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STRIDE | Southeastern Transportation Research, Innovation, Development and Education Center

Final Report

K-12 Workforce Development in Transportation Engineering at FIU (2012- Task Order # 005)

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ABSTRACT

The goals of this project were to (1) improve interest and comfort level of K-12 students and families with STEM subjects as applied to Transportation Engineering; and (2) develop a STEM education and training dissemination program focusing on transportation engineering. The faculty and students at Florida International University (FIU) conducted activities geared for the K-12 pipeline and families to systematically enhance the quality and excellence in STEM education, specifically addressing transportation related topics and how scientific and engineering principles are used in transportation field. A series of hands on activities were developed to promote STEM education and training program in Transportation Engineering. The activities were used in during outreach activities with elementary, middle and high school students.

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CHAPTER 1: INTRODUCTION

As South Florida's first urban public research university, FIU is the university of access for the region's four million residents. Ranked first in the nation in awarding baccalaureate and master's degrees to Hispanic students and third in granting bachelor's degrees to minorities, FIU has distinguished itself as one of the nation's largest, most diverse institutions of higher education. Its student body of 38,000 reflects the vibrant diversity of South Florida: 59% Hispanic, 13% Black, and 56% female. By taking advantage of FIU's composition and location, we will particularly focus on the education and recruitment of Hispanic and African American students. FIU is located in the great Miami area which serves as a large point of immigration. With a sprawling urban system of more than 380,000 students and over 333 schools, the student population in the Miami-Dade County Public Schools (M-DCPS) is composed of a large proportion of minority. Specifically, 87% of M-DCPS student population is minority (56% Hispanic and 31% African American).

The faculty members in collaboration with FIU ITE Student Chapter worked with the area schools to promote transportation engineering, transportation technology, and role of transportation engineering for establishing livable communities.

PROJECT OBJECTIVES

The project had the following goals:

Goal 1:   Improve interest and comfort level of K-12 students and families with STEM subjects

as applied to Transportation Engineering.

Goal 2:   Develop a STEM education and training dissemination program in Transportation

Engineering.

The results of this research can be used for developing educational programs for

increasing interest of students in transportation field. The project activities are specifically

design to engage student learning through hands on activities which incorporate application of

scientific and engineering concepts.

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CHAPTER 2: PROJECT ACTIVITIES

The activities focused on use and importance of GIS, traffic safety education, traffic simulations, and educational hands on activities with direct use of science, technology, mathematics and engineering concepts. The activities targeted students specifically in elementary, middle and high schools in Dade County as well as parents. The program focused on the following:

1. Emphasis on science, technology, engineering, and mathematics skills for a diverse student population with examples from transportation engineering,

2. Outreach and educational materials,

3. Curriculum development and support,

4. Integration of technology into learning with hands-on activities,

5. Dissemination of effective science and engineering education practices focusing on transportation related subjects (e.g., safety, planning, transport of people and cargo).

In collaboration with FIU ITE Student Chapter, the elementary and middle school students were introduced to different video games which provided direct exposure to engineering aspects of traffic safety, scheduling, planning as well as demand management. In addition, the educational materials and hands on activities are being distributed and transportation engineering modules have been used by FIU's existing outreach programs operating at five elementary schools serving grades 1st - 4th as afterschool programs. These programs are conducted through FIU's Center for Access and Success that is housed in the College of Engineering and Computing.

1. Outreach Effects during School Year and Summer Programs

The activities were conducted during the school year and summer months at FIU. Activities were coordinated with FIU's Women in Transportation Student Chapter and Institute of Transportation Engineers (ITE) Student Chapter. The program was conducted using modules and activities emphasizing transportation engineering and transportation safety.

2. Transportation Career Day

This activity was coordinated by the ITE Student Chapter. Over 1,400 students from Miami-Dade County elementary, middle and high schools attended the annual FIU Engineering Expo. The students participated in "engineering immersion" activities to learn about different engineering fields in a fun and interactive way. The FIU ITE student chapter helped organize the event and served as tour guides

This activity was coordinated with the Annual Engineering Gala which took place during Engineers week at FIU. In addition, ITE students conducted interactive demonstrations and hands on activities with elementary and middle school students.

4. Activity development

Faculty in collaboration with FIU students developed a series of hands on activities addressing different aspects of transportation and use of engineering and science concepts. A summary of the hands on activities that have been developed and adapted are provided below:

CHAPTER 3: HANDS ON ACTIVITIES

Activity 1: Around the World

Developed by: Milton Reinoso and Berrin Tansel

Global economies depend highly on transportation of goods. Information about the distances between ports and their locations are needed before a cargo vessel leaves a shipment location. Technology plays an important tools in the transportation field. Earlier travelers used human ingenuity for estimating distances and navigation.

This activity focuses on use mathematics and observations of surroundings. It also emphasizes the importance of modern tools which use satellites, Global Position Systems (GPS), and digital maps using "Google Earth."
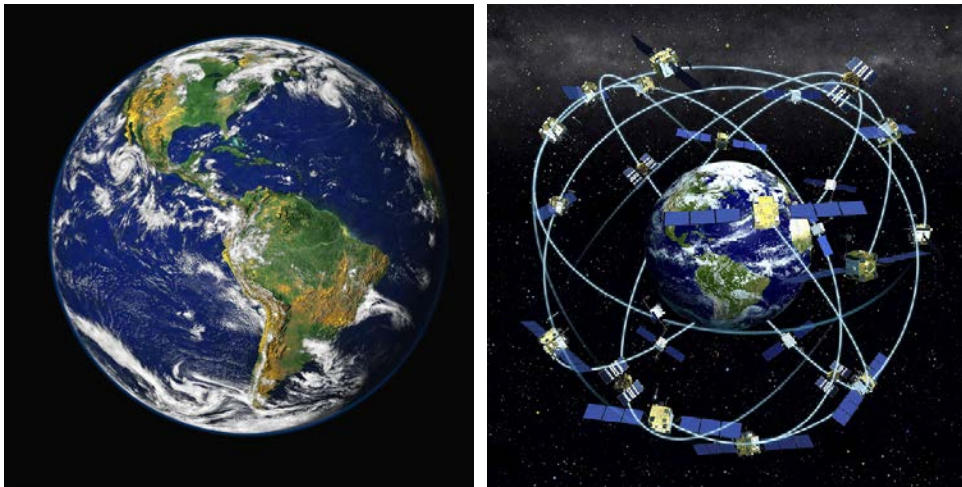
The GPS concept is based on time and the known position of specialized satellites. Navigation in three dimensions is the primary function of GPS. Navigation receivers are made for aircraft, ships, ground vehicles, and for hand carrying by individuals. GPS receivers are used

for navigation, positioning, time dissemination, and other research. The satellites carry very stable atomic clocks that are synchronized to each other and to ground clocks. GPS satellites continuously transmit their current time and position. A GPS receiver monitors multiple satellites and solves equations to determine the precise position of the receiver and its deviation from true time.

GPS receivers convert the signals from the satellites into position, velocity, and time estimates. Using the signals from satellites, four dimensions of X, Y, Z (position) and Time. At a minimum, four satellites must be in view of the GPS receiver for it to compute four unknown quantities (three position coordinates and clock deviation from satellite time).
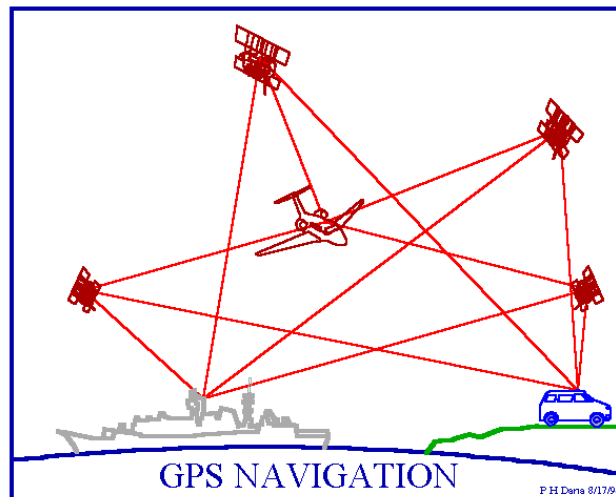
Source: Peter H. Dana, http:/ /www.colorado.edu/geography/gcraft/notes/gps/gps_f.html

Each GPS satellite continually broadcasts a signal (carrier wave with modulation) that includes:

- A pseudorandom code (sequence of ones and zeros) that is known to the receiver. By time-aligning a receiver-generated version and the receiver-measured version

of the code, the time of arrival (TOA) of a defined point in the code sequence, called an epoch, can be found in the receiver clock time scale

- A message that includes the time of transmission (TOT) of the code epoch (in GPS system time scale) and the satellite position at that time.
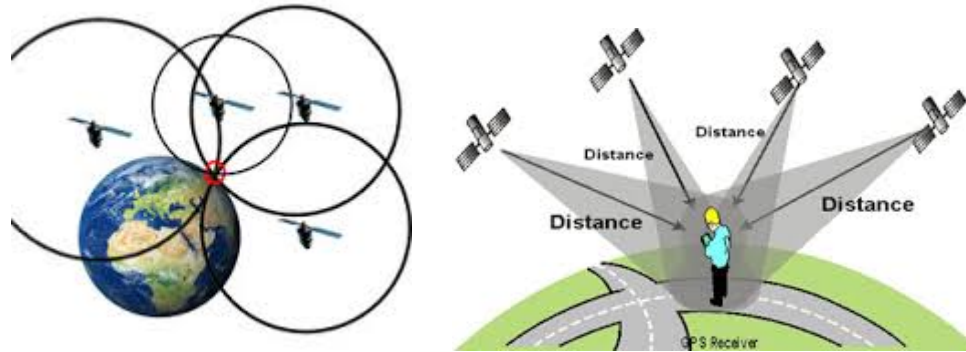

The nominal GPS Operational Constellation consists of 24 satellites that orbit the earth in 12 hours. There are often more than 24 operational satellites as new ones are launched to replace older satellites. The satellite orbits repeat almost the same ground track (as the earth turns beneath them) once each day. The orbit altitude is such that the satellites repeat the same track and configuration over any point approximately each 24 hours (4 minutes earlier each day). There are six orbital planes (with nominally four SVs in each), equally spaced (60 degrees apart), and inclined at about fifty-five degrees with respect to the equatorial plane. This constellation provides the user with between five and eight SVs visible from any point on the earth.

Peter H. Dana 9/22/98
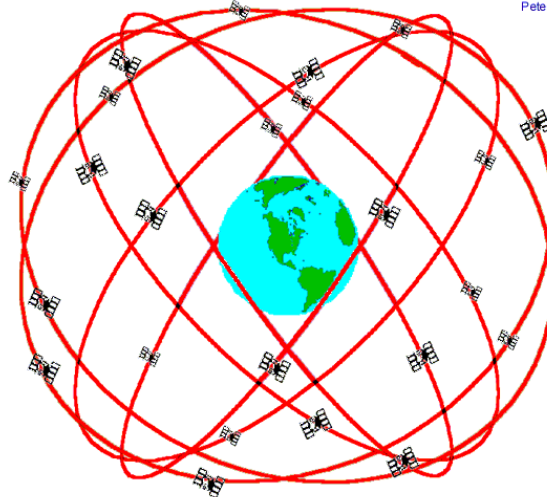
GPS Nominal Constellation
24 Satellites in 6 Orbital Planes
4 Satellites in each Plane
20,200 km Altitudes, 55 Degree Inclination

Source: Peter H. Dana, http:/ /www.colorado.edu/geography/gcraft/notes/gps/gps_f.html
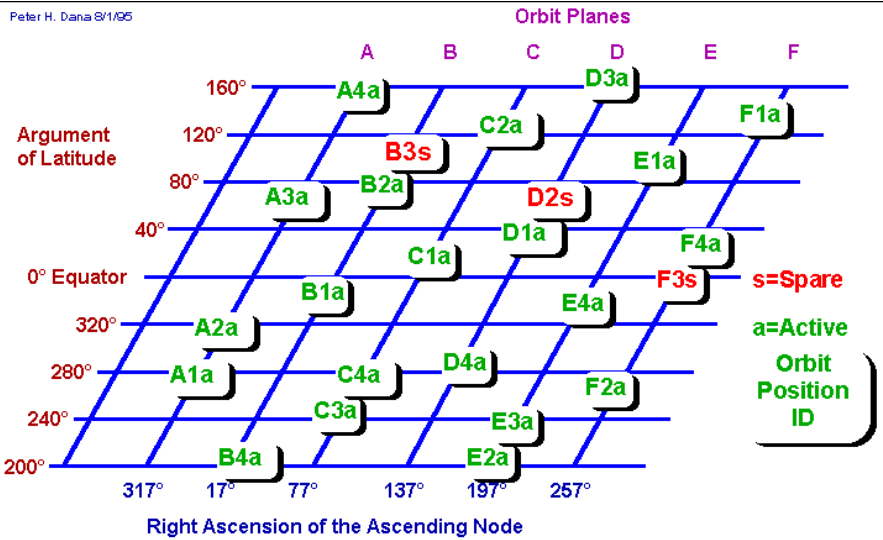
Simplified Representation of Nominal GPS Constellation

Source: Peter H. Dana, http:/ /www.colorado.edu/geography/gcraft/notes/gps/gps_f.html
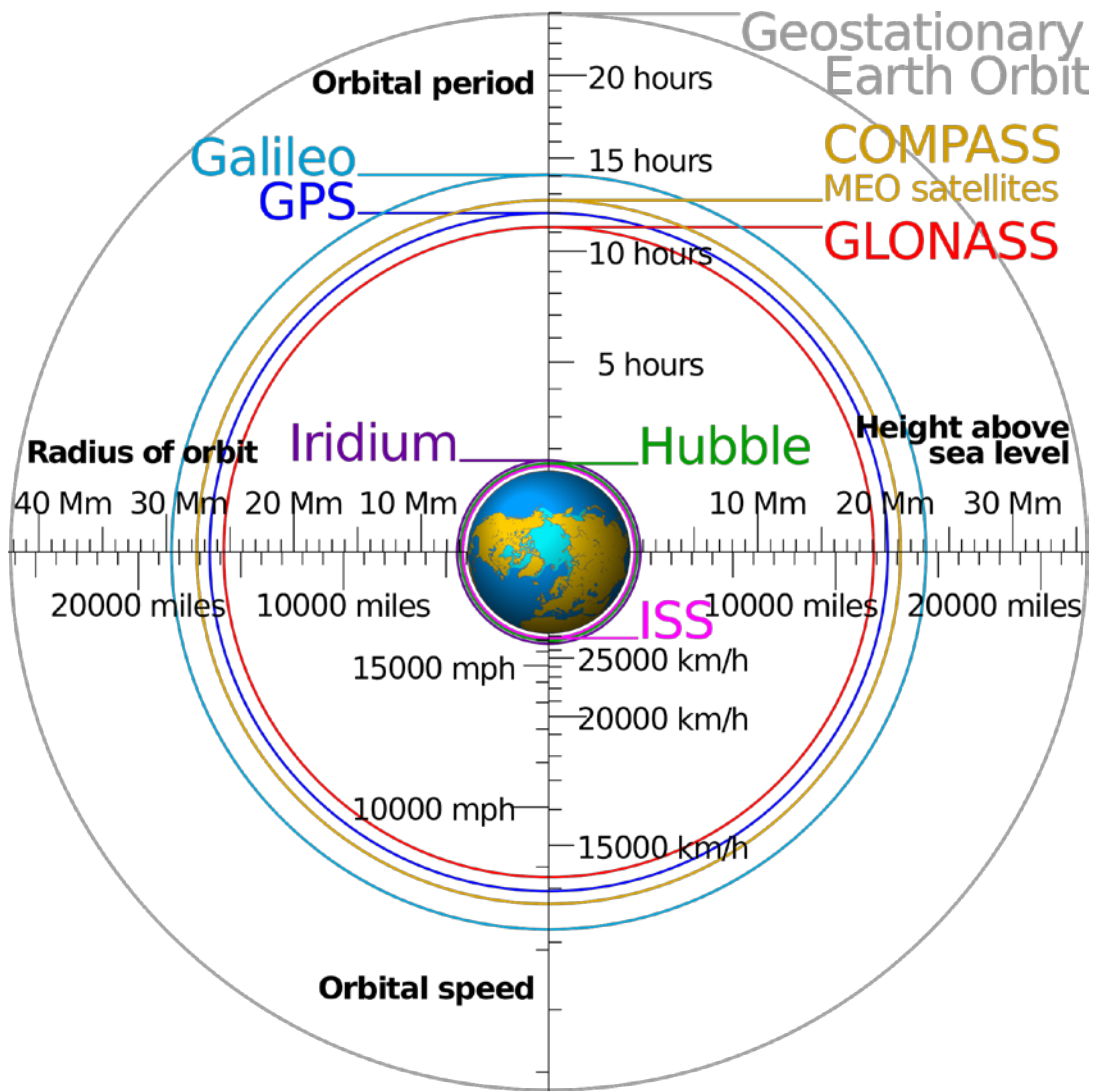
Relative distance of GPS satellites to Earth.

