The Physics of Bicycle and Helmet Safety

Bike Wheels to Steering Wheels Curriculum (BW-2-SW)

Developed August 16, 2006
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Additional Revisions September 5, 2007
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Additional Engineering Lessons October 2011
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Sponsored by
Legacy Emanuel Medical Center's
"Trauma Nurses Talk Tough"
and
Oregon Department of Transportation
Traffic Safety Division

Curriculum Content

NOTE: Education Reinforcement Handouts & Transparencies are a ***Separate Download if accessing the B-2-S Curriculum online

TRAUMA NURSES TALK TOUGH
ABOUT SAVING YOUR LIFE

BW-2-SW Curriculum & Segment Description

Built by Portland Public School science curriculum specialists, the Bike Wheels to Steering Wheels (BW-2-SW) Curriculum is appropriate for 6th-8th grade students to help Youth connect the dots between Newton's Laws of Motion and Traffic Safety.

The Bike Wheels to Steering Wheels curriculum meets the 2009-2017 OED State Standards for:

Eighth Grade:

- *Mathematics Statistics & Probability*
- *Physical Science*
- *Health Education Unintentional Injury Prevention*

Seventh Grade:

- *Mathematics Statistics and Probability*

BW-2-SW Curriculum is designed to be taught in earth science, personal safety, applied math classes or during after school science clubs to foster better understanding of the fundamental reasons for and importance of following traffic laws.

Through the BW-2-SW Curriculum Youth will develop understanding to help build safer bike, skateboard, snowboard, ski or ATV riders with the additional goal of increasing the number of safe drivers in the community, reduce healthcare costs and improve family stability.

BW-2-SW Curriculum is HANDS-ON! Six (6) lessons taught over a period of 2-6 weeks.

In Lesson 5, the TNTT Nurse's presentation illustrates through real-life stories how the student-built projects that teach the affects of friction, inertia, propulsion, motion and mass combined with gravity.

NOTE: Teachers are encouraged to call the TNTT Offices at 503-413-2826 or email tntt@lhs.org for local TNTT Network Member list and contact information.

BW-2-SW Curriculum Lesson Segments, handout and instruction materials are ***FREE*** to download by interested school districts and teachers online at www.oregon.gov/ODOT/TSS/youthsafety.shtml A list of the project materials and where to purchase them is included.

BW-2-SW **Curriculum Outline**

1. Impact/Inertia—Teacher Prep includes tofu & egg purchase, and materials
a. Lesson – "Busting Brains" + Engineering Helmet Design pg 35
b. Demo- Hammering nails-teacher provides demo materials
c. Table Topper*- "Another Day in the Frontal Lobe"

2. Inertia Drop
a. Lesson – Introduction to Inertia
b. Demo- "Lazy Vase" & "Magic Thread"
c. Table Topper- "Nature's Shock Absorber"

3. Friction – two days—Teacher passes out Lego & Ramp building materials
a. Lesson – Stop in the Name of Friction – two days + Engineering Parachute Design Project pgs. 37-41
b. Table Topper- "Maglev Trains"

4. Inquiry—Teacher purchases and prepares eggs
a. Lesson – Mass & Inertia Inquiry b. Demo- Raw & Hard-boiled egg spin
c. Table Topper- "Fitch Barriers" + Engineering Crumple Zone Design project pgs 42-44

5. "Trauma Nurses Talk Tough" classroom presentations—Teacher calls 503-413-2826

6. Wrap Up—Teacher prep includes copying education reinforcement handouts/Quiz
a. Lesson- Wrap up Presentation
b. Table Topper- "NASA Brain Puzzle"
c. Post-quiz

*Table Toppers are for students to read at beginning of lesson, possibly during a snack break.

Physical Science Concepts Covered in the Lessons
Newton's Laws

First Law- An object at rest remains at rest, and an object in motion remains in motion at constant speed and in straight line unless acted on by an unbalanced force.

Second Law- The acceleration of an object depends on the mass of the object and the amount of force applied.

Third Law of Motion- Whenever 1 object exerts a force on a second object, the second object exerts an equal and opposite force on the first.

Friction- Friction is a force that opposes motion.

BW-2-SW Curriculum Materials List

Lesson 1—Busting Brains
Group students into teams'
$ ***Extra Soft*** tofu, ½ package/group
$ Small condiment cups with lids
# Meter sticks, 2/group
# Ruler, 1/group
Hammer
Flat-headed nails, 2/class
Piece of wood (2x4" 4-8" long)
$ Pipe Foam
$ Graph Paper
# Post-Its
$ Strips of soft foam
# Tape or rubber bands
# Poster paper for graphs
# Chart pens
* Student handouts
$ Journals for students
# Safety goggles

Lesson 2—Inertia Drop
$ Eggs (1 for each group)
# Masking tape 50cm
# String
$ 1 kg mass- attachable to a string
# Paper
# Ring stand
$ Tarp for egg dropping
# Ladder 10 feet
# Beaker or vase
$ Thread
$ Gallon size baggie

Lesson 3—Friction (two days of extensive teacher prep)
Stack of books & coins
$ Lego Cars
Rolling cart or any item on rollers
$ Sound tube, carpet, balloons
* Student Sheets
* Parachute Design Sheets
$ Washers, Coffee filters, foil, string, garbage bags
# Weights, large washers, quarters, or any item that can add weight
Ramp building to include various surfaces

Teacher discretion for items not marked
* Need to photocopy
$Teacher purchase
Should be available in building

Lesson 4—Inquiry
Meter sticks
Graph paper
$ Dominos or blocks
$ Marbles
$ Hardboiled egg-labeled "A"
$ Raw egg-labeled "B"
Crumple Zone Barrier Design
$ Cups with lids
$ Sand

Lesson 5—"Trauma Nurses Talk Tough" classroom presentation

Lesson 6—
* Brain puzzle sheets
* "NASA Goes to the Super Bowl"
* Bike Helmet & Safety information materials to copy and send home to Parents
Poster of graphs from prior lesson

NOTE: Engineering Projects for expanding Lessons 1, 3 & 4 beginning on page 34 provides additional materials list

