4-H Shooting Sports Project:

S.T.E.M. Connections

All materials in this manual have been developed by Colorado 4-H. The lesson plans that refer to Colorado 4-H Shooting Sports Curriculum is the same as the Idaho 4-H Shooting Sports Curriculum

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Colorado 4-H Program: Science, Technology, Engineering and Mathematics Activities for the Colorado 4-H Shooting Sports Project

(February 2, 2011)

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COLORADO 4-H SHOOTING SPORTS PROJECT - **S.T.E.M CONNECTIONS**

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www.colorado4h.org

For more information on the Colorado 4-H Shooting Sports Program, point your browser to:

www.co4hshooting.org

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Links to Colorado 4-H Shooting Sports Curriculum Lesson Plans:

This section is designed to be utilized by 4-H Certified Shooting Sports Instructors to understand where each STEM Activity fits within a 4-H Shooting Sports Curriculum. The activities have each discipline lesson plan number and section listed in the Colorado 4-H Shooting Sports Certified Leader teaching Curriculum revised version 06-02. Although these areas are suggestions, instructors may adapt these activities as needed.

1. Why STEM/Why Shooting Sports and STEM:

Rifle:
Lesson 1: Section I
Teach before "Orientation to Rifle"

Pistol:
Lesson 1: Section I
Teach before "Orientation to Pistol"

Muzzleloading:
Lesson 1:
Teach before "Muzzleloading & Muzzleloading Equipment"

Shotgun:
Lesson 1:
Teach before "History of the Shotgun"

Archery:
Teach before "Origins of Archery"

2. Energy … I Need Energy

Rifle:
Lesson 2: Section V
Teach before "Basic Rifle Orientation"

Pistol:
Lesson 5: Section I
Teach before "Ammunition" lesson

Muzzleloading:
Lesson 1: Section I
Teach before "Black Powder & Substitutes"

Shotgun:
Lesson 1: Section IV: Subsection F
Teach before "Carrying Energy to the Target"

Archery:
Lesson 5: Section I
Teach before "Compound Bow"

3. Gravity … It's A Drag

Rifle:
Lesson 4: Section V
Teach before section VI "Sight Adjustment"

Pistol:
Lesson 4: Section IV
Teach before section V "Sight Adjustment"

Muzzleloading:
Lesson 1: Section VI: Subsection A4
Teach after "Parts of Rifle – Ramrod"

Shotgun:
Lesson 1: Section IV: Subsection F
Teach before "Shotshell Sizes & Shot Charges"

Archery:
Lesson 2: Section IV
Teach before "Moving Group to Desired Impact Point"
-or-
Lesson 4: Section I
Teach before "Setting up to Shoot with Sights"

4. Reactions … Hot Times

Rifle:
Lesson 2: Section V
Teach after "Energy … I Need Energy" STEM Connection and before "Basics of Rifle Operation" lesson

Pistol:
Lesson 5: Section II
Teach after "Energy … I Need Energy" STEM Connection

Muzzleloading:
Lesson 1: Section I
Teach after "Energy … I Need Energy" STEM Connection

Shotgun:
Lesson 1: Section IV: Subsection C
Teach before "Powder Charge"

Archery:
None

5. Know Them Bones

Rifle:
Lesson 6: Section I
Teach before "Shooting Positions" lesson

Pistol:
Lesson 2: Section I
Teach before "Pistol Shooting Positions"

Muzzleloading:
Lesson 3: Section III: Subsection A3
Teach before "Standard Shooting Procedure"

Shotgun:
Lesson 3: Section III: Subsection A2
Teach before "Stance"

Archery:
Lesson 2: Section II
Teach before "Archery Form Basics"

6. A Catapult Fling

Rifle:
Lesson 1: Section III
Teach before Section IV "Eye Dominance"

Pistol:
Lesson 5:
Teach before "Introduction to Other Pistol Types"

Muzzleloading:
Lesson 2: Section II
Teach before "Muzzleloading Arms"

Shotgun:
Activity 1 (Lever)
Lesson 3: Section III: Subsection A
Teach after "Know Them Bones" STEM Connection and before "Stance"
Activity 2 (Catapult)
Lesson 3.5 (Between Lessons 3 and 4):
Teach in classroom before Lesson 4

Archery:
Lesson 1: Section I
Teach with "Origins of Archery"

Colorado State University

Extension

Introduction:

COLORADO SHOOTING SPORTS LEARN BY DOING

WHY S.T.E.M. ?