Source:

https://garminoregon6xx.wikispaces.com/file/view/Satellite%20Navigation%20Orbits.png

Hands on activity

For thousands of years humans believed planet Earth was flat. As strange as this idea may sound, it was the accepted model for the ancient scientists and philosophers until some started to analyze position of the Sun, the planet, and the day and night patterns. This activity is inspired by the accomplishment of a Greek man named Eratosthenes of Cyrene; who was a mathematician, geographer, poet, astronomer and music theorist who lived about 2,200 years ago where he measured the circumference of the planet using observation, sticks and shadows. He noticed that one tower close to him cast no shadow but another tower close to his house cast a shadow. This activity explored how Eratosthenes of Cyrene was able to estimate the circumference of the Earth from shadows about 2,200 years ago.
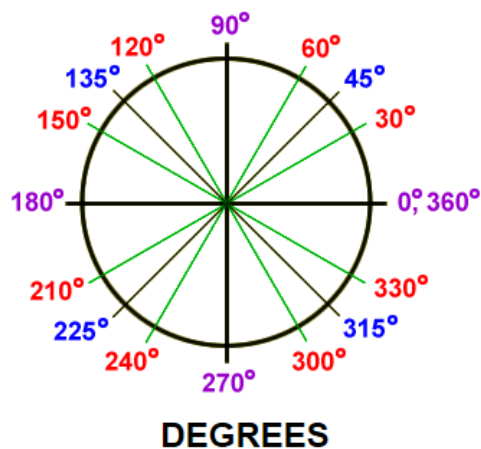
Review of mathematical equations and concepts:

Right Triangle

(I) $a^2 + b^2 = c^2$

(II) $\dfrac{c}{sin(C)} = \dfrac{b}{sin(B)}$

DEGREES
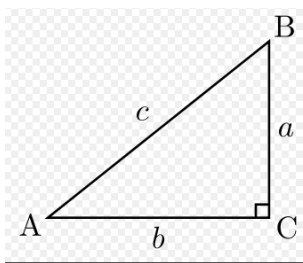
(III) $\sin^{-1} \dfrac{b \times \sin(C)}{c} = B$

Materials:

2 each (12"x1") Styrofoam disc to represent the planet

6 toothpicks (any length)

2 60-inch tape measure (with metric units marked for convenience)

2 pens

2 12-inch-rulers

2 graph paper sheets

2 small scissors

2 flashlights or 2 phones with flashlight applications

1 table

2 scientific calculators

Instructions:

Part # 1 (Set up)

1. The participants are divided into two teams. Each team picks a member who will make sure his/her group is provided with 1 foam disk, 1 ruler, 1 tape measure, 3 toothpicks, 1 scissors, 1 pen, graph paper, flashlight and a calculator.

2. Using the tape measure, measure the circumference of the foam disk. Use the formula for the perimeter of a circle (P=2 π r) to make sure the measurement is correct.

3. Another team member divides the circumference by 2, and with a pen, marking the (0 cm) and the (48 cm) points on the disk.

4. Connect the points marked using a pen and a ruler.

5. Using the tape measure, measure 4 cm along the circumference, from one of the points previously marked, and then draw a line from that point to the middle of the disc. See Figure below

6. Another member uses the scissors and cuts one tip of each toothpick provided, and from that tip measure 3 cm. Mark that distance using the pen as shown below:
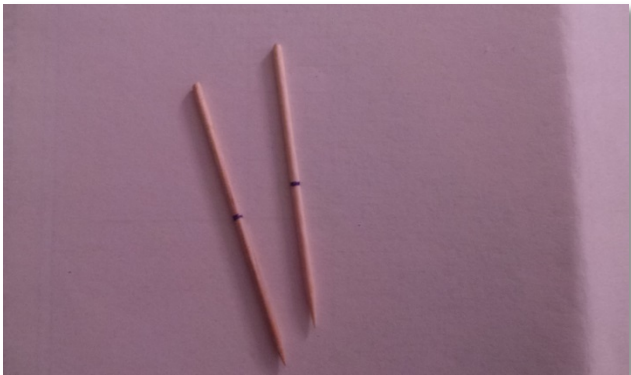
Toothpicks marked.

7. Close to the first point marked, along the curved edge of the disc, insert one toothpick up to the mark. Insert the second toothpick at around 10 cm from the first stick.   The two towers (or toothpicks) should be located close to the midpoint of the thickness disc.

Part # 2 (Analysis)

1. Using your phone or a flashlight, illuminate the area where the two towers stand. Adjust the distance to the point where the shadows can be clearly seen.

2. Rotate the disk and see the change in shadow length. Think about the Sun and rotation of the Earth. Can you make one stick cast no shadow? Can you make both sticks cast no shadows at the same time?

3. Remove the toothpicks and now insert both toothpicks close to the middle of the disk, (on the flat surface), at any distance from each other. Try to do the same with the shadows. Do you think curvature affects shadow length? Were you almost able make the towers cast no shadow at the same time on the flat surface?

Part # 3 (Hands on activity)

Since the Sun is more than 100 times bigger that Earth and they are separated by a large distance, and Sun's rays are practically parallel to each other when they reach Earth's surface.

1. Insert one toothpicks to the 3 cm mark along the circumference of the disk. This time, place them right on the points that connect to the center of the disk, so close to the edge that you will be able to see the sticks along the line, through the foam. See figure below:
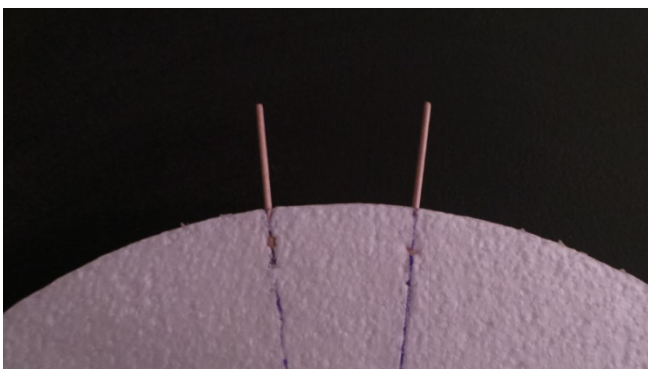
Toothpicks inserted on the edge of the disc.

2. Place the planet (Styrofoam disc) on top of a graph paper sheet in such a way that one of the sticks aligns with one line of the graph paper. The lines parallel to that stick represent the solar rays heating the towers when the Sun is right above that point at 12 noon on the longest day of the year, casting no shadow on the tower along the margin. Note that the other tower does not align with any solar ray; therefore, you need to project the shadow on the surface of the planet.

3. Place the ruler on the graphic paper, along the rays, and touch the surface of the planet with the one end of the ruler and the top of the tower with the side, where the numbers are. Mark that point of the surface of the planet.
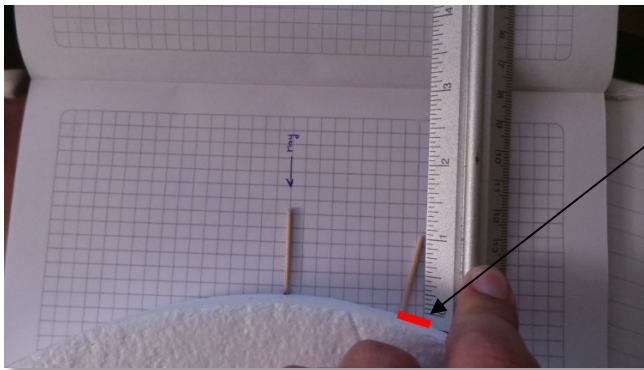
Point represents length of shadow from tower

 The lines on the graph paper represent Sun's rays.

4. Pick up the foam disc and use the tape measure to find the distance from that point just marked to the closest tower. This measure represents the length of the shadow casted by the tower. You should get a number between 0.8 and 0 .9 cm.

5. Pick one member of your team to be in charge of the calculator and another to record the mathematical equations and numerical calculations.

6. Looking at the image of the right triangle above, label letters the distances, locations, and specifications as follows:

   a = Tower casting shadow, (3 cm)

   b = Shadow, (0.8 cm to 0.9 cm)

   C= 90 degrees

   c = ?

   B= ?

   The first goal is to find the values for c and B.

7. Using equation (I), solve for c.

8. Once you find c, use equation (III) and to solve for B.

9. Since 360 degrees account for the entire circle, perform the following operation to find the ratio of B and 360°.

$$\text{Ratio} = \frac{B}{360°}$$

10. Multiply this ratio by the distance between the towers (4 cm). This will give you a close approximation of the circumference of the planet (foam disc). Check your values using measuring tape.
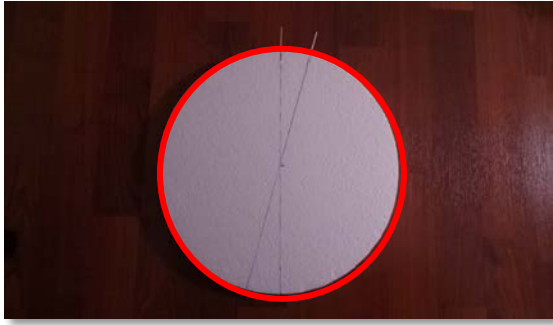
Activity 2: Building Begins with a Beam

Adapted by: Andrew Speroterra

This activity focuses on building a simple-span beam (vertically supported at both ends) out of 48-inch long strips of ¾-inch foam material. The beam is tested for its ability to support as much test load as possible at mid-span without significant deflection under the load. Participants use straws to test the deflection.
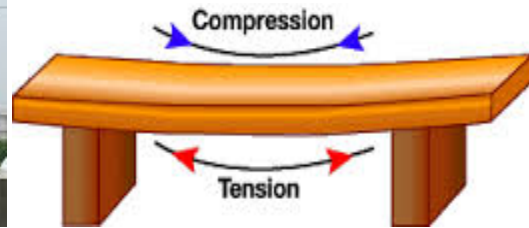
Objective

Build a simple-span beam (vertically supported at both ends) out of 48-inch long strips of ¾-inch foam material. The beam will need to support as much test load as possible at mid-span without significant deflection under the load. The construction materials "cost "of the beam should be as small as possible while meeting the performance criteria related to the load capacity and permissible deflection. Beams help to reinforce structures to make them safer. How do you engineer a foam beam to protect the egg from cracking or breaking?

Background

Beams are traditionally description of building or civil engineering structural elements but smaller structures such as truck or automobile frames, machine frames, and other mechanical or structural systems contain beam structures that are designed and analyzed in a similar fashion.

Start by asking students what types of structures utilize beams. What types of materials are used to construct beams—metal, wood, stone, and combinations of metal and wood. How are beams used in skyscrapers, cars, and homes not only to shape the structures but also to reinforce structures?

Materials:

- Twenty 1-1/2 inch roofing nails (oversize head allows it to be pushed into the foam with thumbs and length keeps nail from protruding out the backside for safety)

- Beam supports (2) that measure roughly four (4) inches in height (e.g., books, wood blocks, reams of paper, bricks

- 2 Weights (1/2 or 1 pounds, but same weight for each team) for the applied load

- Tape measure.

- 4'x8' sheet of ¾-inch thick foam house insulation. Use a knife to precut the sheets into the following strip widths. One sheet will be enough strips for three teams if carefully cut.

  o Four (4) 2-inch wide and 48 inches in length.

  o Four (4) 3-1/2 inch wide pieces and 48 inches in length.

  o Two (2) 5-inch wide pieces and 48 inches in length.

- Medium size egg placed in zip lock bag (two eggs per team).

Instructions

Note 1: Each team needs to consider how to build a 48-inch long beam using some or all of the foam strips provided and how to connect the foam strips together using no more than twenty 1.5-

inch roofing nails. The size of a foam strip cannot be altered by either cutting or breaking into pieces.

Note2: Any stable arrangement of foam and nails may be used as long as the beam only rests on the end supports without being touched by any team members during loading.

Students are divided into teams of three or four per team.

1. Explain competition rules and answer general questions.

2. Allow teams around 20 minutes to build and self-test their beam without using their egg.

3. Have each team complete the score sheet with information about team and beam.

4. Conduct final test using egg under the beam with all teams watching. Complete score sheet based upon observed performance.

Competition

1. Each beam end will rest on supports so that unloaded beam is four (4) inches above "ground". The bearing length at each end of the beam should be two (2) inches in length so that the clear span (inner distance between supports) is 44 inches.

