



SHOOT! Projectiles & Space COUNSELOR EDITION

1. Watch or research. Choose option a, b, or c and complete all the requirements:
 - a. Watch 3 episodes/hours of NOVA, NASA, or other media productions (examples include Discovery Channel, Science Channel, National Geographic, and the History Channel. NASA also has some short multimedia clips) that involve projectiles, aviation, space, weather, astronomy, or aviation and/or space technology.
 - i. Make a list of at least two questions or ideas from each production
 - ii. Discuss the ideas and questions with your counselor
 - b. Read at least three articles about projectiles, aviation, space, weather, astronomy, or aviation and/or space technology. (Examples of magazine sources include Odyssey, Popular Mechanics, Popular Science, Science Illustrated, Discover Magazine, Air and Space, Popular Astronomy, Astronomy Magazine, Science News, Sky and Telescope, Natural History, and Scientific American).
 - i. Make a list of at least two questions or ideas from each article
 - ii. Discuss the ideas and questions with your counselor
 - c. Do a combination of reading and watching
 - i. Make a list of at least two questions or ideas from each article or production
 - ii. Discuss the ideas and questions with your counselor

2. Complete a merit badge from the following list. (If you have already completed one of these merit badges, please complete a different merit badge for this award.)

Archery

Astronomy

Athletics

Aviation

Rifle Shooting

Robotics

Shotgun Shooting

Space Exploration

Weather

3. Projectile Motion – choose option a or b and complete all the requirements.

a. Simulations -

- i. Find and use a projectile simulation applet on the internet.

Possible links:

- a. <http://www.mhhe.com/physsci/physical/giambattista/proj/projectile.html>
- b. http://galileoandstein.physics.virginia.edu/more_stuff/Applets/ProjectileMotion/enapplet.html
- c. <http://www.walter-fendt.de/ph14e/projectile.htm>

- ii. Design and complete a hands-on experiment to demonstrate projectile motion.

1. Keep a record of the

- a. Angle
- b. Time
- c. Distance

2. Graph the results of your experiment (Note – using a high speed camera or video camera may make the graphing easier, as will doing many repetitions using variable heights for where the projectile can land.)

- iii. Explain to your counselor

1. the definition of

- a. a projectile

Projectile

- an object that is fired, launched, or thrown, but which cannot propel itself

-a self-propelled missile, like a rocket

- b. projectile motion

Projectile motion is the curved path taken by an object that is fired, launched, or thrown.

http://www.ncsec.org/cadre2/team1_2/pm.htm

2. Discuss the factors affecting the path of a projectile.

When an object is fired, launched, or thrown, it is given **horizontal velocity**. (Velocity is the same as speed, but it is speed in a given direction.) Once the object is launched, no additional horizontal velocity giving force is applied. Newton's

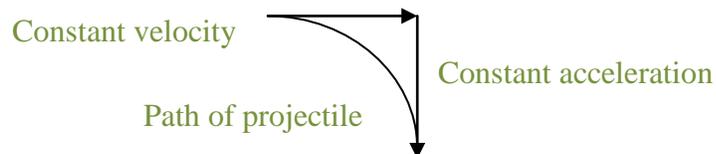
First Law of Motion states that a body at rest stays at rest and a body in motion stays in motion unless acted upon by an outside force. If gravity did not act on the projectile's path, the object would continue to move in the direction it was launched.

Once the object has been launched, the only force acting upon it is the **force of gravity**, which accelerates the object toward the earth.

(<http://www.regentsprep.org/regents/physics/phys01/accgravi/index.htm>)

<http://www.physicsclassroom.com/class/1dkin/u1l5b.cfm>

Projectile motion is caused by the force of gravity giving vertical acceleration to an object that has horizontal velocity. (If an object is thrown straight up in the air, the force of gravity slows it down, it comes momentarily to a complete stop, then accelerates downward.) An object which has been launched will continue to move in the direction it was thrown at the speed with which it was thrown (except for being slowed down by friction with the air – air resistance), but it will begin to accelerate toward the earth, moving faster toward the earth all the time. The combination of constant horizontal velocity and increasing downward velocity due to the acceleration of gravity is what gives a projectile its curved path.