Colorado 4-H Shooting Sports Curriculum Links- Where to Teach: **Rifle:** Lesson 1: Section I: Teach before “Orientation to Rifle” **Pistol:** Lesson 1: Section I: Teach before “Orientation to Pistol” **Muzzleloading:** Lesson 1: Teach before “Muzzleloading & Muzzleloading Equipment” **Shotgun:** Lesson 1: Teach before “History of the Shotgun” **Archery:** Teach before “Origins of Archery”

NARRATIVE

WHY S.T.E.M. (Science, Technology, Engineering, Math)? (1)

America faces a future of intense global competition with a startling shortage of scientists. In fact, only 18 percent of U.S. high school seniors are proficient in science (National Assessment Educational Progress 2005) and a mere 5 percent of current U.S. college graduates earn science, engineering, or technology degrees compared to 66 percent in Japan and 59 percent in China.

To address increased demand for science and technology professionals, 4-H is working to reach a bold goal of engaging one million new young people in science programs by 2013. Currently, 4-H STEM programs reach more than 5 million youth with hands-on learning experiences to ensure global competitiveness and prepare the next generation of science, engineering, and technology leaders. 4-H’s approach is comprehensive and holistic—from agriculture to climate change to alternative energy—youth are learning about highly relevant complex systems and issues that will ensure their contributions to their communities today and their success as global leaders tomorrow.

The work of scientists and engineers impacts our daily life on so many levels, but sometimes it’s hard to isolate just how those professionals contribute to programs we watch on television or items we see in stores. 4-H uses its projects and programs to help youth understand just how important an interest in science, engineering and mathematics is to advancing our society’s access to new technology. The programs provide a unique opportunity for 4-H members to interact with the community through volunteer activities and avenues for the club to engage new mentors who are local industry experts.

Colorado 4-H Science (STEM) Vision

4-H is leading the way and is recognized as a leader in providing experiential, non-formal learning experiences that engage youth in a dynamic process of discovery and exploration in Science to help them develop 21st century skills to prepare them for their futures.

Colorado 4-H Science (STEM) Mission

To provide experiential, non-formal learning experiences that engage youth in a process of discovery and exploration in Science so they are prepared to meet the challenges of the 21st century.

Overall Colorado 4-H Science (STEM) Objectives

To increase the knowledge, skills, competencies, attitudes, literacy and interest of youth in Science

To increase the number of 4-H youth pursuing post-secondary education in Science, and

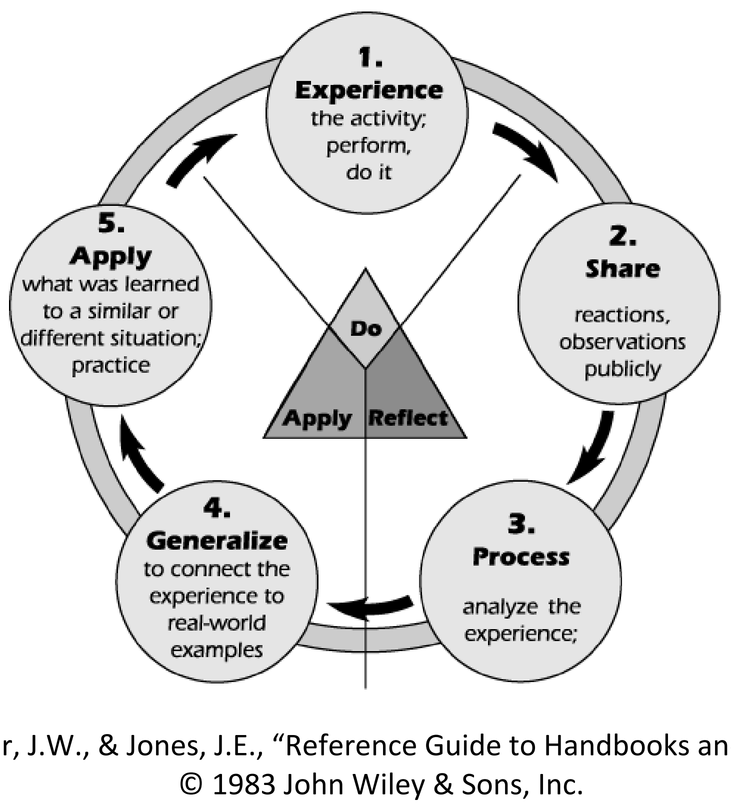
To increase the number of 4-H youth pursuing careers in Science

