clamps—one per group of students (available at local home improvement stores)

Teacher Prep Notes: This activity will require plenty of space for group work and caution for students moving between groups working as meter sticks will be falling to the ground. It may be helpful to designate working areas for groups and do not allow people to walk in those areas for the parts of the activity when students are balancing their meter sticks.

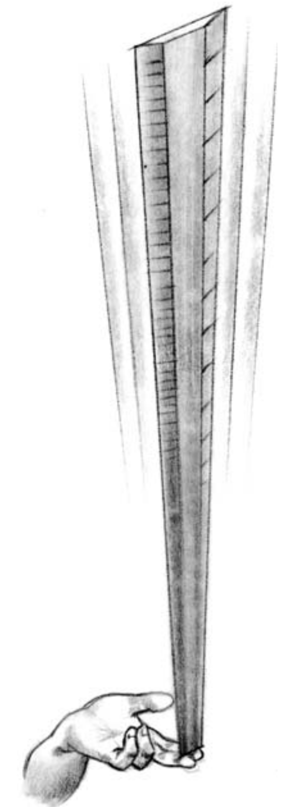
Background: Most of us have experimented with balance in our lives. We have mindlessly balanced a pencil on our fingers during a long phone conversation or we may have played with balancing toys as small children. Some objects in everyday life seem impossible to balance based on their size or shape. If we find the center of gravity, generally located over the base, these odd items can indeed be balanced.

To further understand center of gravity, think of the following example: If you suspend an object from any point, let it go and allow it to come to rest, the center of gravity will lie along a vertical line that passes through the point of suspension.

Rotational mass or moment of inertia depends upon the distribution of the mass. Masses close to the axis of rotation have a small rotational mass. This means they are easy to rotate. Masses far from the axis of rotation have a large rotational mass. This means they are difficult to rotate.

To Do: Arrange students in working groups in different parts of the work space, allowing plenty of work room for the activity. Give each group a meter stick and challenge them to see how long they can balance the stick using only their hands. Most students, based on what they know about balancing objects, may achieve this by balancing the stick horizontally on one finger. However, this is only one way to balance a stick. Challenge students to balance the meter stick vertically in the palm of their hand. Ask students to notice the difference between a vertical balance and a horizontal one. After all students have been able to balance the stick both ways, ask them to record their findingsin their notebooks.

Now try the activity again, but this time give each group a "C" clamp. Ask each group to balance the meter stick with the clamp attached to the stick at any location. Some students will try to balance the stick horizontally, but challenge them to balance the stick vertically. Ask students to measure the location of the clamp on the stick. Have students record their findings in their science notebooks.



Allow time for each student to reflect in their science notebooks using the following prompts:

- Did the stick balance when the clamp was closer or further from their hand?
- Which techniques were used to balance the stick horizontally?
- What relation did the rest of their body play in both balancing challenges?
- Which balance challenge was harder to accomplish? Why?

What's Going On & Why? In the first part of the activity, the point at which the stick balanced horizontally is called its center of gravity. The center of gravity is the point at which the stick's mass is even on both sides allowing the stick to hang in the balance, or to be stable. When the meter stick was in balance this way, its base was located directly under the center of gravity. When the stick was balanced vertically, the center of gravity was near the middle of the upright stick. Yet the base of the stick was at its bottom. This means the stick's base is at a different location than its center of gravity. When students tried to balance the stick on their hands this way, they noticed that the stick started to fall. The falling motion was not just in a downward motion. The stick began to fall in a rotating fashion with the center of gravity changing in a downward arc movement. This arc movement is actually making the center of gravity fall or rotate around the stick's base. This rotation is called rotational mass. (See diagram.)

When the clamps were placed on the sticks, the additional weight made the stick tip more slowly. When the students moved their hands, they also moved the stick's base (their hand) to keep it under the center of gravity. The stick is easier to balance when the clamp is placed higher on the stick because its rotational mass is larger and more difficult to rotate. This means there is more time available to adjust the stick's base to keep the center of gravity balanced with it.

Impact

ACTIVITY SEVEN

Objective: Students will investigate the relationships between force, pressure and surface area as well as their importance in collisions.

In The Film: Protective clothes and other gear are worn by people who persue speed for sport. Their helmets, pads, fire retardant suits, wrist guards and safety belts keep them safe when their speed quest ends in a sudden and involuntary stop —a crash! While crash tests are done to prove the security of their protective gear, the athletes in the film take their health and safety in their own hands each time they hit the road.

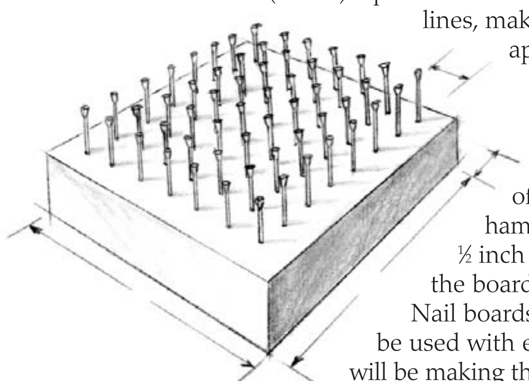
KEY WORDS

Pressure – A standard way of describing the force per area.