Weight in the middle of the beam

Egg in Zip lock bag
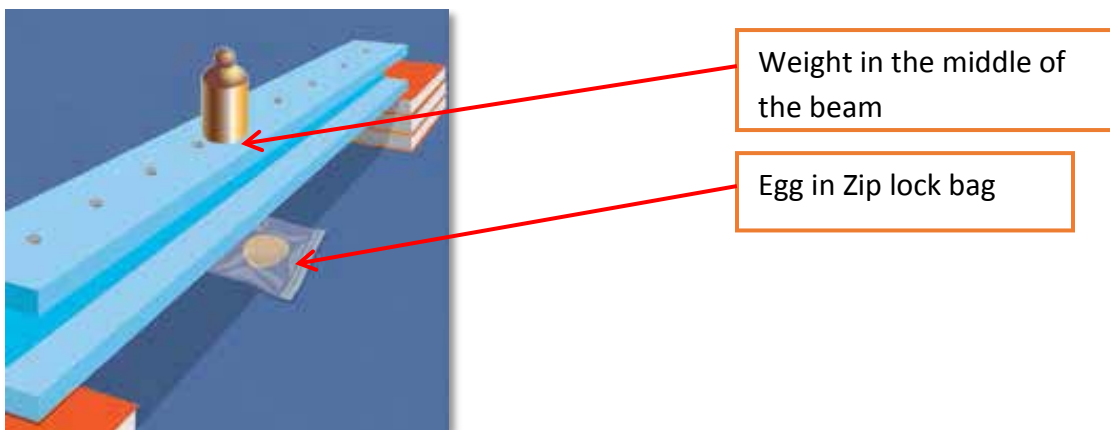
2. An uncracked medium size fresh egg placed in a zip lock bag is placed under the beam at mid-span.

3. The test load is carefully placed on top of the beam. Note whether the beam contacts the egg or, worse, cracks the egg.

Observations

1. Ask teams which structure was most successful and why?

2. Did the cost of the materials help make the beam stronger?

3. What is most important cost or strength, and how do engineers balance the two?

This is an activity adapted with modifications from www.DiscoverE.org.

Activity 3: City Grid (team activity)

Developed by: Milton Reinoso

This activity emphasizes the importance of transportation engineering terms and applications in daily life. The activity is conducted in teams. Each team develops strategies and estimates the travel times and congestion conditions on different road segments under different scenarios (number of people, location of school, location of grocery stores, accident, rush hour conditions, etc.).
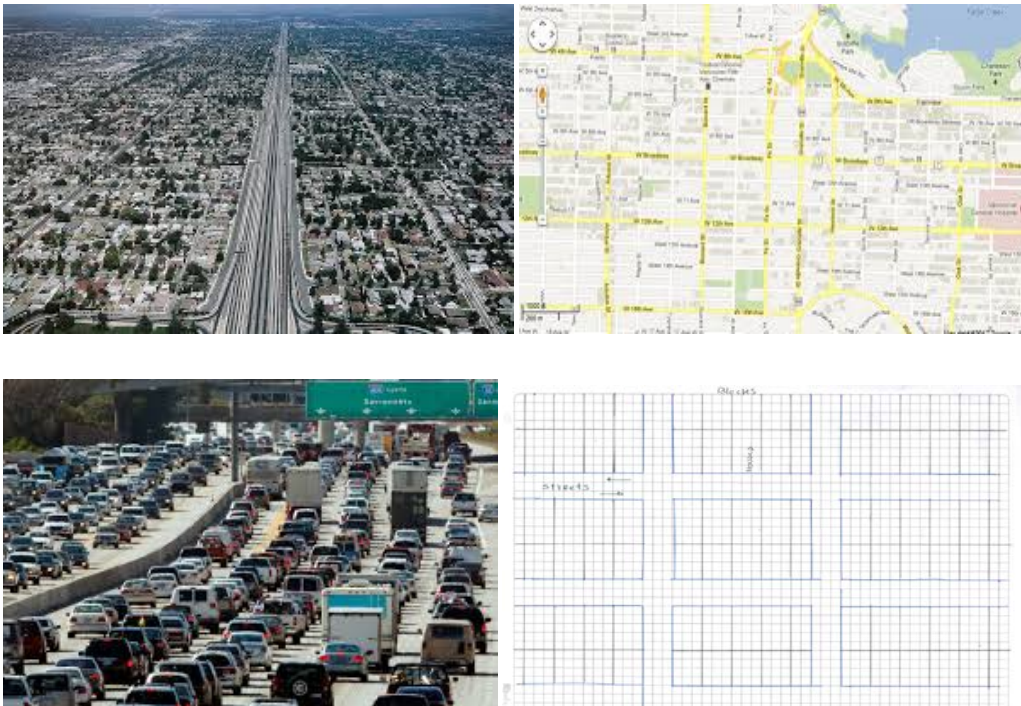
Objective

This activity is designed to promote critical thinking skills used for planning and decision making in transportation engineering and demonstrated how transportation planning is used in applications involving daily life.

Background

Transport engineering is the application of technology and scientific principles to the planning, design, operation and management of facilities for any mode of transportation in order to provide a safe, rapid, comfortable, convenient, economical and environmentally compatible movement of people and goods. For planning, an inventory of the area, or of the existing system in place, is required.

Materials

- 1 sheet of graph paper approx. (8 ½ x 11)
- 2 pencils
- 2 (12 inch) rulers
- 1 calculator

Instructions

1. Divide the group into two teams.
2. Each team picks a member to be the "planner" who sketches a city grid with roads and nine blocks as shown below:
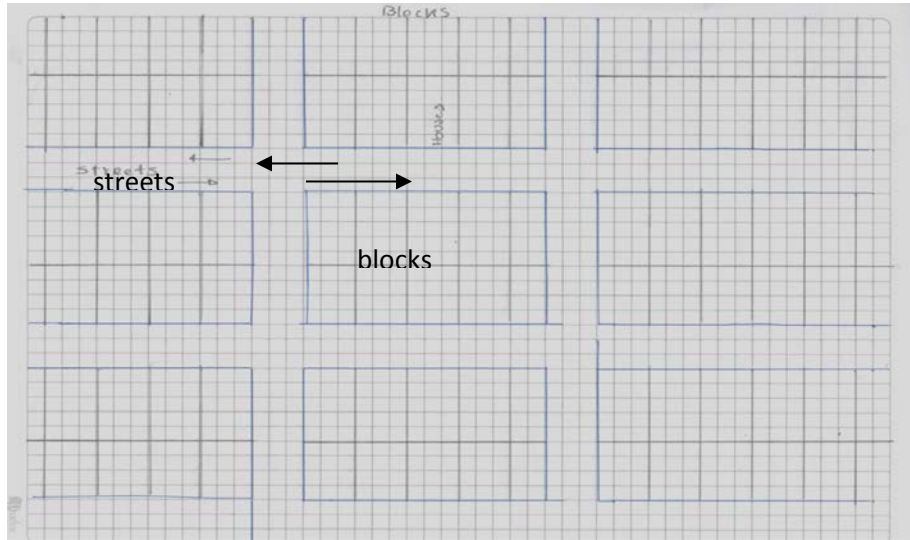
Grid example to be created by the "planner" in each team.

3. Team members pick the locations for the school and the supermarket. Each block can contain up to 6 houses. Allocate one block for school and one block for supermarket.

4. The cluster of small rectangular shapes will be houses, the school and supermarket will occupy an entire block and lines between blocks will be streets.

5. Ask every member of the team, how many live in your house? Then, assign the average number to each single house. For the school and the supermarket use the average number times five to represent the number of people working in these two facilities.

6. Calculate the amount of houses and people and write it down on the upper right corner of the sheet and name it grid population.

7. Assuming 75% of the grids population is adults, calculate the amount of adults.

8. Using the school schedule to indicate when school begins and when it ends every day.

9. Hand your paper with your analysis to the opposing team.

10. Use the following assumptions to estimate:

a. times during the day experiencing the highest concentration of vehicles in the streets,

b. number of car during these critical hours, and

c. number of people working in schools and supermarket.

Note: your answer can be represented by a time range. (e.g., 8-10) pm

11. Assumptions:
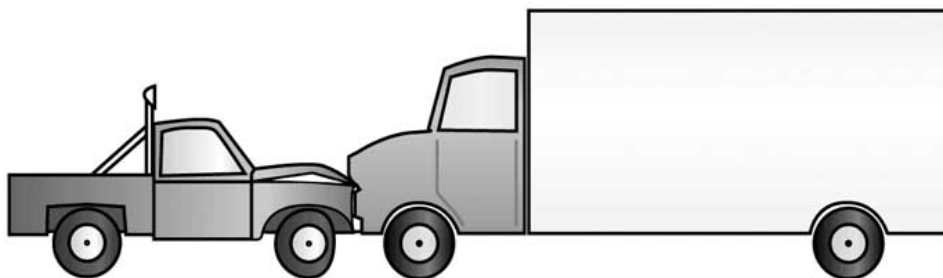
o There is at least one student in every household.

o Every adult drives a car.

o 20% of adults work from home.

o Adults start working one hour after school starts and finish at around 5:00 pm.

Discuss the results and compare analyses.

Activity 4: Marbles' Momentum

Developed by: Milton Reinoso

      This activity aims to analyze and explain the concepts of momentum and impulse as well as the relationship between them.

Equations

Objective

This activity is meant to analyze and understand the concepts of momentum and impulse as well as the relationship between them.

Background

Momentum is a term commonly used in sports. When sports announcers say "that team has momentum" they really mean that the team is really on the move, but this term is really a physics concept. Any object with momentum is going to require a force applied against its motion for a given period of time for the object to stop. The more momentum that an object has, the greater the amount of force, or a longer amount of time, or both are required to bring such an object to a halt. As the force acts upon the object for a certain amount of time, the object's velocity is changed; hence, the object's momentum is altered.

The change in momentum of a certain particle during a time interval equals the impulse of net force that acts on the particle during that interval.

Equation for momentum: $p = m\,v$

where p = momentum, m = mass of object and v = velocity of object.

Impulse, J, is change in momentum.

Impulse - Momentum theorem: $J = F\,\Delta t = m\,\Delta v$

Where F is force, t is time and J is impulse.

Materials

- 2 (12 inch) rulers
- 10 marbles (any size)
- 1 roll of scotch tape
- 1 Chalk stick (any color)
- 1 (8 ½ x 11) sheet of paper
- 1 small scissor
- 1 pencil

Instructions

Part # 1 (Planning)

1. First, two rulers are taped on a table surface parallel to each other with a space between them which is equal to the marble diameter. Then, two marbles are placed inside the track with some space between them.

2. Gently flick 1st marble in order to hit the other one and wait for the 2nd marble to stop.

3. Analyze: Provide instructions and explains theory behind momentum.

4. Repeat part one, but this time, hold the targeted marble with a finger

5. Flick the 1st marble in order to hit the 2nd marble which is held (by pressing down with finger) and wait for the 1st marble to stop.

6. Analyze observations.

7. Now, Place three marbles inside the track, two of them touching each other and the other one at a certain distance from them.

8. Flick the 1st marble, hitting the closest marble which is in contact with the third one.

9. Analyze observations.

10. Repeat steps 7- 8, but this time hold with your finger the marble closest to the one being flicked, in contact with the third one.

11. Analyze observations.

Part # 2 (Competition)

1. Using chalk, draw a 5 inch radius circle inside a 15 inch radius circle.

2. Place 8 marbles in line in the middle of the smaller circle.

3. Draw a line five feet away and parallel to the line made up with marbles and call it starting line.

4. Each team is given one marble.

5. With a coin toss, one steam starts the competition.

6. By flicking the marble from the START line, the teams try to hit those in the inner circle. Each team flicks the SAME marble three times.

7. The winning team is the one that gets more marbles out of the inner circle, BUT they have to stay inside the big one.

Activity 5: Transportation Quiz Ball

Developed by: Andrew Speroterra, Milton Reinoso, Berrin Tansel

This index card game was developed to introduce participants to basic concepts and applications of the transportation engineering field. A series of questions were developed for a Quiz game emphasizing the application of technology and scientific principles to the planning, design, operation and management of facilities for any mode of transportation in order to provide a safe, rapid, comfortable, convenient, economical and environmentally compatible movement of people and goods. The questions included 1) aerospace, 2) air transportation, 3) highways, 4) pipelines, 5) waterways, port, coastal and ocean and 6) urban transportation concepts and terminology.

Examples of questions are provided below. There are 10 index cards with the following information.

1. Transportation engineering applies its tools to the _____,_____, _____, and _____ of facilities for any mode of transportation.
   a) Planning, design, operation, management.
   b) Painting, gaming, entertainment, spying.
   c) None of the above.

      Correct answer: a

2. Transportation engineering uses:
   a) Scientific principles

b) Technology

c) All of the above

Correct answer: c

3. Transportation includes the safe and efficient movement of:

a) People, cows and water

b) Meat, bread, vegetables

c) Both a and b.

Correct answer: c

4. The following is NOT a subdivision of transportation engineering.

a) Aerospace

b) Highways

c) Restaurants

Correct answer: c

5. The following is NOT a subdivision of transportation engineering.

a) Urban transportation

b) Waterway, ports, coastal and ocean

c) Tablets and smart media.

Correct answer: c

6. Which of the following scenarios pertains to transportation engineering?

a) The launch of a rocket into space in order to bring electronic instruments needed in the space station.

b) Pipeline construction to move crude oil from Alberta, Canada to Texas, USA

c) Both a and b

Correct answer: c

7. Which of the following technologies will benefit the most urban transportation?

a) A new football video game

b) A phone app that allows drives to find alternative routes when traffic jams.

c) A new cell phone application to download free music while driving.

Correct answer: b

8. The construction of bridges, bus terminals, train stations and rocket platforms are directly related to what field?

a) Food and restaurant industry

b) Reality show business

c) Engineering

Correct answer: c

9. When a transportation engineer starts the planning process of a road from your neighborhood to school, what of the following aspects do you consider important?

a) Type of transportation used for people in the area

b) How many cars could be on the road daily

c) All of the above

Correct answer: c

10. Before the planning process begins, an inventory must be created. If you were to select important information before planning a road or rail road construction, which of the following aspects should be in an inventory?

a) Population

b) Economic activity

c) All of the above

Correct answer: c

Activity 6: Wind Jammer

Developed by: Milton Reinoso and Berrin Tansel

During this activity, participants use wind energy to transport a specific object. The wind blows towards the object and pushes against it.

Source: http://www.physicsforarchitects.com/Sailing_against_the_wind.php

What is lifting the flag?

The goal of the team activity is to transport two erasers from the starting point to the finish line using only the wind generated by a small fan. Alternatively, activity can be conducted by participants who provide wind by blowing into straw to move the erasers.

Objective

This activity explores the transformation of wind energy to kinetic energy.

Background

As the Sun heats the surface of Earth, differences in temperature create wind, and with them, also energy. Wind is the movement of air from one area with high pressure to an area with lower pressure. In fact, humans have been using wind power for millennia. From wind, we can capture kinetic energy, produce electricity and do work.

In this activity, participants use wind energy to transport load traveling parallel to the wind. The wind blows into the area of the object and pushes against it. As long as wind travels towards the object being moved by it, wind energy is transferred to the object and air is decelerated by the object. The object pushes the wind back, and the wind pushes the object forward.

Have you noticed that in a strong wind, it is easier to walk, run or bike if wind pushes on our backs?

You will need these concepts.