- **Goal #1:** Youth and adults develop and deliver 4-H Science programs that are content and contextually valid to youth in a variety of Settings and locations that meet the needs of diverse youth.
- **Goal # 2:** 4-H volunteers (youth and adults) and professionals are eager and well-prepared to incorporate Science in 4-H activities through a well-coordinated system of professional development opportunities.
- **Goal # 3:** There is an evaluation and research system in place to measure the effectiveness of 4-H Science programs in reaching the 4-H Science goals and objectives.

(Adapted from the Colorado 4-H Science Plan of Action and the National 4-H Mission Mandates of http://www.4-h.org/youth-development-programs/4-h-science-programs/)

WHY 4-H SHOOTING SPORTS AND S.T.E.M.??

4-H shooting sports program is a great way to show how science, technology, engineering, and math are part of the 4-H projects. There are several ways of incorporating STEM into teaching the shooting sports, as well as explaining why and how something works. The purpose of this activity guide is to provide some hands-on STEM activities that directly relate to shooting sports. These activities are designed for 4-H certified shooting sports leaders to adapt into their regular discipline curriculum and use as teaching aids. The goal is to make STEM activities a core part of the shooting sports curriculum. These activities may also be adapted by other adults for use in areas outside of the formal shooting sports program. These activities fall directly into the hands-on experiential learning concepts integral to the 4-H Youth Development program. Please see the Experiential Learning Process illustration below:



(2) Pfeiffer, J.W., & Jones, J.E., "Reference Guide to Handbooks and Annuals"

S.T.E.M. Activity Sheets:

Energy … I Need Energy!

Authors:
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Colorado 4-H Shooting Sports Curriculum Links- Where to teach: **Rifle:** Lesson 2: Section V**:** Teach before "Basic Rifle Orientation" **Pistol:** Lesson 5: Section I**:** Teach before "Ammunition" lesson **Muzzleloading:** Lesson 1: Section I**:** Teach before "Black Powder & Substitutes" **Shotgun:** Lesson 1: Section IV: Subsection F**:** Teach before "Carrying Energy to the Target" **Archery:** Lesson 5: Section I**:** Teach before "Compound Bow"

NARRATIVE (4)


(3) Kwang, B. & Brewer, P. November 2010.

Energy

Energy comes in several types. Stored energy (potential energy) based on the mass of an object, and kinetic energy (the energy of motion or momentum). Energy can be derived several different ways including chemical energy reaction (as in burning gunpowder) and elastic energy (in a bow string). Energy is always conserved (meaning energy cannot be created or lost). Energy can be transferred between objects (between burning gunpowder and the rifle bullet or between a bow string and an arrow). The energy that will be observed in this activity it gravitational energy. This is the energy (both potential and kinetic) of objects moving in a gravitational field.

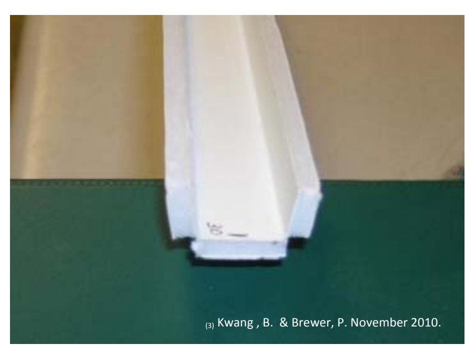
OBJECTIVES

4-H Shooting Sports members will learn a basic understanding of some the physics principals in shooting. Members will gain a basic understanding of the Science, Technology, Engineering and Mathematics that make shooting possible.