Resources for Curriculum Materials Kit | *Approximate Cost*

Approx. 2’x5’ Carpet Remnant piece—Carpet dealership	$Sometimes donated
Ramp & barrier building wood	$Lumber yards
Sweetheart 2 or 4oz Cups & Lids-Restaurant Supply Store	$5.00
12 Toy Parachutist—Partypalooza.com (online)	$16.69 + SH
Sound Hoses—stevespanglerscience.com (online)	$6.95 + SH
1 Kg Hooked Weight product #119-11 —thesciencefair.com (online)	$11.00 + SH
MyChron timers—learningforallages.com (online) set of 6	$28.00 + SH
Lego sets for building cars found on Amazon .com 2009 pricing:	
1 Lego Wheels & Axles Single Set	$23.77 + SH
1 Lego Wheels Set	$33.99 + SH
1 Ultimate Lego Building Set	$29.99 + SH

Variety Store

Plastic drop cloth, safety goggles, thread, gallon Baggies,
Masking tape, Sharpie black pens, sand paper, balloons
3” flat head nails, 1 box dominos, 1 sack of marbles, hammer,
Cotton Twine/String, 3/8” weather stripping foam strips $10.00-$20.00

Additional Experiment & Project Materials & Costs: Extra Soft Tofu, Eggs, Condiment cups, Sand, Pipe foam, Cups with lids, Washers, Foil, Garbage bags, Coffee filters, Ramp and barrier building materials
Copying: graph paper, student journals, and student and education reinforcement handouts

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TRAUMA NURSES TALK TOUGH
ABOUT SAVING YOUR LIFE

Pre Quiz Today's Date:_____________Birth date:_______
Circle Gender: Male Female

1. When riding your bike you swerve sharply to the right to miss a squirrel and you crash into the curb. Which of the following best describes how your body moves?
   a. Your body flies backwards, because of your inertia.
   b. Your body flies forward head first over the handlebars, because of your inertia.
   c. Your body flies left, with your right leg just missing the handlebars, because of your inertia.
   d. Your body flies right, with you left let just missing the handlebars, because of your inertia.

2. On which surface is it easiest to stop while riding a bike?
   a. Dry gravel road
   b. Wet road
   c. Oil slick road
   d. Fresh powdered snow
   e. Dry pavement

3. Helmets work to protect your brain because:
   a. They are fashionably smart
   b. They stop impact
   c. They slow and reduce impact
   d. They push your brain the other way

4. Tony (35kg) and Maria (50kg) were racing their bikes down a hill and crashed into a hedge. Which shrubs are more severely damaged?
   a. The shrubs Tony hit
   b. The shrubs Maria hit
   c. The shrubs had equal damage
   d. No shrubs were damaged

5. Wearing a bike helmet is important while riding a bike because:
   a. Bike helmets help protect the brain from concussions and other brain injuries.
   b. Bike helmets help prevent damage or injury to the face.
   c. Unlike broken bones, brain injuries do not heal completely.
   d. All of the above

6. Bobby and Barry were racing down a path: they hit some gravel and crashed. Bobby lands on some soft grass and poor Barry onto the pathway. Why did Barry's helmet have to be replaced and not Bobby's?
   a. Because of the differences in their velocity.
   b. Because of the differences in their mass.
   c. Because of the differences in the surface they hit.
   d. All of the above

Quiz Key

1. C
2. E
3. C
4. B
5. D
6. D

Lesson 1: Busting Brains

Another day in the frontal lobe

Objective:
The purpose of a helmet is to absorb the shock of impact to the brain. Impact can be reduced by slowing the velocity of an object, changing the angle of the impact or by spreading the impact over a larger area.

Teacher Preparation:
1. Prepare and hang poster paper with graphs for data.
2. Cut tofu into 2cm x 2cm x 2cm sections for each group.
3. Copy pre tests

Pre Quiz:
Allow 5 minutes for students to complete the pre quiz. When students are done, collect the Pre quiz. Review to be sure the birth date and gender are completed.

Materials group:
½ Package ***extra soft*** tofu
3 Small condiment cups with lids
2 Meter sticks
Ruler
Paper Towels
Strips of soft foam
Tape or rubber bands
Procedure/data collection sheet
Journal for each student
Post it notes

Additional Student Activity: Expand the lesson to include Tofu Helmet project found on page 35.

1. Ask students to bring 'helmet' protection materials for designing a helmet (scotch tape, masking tape, bubble wrap, pipe foam, etc.)
2. Distribute materials. Allow students to design 'protection' for dropping the tofu for the 2nd & 3rd demonstration (1st demonstration without protection)
3. Review procedures with the students.
4. After each group has found their average or mean, have them mark the graphs with their labeled Post-its.
5. Distribute journals to students. Have them cut and paste their data into their journal. Give them some time
6. Use the following discussion prompts to promote reflection in their journals.

Post-lab discussion prompts:

· "Looking at the data graphs, what differences do you see between the plain tofu, the container tofu and the wrapped container tofu?" *Example: Cubes splatter, container tofu "shreds", but when wrapped in a sheet of paper towel most of the tofu remains intact.*

· "How is this model of a brain limited?" *Example: The tofu does not swell when bruised. Tofu does not bleed. Tofu does not have connective tissue or blood vessels to hold it together.*

· "So why does our brain not splatter when we take a moderate fall?" *Inside of the skull, a tough membrane called the Dura-matter protects the brain.*

· "Can the brain still have damage even if we can't see it from the outside?"

Materials for class:

Poster graph paper
Safety goggles
Chart pens
Meter stick
2 flat-headed nails, roofing nails work
Piece of wood
Hammer

Demonstration:

To show how increasing the area of an impact can reduce the severity of damage caused.

1. Have a student put on safety goggles.

2. Have the student hammer a nail into the piece of wood with three moderate hits.

3. After the nail has penetrated enough to stay in the wood, have the same student try to hammer the nail in with the head of the nail to the wood. They should observe that the nail does not enter the wood as easily or as far.

4. Ask the students why the nail head did not go in the wood as easily. If several students have proposed their ideas and they do not understand the importance of a larger area explain it to them.

5. Store the poster graphs for redisplay during Wrap Up Lesson 6

6. Copy page 11 for students

Tofu Drop

Carefully open the tofu package without damaging the block. Cut the block into 2 cm cubes. Drop the tofu square from 50 cm and measure across the diameter of the tofu in 3-places. Average the diameter and record. Repeat dropping the cubes from 80, 110, and 140 cm.