Drag force can be calculated by the following equations:

$$F_D = \tfrac{1}{2}\, \rho\, \upsilon^2\, C_D\, A$$

where F_D is the drag force, which is by definition the force component in the direction of the flow velocity, ρ is density of the fluid, υ is the flow velocity relative to the object, A is the reference area C_D is the drag coefficient, a dimensionless coefficient related to the object's geometry and surface characteristics.

Friction: The resistance that one surface or object encounters when moving over another

Gravity: Natural phenomenon by which all physical bodies attract each other.

Mass: A property of an object that measures the amount of matter in it.

Materials

- 4 foam blocks in the shape of rectangular prisms (1 inch x 1 inch x 3 inch or size available closest to it)

- Electrical house fan

- 4 medium erasers (same size)

- 2 rolls of scotch tape

- 16 (1 inch) paper clips.

- 4 (8 ½ x 11) sheet of paper

- 2 small scissors

- 4 (7 inch) stirring sticks (wood or plastic)

- Table

- Chair

- Cell phone or timer

Instructions:

Part # 1 (Set up)

1. The group is divided into two teams. Each team picks a member who is going to make sure his/her group is provided with 2 foam blocks, 2 erasers, 1 roll of scotch tape, 8 paper clips, 2 sheets of paper, 1 scissor and 4 stirring sticks.

2. The instructor or a student sets the fan at one end of the table in such a way that the air flow is parallel to the table surface.

3. A starting point at about 1 foot from the fan, and a finish line at about 4-5 feet from the starting point are defined on the table.

Part # 2 (Competition)

1. The goal of each team is to transport both erasers from the starting point to the finish line using only the wind generated by the fan. Each team should create, with material provided, an object that is able to glide along the surface of the table.

2. Set the timer to 10 to 15 minutes for the analytic part of the activity. Here, each team should use one (8x11) sheet to write down ideas and design. During this stage think about terms listed below.

   Refer to equations/ definitions of terms listed and use them as much as possible.

   o Friction

- Drag force

- Gravity

- Mass

The person conducting the activity asks the following hint questions, each worth 2 points.

- What two terms should be equal for both teams?

- Which term represents the force the earth exerts on objects?

- Which term should be reduced in order to make the object move faster competition?

3. Write down your team's answers on a piece the sheet provided. Questions will be checked at the end of the competition.

4. Set ten minutes for the construction phase.

5. Once the teams are ready to compete, place each object with cargo on it (cargo being the eraser) on the start line, place erasers on it, and turn on the fan to its lowest setting.

   Note: If the vehicle does not move with lowest speed, set the fan to the next higher setting.

6. If the object moves, then wait until it reaches the finish line and do the same with the second object (cargo being the eraser).

7. The winning team is the one who delivers the cargo or erasers passing the finish line, using the lowest fan velocity possible.

   Note: in the event of a tie, then questions will become critical in order to pick a winner. Remember that each question is worth 2 points.

Activity 7: What could happen next, if you send that text? (for middle and high school students)

Developed by: Andrew Speroterra and Berrin Tansel

Objective

This activity involves increasing awareness about texting and driving.

Activity

1. One person sits in a chair and pretends to be in the driving position with their phone within reach.

2. A second person sits in front of them holding index cards at the driver's eye level. As the 2nd person rapidly shows different traffic related images (e.g., stop sign, person, dog, children, red light, etc.) placed on a series of index cards.

3. The driver calls out the picture that they s/he sees while trying to type a short text into their phone.

4. A third person keeps a log on paper of what the driver sees (number of items) and the actual number of items have been shown from the index cards.

5. The observers compare what the driver saw and missed. Loss of attention and the risks of texting while driving are discussed.

Points to emphasize
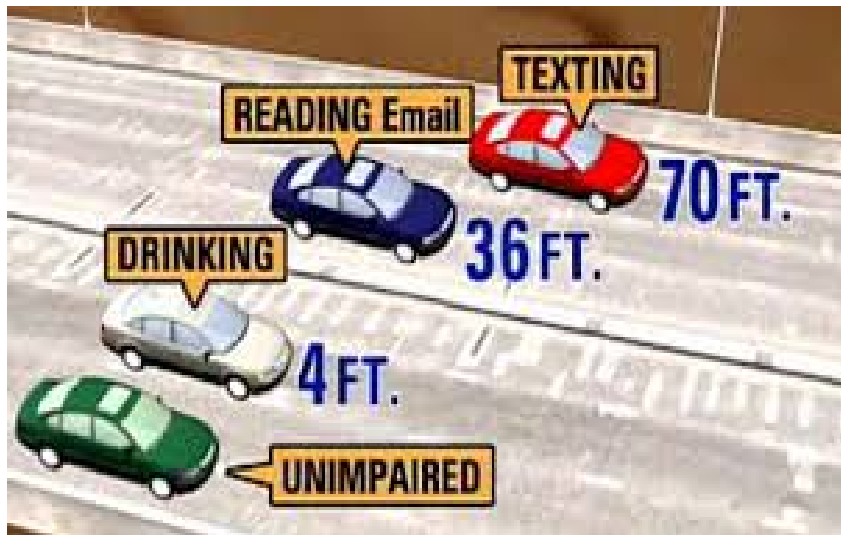
A text message delays reaction times by 37 per cent. By comparison, using cannabis

slows it by 21 per cent, and drinking to the legal limit by 13 per cent.

Source: http://www.trl.co.uk/case-studies/behaviour-dangers-of-texting-whilst-driving/

Source: https://www.linkedin.com/pulse/driving-mobilephone-safety-habitual-ian-milne

Source: https://grovemedical.wordpress.com/2013/09/09/the-dangers-of-texting-and-driving/
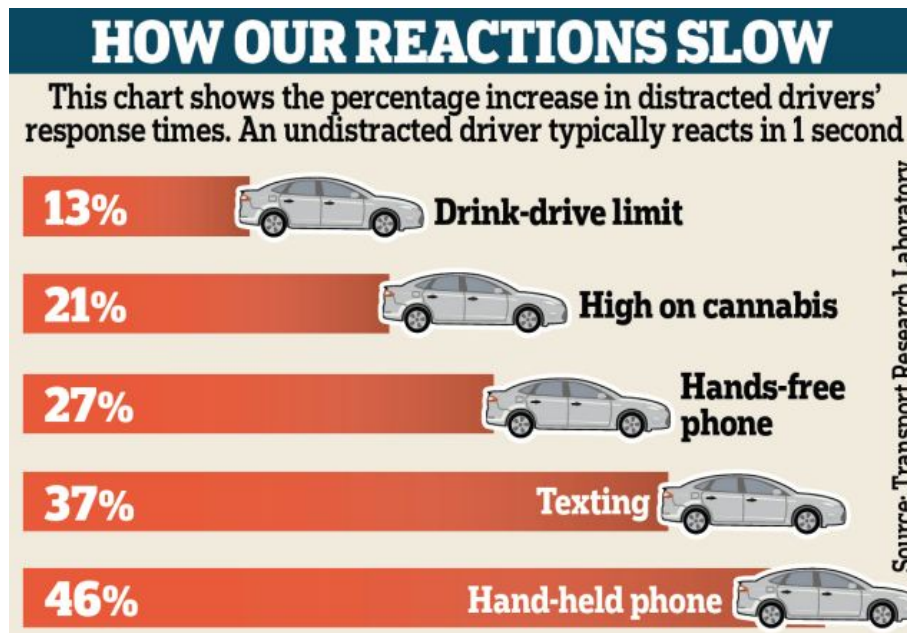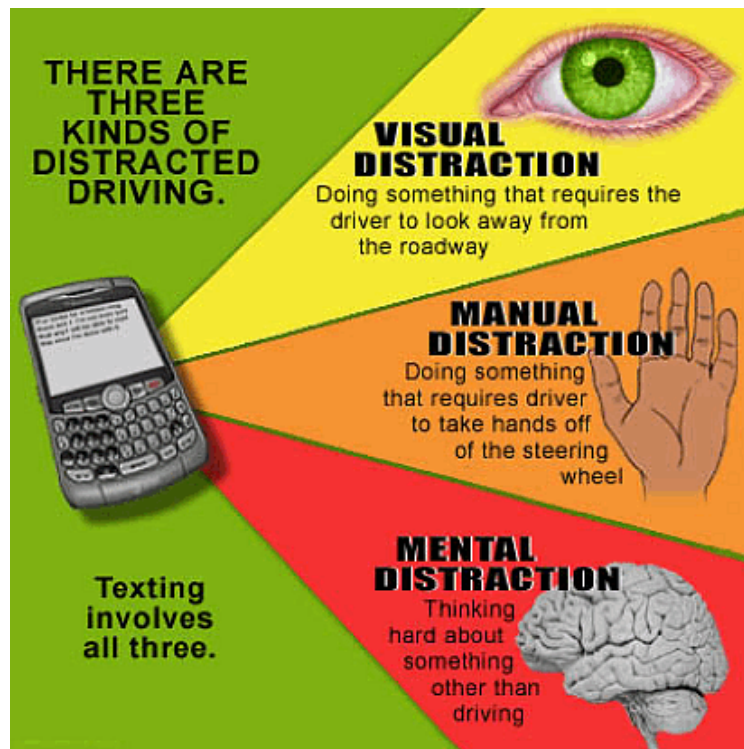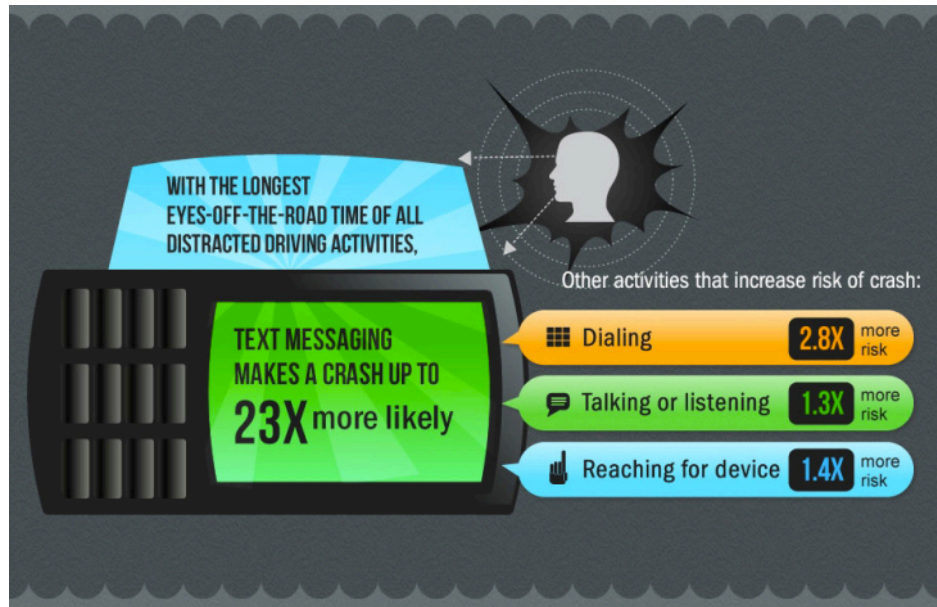
Texting and Driving Statistics [from textinganddrivingsafety.com/]

Texting while driving is a growing trend, and a national epidemic, quickly becoming one of the country's top killers. Drivers assume they can handle texting while driving and remain safe, but the numbers do not lie.

Texting while driving causes:

1. 1,600,000 accidents per year – National Safety Council

2. 330,000 injuries per year – Harvard Center for Risk Analysis Study

3. 11 teen deaths EVERY DAY – Ins. Institute for Hwy Safety Fatality Facts

4. Nearly 25% of ALL car accidents

Texting while driving is:

1. About 6 times more likely to cause an accident than driving intoxicated

2. The same as driving after 4 beers – National Highway Transportation Safety Administration.

3. The number one driving distraction reported by teen drivers

Texting while driving:

1. Makes you 23 times more likely to crash – Highway Transportation Safety Administration.

2. Is the same as driving blind for 5 seconds at a time – VA. Tech Transportation Institute

3. Takes place by 800,000 drivers at any given time across the country

4. Slows your brake reaction speed by 18% – Human Factors & Ergonomics Society

5. Leads to a 400% increase with eyes off the road.

Activity 8: Where the Rubber Meets the Road

Developed by: Andrew Speroterra and BerrinTansel

This activity demonstrates the importance of tire design and threads on grip performance and performance on different surfaces. Depending on the type, a bicycle has either fat tires or thin tires. Most road bikes and touring bikes have thinner tires, while mountain bikes have big fat tires.
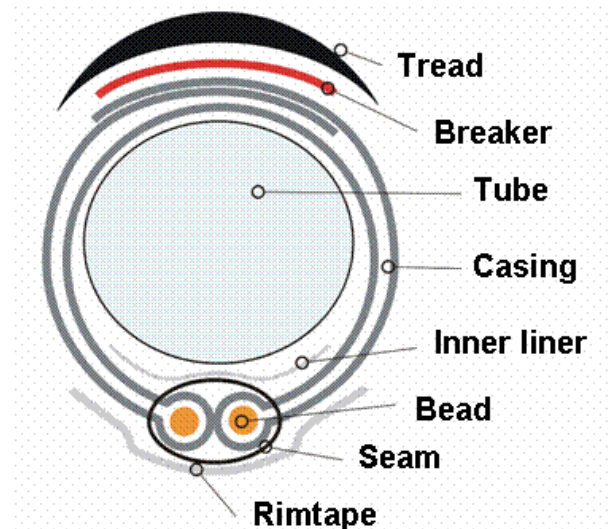

Source: http://autobus.cyclingnews.com/tech/?id=2005/features/conti_tech

Each type of tire has been adapted for the surfaces they ride on (i.e., mountain bike for dirt road, city bike for concrete/asphalt). The road tires are inflated to 100 or even 120 psi (pounds per square inch). A firm thin tire on the asphalt surface will not flatten much. The less the tire flattens out on the bottom, the less surface area is in contact with the road. Less contact in

this case means less friction, and more speed. This is why keeping tires properly inflated is very important.

The treads of mountain bike tires can affect the performance. Rough or "knobby" treads grip dirt trails better, but create greater friction on smooth roads. Smooth tires grip smooth roads better, with less resistance, but slip on dirt trails. Mountain bike tire manufacturers produce a variety of different patterned knobby treads. While cyclists have different preferences, there has been little scientific support for one tread performing better than another.
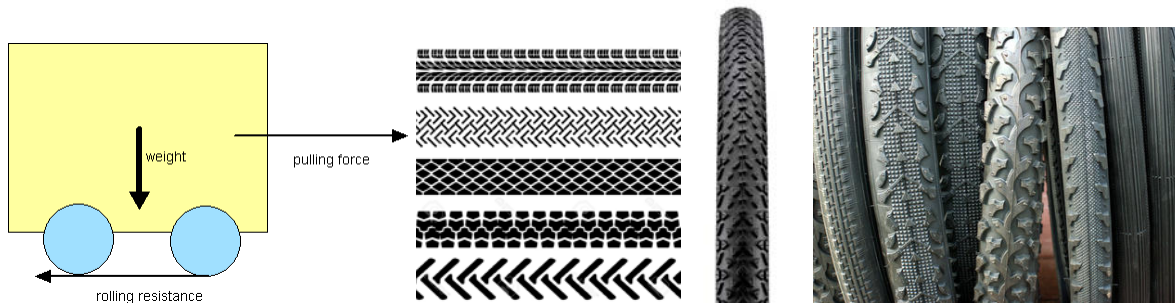
The force that resists the motion when a body rolls on a surface is called the rolling resistance or the rolling friction.