(3) Kwang , B. & Brewer, P. November 2010.

1. Members will learn about "potential energy".
2. Members will learn about "kinetic energy".
3. Members will learn that energy can be transferred between objects
4. Members will learn that objects that have different masses have different energy potentials.

MATERIALS


(3) Kwang , B. & Brewer, P. November 2010.

1. Glass marbles
2. Foam Core board for marble ramp and marble stand
3. Pencil or pen for marking on foam core board
4. Ruler
5. Box Cutter
6. Several wood (cardboard) blocks

CONSTRUCTION

1. Construct a ramp from foam core board. The ramp should measure 30 inches long by ¾ inches wide with ½ inch sides to contain a marble. When constructing the ramp use the ruler to layout the ramp dimensions and the box cutter to score the foam core board. Do not cut all the way through the foam core board.
2. Construct a marble stand out of foam core board. The actual dimensions are not critical. Using the ruler to measure a ¼ inch line down the center of the marble stand. Use the box cutter to cut a V shaped groove along the ¼ inch mark. Remember to not cut all the way through the foam core board.

PROCEDURES - EXPERIMENT 1 (This activity will demonstrate potential energy and kinetic energy and how it relates to a bullet or arrow.)

1. Set the ramp on an incline of about 3 - 4 inches high.
2. Place a marble ¼ the distance of the ramp.
3. Observe how fast and far the marble traveled when released.
4. Place a marble ½ the distance of the ramp.
5. Again make observations of what happens when the marble is released.
6. Place a marble at the top of the ramp.
7. Observe what happens when the marble is released.
8. Repeat the process by raising the ramp higher!

DISCUSSION QUESTIONS - EXPERIMENT 1

1. What did you observe about the distance and speed of the marble as it traveled down the ramp?
2. What happened to the distance and speed of the marble as you raised it up the ramp?
3. What happened to the distance and speed of the marble as you raised the ramp higher?
4. Where was the marble traveling the fastest?
5. What general observations can you make about the amount of energy of the marble?
6. How do you think this activity and your observations relate to shooting sports?

WHAT IS GOING ON - EXPERIMENT 1

In experiment 1, you have set up a ramp. A ramp is an example of a simple machine. A simple machine allows us to push or pull an object over a greater distance! The physics principals involved in this experiment is that of "potential" and "kinetic" energy. When the marble is at the top of the ramp (but not in motion) it has high potential (stored) energy. In shooting, there is high potential energy stored in the gunpowder. When the marble travels down the ramp it builds kinetic energy (energy of motion). The marble will have the highest kinetic energy when it reaches the bottom of the ramp.


(5) <www.inqusitr.com>

In shooting sports, burning gunpowder provides kinetic energy to the bullet as it travels down the barrel of the rifle. The bullet will have the highest kinetic energy as it exits the barrel.

Objects that have different masses usually have different amounts of potential and kinetic energy. In shooting sports, heavier bullets require more energy to accelerate then lighter bullets.

<u>PROCEDURES - EXPERIMENT 2</u> (This activity will demonstrate how energy can be transferred between objects and how this relates to a bullet or arrow.)

1. Set the ramp on an incline of about 3 - 4 inches high.
2. Place the marble stand at the bottom of the ramp.
3. Place 4 or 5 marbles in the stand groove. The marbles should be touching each other and be placed where the ramp and stand meet.
4. Place a marble ¼ the distance of the ramp then release it.
5. Observe what happens to the marbles on the stand when they are hit by the marble on the ramp.
6. Place a marble ½ the distance of the ramp then release it.
7. Again make observations of what happens to the marbles on the stand when they are hit by the marble on the ramp.
8. Place a marble at the top of the ramp then release it.
9. Observe what happens when the marble is released.
10. Repeat the process by raising the ramp higher!