Data table: Tofu cube alone

Tofu drop distance	50 cm	80 cm	110 cm	140 cm
First measurement				
Second measurement				
Third measurement				
Average				

Repeat the drops with the cubes of tofu inside of the egg or condiment container. The tofu will not spatter because of the protection. Record the amount of damage that you see.

No damage: cube looks just as it did before dropping.
Some damage: the edges crumbled
Damaged: edges crumbled, pieces falling off
Major damage: cube is in pieces

Data table: Tofu in container

Tofu drop distance	50 cm	80 cm	110 cm	140 cm
First opinion				
Second opinion				
Third opinion				
Mode				

Data table: Tofu in helmet designed with the materials chosen by students

Tofu drop distance	50 cm	80 cm	110 cm	140 cm
First opinion				
Second opinion				
Third opinion				
Mode				

Add Post-Its to the class graphs to show your data & opinion.

Overhead Starter: Nature's Shock Absorber

Lesson 2: Introduction to Inertia

Objective: Following this lesson help students understand the concept of inertia. (*All objects are lazy and want to keep doing what they are already doing.*)

Materials:

Groups:
Eggs (1 for each group)
Masking tape 50cm
Thread
String 1m
Paper
Gallon size Baggie

Teacher:
Ladder 10 feet
Tarp for dropping on
Beaker or vase
1 kg mass
Twine or String
Ring stand

Teacher's Introduction: Define inertia as—"Inertia is a word that scientists use to describe laziness. Objects will keep moving if they are moving and will stay still if not moving. Objects are lazy, it takes a force to slow objects down or speed them up orcreate a change in direction."

Demonstrations:

Lazy Vase Demonstration:
1. Place beaker or vases on top of paper then quickly remove the paper.
2. Ask students what they see and why it happened. *The vase will not move it is lazy. It wants to stay at rest.*

Magic thread demonstration:
1. Tie a string to the end of the mass and hang it from a ring stand.
2. Cut a piece of thread about 40 cm long and tie it around the bottom of the mass.
3. Pull the thread gently and observe what happens. (*The mass swings)*
4. Stop the mass from moving and hold the thread so there is a lot of slack between your fingers and the mass. Give the thread a quick, hard pull. (*The string breaks)*
5. How and why are the two examples different? Why did this happen? (*The mass was lazy- it wanted to stay at rest. The force on the string spread out in the first demonstration allows the impact to be more gradual)*

Activity:

1. Question: Ask students, "How does someone playing baseball run the bases after hitting a ball?" Have someone demonstrate. (Their path will curve so they will not be taking the bases at 90-degree angles.) "Why did you round the bases? Isn't the quickest path a straight line?" (The force needed to change direction was great. Their body is lazy. It wants to keep going in a straight line.)

2. Student task: “Your job today is to reduce the motion of the egg gradually so that it doesn’t break.” Encourage students to think about what to use to protect the egg and have students bring the ‘cushioning’ materials to class before the day of the lesson. There should be a number of materials from which to choose for egg protection. Suggested cushioning material: Bubble Wrap, Masking Tape, Cloth, Foam Rubber, etc.

3. On the day of the lesson, hand out materials and have students protect-prepare the eggs

4. Drop the protected eggs with all participants observing from a height of 1 meter.
Survivor eggs drop from 2 meters and then from 3 meters.

5. Clean up (5 min)

6. Journal wrap-up discussion and questions:
· Will a fall from a height of .5-1 meter to concrete destroy most brains?
· What conclusions can you draw from this fact?
· How high do most bicycle riders sit? (*1.5 meters off the ground)*

Lesson 3- Stop in the Name of Friction!—Lesson 1 of 2

Grade Level: 6-8
Subject(s): Physics, Mathematics
Prep Time: 10-30 minutes
Activity Duration: Two class periods
Materials Category: Common household

Objective: To observe that friction is more dependent on mass than surface area, and different surfaces have different coefficients of friction.

Materials:

For teacher demonstration:

- Toy Parachutist
- Sound tube
- Stack of coins
- Stack of books
- Rolling cart or any item on rollers

For each team activity:

- Masking tape
- Old Science display boards
- Lego Car Building
- Ramp building materials
- Scissors
- Meter Stick
- One stopwatch
- Set of slotted weights, large washers, quarters, or any item that can add weight
- Sandpaper
- Strip of carpet remnant

First day—students build Lego cars; ramp and parachute; start collecting data

NOTE: Have students design the car with a way to incorporate a weight without popping out when moving.

Slippery When Wet!
Teacher copy and handout sheets

Pre-lesson Instructions—*Lesson 2 of 2*

Second day—students experiment with their cars, modify cars, and race them. □□Be sure all materials are either centrally located or already distributed to the teams.

Background
Friction is a force that acts in a direction opposite to the motion of a moving object. Friction will cause a moving object to slow down and finally stop. Every surface has little bumps and hollows on it. When rubbing two surfaces together, the bumps and hollows catch and stick creating resistence of movement on the surfaces over each other. Thus, the amount of friction between two surfaces depends on how hard the surfaces when forced together and on the materials of which the surfaces created. A heavy desk will force the surfaces together more than a light desk will. Likewise, floors covered with a rough material such as carpeting, will make the desk harder to push.

There are three types of friction. **1**. Sliding friction is when solid objects slide over each other and more force is needed to start an object sliding than to keep it sliding. **2.** Rolling friction produced by objects such as wheels or ball bearings has less sliding friction. Sliding friction and rolling friction describe friction between two solid surfaces. **3.** However, there is friction that exists when objects move across or through a fluid. The force exerted by a fluid is 'fluid friction'. All liquids and gases are fluids. Water, oil, and air are examples of fluids.

Friction is useful. In fact, without friction you would not be able to walk, cars would not be able to stop; could not write, unscrew bottle tops, etc. NASA's research on friction and their application to hazardous runways have benefited mankind. Lives saved in many hazardous locations by reducing hydroplaning, considered the primary cause of uncontrolled skidding during wet weather conditions.

Guidelines:

Day one

1. Read the Maglev trains article and discuss what friction is and why it is important to automobile and bicycle safety using information above and any other sources available.

2. Throw a toy parachutist in the air. Ask students how this relates to friction. Spin a sound tube, and ask the same question. (Both items are examples of

fluid friction.) Next, push a stack of books across the floor, a stack of coins across a desk, and ask how they relate to friction. (Both are examples of sliding friction) Finally, use an item that rolls, and ask the same question. Explain that this is an example of rolling friction, which is what they will be testing in this experiment.