Rolling Coefficients of Cars

The rolling coefficients for pneumatic tires on dry roads can be calculated as

$$c = 0.005 + 1/p \ (0.01 + 0.0095 \ (v/100)^2)$$

where,

c = rolling resistance coefficient

p = tire pressure (bar)

v = velocity (km/h)

Example - The rolling resistance of a car on asphalt

The rolling resistance of a car with weight 1500 kg on asphalt with rolling friction coefficient 0.03 can be estimated as follows:

$$F_r = 0.03 \ (1500 \text{ kg}) \ (9.81 \text{ m/s}^2) \ = \ 441 \text{ N}$$

Typical rolling coefficients

Rolling resistance coefficient (c)	Vehicle and surface
0.001 - 0.002	railroad steel wheels on steel rails
0.001	bicycle tire on wooden track
0.002 - 0.005	low resistance tubeless tires
0.002	bicycle tire on concrete
0.004	bicycle tire on asphalt road
0.005	dirty tram rails
0.006 - 0.01	truck tire on asphalt
0.008	bicycle tire on rough paved road
0.01 - 0.015	ordinary car tires on concrete
0.03	car tires on tar or asphalt
0.04 - 0.08	car tire on solid sand

| 0.2 - 0.4	car tire on loose sand

Are your tires fat or thin?

Depending on the type, your bicycle has either fat tires or thin tires. Most road bikes and touring bikes have thinner tires, while mountain bikes have big fat tires. Each type of tire has been adapted for the surfaces they ride on. The road tires are inflated to 100 or even 120 PSI (pounds per square inch). A firm thin tire on the asphalt surface won't flatten much. The less the tire flattens out on the bottom, the less surface area is in contact with the road. Less contact in this case means less friction, and more speed. This is why keeping tires properly inflated is so important.


Source: http://www.ridingfeelsgood.com/tire-pressure-width/
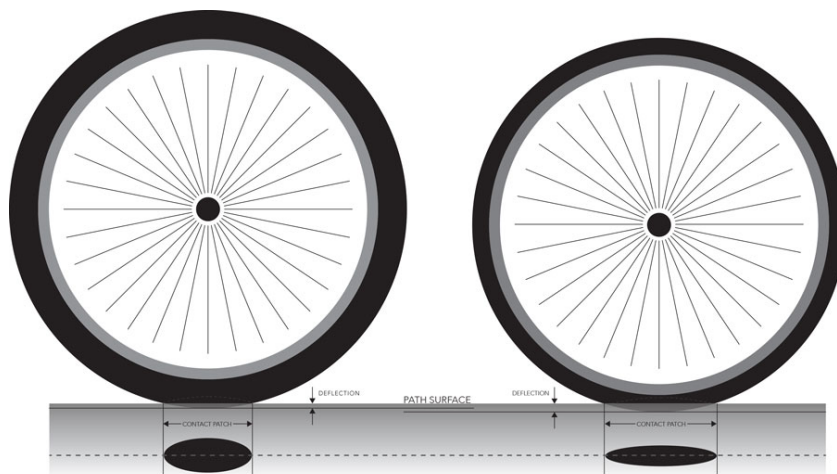
Wide and fat mountain bike tires flatten out more on a hard asphalt surface. However, on a dirt trail, a mountain bike tire "floats" on top of the rough surface. A thinner road tire would cut deep into the dirt, forcing the cyclist to pedal her way out of a hole.

Source: http://www.spherikbike.com/en/fat-bike-rims/
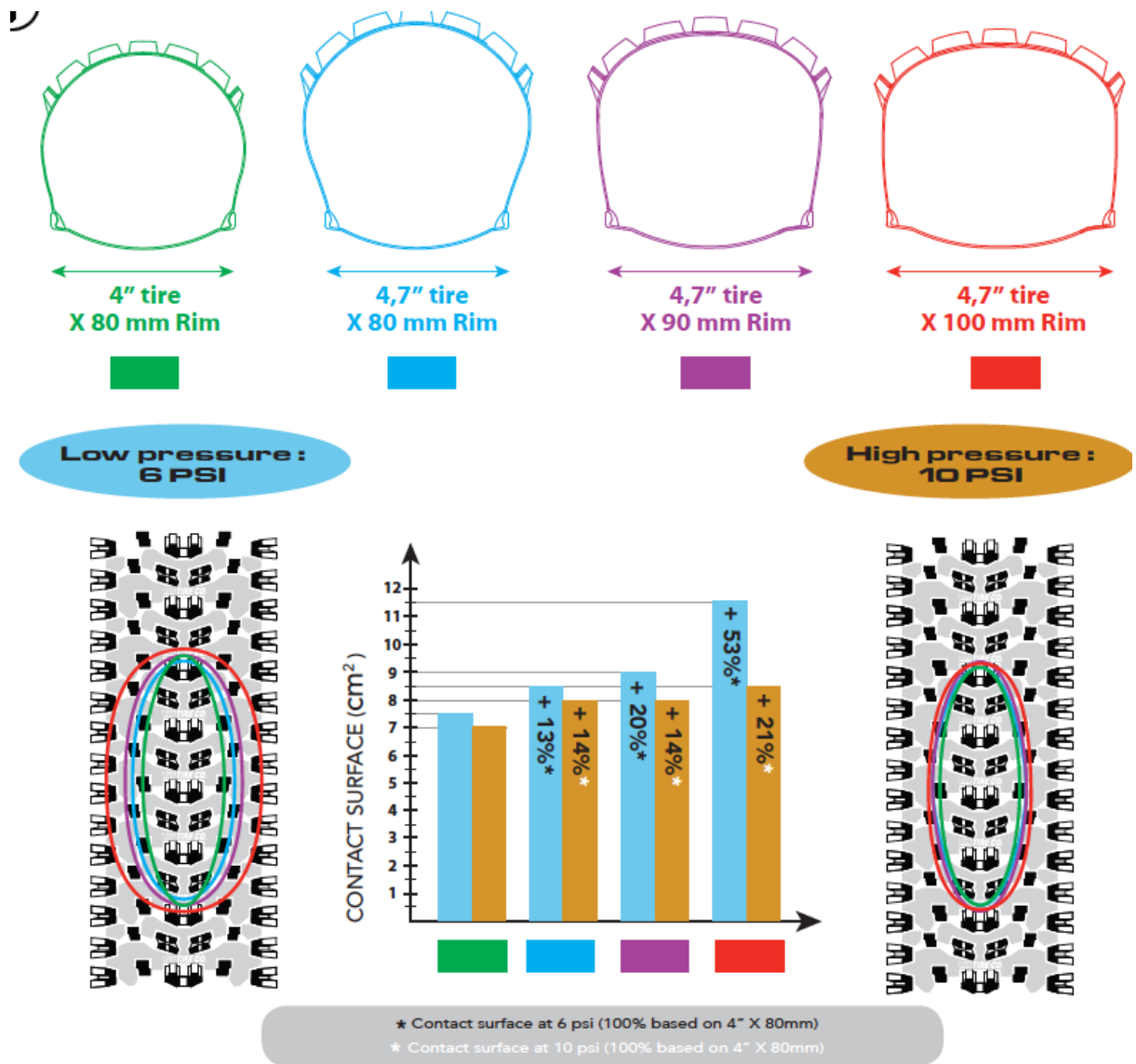
## Traction over loose gravel
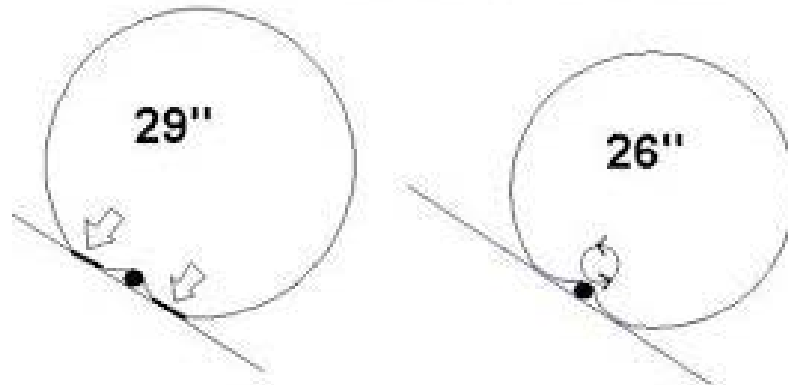
Source: forums.mtbr.com

Tire treads

  The treads of mountain bike tires can affect their performance. Rough or "knobby" treads grip dirt trails better, but create higher friction on smooth roads. Smooth tires, due to lower resistance, slip on dirt trails. Mountain bike tire manufacturers produce tires with a variety of different patterns. Although cyclists have different pattern preferences, there is little scientific support for one tread performing better than another.

Source: http://www.billbonebikelaw.com/cycling/bicycle-buying-guide-for-beginners-road-

bicycles/
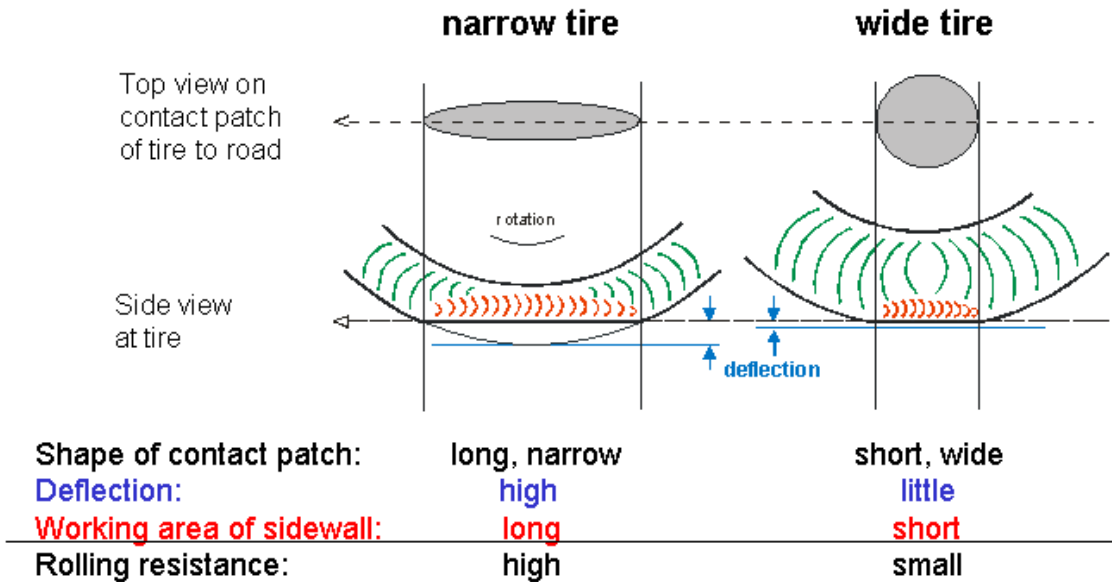
Source: http://autobus.cyclingnews.com/tech/?id=2005/features/conti_tech

Activity

One quick and easy way to experiment with the effect of tread is to use two small cylindrical objects (large highlighters or markers work well as cylindrical objects), identical in size and shape and a few pairs of rubber bands with different types (i.e. varying from small, thin ones to large thick ones).

Place the pair of rubber bands around each object. The location and configuration of the bands that you use is up to you. However, make a table to keep track of the configurations used and results observed. For instance you can try first with the pair of large thick rubber banks

loosely wrapped around the cylindrical object (large marker) to simulate a lower air pressure

then try again with the rubber band wrapped tighter.

Once your rubber bands are in place on both markers, place them side-by-side, near the

edge, on top of a large, rigid notebook or similar surface. Then slowly lift the edge of the surface,

where the markers are so that they begin roll down. Record your observations and attempt to

justify them with the information provided above.
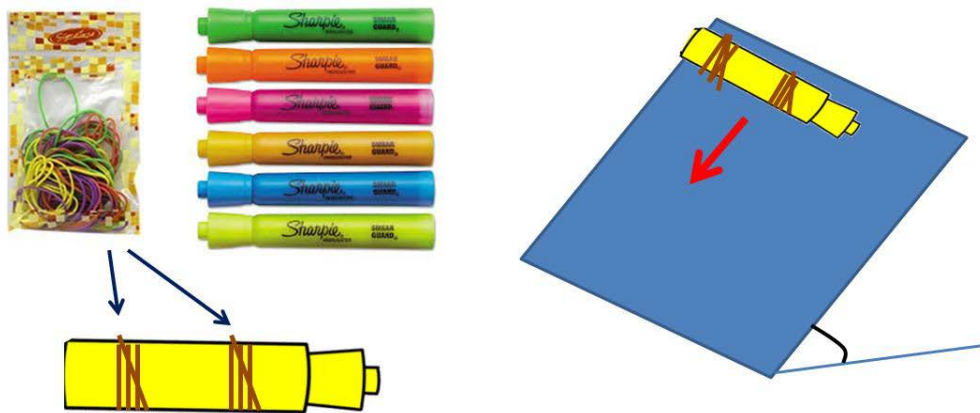
Trial	Type 1	Type 2	Winner
1st	Large, Loose	Small, Loose	2
2nd	Large, kind-of-tight	Small, Loose	1
3rd	Large, kind-of-tight		
4th			
5th			
6th			
7th			
8th			
9th			