<http://www.physicsclassroom.com/class/vectors/u3l2a.cfm>

3. Discuss the difference between forward velocity and acceleration due to gravity.

Forward velocity is the speed horizontal to the earth given to a projectile. If the projectile is thrown parallel to the earth, all of its original speed will be its forward velocity. If an object is thrown at an angle to the earth, the forward velocity is that portion of the velocity that is parallel to the earth. (Determining forward velocity can be done by separating the velocity into horizontal and vertical components - like on a triangle - using vector resolution <http://www.physicsclassroom.com/class/vectors/u3l1e.cfm#trig> and <http://www.physicsclassroom.com/class/vectors/u3l2d.cfm>.)

Forward velocity has a constant speed.

Acceleration due to gravity slows things down that are moving upwards and speeds things up that are moving downwards. At most locations on earth, the acceleration of gravity (9.80 m/s^2 or $\sim 32.174 \text{ ft/s}^2$). will cause an object to fall 9.8 meters/second faster every second. An object starting with no vertical motion will be falling toward earth at the rate of 9.8m/s at the end of one second and at the rate of 19.6m/s at the end of two seconds.

Acceleration due to gravity is constantly changing the vertical speed/velocity of an object.

b. Discover-

- i. Explain to your counselor the difference between escape velocity (not the game), orbital velocity, and terminal velocity.

Escape Velocity is the speed at which an object will be able to escape the gravity of the earth, moon, or other body. An object must travel fast enough that it will not fall back to the surface. **Escape velocity from the earth is 11.2 km/s or 25038.72 mph.** <http://hyperphysics.phy-astr.gsu.edu/hbase/vesc.html> Escape velocity is proportional to the square root of the ratio between the mass of the larger body and the distance of the smaller object from the center of the larger body.

<http://science.howstuffworks.com/framed.htm?parent=satellite.htm&url=http://www.kidsplanet.com/ce5/CE017285.html>

<http://www.qrg.northwestern.edu/projects/vss/docs/space-environment/2-whats-escape-velocity.html>

Orbital Velocity - An object goes into orbit (achieves **orbital velocity**) when its horizontal velocity balances the acceleration of gravity at that location in space. An object that has orbital velocity continues to fall toward the earth as it travels away from the earth, giving the object a circular path around the earth. The object continually falls around the earth due to the combination of horizontal velocity and acceleration due to gravity.

Terminal velocity - The point at which the acceleration of gravity on an object matches the air resistance of the object. Terminal velocity is affected by the weight of the object and the orientation of the object. (The more surface area that is horizontal to the earth, the lower the terminal velocity. Skydivers who perform aerial displays use this fact. The first divers to jump lie flat to increase their air resistance while later divers streamline dive to catch them in the air.)

NOTE: If it were not for air resistance, all objects, regardless of mass, size, or any other factor, would fall at the SAME velocity.

Watch – Astronauts David Scott and Jim Irwin do Galileo’s experiment on the moon <http://er.jsc.nasa.gov/seh/feather.html>

ii. Do two of the following (you may wish to explore internet sites to find this information). <http://science.howstuffworks.com/satellite3.htm>

1. Why are satellites usually launched toward the east and what is a launch window?

When satellites are launched to the east, the spin of the earth effectively adds to their velocity, making escape velocity easier to obtain and requiring less fuel. Not all spacecraft are launched toward the east; launch direction depends also on the final orbit and purpose of the satellite.

<http://www.braeunig.us/space/orbmech.htm>

http://www.eumetsat.int/Home/Main/Satellites/SatelliteProgrammesOverview/SP_20100427133512861?l=en

In order for a spacecraft to rendezvous with another spacecraft or other object in space, the launch must occur at a time when the orbits of the two will overlap in the future. A **launch window** describes a time period in which a mission must be launched in order to match orbits.

http://www.esa.int/esaSC/SEMO49YO4HD_index_0.html

“The perfect launch window requires the coincidence of orbits and their inclinations, precession, weather and

lighting.” <http://www.npr.org/templates/story/story.php?storyId=4749663>

http://www.nasa.gov/audience/forstudents/brainbites/nonflash/bb_home_launchwindow.html

2. What is the average terminal velocity of a skydiver? (What is the fastest you would go if you were to jump out of an airplane?)

Terminal Velocity is when the acceleration due to gravity is matched by the air resistance (or resistance of whatever fluid the object is travelling through). When the acceleration of gravity is balanced by air resistance, the object continues to fall, but it does not increase its velocity.

"A person has a terminal velocity of about 200 mph when balled up and about 125 mph with arms and feet fully extended to catch the wind." 49-89 m/s

<http://hypertextbook.com/facts/JianHuang.shtml>

Also check:

<http://exploration.grc.nasa.gov/education/rocket/termvr.html>

3. How fast a bullet, baseball, airplane, or rocket would have to travel in order to escape Earth's gravitational field? (What is earth's

escape velocity?) Escape velocity from the earth is 11.2 km/s or 25038.72 mph.