3. Talk about the experiment with students, have them make predictions on which surface will be fastest, and whether added mass will increase or decrease the speed of the car.

4. Distribute the materials and worksheets to each team. Have students design parachutes **(Copy pages 17-21 and 37-41)**

5. Remind students to follow directions.

6. Students should start collecting data on day one.

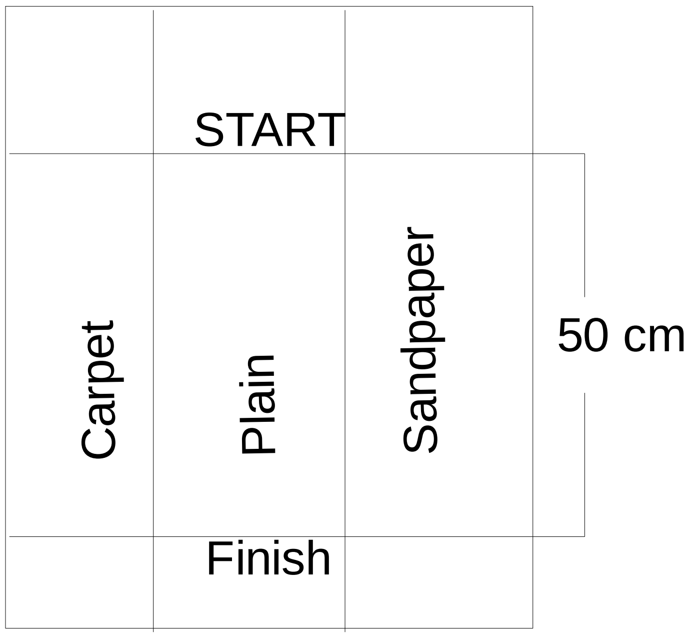
Day Two:

1. Have students finish collecting data with and without added mass.
2. Encourage group discussion of the results; do the results match their predictions?
3. If one or two groups are way ahead of other groups, have them make predictions of how even more mass would change the results and have them test their predictions
4. Have a short class discussion on friction. Have each group share results from their experiment. How does this experiment relate to helmet safety? Why are helmets smooth? How does your mass affect your crash result? When riding your bike, what surfaces are going to be easier to stop on? (gravel vs. asphalt, grass vs. concrete) Note: Mass increases friction, but it also increases inertia, to be covered in the next lesson. A kid with greater mass will have more friction (stopping power) but will also have more inertia to overcome.
5. Allow groups to work on cars, trying to reduce friction. Encourage groups to think about what they have learned about reducing friction; Consider making some sort of lubricant available. Then have groups add a cushioning source. (Balloons, Bubble Wrap, Foil, Parachutes, etc.) See if there is any ‘crash’ improvement.
6. I you have time, have students’ racecars, and have a prize for the winning group.

Friction! Friend and Foe

Building the ramp:

1. You need to create a ramp with three different surfaces that has a starting line and a finish line. Build your ramp based on the drawing below. Leave display board folded. Carpet and sandpaper should run clear from the top to the bottom of the display board.



2. Setting the angle of the ramp: place car on the start line and lift the start end of the display board until the car runs down. Repeat with each of the three surfaces. Place books, or whatever works, under the ramp at an angle greater than the angle that works for every surface.

3. Collect data with car – fill out worksheet. Add mass to car – repeat experiment.

4. Compare results. How does the surface affect the speed of the car? How does the mass affect the speed of the car? What does this tell you about friction?

Car without added mass

Plain

Trial	Distance	Time	Speed (Speed = Distance/ Time)
1			
2			
3			

Average (Mean) Speed = _________

Carpet

Trial	Distance	Time	Speed (Speed = Distance/ Time)
1			
2			
3			

Average (Mean) Speed = _________

Sandpaper

Trial	Distance	Time	Speed (Speed = Distance/ Time)
1			
2			
3			

Average (Mean) Speed = _________

Car with added mass

Plain

Trial	Distance	Time	Speed (Speed = Distance/ Time)
1			
2			
3			

Average (Mean) Speed = _________

Carpet

Trial	Distance	Time	Speed (Speed = Distance/ Time)
1			
2			
3			

Average (Mean) Speed = _________

Sandpaper

Trial	Distance	Time	Speed (Speed = Distance/ Time)
1			
2			
3			

Average (Mean) Speed = _________

Provide teams of four-five students the following minimal instructions for building Lego cars.

1. Build a car that will roll smoothly
2. Design a car to hold additonal ‘weight’ in place when it rolls down a ramp
3. Design a car with crash protection consideration

Close up photo of example cars

It is possible to build a minimum of 11 cars from the parts provided.

Lesson 4: Mass and Inertia Inquiry

Table Topper:
Fitch Barriers

Objective:
By the end of this lesson, students will understand that more mass will mean having more inertia. An object that is moving will want to keep moving more because it is lazy. It will also apply more force than a lighter object.

Materials:
Lego Cars
Meter sticks
Graph paper
Dominos or blocks
Marbles
Hardboiled egg-labeled "A"
Raw egg-labeled "B"
Inquiry prompt overhead
"In the Eyes of a Physicist" overheads
Foam Strips & Balloons

Demonstration:
1. Spin a hardboiled egg (A) and stop it.

2. Spin a raw egg (B) and stop it. Students will observe that the raw egg will start spinning again.

3. Why? (*The yolk in the egg will continue to move because of its inertia. It is lazy*)

Teacher's Introduction:

1. Review with students what they know about inertia so far.

2. Using the overhead, have students think about, "If we have more mass do we have more inertia?"

3. "How can we test this statement?"

Activity:
1. In teams of 4-5 students, use Lego cars to set up an experiment to prove or disprove the inertia premis.

2. Things to consider—

a. “How will your variables be controlled?”
b. “What materials do you need to use?”
c. “How will you measure your data?”

3. Give students ample time to explore and set up these questions.

4. Approve their design before allowing them to pick up materials.

Follow up:

1. Ask the teams, “So does more mass mean we have more inertia? How did you design your experiment to test it? Using your data support your conclusion.”