10th			

Activity 9: Shock Absorber

Developed by: Berrin Tansel

This activity emphasizes the importance of shock absorbers in vehicles. It is illustrated through different activities using a ball and different surfaces.
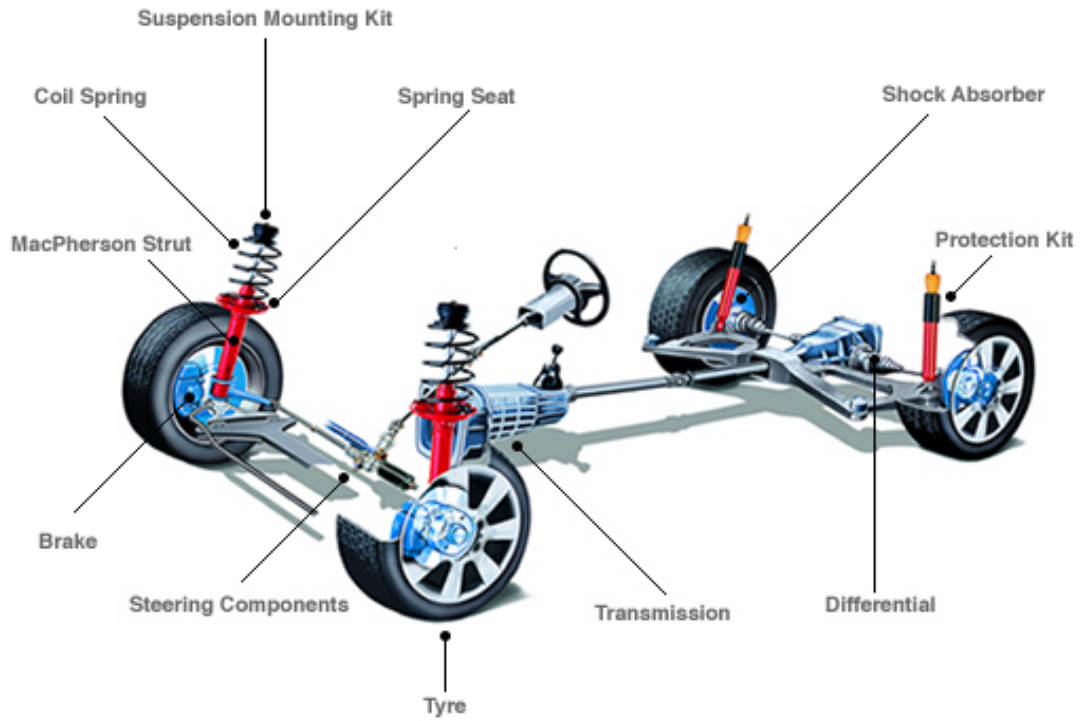
Materials

1 tennis ball

Different type of surfaces (10 inch x 10 inch) (e.g., wood, sponge, Styrofoam, card board, marble tile, carpet, book)

Activity

1. Ask the students which surface will make the ball bounce highest.

2. Have the student drop the ball freely fro, about 2 feet height.

3. Ask what happened to the kinetic energy of the ball if it does not bounce back.

4. Discuss where would the kinetic energy go if you wear shoes with hard soles and soft soles?

5. How is this concept used in cars? What does the shock absorber do in the car? What happens if the car does not have a shock absorber?
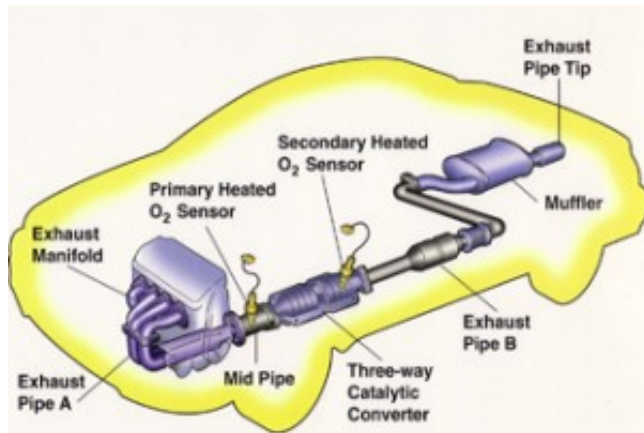
Activity 10: How a Muffler Works

Developed by: Berrin Tansel

This activity involves building a muffler using commonly found materials. Noise control and different types of muffling mechanisms are discussed.
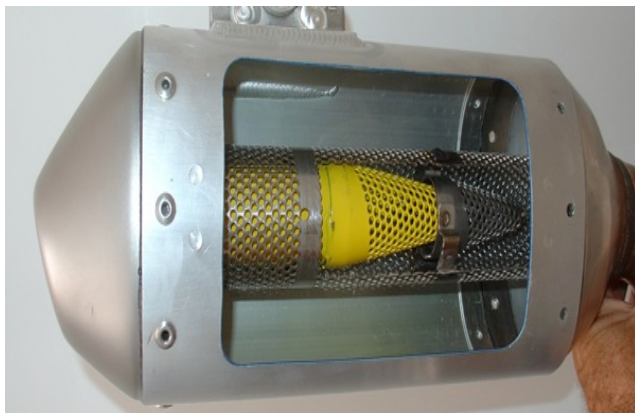
Different Muffler Designs

Sound Canceling

Sound Absorbing

Muffling mechanisms

Mufflers are installed within the exhaust system of cars, although the muffler is not designed to serve any exhaust function. The muffler is engineered as an acoustic soundproofing device to reduce the loudness of the sound pressure created by the engine by way of acoustic quieting methods. However, an adverse effect of muffler in a car is that it causes increase of back pressure which decreases engine efficiency.

This is caused due to the fact that engine exhaust shares the same complex exit pathway built inside the muffler as the sound pressure that the muffler is designed to mitigate.

Soundproofing is any means of reducing the sound pressure with respect to a specified sound source and receptor.

A glasspack is a type of automobile muffler in which the exhaust gas passes through the center of the muffler. The basic design consists of a smaller tube centered inside of a larger outer tube that is enlarged or swollen in the middle. The gap between the swollen part of the larger outer tube and the smaller diameter center tube is packed with fibreglass, which is why this type of muffler is referred as glasspack. Some modern muffler designs are similar in principle to the glasspack, but use more sophisticated sound-absorbing materials (i.e., stainless steel mesh) and more advanced acoustical engineering principles for reducing noise while retaining the power-preserving advantages of a straight-through exhaust flow.

Materials

- 2 large plastic bottles (2L)

- 1 small water bottle

- Styrofoam packing material enough to fill the two large plastic bottles

- Scissors

- Knife with a sharp tip to puncture the plastic bottle

- Duct tape
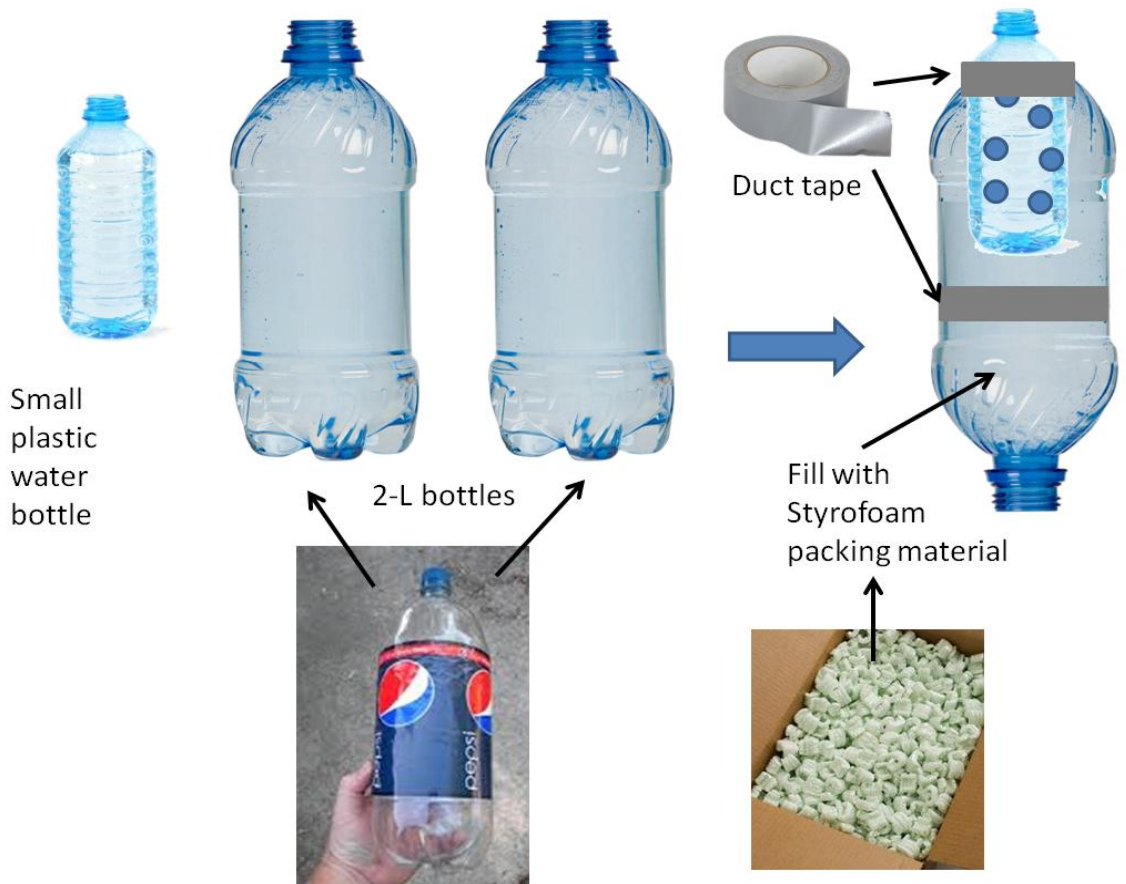
Assembly of muffler

Activity

1.   Carefully cut the bottom portion of the two large plastic bottles.

2.   For one of the bottle without the bottom, also cut the top so that the top of the water bottle can fit to the large bottle.

3.   Make holes on the side of the small water bottle. Do not cut any part of the bottle. Only puncture holes on the side (middle portion of the bottle).
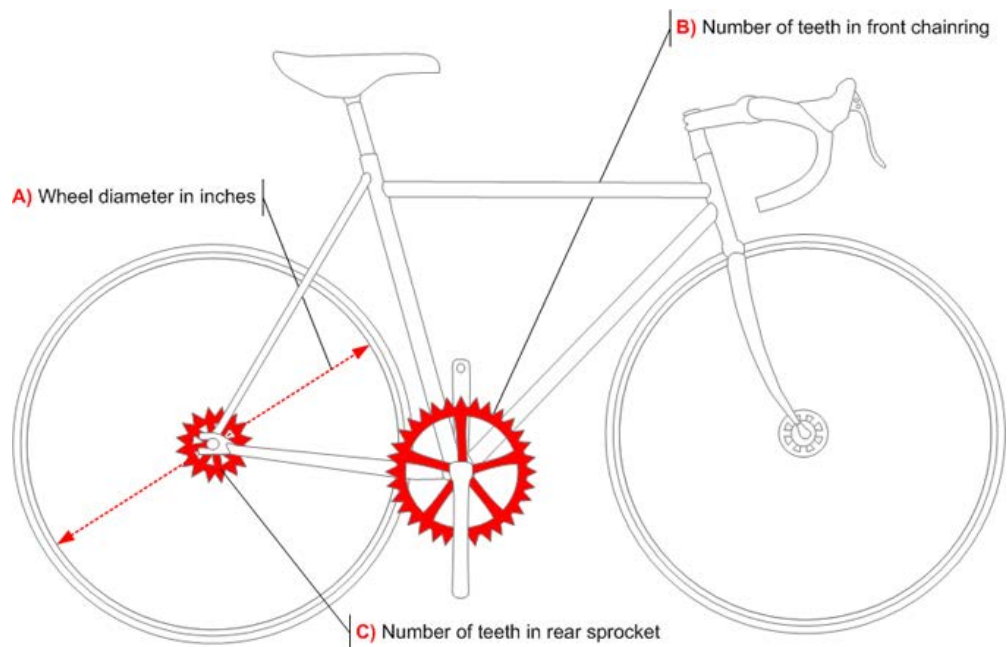
4.   Insert the water bottle inside the large bottle with both the top and the bottom cut. Make sure that the top of the small bottle is tightly coming out from the top of the large bottle. Note that the large bottle does not have a top, so its top will be the the top of the small water bottle.

5.   Using the duct tape, tape small bottle into the large bottle.

6.   Fill both cut large bottle with Styrofoam.

7.   Using the duct tape, tape the two large bottle together such that one end has the bottle top of the small with water bottle and the other end has the top of the large bottle.

8.   You can test the muffle by talking into it. You can also play a song from the phone while keeping the speaker near the entrance of the muffler. Do you notice any difference?

9.   Comment of the performance of the muffle for soound absorption.

Activity 11: Gears on Your Bicycle

Developed by: Berrin Tansel

   This experiment is designed to test what we learned about gear ratios, using a bicycle. On some bicycles, there is only one gear and the gear ratio is fixed. Many contemporary bicycles have multiple gears and thus multiple gear ratios. On single-speed and multi-speed bicycles, the gear ratio depends on the ratio of the number of teeth on the chainring to the number of teeth on the rear sprocket (cog). The "sprockets" or "cogs" are found in the rear hub. Modern sprockets consist of 7-9 size ranges from 36-11 teeth. If you have a 44/16 gear ratio means 44 teeth on the front, 16 teeth on the back.

Rear cog size (teeth#)

Chain ring size (teeth#)	19	18	17	16	15	14	13
42	60	63	67	71	76	81	87
44	63	66	70	74	79	85	91
45	64	68	71	76	81	87	93
46	65	69	73	78	83	89	96
47	67	71	75	79	85	91	98
48	68	72	76	81	86	93	100
50	71	75	79	84	90	96	104
52	74	78	83	88	94	100	108

B) Number of teeth in front chainring

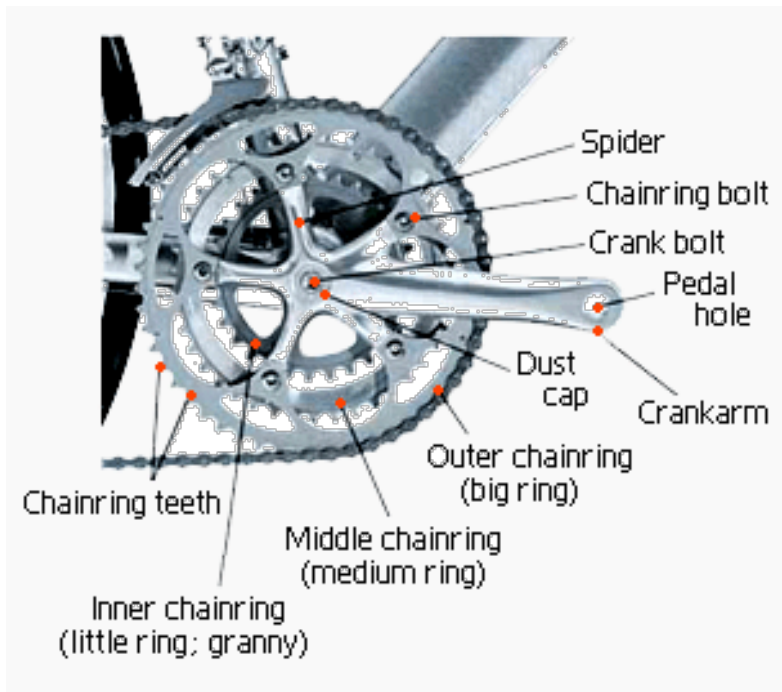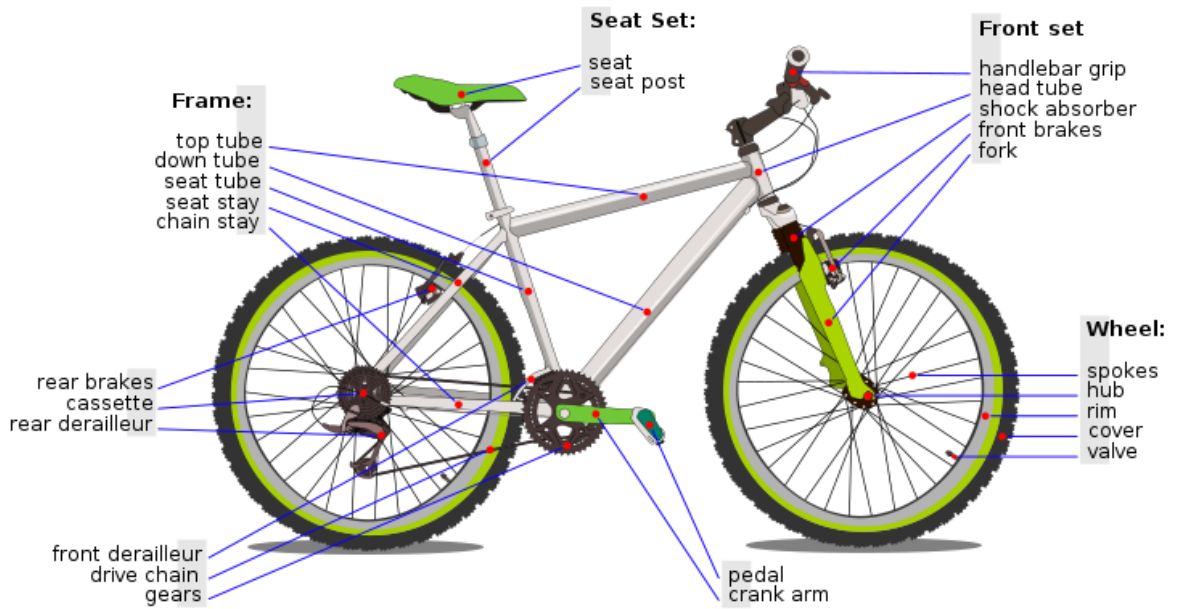A) Wheel diameter in inches