4. Visit or view. Choose one and complete all the requirements.
 - a. Visit
 - i. Choose one
 1. An observatory
 2. A flight, aviation, or space museum
 - ii. Talk to a docent or person in charge about a science topic related to the site.
 - iii. Discuss your visit with your counselor.
 - b. View
 - i. Discover your latitude and longitude coordinates.
 - ii. Find the time for a satellite to pass over your area. (A good resource to find the times for satellite passes is <http://www.heavens-above.com/>)
 - iii. Watch the satellite using binoculars.
 - iv. Record
 1. The time of your viewing
 2. The weather conditions
 3. How long the satellite was visible
 4. The path of the satellite
 - v. Discuss your viewing with your counselor.
5. Hands-ON! Choose a, b, or c and complete all the requirements.
 - a. Design and build a catapult that will launch a marshmallow a distance of four feet.
 - i. Keep track of your experimental data
 1. Angle of launch
 2. Distance projected
 - ii. Make sure you apply the same force every time - perhaps you could use a weight to launch the marshmallow.
 - iii. Discuss your design, data, and experiments, both failures and successes, with your counselor.
 - b. Design a pitching machine that will lob a softball into the strike zone.
 - i. At what angle and velocity will your machine need to eject the softball in order for the ball to travel through the strike zone from the pitcher's mound?
 - ii. How much force you will need to apply in order to power the ball over the distance to the plate?
 - iii. If you were to use a power supply on your machine, what would be your power source and why?
 - iv. Discuss your design, data, and experiments, both failures and successes, with your counselor.

- c. Design and build a marble run or roller coaster that includes an empty space where the marble has to jump from one part of the chute to the other.
http://www.ehow.com/how_6352569_make-toy-marble-run.html
- i. Keep track of your experimental data for every try. Include:
 1. Vertical angle between the two parts of the chute
 2. Horizontal distance between the two parts of the chute
 - ii. Experiment with different heights to start the marble.
 1. How do the start heights affect the velocity of the marble?
 2. Does a higher start height allow a greater jump distance?
 - iii. Discuss your design, data, and experiments, both failures and successes, with your counselor.



1. Watch or Research. Choose option a, b, or c and complete all the requirements:
 - a. Watch 3 episodes/hours of NOVA or other media productions (examples include Discovery Channel, Science Channel, National Geographic, and the History Channel) that involve transportation or transportation technology.
 - i. Make a list of at least two questions or ideas from each production
 - ii. Discuss the ideas and questions with your counselor
 - b. Read at least three articles about transportation or transportation technology. (Examples of magazine sources include Popular Mechanics, Popular Science, Science Illustrated, Discover Magazine, Professional Motor Mechanic, Odyssey, and Scientific American). **Good resources, but NOT an exhaustive list -**
 1. <http://www.popularmechanics.com/cars/alternative-fuel/>
 2. **Diesel fuel history and future** <http://www.edmunds.com/fuel-economy/diesel-reborn.html>
 3. **Aviation Week, alternative jet fuels,** http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=bca&id=news/bca0907p3.xml&headline=null&prev=10
 - ii. Make a list of at least two questions or ideas from each article
 - iii. Discuss the ideas and questions with your counselor
- c. Do a combination of reading and watching
 - i. Make a list of at least two questions or ideas from each article or production
 - ii. Discuss the ideas and questions with your counselor

2. Complete a merit badge from the following list. (If you have already completed one of these merit badges, please complete a different merit badge for this award.)

- | | |
|------------------------|----------------------|
| Automotive Maintenance | Motor Boating |
| Aviation | Railroading |
| Canoeing | Small-Boat Sailing |
| Cycling | Space Exploration |
| Farm Mechanics | Truck Transportation |

3. Energy Sources

- a. Using the requirements from the above list of merit badges,
 - i. Tell your counselor the energy source(s) for the types of transportation in the listed merit badges
 - ii. Discuss the pros and cons of each energy source with your counselor

Automotive Maintenance Gasoline, Diesel fuel, Electric, Blended gasoline, Biodiesel, Hybrid	Motor Boating Gasoline, Diesel fuel, Blended gasoline, Biodiesel
Aviation Aviation fuel/kerosene	Railroading Diesel fuel
Canoeing Human power	Small-Boat Sailing Wind
Cycling Human power	Space Exploration Most common solid - Ammonium perchlorate mixed with powdered aluminum Liquids for first stage rockets - RP-1 Liquids for second stage rockets – liquid hydrogen, liquid oxygen
Farm Mechanics Diesel fuel	Truck Transportation Diesel fuel