2. “Newton’s 2nd Law states that force is equal to mass and acceleration. What will happen when the mass is increased and the acceleration remains the same? For example you are riding a bike then your buddy wants a ride how does this extra person’s mass affect your force on the pedals?” *(The force increases)*

3.“How will wearing a backpack affect your stopping distance when riding your bike?” (More mass *increases the stopping distance.)*

4. Show students the “In the eyes of a physicist” overhead series. Have them respond in their journals.

5. Have students build Fitch Barriers and Crumple Zone Contruction Projects (pg 42-44) to further test Mass and Inertia inquiry

Lesson 5: "Trauma Nurses Talk Tough" Presentation

Now it is time for real-life stories to help illustrate all the lessons the students have developed.

NOTE: ***Be sure to schedule the TNTT nurse at least 1-2 months BEFORE the date you need her/him***

Teacher Preparation

1. Call 503-413-2826 to find a TNTT Nurse Network presenter in your local area
2. Call the local nurse to schedule a "Trauma Nurses Talk Tough" classroom presentation

*********If you are unable to schedule a TNTT Nurse's presentation in your location, please call our offices 503-413-2826 to discuss options.*********

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Lesson 6: No-Brainer Puzzle Activity

Objective:
Students learn the main brain impact points in a crash and the functional implications.
Using data from previous experiments, each team of students will present data, relating
results to bike helmet safety.

Materials:
Brain puzzle sheets
Overhead of puzzle answer key
Copies of “NASA Goes to the Super Bowl”, if desired
Overhead of helmet photo
Overhead of “Brain Bruising”
Poster graphs from prior lessons
Table Toppers

Teacher Preparation:
Copy the brain puzzle pieces & “NASA Goes to the Super Bowl”
Retrieve posters from prior sessions

Student Activity:

1. Students piece together the brain puzzle from NASA.

2. Show students the overhead of the answer key.

3. Discuss the “Brain Bruising” overhead. “From the physics you have learned, why are there two areas that are damaged when there is an impact to the brain?”

4. Read to the class the first 8 paragraphs of NASA Goes to the Super bowl. You may wish to have student copies so they may read with you. Show the overheads of the helmet.

5. Discuss the features of the helmet that protect the brain from injury. They should include- straps, hard shell padding.

6. Divide the groups into teams to present the data from the prior experiments.

7. Hand out reserved graphs to groups.

8. Tell the groups, “You have 20 minutes to plan a presentation to the class showing how the data from the experiment you have been assigned relates to bike helmet safety. Remember to use the science terms we have discussed in the past sessions.”

9. Students present their data.

10. Copy Bike Helmet education reinforcement materials along with the parent signature forms. Ask students to share the education materials with his/her parent and request parent signs the signature form for student to return to his/her teacher.

11. Consider giving extra credit to students who return signed forms

Post Quiz:

Copy post quiz. Allow 5 minutes for students to complete the post quiz. When students are done, collect the Post quiz. Verify the birth date and gender information is completed. You may want compare the answers to the pre quiz to determine progress of learning.

Post Quiz **Today's Date:_______________**
Circle Gender: Male or Female Birth date:_____________

1. When riding your bike you swerve sharply to the right to miss a squirrel and you crash into the curb. Which of the following best describes how your body moves?
a. Your body flies backwards, because of your inertia.
b. Your body flies forward head first over the handlebars, because of your inertia.
c. Your body flies left, with your right leg just missing the handlebars, because of your inertia.
d. Your body flies right, with your left leg just missing the handlebars, because of your inertia.

2. On which surface is it easiest to stop while riding a bike?
a. Dry gravel road
b. Wet road
c. Oil slick road
d. Fresh powdered snow
e. Dry pavement

3. Helmets work to protect your brain because
a. They are fashionably smart
b. They stop impact
c. They slow and reduce impact
d. They push your brain the other way

4. Tony (35kg) and Maria (50kg) were racing their bikes down a hill and crashed into a hedge. Which shrubs were more severely damaged?
a. The shrubs Tony hit
b. The shrubs Maria hit
c. The shrubs had equal damage
d. No shrubs were damaged

5. Wearing a bike helmet is important while riding a bike because
a. Bike helmets help protect the brain from concussions and other brain injuries.
b. Bike helmets help prevent damage or injury to the face.
c. Unlike broken bones, brain injuries do not heal completely.
d. All of the above.

6. Bobby and Barry were racing down a path; they hit some gravel and crashed. Bobby lands on some soft grass and poor Barry onto the pathway. Why did Barry's helmet have to be replaced and not Bobby's?
a. Because of the differences in their velocity.
b. Because of the differences in their mass.
c. Because of the differences in the surfaces they hit.
d. All of the above could be causes.

Quiz Key

1. C
2. E
3. C
4. B
5. D
6. D

Student/Parent Activity

To reinforce the education your student has been learning through the Bike Wheels to Steering Wheels curriculum, please have your student tell you the answers to the following questions:

7. **When riding a bicycle, scooter, skateboard, snowboard, ATV or on skis, it is safest to wear a helmet to ________ ____**

8. **Because the internal organs of youth are not developed enough to sustain the blow of an airbag deploying at up to 200MPH, regardless of size, it is safest for youth under the age of 15 to sit in______________________________**

3. **An easy way to explain one of Newton's Laws of Motion is "the faster you go, the__________________________ ______hit."**

4. **As a pedestrian, before crossing the street at a corner or inner section, after looking both ways twice, be sure to do what with the driver?____________________________**

5. **Circle the circumstances that will affect the stopping distance of a motor vehicle:**

Friction Barriers Weather Oil

Time of Day Condition of the Driver Inertia

Road Condition Gravel Mass

Uncontrollable External Circumstances

Visibility Distraction

TRAUMA NURSES TALK TOUGH
ABOUT SAVING YOUR LIFE

Parent Signature Form

My son/daughter ___________________________brought home the Bike Helmet and Safety information materials on:_____________ .

My student and I took part in the Student/Parent Activity. Yes No

My student and I spent some time talking about the information in the Bike Helmet and Safety materials.

Yes No

I plan to read the Bike Helmet and other Safety information. Yes No

Please sign and return this form to your student's teacher.

