



# SHOOT! Projectiles & Space

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](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 and
  - b. projectile motion.
2. Discuss the factors affecting the path of a projectile.
3. Discuss the difference between forward velocity and acceleration due to gravity.

b. Discover-

- i. Explain to your counselor the difference between escape velocity (not the game), orbital velocity, and terminal velocity.
- ii. Do two of the following (you may wish to explore internet sites to find this information).
  1. Why are satellites usually launched toward the east and what is a launch window?

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

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- 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.
- 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).
    - 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.)

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

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
- 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 sources

4. Design and build a working model vehicle (not from a kit)

- a. Make drawings and specifications of your model vehicle before you begin to build
- b. Include an energy source to power your vehicle
  - i. Solar power
  - ii. Wind power
  - iii. Battery power
  - iv. (Do not use gasoline or other combustible fuel source)
- c. Test your model
  - i. How well did it perform?
  - ii. Did it move as well as you thought it would?
  - iii. Did you encounter problems? How can these problems be corrected?
- d. Discuss with your counselor
  - i. What difficulties you encountered in designing and building your model
  - ii. Why you chose your energy source
  - iii. If your model met your specifications
  - iv. How you would modify your design to make it better



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	Rifle Shooting
Auto Mechanics	Rowing
Aviation	Shotgun Shooting
Canoeing	Small Boat Sailing
Music	Truck Transportation
Railroading	

3. Machines

- a. Make a list or drawing of the six simple machines.
- 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](http://www.constructionknowledge.net/general_technical_knowledge/general_tech_basic_six_simple_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)
  - ii. The energy source causing the motion for the subject of your merit badge
  - 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.
- 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.

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



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
    - i. How does your horsepower compare to the power of a horse?  
<http://www.wikihow.com/Calculate-Your-Horsepower>  
<http://onlinephys.com/labpower1.html>
    - ii. How does your horsepower compare to the horsepower of your favorite 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.)
    - 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.)