Surface Area – The amount of space located on the surface of an object.

Materials:
- □ science notebooks
- □ nail boards—one per group of 2-3 students (directions to make nail boards are listed below)
- □ pencils
- □ one nail per student
- □ safety devices (helmets, knee pads, safety belts)

Teacher Prep Notes:
TO MAKE NAIL BOARDS: Cut wood into 5-inch (13 cm) squares. Use a ruler and pencil to mark lines, making a grid with the lines approximately 1 cm apart. Use a hammer to nail in the finishing nails at each area where the lines intersect. Make sure all of the nails are evenly hammered with approximately ½ inch (1 cm) remaining above the board. (See diagram.)



Nail boards in this activity need to be used with extreme care! If students will be making the nail boards, be sure they wear protective goggles. Consider asking parents, school custodial staff or shop classes for assistance with this.

Background: In order for humans to survive the forces involved with collisions, we develop and wear protective devices that increase the surface area of the impact, making it easier for the head or body to tolerate impact. Helmets, for example, absorb some of the force of an impact and spread the rest of it over the entire skull. Elbow pads spread the force of impact over the entire elbow area, making the possibility of injury to a specific area less likely. Safety belts are designed wide to spread the forces of a collision along the body. The belts allow only the harder parts of the body (shoulders, hips) to be braced in an impact, while soft areas of the body (stomach) are protected.

To Do: Begin the activity by giving each student a nail. *Note:* Use caution when using nails. Ask each student to *carefully* and lightly rest the palm of their hand on the head of the nail. Ask them to record the feeling in their science notebooks. Then ask students to apply slightly more pressure and record how the feeling changes. Ask students to reflect on this by writing descriptive words in their notebooks.

Next, pass one nail board to each group and ask them to locate three different spots on their hands (fingertip, heel, joint) that they will use to investigate during the activity. Before starting the activity, ask students to predict what each of the three parts of the hand might feel like if they were placed in the nail board with a gentle but constant pressure. After students have made their predictions, have them carry out the tests on the spots they have discussed. Ask them to record their findings. Does the feeling change with a more intense pressure? How were the feelings in the first part of the activity the same or different than this part?

Lay out a variety of safety devices for students and ask them to select one safety device (helmet, pad, etc.) to be placed on the nail board. Ask students to perform the same procedure as before with the three parts of their hand. This time it should be done with only the safety device resting on the nails (hand parts will be on or in the safety devices). Have students reflect on what they feel and the differences between this part of the activity and the others. What conclusions can they make based on their observations? What is the importance of using protective devices on the human body in case of a collision?

What's Going On & Why? We all know that collisions or crashes involve forces that act over areas to stop a moving object. While the moving object might stop, the kinetic energy from the moving object can never be destroyed, but can be transferred into other forms of energy. For example, kinetic energy can be transferred into heat. which in the case of an auto accident, could be as dangerous as the crash itself. Safety helmets are examples of how scientists are working to create ways to transfer kinetic energy into other forms for public safety. Helmets protect the head in a collision by dissipating (spreading out) the force to all parts of the helmet, making the direct impact to a specific area of the head less traumatic. While this does not make the impact energy go away completely, the dissipation to all areas ensures that dangerous levels of energy may be avoided.

In this activity, students felt the direct pressure of one nail head on their hands. With a single nail, one point of pressure takes all the force. When using the nail board, the soft parts of the hand are more sensitive to the pressure of the nail board than hard parts. For the final part of the activity, the force on the hand is greatly reduced by the use of the safety devices.

Resources/Acknowledgements

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The large format film, *Top Speed*, is appropriate for all intermediate grades (4-8). This Educator's Guide will be most useful when accompanying the film, but is a valuable resource on its own. Teachers are strongly encouraged to adapt activities included in this guide to meet the specific needs of the grades they teach and their students. All activities developed for this guide support National Education Standards for Science, Geography, Math and English, but are not referenced in this guide due to space constraints and differences in standard use throughout the nation.

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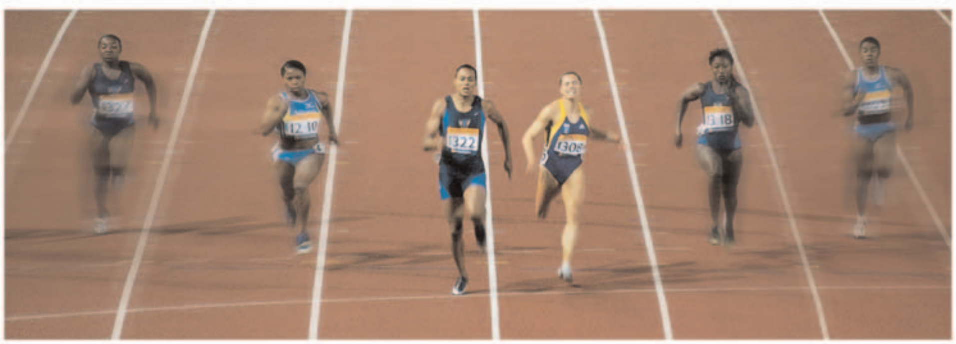

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