1. Places to start - Fuel types pros and cons

- a. <http://www.carsdirect.com/car-buying/diesel-fuel-vs-unleaded-gasoline-understand-the-pros-and-cons> Pros and cons of gasoline and diesel for cars
- b. <http://www.carsdirect.com/car-buying/diesel-fuel-vs-unleaded-gasoline-understand-the-pros-and-cons> pros and cons of electric vs. gasoline for cars
- c. http://www.ehow.com/facts_5098606_pros-cons-biodiesel-fuel.html Pros and cons of biodiesel

- d. http://www.centennialofflight.gov/essay/Evolution_of_Technology/fuel/Tech21.htm Aviation fuel
 - e. <http://www.csgnetwork.com/jetfuel.html> Aviation jet fuel information
 - f. <http://www.suite101.com/content/todays-marine-fuel-choices-a27218> Motor boat fuel choices
 - g. <http://www.scientificamerican.com/article.cfm?id=what-kind-of-fuel-do-rock> Rocket fuel types
- b. Make a list of other sources of energy that may be possible to use in transportation
 - c. With your counselor
 - i. Discuss alternative sources of energy
 - ii. Discuss the pros and cons of using alternative energy sourcesPlaces to start:
 - a. A Student's Guide to Alternative Fuels
<http://www.energyquest.ca.gov/transportation/index.html>
 - b. Overview of Alternative fuels
<http://www.edmunds.com/fuel-economy/ethanol-fuel-cell-biodiesel-an-alternative-fuel-overview.html?articleid=110054&>
 - c. Department of Energy Comparison of Alternately-fueled Vehicles
http://www.afdc.energy.gov/afdc/vehicles/electric_benefits.html
 - d. Alternative fuels for Vehicles
<http://www.fueleconomy.gov/feg/current.shtml>
 - e. Aviation alternative fuels
<http://www.energybulletin.net/node/23098>
2. Solar Power
 - a. Introduction to Solar Energy
<http://www.ccs.neu.edu/home/feneric/solar.html>
 - b. Solar Power for Transportation
<http://gas2.org/2008/03/25/how-solar-panels-could-power-90-of-us-transportation/>
 3. Nuclear Power
 - a. Nuclear Power to Reduce Oil Imports
<http://www.ans.org/pi/ps/docs/ps82.pdf>
 - b. Nuclear Power and the Environment
<http://www.eia.doe.gov/cneaf/nuclear/page/nuclearenvissues.html>
 4. Wind Power
 - a. Wind and Solar Powered Vehicle
 - i. <http://inhabitat.com/venturi-eclectic-the-1st-energy-autonomous-vehicle/>
 - ii. <http://windpowerauthority.com/wind-power-for-cars/>



WHOOSH!

COUNSELOR EDITION

1. Watch or research. Choose a, b, or c and complete all the requirements:
 - a. Watch 3 episodes/hours of NOVA or other media productions (examples include Discovery Channel, Science Channel, National Geographic, and the History Channel) that involve motion or motion-inspired technology. (NOVA website on Ancient Egypt and the use of levers <http://www.pbs.org/wgbh/nova/egypt/raising/lever.html>)
 - i. Make a list of at least two questions or ideas from each production
 - ii. Discuss the ideas and questions with your counselor
 - b. Read at least three articles about motion or motion-inspired technology. (Examples of magazine sources include *Odyssey*, *Popular Mechanics*, *Popular Science*, *Science Illustrated*, *Discover Magazine*, and *Scientific American*).
 - i. Make a list of at least two questions or ideas from each article
 - ii. Discuss the ideas and questions with your counselor
 - c. Do a combination of reading and watching
 - i. Make a list of at least two questions or ideas from each article or production
 - ii. Discuss the ideas and questions with your counselor

2. Complete a merit badge from the following list. (If you have already completed one of these merit badges, please complete a different merit badge for this award.)

Archery
Auto Mechanics
Aviation
Bugling
Canoeing
Railroading

Rifle Shooting
Rowing
Shotgun Shooting
Small Boat Sailing
Truck Transportation

3. Machines

- a. Make a list or drawing of the six simple machines.