C) Number of teeth in rear sprocket

Gear ratio calculation:

Chainring: 32 teeth

Cog: 18 teeth

Gear ratio :   32 / 18 = 1.78

Seat Set:
seat
seat post

Front set
handlebar grip
head tube
shock absorber
front brakes
fork

Frame:
top tube
down tube
seat tube
seat stay
chain stay

Wheel:
spokes
hub
rim
cover
valve

rear brakes
cassette
rear derailleur

front derailleur
drive chain
gears

pedal
crank arm

Spider
Chainring bolt
Crank bolt
Pedal hole
Dust cap
Crankarm
Outer chainring (big ring)
Chainring teeth
Middle chainring (medium ring)
Inner chainring (little ring; granny)

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Most often, a beginner cyclists get confused about which gear to use and when. However, mastering the art of using the front and rear derailleur will make climbs easier and descents faster if you are able to match the gear to your speed, just as you do when driving a car. Selecting the wrong gear can put unnecessary strain on body, especially on knees, as well the bike.
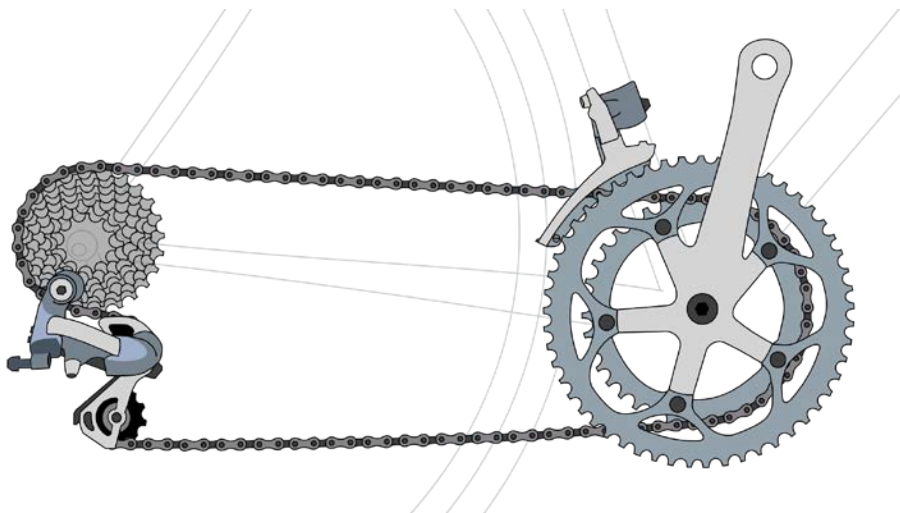
You can think of gears as the same as speeds -- a bike with 18 gears is an 18-speed bike. Bikes generally have 1, 3, 18, 21, 24, or 27 speeds. (10- and 15-speeds are obsolete and you do not see them on new bikes any more.)

Lower numbers are the low gears, and higher numbers are the high gears. First gear is a low gear. Twenty-first gear is a high gear. Shifting means going from one gear to another. You shift gears by sliding the shifter on the handlebars. On most bikes this shifts the chain onto a different sized ring. On three-speed bikes the gears are inside the hub of the wheel so you do not see them. Downshifting means going to a lower gear, and upshifting means going to a higher gear. You can also say shift down and shift up.
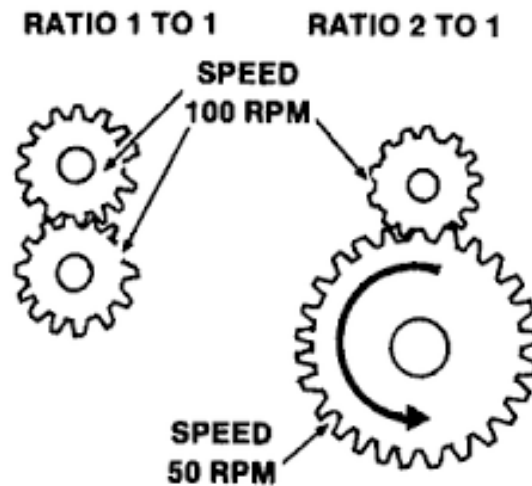
If you are on a three-speed bike, in second speed, and you start to go up a hill. Suddenly your legs can not spin the pedals as fast and you are going so slowly you think you might fall over. The solution? Downshift to first gear.

How does that solve the problem? First gear moves you a shorter distance for each spin of the pedals, which makes it easier to pedal.

GOING DOWN HILL:
LOAD IS LOW
USE GEAR RATIO WITH
INCREASED SPEED AT
LOW OUTPUT TORQUE

GOING UP HILL:
LOAD IS HIGH
USE GEAR RATIO WITH
INCREASED OUTPUT
TORQUE AT LOW SPEED

(Source: http://curriculum.vexrobotics.com/curriculum/mechanical-power-transmission/gear-ratios)

Now let's say you have reached the top of the hill, and you start going downhill slightly. Soon you feel that there is no resistance in the pedals -- you can spin them as

fast as you want and you are not really getting anywhere. Solution? Upshift back to 2, and if it is still too easy, then upshift to 3. This works because the higher gears move you farther for each spin of the pedals, making you do more work.

For a bicycle to travel at the same speed, using a lower gear (higher mechanical advantage) requires the rider to pedal at a faster cadence, but with less force. Conversely, a higher gear (smaller mechanical advantage) provides a higher speed for a given cadence, but requires the rider to exert greater force. Gain ratio and gear ratio of bicycles are explained using the following equations:

Gain ratio = (Radius of drive wheel / length of pedal crank) × (number of teeth in front chainring / number of teeth in rear sprocket).

Gear inches = Diameter of drive wheel in inches × (number of teeth in front chainring / number of teeth in rear sprocket).

Activity

Using the tape measure or ruler, the radius of the gear on wheel is measured. This is the distance from the center of the gear to where the chain sits on the teeth of the gear. Then, the radius of the gear on the pedals is measured.
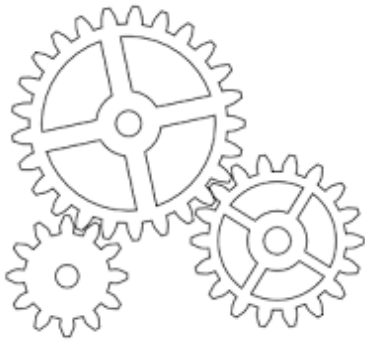
Data Table 1

	Wheel gear radius	Pedal gear radius	Wheel revolutions after 1 pedal revolution	Wheel revolutions after 5 pedal revolutions
Trial 1				
Trial 2				
Trial 3				

Gear ratio is the reciprocal of the ratio of revolutions.

Data Table 2

	gear ratio	Ratio of Revolutions: 1 pedal revolution	Ratio of Revolutions: 5 pedal revolutions	Ratio of Revolutions: average	Reciprocal of average
Trial 1					
Trial 2					
Trial 3					

Activity 12: Slippery When Wet

Developed by: Berrin Tansel

This activity involves a series of activities that are designed to demonstrate the effects of friction and how surface conditions and friction forces. Activity involves shoes with different types of soles, a flat surface with adjustable height (inclination). Effects of moisture and surface inclination on friction are observed.

Materials

- 2 pieces of wood board (lumber with 4 feet long, 6 inches wide, 2 inches thick)

- 10 bricks

- 1 gallon water

Activity

1. Make one board wet using water.

2. Place the dry and wet wood boards on the floor and ask one student to walk on them while they are flat on the floor.

3. Add one brick at a time to one end of the board so that the incline is increased.

4. Ask the students to walk on them. Students observe when they feel the slipping on the board and which board becomes more slippery.

5. Discuss why wet board become slipper and why incline makes it difficult to walk on the boards.

Activity 13: Comparing Surface Friction

Developed by: Berrin Tansel

This activity is used to illustrate effect of surface characteristics on friction. Participants feel and see different surfaces and guess which type of surface would have the highest friction and which types of shoes may be suitable to walk on those surfaces.

Hands on activity

Following shoe and surface schematics can be reduced to fewer choices for elementary school students (i.e., 6 types of shoes and 6 types of surfaces).

This activity can be demonstrated as a game. For game options, the images are printed in color and separated so that each card contains one image. Students see the type of shoe and try to match with an appropriate surface. Discuss why some shoes/soles are not appropriate to walk on some of the surfaces.

a	**b**	**c**
d	**e**	**f**
g	**h**	**i**
j	**k**	**l**

Shoes

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Surfaces

Activity 14: Measuring Wear on Tires

Developed by: Berrin Tansel

Road surface and tire conditions are discussed. Students identify different types of wear and causes. Low friction coefficients of worn tires on wet surfaces are discussed.

Students inspect the tires on a car. Using a penny, participants measure the tread depth on all four tires. Students should measure the tread depth at different locations on the tires to identify different types of wear that can occur.

Worn tires have lower friction. Vehicles with worn tires cannot stop easily. When the road surface is wet, this becomes very dangerous.
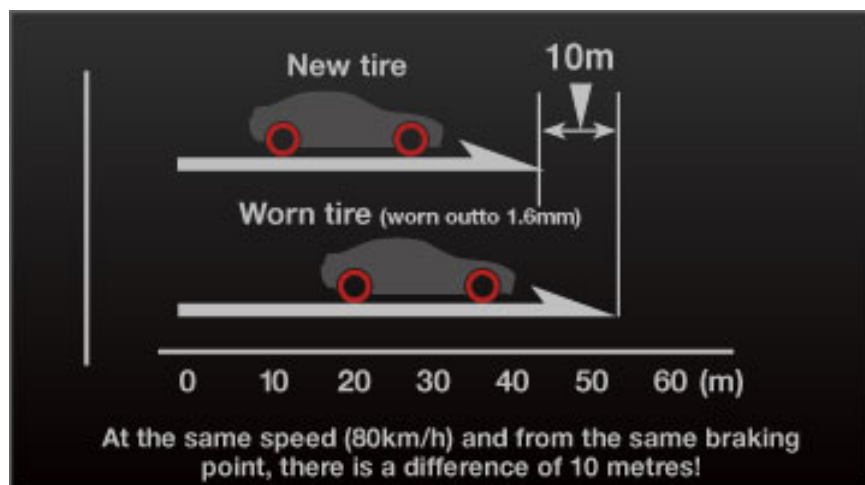
Tire reaches wear limit and must be replaced when the tread depth is 1.6 mm or leveled with the TWI (Tread Wear Indicator). Factors that affect tire life are:

- Driving habits and styles

- Tires paired with correct vehicle model

- Different road surfaces

- Vehicle and tire maintenance

- Improper wheel alignment

- Braking system error

How to read a tire
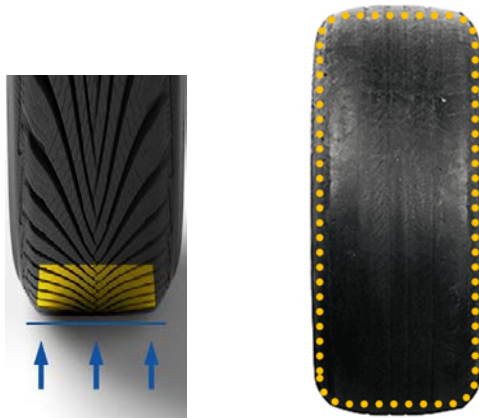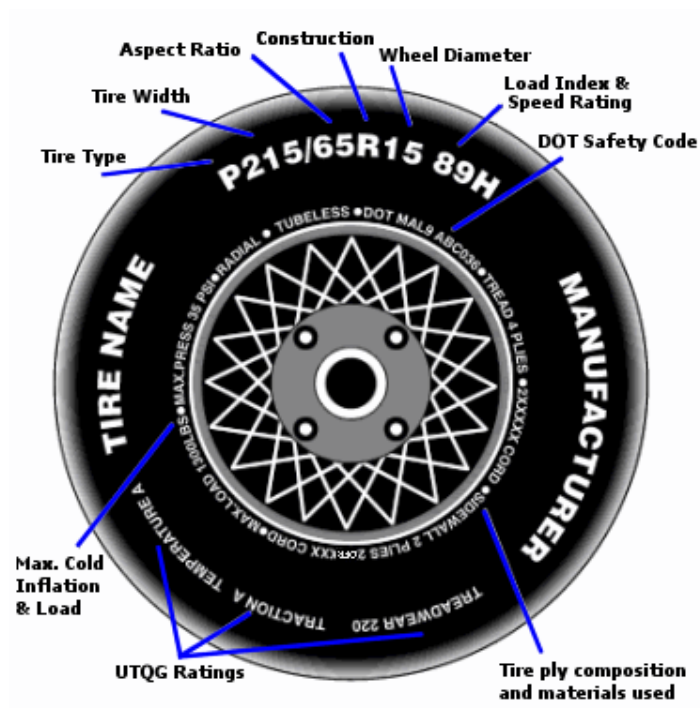
From: http://www.tamimi-commercial.com/
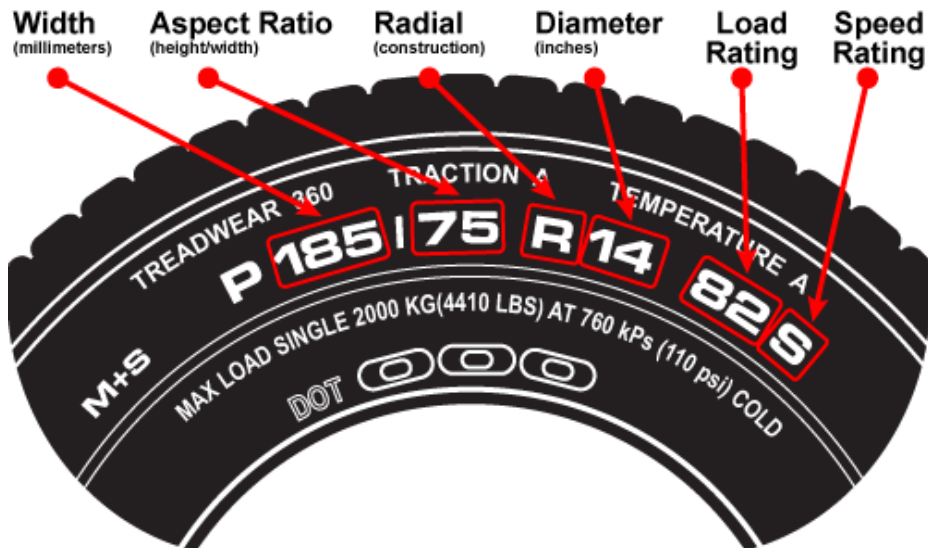
Tire specifications

The "185" is the nominal width of the tire's cross section in millimeters. The "70" is the aspect ratio-the ratio of the sidewall's height to the cross-section width. (Here the height of the sidewall measures 70 percent of 185 mm, or about 130 mm). The "R" stands for radial-ply construction, which is how virtually all passenger-car tires are made today. The "14" stands for the diameter, in inches, of the wheel the tire is designed to fit

Load Index and Speed rating

The "82" is a code representing the maximum weight the tire can carry at the speed indicated by its speed-rating symbol; The "S" the speed rating means the manufacturer has certified the tire to be safe at a maintained 186 Km/h. Other common speed rating; "T", 190 Km/h; "U", 200; "H", 210; "V", 240; and "Z", more than 240

Temperature Resistance

The higher the speed, harder the driving, and heavier the load, the hotter the tires run. This is an index of the tire's ability to tolerate high temperatures without failing. "A" is the highest grade, "C" is the lowest.