Signed:____

Address:____

City:__________________________________Zip Code:__________

Project Evaluation and Enhancement

Observations:

- Pre curriculum, observe helmet use among youth who will participate in the project
- Post curriculum, observe helmet use among youth who have participated in the project

Reinforcement Education

- Pre/Post curriculum student quiz
- Bike Safety handouts sent home to parents
- Parent Signature form returned to teacher indicating whether the parent read the bike safety handout information
- Student Preliminary Survey conducted in-class after the curriculum is completed
- Families provided the Bike Wheels to Steering Wheels: A Parent's Guide to Strengthen Traffic Safety in Families booklet (a copy is included with the curriculum)
- Family Follow-up Survey conducted 2-3 months after curriculum is completed
- Partner with a local bicycling organization to organize a supervised student bike ride

NOTE: To help increase survey return, consider offering incentives to both students and parents

FYI: Surveys formatted to collect mailing information to facilitate incentives. If you do not plan to use incentives, simply design a survey without information collection

Survey Participation Incentives:

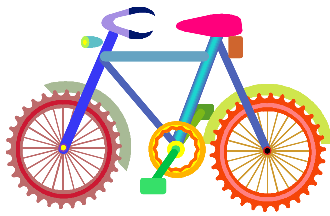
- Bike lights
- Bike helmet raffle drawing
- Coupon redeemable for a bike helmet free or at a reduced cost to be claimed at a local hospital-sponsored bike helmet fitting fair or other sponsored partner event (Design the coupon indicating date, event, limit & where it is redeemable)

Funding & Partners:

Consider applying project funds or in-kind support and partnership through:

- State Department of Transportation grant support
- City Department of Transportation grant support
- Hospital or Fire Department Health Fair
- Rotary Chapter or other philanthropic organization support

Bike Wheels to Steering Wheels Project
Preliminary Student Survey



It is just a short while before YOU continue driving a bike
and BEGIN driving a car!

What have you learned?

√Answer the questions below **√Fill out the contact information** **√Return this form to your teacher**

1. Did the safety curriculum you just completed in your class help you understand *HOW* Newton's Laws of Motion connect to traffic safety?
   ˚ Yes ˚ No
2. Do you ever ride on a bike, scooter, skateboard, snowboard, skis or ATV? ˚ Yes ˚ No
3. Do you have a helmet to wear when riding on a bike, scooter, skateboard, snowboard, skis or ATV? ˚ Yes ˚ No
4. If you answered 'yes' to question #3, do you ***properly*** wear your helmet ***each time*** you ride on: (circle all that apply)

Bike Scooter Skateboard Snowboard Skis ATV

5. Do you understand it is safer for you to sit in the backseat of a car properly safety belted until reaching age 15 because some internal organs in your body are not yet fully developed and because the back seat is the safest place to sit in a car? ˚ Yes ˚ No

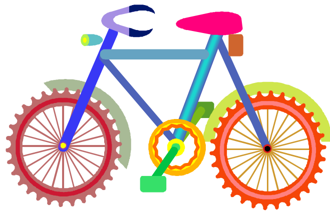
Thank YOU for your participation!!!

Please return the survey to your teacher.

Your Name:
Address:

Bike Wheels to Steering Wheels Project

Family Follow-up Survey

Before you know it, your student will be driving a Car!

Are you prepared?

√Answer the questions below √Fill out the contact information √Return this form to your teacher

1. Did your student share what he/she learned in class about *HOW* Newton's Laws of Motion connect to traffic safety? ˚ Yes ˚ No
2. Have you read the Bike Wheels to Steering Wheels Parent Guide booklet included with this survey? ˚ Yes ˚ No
3. Will you and your student sign the Traffic Safety Agreements found in the booklet? ˚ Yes ˚ No
4. Is it your family policy to require your children to wear a helmet when riding: (Circle all that apply)

   Bike Scooter Skateboard Snowboard Skis ATV
5. Do you require your children to sit in the backseat of a car properly safety belted until reaching age 15 because some internal organs are at risk from damage by airbags when deploying and because the back seat is the safest place to sit in a car? ˚ Yes ˚ No

Thank YOU for your participation!!!

Please return this survey to your son/daughter's teacher.

Parent's Name:
Address:

Bike Wheels to Steering Wheels
Beaverton School District
Engineering Design Components

Additional engineering design components for the Bike Wheels to Steering Wheels Kit for 7th grade:

1. Lesson 1: Tofu Brain: Engineering Design Component: Tofu Brain Helmet
2. Lesson 3: Friction: Engineering Design Component: Parachute Design
3. Lesson 4: Mass_Inertia: Engineering Design Component: Crumple Zone Barriers

Additional Kit Materials/Cost (per kit):

Lesson 1: Tofu Brain Helmet: Pipe insulation foam--approx. cost: $5.00
All other supplies teacher provided
Lesson 3: Parachute Design: Washers, coffee filters, foil, string, garbage bags—approx. cost $8.00
All other supplies teacher provided
Lesson 4: Crumple Zone Barriers: sand, cups with lids—approx. cost:

Revised Lesson Plan or Activity Sheets:

Lesson 1: Tofu Brain: Engineering Design Component: Tofu Brain Helmet

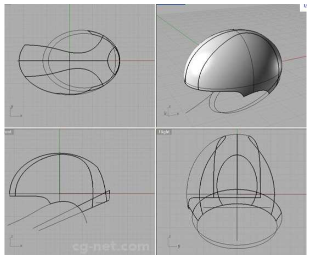
- All the same except for the additional challenge sheet and student worksheet.

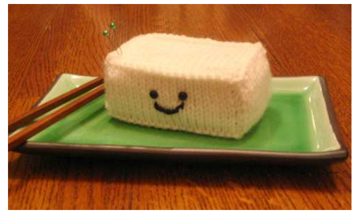
Lesson 3: Friction: Engineering Design Component: Parachute Design

- Add in TryEngineering Parachute Challenge; plus powerpoint resources and student worksheet.

Lesson 4: Mass_Inertia: Engineering Design Component: Crumple Zone Barriers

- Add in Crumple Zone Activity Sheet Challenge





Lesson 1

Tofu Brain Engineering Design Work Sample Assignment:

Your helmet company has been working to improve bike, skateboard, and scooter safety amongst teenagers. It has been determined that tofu resembles many of the characteristics of the human brain when a force is applied.