A lever is a rigid bar that turns around a fulcrum (a fixed point). The force, a push or a pull, which is applied to the lever is called the effort. The farther the effort is from the fulcrum, the easier it is to use the lever. What the lever moves is called the load or the resistance. Levers can change the direction of motion, make it easier to move something, or cause something to move a greater distance.

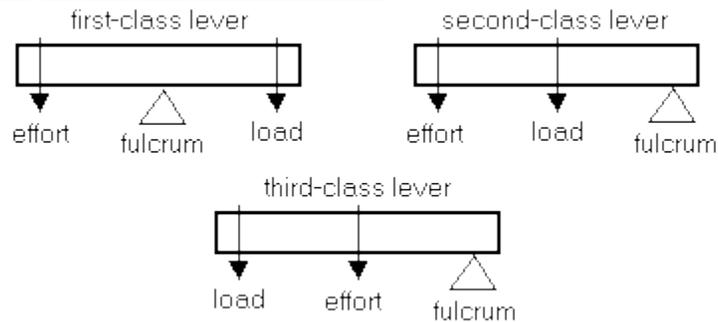
There are three classes of levers.

Class 1 lever. The fulcrum is located between the effort and the load. The direction the load moves is opposite to the direction of the effort. Depending on where the fulcrum is placed, a first class lever can either make the load move more easily or move a greater distance. Examples of first class levers include seesaws, crowbars, scissors, and pliers.

Class 2 lever. The fulcrum is at one end, the effort is at the other end, and the load is in the middle. The effort and the load move in the same direction. A Class 2 lever makes an object easier to move. Examples of second class levers include catapults, screwdrivers, nutcrackers, staplers, and wheelbarrows.

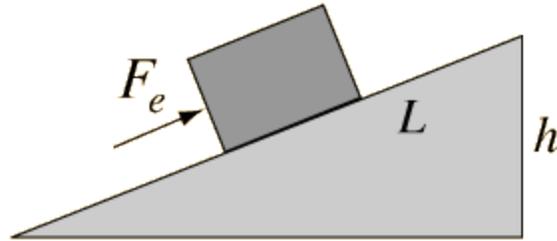
Class 3 lever. The fulcrum is at one end. The effort is applied between the fulcrum and the load. The effort and the load move in the same direction. A third class lever makes an object harder to move, but moves the object through a much greater distance than the effort force moves. Because the load end moves faster than the effort (it has to travel farther during the same time length) the load gains speed. Many sporting activities use Class 3 levers. Class 3 levers include bats, rackets, paddles, clubs, clubs, fishing poles, and brooms.

<http://www.fi.edu/pieces/knox/automaton/lever.htm>



http://www.google.com/imgres?imgurl=http://qldscienceteachers.tripod.com/junior/physics/simple01.gif&imgrefurl=http://qldscienceteachers.tripod.com/junior/physics/simple.html&usq=__jP9Gu_mQk1V7yyUxe0D92XCry=&h=164&w=361&sz=2&hl=en&start=34&sz=2=16PkDcKGGBs6vEwYCSg&zoom=1&tbid=gS9c8V1LSU7NJM:&tbh=92&tbw=202&ei=cA8TeSWBybG1Qe5

Incline Plane – a ramp (stair, hill, ladder) used to raise a load using less force. The mechanical advantage (ease to move) increases as the slope of the incline decreases but the load will then have to be moved a greater distance.



Incline $IMA = \frac{L}{h}$

Wedge – a moveable double incline plane used to separate object by the use of force (knife, ax, nail)

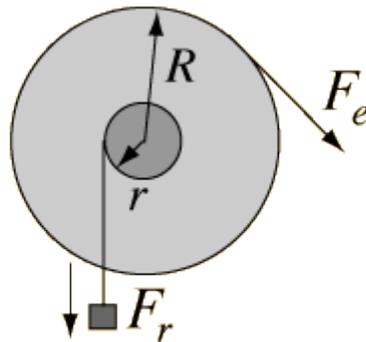


Wedge $IMA = \frac{L}{t}$

L = depth of penetration

t = separation of wedged surfaces

Wheel and Axle - essentially a modified lever, but it can move a load farther than a lever can. The center of the axle serves as a fulcrum.