Maximum Load and Pressure

According to its markings, this tire can support up to 545 Kg, including the car, its occupants, and luggage. Tires should be inflated to the pressure recommended by the auto maker - and never above the maximum pressure stated on the sidewall (i.e., 35 pounds per square inch).

Traction

An index of stopping ability on wet pavement, based on tests run by the tire maker, "A" is the highest grade, "C" is the lowest.

Tire Manufacturing Date

The number includes a code that identifies the plant where the tire was manufactured The last four digits, "0304", reveal the week and year the tire was made (in this case, the third week of 2004).

Tread Wear Index

A comparative rating of a tire's resistance to tread wear, based on tests that the tire make runs. A tire graded "420" should last about 4.2 times as long as a tire graded "100", although the car, driving conditions, and driving style affect tread life considerably.

Inside a tire
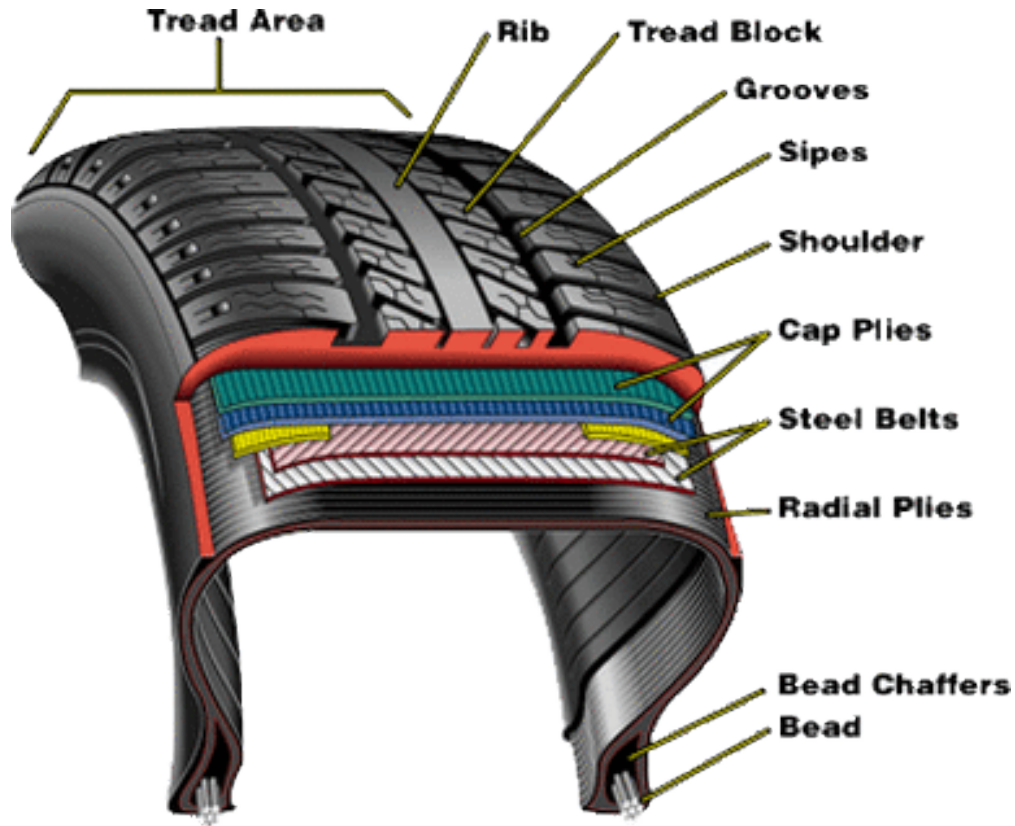
Source: http://tires.about.com/od/understanding_tires/a/What-Tires-Are-Made-Of.htm

Plies: The body plies constitute the tire's basic skeletal structure. Plies are usually composed of

polyester or other fiber cords wound together and sandwiched in rubber as well. Radial plies all

run perpendicular to the direction of the tire's spin, and it is this pattern that gives a "radial" tire

its name, as opposed to "bias-ply" tires in which the plies are placed at overlapping angles. Fiber

cords are used because they are quite flexible, but inelastic, that is, they do not stretch.

Steel Belts: The steel belts run longitudinally around the circle of the tire. Steel belts are made up of thin steel wires that are woven together into thicker cords, then woven again to form large sheets of braided steel.The sheets are then sandwiched between two layers of rubber. Most passenger tires contain two or three steel belts. Some manufacturers will now also wind Kevlar cord or other materials around the belts to improve rigidity and other running characteristics.

Cap Plies: Above the steel belts and towards the tread are the cap plies, which are much like the steel belts, except that the sheets are composed of woven fibers, again usually nylon, Kevlar or other fabrics. Many tires are now made with "jointless" steel belts and cap plies. Instead of simply clamping the ends of the belts or plies together, which creates a slight roundness irregularity in the tire, the ends are woven or otherwise seamlessly connected. This tends to result in a smoother-running tire.

Bead and Chaffer: The area where the tire seats against the edges of the wheel, creating the seal that holds air in the tire is called the bead on both the wheel and the tire. In tires, the beads are composed of two braided steel cords encased in a very thick rigid plug of rubber called the chaffer. The chaffer protects the body plies against abrasion from the steel bead wires and helps to stiffen the bead area of the tire.

Liner: Covering the inside of the tire is the thin rubber liner. The rubber of the liner is made as gas-impermeable as possible, but air will still slowly leak out of the tires via osmosis.

Sidewall: In construction terms the tire sidewall is the outer layer of rubber in the sandwich of materials that runs vertically from the bead to the tread
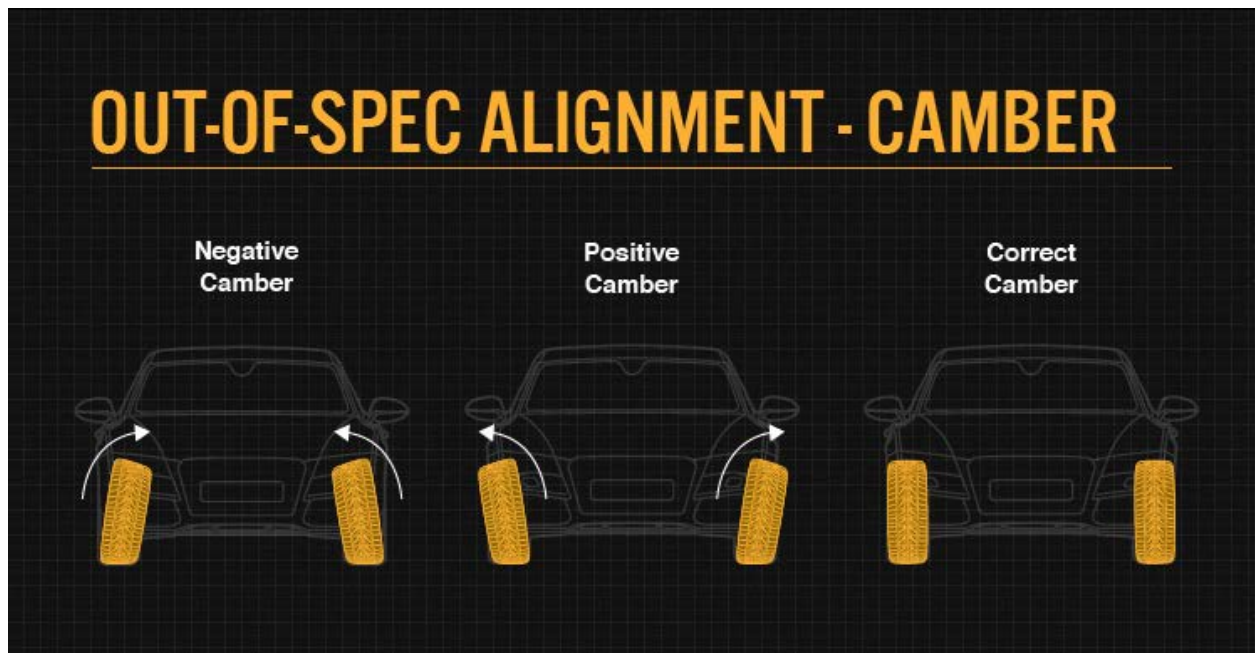
Tread Area: Above one or more layers of cushioning gum, which help to give a softer ride, lies the business end of the tire – the tread.
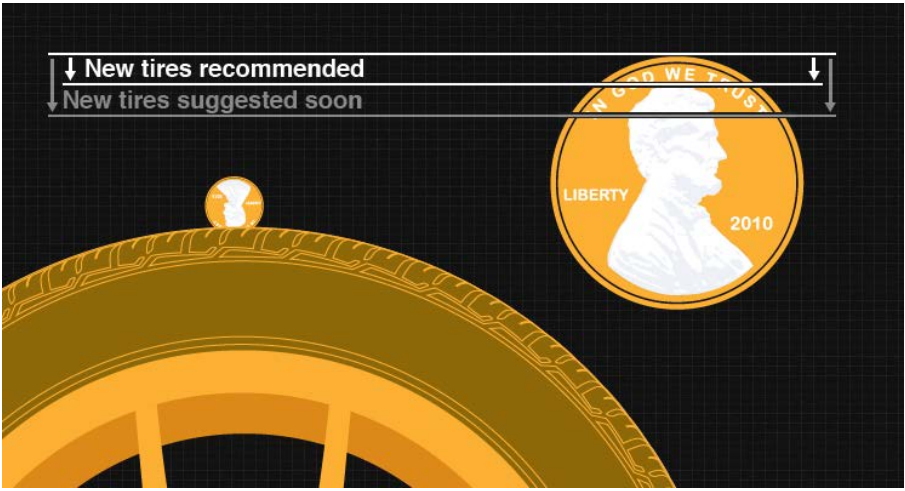
Grooves and Sipes: The tread area is separated into independent tread blocks by the deep channels known as grooves, which both define the tread blocks and help to channel water out from underneath them.

Rib: Many tires feature an unsiped central rib. By reinforcing the natural weak point at the center of the tread, the rib increases the rigidity of the tire in several dimensions.

Shoulder: The beveled or rounded area where the tread turns into the sidewall. How the shoulder is formed and siped affects how the tire corners. The shoulder flexes more than just about any other part of the tire. Nail punctures or other kinds of damage to the shoulder should not be plugged or patched, as the shoulder flex will eventually work the repair loose.
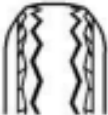
Tire wear

A **Over inflation**	**B** **Underinflation**	**C** **Camber wear**
D **Spotty/chopped wear**	**E** **New tread**	**F** **Worn tread**

http://www.bridgestonetire.com/content/dam/bridgestone/consumer/bst/research/tread-depth.png

Tire wear, characteristics, and measuring wear with a penny.

Students inspect the tire on a car. Identify its specifications. Examine and identify different

tyepes of wear, if any, and possible causes using the following chart:

Tire Wear Diagnostic Chart

Wear Pattern		Cause	Action
	Center Wear	Over Inflation	Adjust pressure to particular load per tire catalog
	Edge Wear	Under Inflation	Adjust pressure to particular load per tire catalog
	Side Wear	Loss of camber or overloading	Make sure load doesn't exceed axle rating. Align at alignment shop
	Toe Wear	Incorrect toe-in	Align at alignment shop
	Cupping	Out-of-balance	Check bearing adjustment and balance tires
	Flat Spots	Wheel lockup & tire skidding	Avoid sudden stops when possible and adjust brakes

Source: http://blog.ptrailerusa.com/2013_09_01_archive.html

Activity 15: Raft Rally

Adapted by: Berrin Tansel

This activity involves designing a "raft" from a 20 cm x 20 cm piece of aluminum foil that will hold the highest number of pennies.

Activity 1

Materials

- Aluminum foil cut into 20 cm x 20 cm pieces (2 pieces for each team)

- 4 plastic straws (for each team)

- 200 pennies

- A rectangular plastic container which can hold between 3-4 gallons of water

- 3 gallons of water

Each team is provided with 2 sheets of foil and 4 straws. The teams will use one sheet experiment their concept design for the raft. Completed rafts will be placed on a table. Each raft

will be tested individually. Pennies, one at a time will be added to the raft. When it appears that the raft is nearing its maximum load, wait a few seconds between adding pennies. At the point that any amount of water enters the raft, it is considered it reached its carrying capacity.

Activity 2

Materials

- Aluminum foil cut into 20 cm x 20 cm pieces (1 piece for each team)

- 8 plastic straws (for each team)

- 200 pennies

- A rectangular plastic container which can hold between 3-4 gallons of water

- 3 gallons of water

The rafts will be completed such that the teams can use up to 6 straws to build the raft with a sail. Each raft will be placed on water loaded with 10 pennies. Two members from each team will use straws (one straw each) to blow air to move the raft on water. The times for the rafts to travel 30 cm distance will be recorded. The team with the shortest time wins.

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