We Challenge You To…

*…**Design and build a helmet that will protect a "tofu brain" (tofu in package) when released from a 10' foot height.***

Choose from the following materials:

____

Use the attached student worksheet to record your thinking as you go through the engineering design process to answer:

1. The problem.
   - A. What science ideas do you know that relate to this topic?
   - B. What is the problem you are trying to solve?
   - C. Why are you trying to solve this problem?
2. The solution.
   - A. What did you brainstorm about before picking a solution?
   - B. What parts of the helmet did you consider when comparing possible designs?
   - C. What design did you pick to test?
   - D. Why did you choose that design?
3. Testing and collecting data
   - A. How did you test your helmet design? What steps did you take?
   - B. Record and label the data you collected in a graph, chart, table, etc. (See back for ideas)
4. Analyzing and interpreting results

   In this section of your paper, make sure you tell:
   - A. How well did your helmet work?
   - B. What parts of your solution worked well? What parts did NOT work well?
   - C. How would you change your design next time?

Table:

Graph:

Name_____________________________________Class__________Date______

Lesson 3

Parachute Reading – Key Terms

Visual	Word	Meaning
QuickTime™ and a decompressor are needed to see this picture.	Parachute	
	Canopy	
	Lines	
QuickTime™ and a decompressor are needed to see this picture.	Air resistance or drag	
	Gravity	

Name ______________________ Class __________ Date ________

Playing with Parachutes

Student Worksheet: Design a parachute

You are a team of engineers who have been given the challenge to design a parachute out of everyday items. Your challenge is to design a parachute that can carry one metal washer to the ground from a height of 2M and hit a 10 cm target with the slowest possible rate of descent. The parachute that can hit the target with the slowest descent rate is the winner.

◆ Planning Stage

Meet as a team and discuss the problem you need to solve. Then develop and agree on a design for your parachute. You'll need to determine what materials you want to use.

Draw your design in the box below, and be sure to indicate the description and number of parts you plan to use. Present your design to the class.

You may choose to revise your teams' plan after you receive feedback from class.

Design:

Materials Needed:

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Playing with Parachutes

Student Worksheet (continued):

◆ Construction Phase
Build your parachute. During construction you may decide you need additional materials or that your design needs to change. This is ok – just make a new sketch and revise your materials list.

◆ Testing Phase
Each team will test their parachute. You'll need to time your test to make sure your can support the washer and achieve the slowest rate of descent.

Parachute Testing Data

	Drop Height (m)	Drop Time (s)	Velocity (m/s)	Distance Landed from Target
Test 1				
Test 2				
Test 3				
Test 4				
Average				

◆ Evaluation Phase

Evaluate your team's results and present your finding to the class

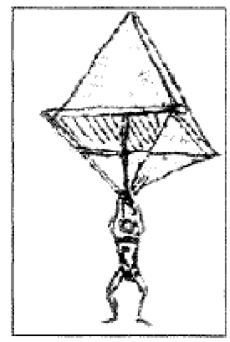
Please answer these questions on another piece of paper and attach to the lab worksheet.

1. Did you succeed in creating a parachute that could hit the target? Explain why or why not.
2. What was your slowest rate of descent? Explain
3. Did you decide to revise your original design? Why or why not?
4. If you could have had access to materials that were different than those provided, what would your team have requested? Why?
5. Do you think that engineers have to adapt their original plans during the construction of systems or products. Why might they do that?
6. If you had it to do all over again, how would your planned design change? Why?
7. What methods or designs did you see other teams try that you thought worked well?
8. Do you think you would have been able to complete this project easier if you were working alone? Explain….
9. What kind of changes do you think you would need to make to your design if you needed to transport a heavier payload? Try it!

Name______________________________ Class__________ Date________

Parachute Reading

◈ History of Parachutes

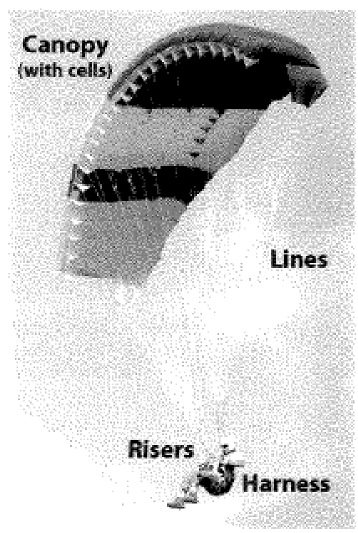


DaVinci's Sketch
Source: http://news.bbc.co.uk/1/hi/sci/tech/808246.stm

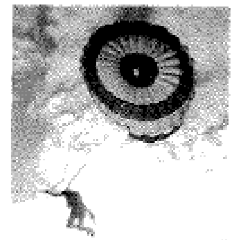
Parachutes are devices used to slow the movement of objects. Parachutes are typically used to slow the movement of falling objects but they can also be used to slow down horizontally moving objects such as racecars. The word parachute is believed to be of French origin combing the words para, (a French word with Greek roots) chute meaning to shield against falling. The modern parachute has evolved over several centuries. It is believed that Chinese acrobats used parachutes in their acts as early as the 1300's. Leonardo DaVinci sketched designs for a pyramid shaped parachute in the mid 15th century. The first time a parachute was actually attempted by a human was in the mid 16th century by Faust Vrancic, a Croatian Inventor. He called his invention Homo Volans or the Flying man. He actually tested out his parachute in 1617 by jumping off a tower in Venice. Andrew Garnerin was the first person on record to use a parachute that did not possess a rigid frame. He used his parachute to jump out of hot air balloons from a height of 8000 feet! He was also the first person to include a vent in the canopy to reduce instability. The parachutes we are more familiar with today didn't begin to take shape until the 18th century.

◈ Parts of a parachute

The upper portion of the parachute is known as the canopy. Historically, canopies were made of silk but now they are usually made out of nylon fabric. Sometimes the canopy has a hole or vent in the center to release pressure. When a parachute is housed in a container such as a backpack, it may consist of main canopy and another smaller canopy known as a pilot chute. The pilot chute comes out of the container first and serves to pull open the main canopy. A set of lines connects the canopy to the backpack. The lines are gathered through metal or canvas links attached to thick straps known as risers. The risers are then connected to a harness if the parachute is going to be used by a person.



◆ **Types of Parachutes**
There are many different types of parachutes. Here are some of the more common parachute designs.


Round parachute

Round parachute
The parachute most people are familiar with is the round parachute. The round parachute is characterized by a circular canopy.