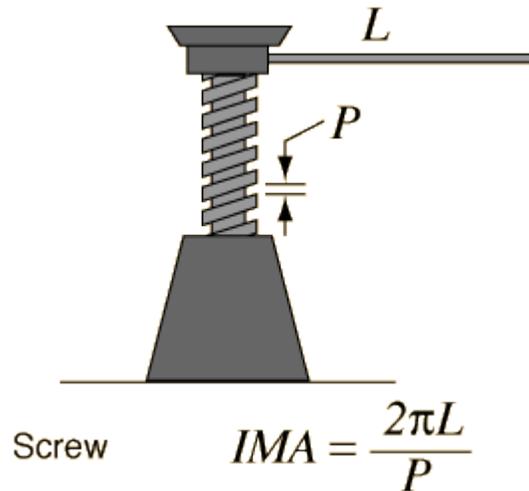


Wheel and axle $IMA = \frac{R}{r}$

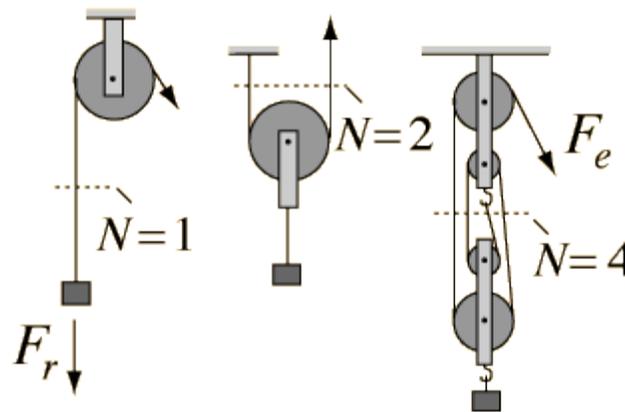
Gears, Belts, Cams, and Cranks include applications of wheel and axles.

<http://cnx.org/content/m13594/latest/>

Screw - an inclined plane wrapped in a spiral around a shaft.



Pulley- a wheel over which a rope or belt is passed. It is also a form of the wheel and axle. Pulleys are often interconnected in order to obtain considerable mechanical advantage. Pulleys may be used to change the direction of the force or to increase the ease of lifting an object.



Pulley $IMA = N$

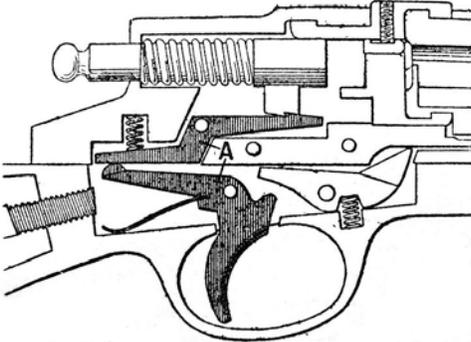
http://www.phy.ilstu.edu/pte/489.01content/simple_machines/simple_machines.html

- b. Be able to tell your counselor
- i. The name of each machine
 - ii. How it works.

http://www.constructionknowledge.net/general_technical_knowledge/general_tech_basic_six_simple_machines.php (This is a great resource about machines and how they work.)

<http://juniorengineering.usu.edu/workshops/machines/machines.php>

- c. With your counselor, discuss
 - i. The simple machines were involved with the motion in your chosen merit badge (Hint - look at the moving parts of an engine to find simple machines)

<p style="text-align: center;">Archery</p> <p>The bow is a lever and the hand is the fulcrum. Crossbows use a pulley Energy source is human power.</p>	<p style="text-align: center;">Rifle Shooting</p>  <p>http://en.wikipedia.org/wiki/File:Trigger_mechanism_bf_1923.jpg</p> <p>The fulcrum (pivot point) is between the effort (applied by the trigger finger) and where the pressure (the load or resistance) is applied to the spring.</p>
<p>Auto Mechanics Levers in pedals, gear shifts, Wheel and Axle Gears are compound machines based on screws and wheel and axles. http://www.edheads.org/activities/simple-machines/glossary.htm</p>	<p style="text-align: center;">Rowing Levers</p>
<p>Aviation Wheel and Axle Levers Pulleys Airplane propellers are a type of screw</p>	<p style="text-align: center;">Shotgun Shooting See Rifle Shooting</p>
<p>Canoeing Third class Lever</p>	<p style="text-align: center;">Small Boat Sailing Levers, Pulleys</p>
<p>Music Levers</p>	<p>Truck Transportation Levers in pedals, gear shifts. Wheel and Axle Gears are compound machines based on screws and wheel and axles. http://www.edheads.org/activities/simple-machines/glossary.htm</p>

Railroading Levers Wheel and axle http://cnx.org/content/m13594/latest/	
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ii. The energy source causing the motion for the subject of your merit badge
Wind, gasoline/fossil fuel, electric power, human power

iii. What you learned about motion from doing the requirements of the merit badge

4. Visit – choose one

a. An amusement park

i. Discuss with your counselor

1. What simple machines were present in at least two of the rides

2. What forces were involved in the motion of any two rides.

A Force is a push or a pull. Many rides use the force of gravity to cause changes in up and down motion. Rides that go in a circle use centripetal force.

b. A playground

i. Discuss with your counselor

1. What simple machines were present in the playground equipment

2. What forces are involved in the motion of any two playground fixtures.

A Force is a push or a pull. Many rides use the force of gravity to cause changes in up and down motion. Rides that go in a circle use centripetal force.

5. Design

a. Design, including a drawing or sketch, one of the following

i. A new amusement park ride

ii. A new playground fixture

iii. A new method of transportation

b. Discuss with your counselor

i. The simple machines present in your new design

ii. The energy source powering the motion of your new creation



DESIGNED TO CRUNCH COUNSELOR EDITION

1. Watch or Research, choose option a, b, c, or d and complete all the requirements:
 - a. Watch 3 episodes of NOVA or other media production that involve scientific models and modeling, math, physics, sports equipment design, bridge building, or Cryptography. (Examples of media productions include Discovery Channel, Science Channel, National Geographic, and the History Channel)
 - i. Make a list of at least two questions or ideas from each production
 - ii. Discuss the ideas and questions with your counselor
 - b. Research several on-line sites that discuss and explain Cryptography or the discoveries of people who extensively worked with cryptography
 - i. List and record (you may use the copy and paste function if you include your sources)
 1. The URLs of the sites you visited
 2. Major topics covered on the sites you visited
 3. How cryptography is used in the military and in everyday life
 - ii. Discuss with your counselor how a cryptographer uses mathematics (a sample site - <http://www.math.umass.edu/~gunnells/talks/crypt.pdf>)
 - c. Read at least three articles about physics, math, modeling, or cryptography. You may wish to read about how technology and engineering are changing sports equipment, why and how triangles are used in building, bridge building, engineering, climate and/or weather models, how banks keep information secure,

or about the stock market. (Examples of magazine sources include Popular Mechanics, Popular Science, Science Illustrated, Discover Magazine, Professional Motor Mechanic, *Odyssey*, and Scientific American.)

- i. Make a list of at least two questions or ideas from each article
 - ii. Discuss the ideas and questions with your counselor
 - d. Do a combination of reading, watching, or researching
 - i. Make a list of at least two questions or ideas from each article, site, or production
 - ii. Discuss the ideas and questions with your counselor
2. Merit badge
- a. Complete ONE merit badge from the following list. (If you have already completed one of these merit badges, please complete a different merit badge for this award.)

American Business	Plumbing
Architecture	Pottery
Drafting	Radio
Entrepreneurship	Salesmanship
Inventing	Space Exploration
Landscape Architecture	Surveying
Model Design and Building	Traffic Safety
Orienteering	Truck Transportation
Photography	Weather
Pioneering	Woodworking
 - b. Discuss with your counselor how the merit badge you completed uses mathematics
3. Calculate - choose TWO. (Write down your data and calculations to support your explanation to your counselor. Do not use someone else's data or calculations.):
- a. Your horsepower when you run up a flight of stairs

From <http://www.wikihow.com/Calculate-Your-Horsepower> Or use <http://onlinephys.com/labpower1.html>

 - **Find out how much you weigh in kilograms and write it down** (your weight in pounds multiplied by 0.454).
 - **Find a stair, ladder or something similar** (as long as it gets you upwards).
 - **Measure HEIGHT (not length) of the stairs (or whatever you use) to the ending point at the top and write it down**, this can be done by multiplying the height of one stair by the number of stairs (you don't care about how LONG the stairs are).
 - **Start off with a running start towards the stairs, once you step to the first step, start the timer, once both feet are on the top step, stop it.** Now you have all the numbers needed.
 - **Calculate the Power (P) with the formula:** mah/t ($m*9.80*h$)/ t , where m = mass (your weight) in kilograms, h = height of staircase in meters, 9.80 is the acceleration caused by Earth's gravity and t = time in seconds. The number you get is in Watts, which is equal to

Joules per second (J/s) and Newton meters per second (Nm/s). If you don't divide by time, you will calculate the energy needed to climb the stairs. (Work = mah, Power = mah/t. Work, and/or energy, is measured in Newton meters or Joules, Power is measured in Joules/second or Watts).