Square parachute
The square or cruciform parachute possesses a squarish shaped canopy. Square parachutes are beneficial because they reduce jostling of the user and have a slower rate of descent; reducing injuries.

Ram-air parachute
Most of the parachutes which are intended for use by people that we see today are ram-air parachutes. The design of ram type parachutes gives the person using it a great deal more control. The canopy in a ram type parachute is made up of 2 layers of material which are sewn together to form air filled cells.


Ram-air parachute

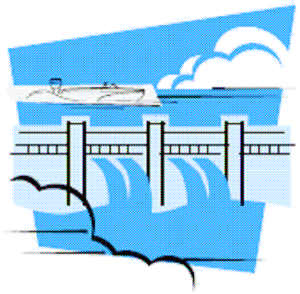
Ribbon and ring parachute
Ribbon and ring parachutes are intended to be used at supersonic speeds. The canopy has a hole in the center which is designed to release pressure. Sometimes the ring is cut into ribbons so more pressure can be released and so the canopy doesn't explode. These types of parachutes are used when a great deal of strength is required.

◆ **Law of Falling Bodies**
Galileo Galilei (1564-1642) was an Italian astronomer and physicist. Galileo conducted much research on motion and developed what is known as the Law of Falling Bodies. This law states that all objects regardless of their mass fall at the same speed, and that their speed increases uniformly as they fall. Galileo's calculations however, did not take into consideration air resistance. Drag, or the force that opposes the motion of an object plays a significant role in the motion of a falling parachute.

1. How have parachutes changed throughout history?

2. What are the pros and cons of different parachute designs?

3. Why is air resistance important in parachutes



Constructing Crumple Zones

Larry Roberts, Tech Directions

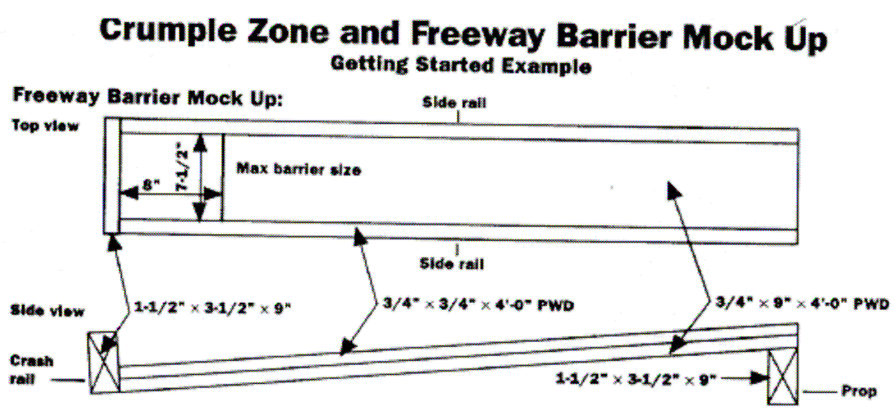
Objective:

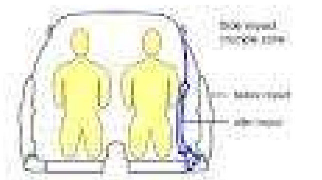
Use the materials provided to build a crumple zone (freeway barrier) that you will test on a freeway mock-up.

Tools and Materials:

Ramp

road	-	1 board ¾" x 9" x 4'
side rail	-	2 boards ¾" x ¾" X 4'
crash rail	-	1 board 1-1/2" X 3-1/2" X 9"
prop	-	1 board 1-1/2" x 3-1/2" x 9"





Background Information:

A crumple zone is a predetermined crease or wrinkle in the surface of a collapsing material. As the material is crushed, it breaks along desired lines or regions. Scoring lines one inch apart on a piece of paper, alternating front and back down its length, the pushing in on each side, will automatically corrugate the paper. Other examples of crumple zones are found in collapsible straws and pitchers.

The automobile industry also uses crumple zones. The zones are designed into the subframe and unibody of cars. As a vehicle hits a solid object, the automobile shell crushes in a predetermined pattern to reduce the injury of the vehicle occupants. In a head-on collision, the front fenders and engine will crumple downward, underneath the vehicle's cockpit. This eliminates the engine from coming through the firewall and pinning or crushing the driver to the seat.

Freeway barriers have crumple zones designed into them. Most apparent on off-ramps, they look like wrinkled yellow plastic barrels filled with water. These barriers slow down crashing vehicles, absorbing their energy, because an object at rest needs energy to be moved or crushed. The freeway barriers stop cars in a predetermined area.

An automobile moving down the road has stored potential energy. If the engine is turned off and the brakes are not applied, the vehicle will continue to move forward because of the stored energy in its forward momentum, like a thrown baseball. If this automobile hits an object, as when a person jumps on a trampoline. Excess energy returns to the car, crushing it (or, in the case of the trampoline, returns to the person jumping, throwing him back into the air). Because automobiles are solid objects and don't have elasticity, the shell must absorb this excess energy to prevent injuries to the occupants. The alternative is for the object being hit to absorb more energy.

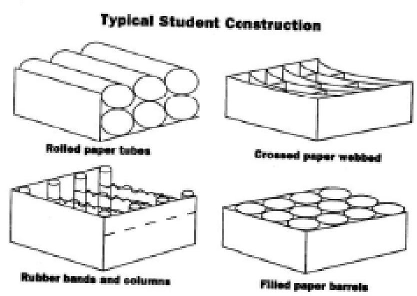
Procedure:

1. Design a freeway barrier that will absorb all the energy sent and prevent the block from sliding forward beyond the set limits.

2. The barrier must fit inside the designated area and cannot be attached to the mock-up.

3. The crumple zone must have structure. Crumpling up paper will not absorb enough energy.

4. Test your barrier on the freeway mock-up. Payload block movement in vehicle shall not exceed ¼" after impact with barrier.



Crumble Zone Questions

1. What is a crumple zone?
2. List two examples of crumple zones.
3. Where are crumple zones used?
4. How do crumple zones absorb energy?
5. What is a potential energy?
6. Why is the excess energy returned to a vehicle when it hits a solid object?
7. How does a bouncing ball differ from a vehicle hitting a solid object?
8. List three other objects that use crumple zones.
9. Could an aluminum soda can be scored to collapse in a predetermined shape?
10. Draw a side view of a soda can and indicate using lines and arrows how crumple zones could flatten the can the same way every time.