- **Divide the number of Watts by 745.6 to get the number in horsepower.**
 - i. How does your horsepower compare to the power of a horse?
 - ii. How does your horsepower compare to the horsepower of your favorite car? <http://www.wikihow.com/Calculate-Your-Horsepower>
<http://onlinephys.com/labpower1.html>
 1. Horsepower is a unit of power. One horsepower equals 33,000 ft-lbs of work per minute, or 745.6 watts. James Watt, who invented steam engines, based his unit of power on how much weight a real horse could pull from a coal mine in one minute. (Good information <http://www.web-cars.com/math/horsepower.html>)
 2. Most car information packets and on-line sites list the horsepower of the car.
- b. Attend at least two track, cross-country, or swim meets.
 - i. For each meet, time at least three racers (Time the same racers at each meet.)
 - ii. Calculate the average speed of the racers you timed. (Make sure you write down your data and calculations.)
 1. $Average\ speed = Distance / Time$
 - iii. Compare the average speeds of your racers
 1. To each other
 2. To their times at the two meets you attended.
 - iv. Show your calculations to your counselor.
- c. Attend a baseball, softball, or basketball game.
 - i. Choose two players
 - ii. Keep track of their efforts during the game. (Make sure you write down your data and calculations.)
 1. Calculate their statistics – examples:
 - a. Baseball or softball
 - i. Batting average
 - ii. Runs Batted In
 - iii. Fielding statistics
 - iv. Pitching statistics
 - b. Basketball
 - i. Points
 - ii. Baskets attempted
 - iii. Rebounds
 - iv. Steals and Takeaways
 - v. Turnovers
 - iii. Show your calculations to your counselor.
- d. Attend a football game or watch on TV. (Fun to do with a parent or friend!)
 - i. Keep track of the efforts of your team during the game. (Make sure you write down your data and calculations.) – examples:

1. Kick/Punt teams
 - a. Kickoff
 - i. Kick return yards
 - b. Punt
 - i. Number of punts
 - ii. Yards of each punt
 - c. Field goals
 - i. Attempted
 - ii. Percent completed
 - iii. Yards of each kick
 - d. Extra point
 - i. Attempted
 - ii. Percent completed
2. Offense
 - a. Number of first downs
 - b. Forward passes
 - i. Attempted
 - ii. Percent completed
 - iii. Length
 1. Longest
 2. Length of all passes
 - iv. Receivers
 1. Number of passes caught
 2. Length of passes caught
 3. Yards run after catching a pass
 - c. Running plays
 - i. Number of running plays
 - ii. Yards gained or lost
 1. Each run
 2. Longest run from scrimmage line
 3. Total yards gained
 - d. Number of touchdowns
3. Defense
 - a. Number of quarterback sacks
 - b. Number of interceptions
 - c. Number of turnovers
 - d. Number of safeties
 - ii. Show your calculations to your counselor.
4. Calculator (scientific or graphing)
 - a. Investigate your calculator – explore the different functions
 - b. Discuss the functions, abilities, and limitations of your calculator with your counselor. Talk about how these affect what you can and cannot do with a calculator. (See your counselor for some ideas to consider.)

For Requirement 4 of Designed to Crunch, are some ideas for your Scout to consider. Pick a few or think of others.

- How can you add fractions, using your calculator, and get an answer in fraction form?
- How can you perform repeated calculations efficiently?
- How many digits in a numerical answer can your calculator show you? What if the answer to your calculation has more digits than your calculator can show you? Can you figure out how many digits your answer has? Can you figure out the hidden digits?
- How can you enter, store, recall, and use a list of data to perform data analysis calculations?
- For a calculator with graphing capabilities, how can you display a graph? Will a graphing calculator always show the *entire* graph or must it sometimes show only a portion of the graph? If it shows only a portion of a graph, how can you be certain that the portion you are viewing shows the features you want to see?
- For numerical calculations, when does your calculator give *exact* answers and when does it give *approximate* answers? What is the difference? How can you tell? Does it matter?
- If your calculator defaults to giving you an approximate answer, but you need an exact answer, what do you do?
- If an approximate answer will do, how might your calculator's internal calculation limitations affect the accuracy of the approximation?
- For a calculator with graphing capabilities, how might pixel limitations affect its depiction of a graph?
- Is the calculator always right? Why or why not? How might you tell? What might cause a calculator to give you an incorrect answer? (For a graphing calculator, what might cause the calculator to give you an incorrect graph, or *no* graph, or a graph that cannot be readily interpreted?)
- Are there numerical calculations that calculators *can't* do? If possible, give an example.