[3] Kwang, B. & Brewer, P. November 2010.

<u>DISCUSSION QUESTIONS - EXPERIMENT 2</u>

1. What did you observe about the marbles on the marble stand when they were hit by the marble on the ramp?
2. What happened to the distance and speed of the last marble on the stand as you raised the striking marble up the ramp?
3. What happened to the distance and speed of the marbles as you raised the ramp higher?
4. When was the last marble in the stand traveling the fastest?
5. What general observations can you make about what happened to the energy of the marble on the ramp when it hit the marbles on the stand?
6. How do you think this activity and your observations relate to shooting sports?


[6] <olympics.about.com. >

WHAT IS GOING ON - EXPERIMENT 2

In experiment 2, you used the ramp to generate kinetic energy in the marble as it rolled down the ramp. The higher up the ramp the marble was placed the greater the kinetic energy it developed. In shooting sports, kinetic energy is developed from the expanding gasses of burning gunpowder or the release of a bow string. Kinetic energy can be transferred from one object to another. This is what happened when the marble on the ramp hit the marbles on the stand. The kinetic energy of the moving marble was transferred through each of the marbles on the stand and into the last marble on the stand and that energy made the last marble move.

Burning gunpowder creates expanding gasses which cause the bullet to gain speed and kinetic energy as it moves down the barrel of a rifle. Some of the energy of the burning gunpowder is transferred to the bullet as it moves down the barrel. Likewise, the energy stored in a drawn bow string is transferred to the arrow when the bow string is released.

INCREASING YOUR S.T.E.M. KNOWLEDGE (FURTHER KNOWLEDGE) (7)

Energy: Energy is the capacity of a physical system to perform work. Energy exists in several forms such as heat, kinetic or mechanical energy, light, potential energy, electrical, or other forms.
Work: Traditionally work is expressed as: Work is force times distance travelled. It is also expressed as work equals change in kinetic energy.
Mass: Mass is the quantity of inertia possessed by an object. Because of the relationship between weight and mass, these concepts are frequently confused. You can, in fact, convert exactly between weight and mass on the Earth's surface. The main difference is that if you were to leave the Earth and go to the Moon, your weight would change but your mass would remain constant.
Conservation of Energy: Law of physics which states that energy cannot be created or destroyed, but may be changed from one form to another.

STANDARDS (8) (9)

Colorado Science Academic Standards (Physical Science)
Observe, explain, and predict natural phenomena governed by Newton's laws of motion, acknowledging the limitations of their application to very small or very fast objects.

Colorado Science Academic Standards (Physical Science)
Apply an understanding that energy exists in various forms, and its transformation and conservation occur in processes that are predictable and measurable.

National Science Education Standards (Physical Science)
Content Standard B (5^{th} to 8^{th} grade) – Properties and changes in properties of matter …
Motions and Forces … Transfer of Energy

National Science Education Standards (Physical Science)
Content Standard B (9^{th} to 12^{th} grade) – Motions and Forces … Conservation of energy …
Interactions of energy and matter

What would happen if you fired a gun on a train moving as fast as a bullet? (10)

This is a good question because it involves the concept of **reference frames** (or point of view). The quick answer is that relative to you, the bullet will always travel at the same speed. In other reference frames, however, unexpected things can happen!

Imagine you are on a perfectly smooth speeding train, moving at a uniform speed (not accelerating or turning), in a car with no windows. You would have no way of knowing how fast you are going (or if you were moving at all). If you throw a ball straight up in the air, it will come straight back down whether the train is sitting still or going 1,000 mph. Since you and the ball are already moving at the same speed as the train, the only forces acting on the ball are your hand and gravity. So the ball behaves exactly as it would if you were standing on the ground and not moving.


(11) <www.soccerexcursions.com>

So what does this mean for our gun? If the gun shoots bullets at 1,000 mph, then the bullet will always move away from the gun at 1,000 mph. If you go to the front of a train that is moving at 1,000 mph and shoot the gun forward, the bullet will move away from you and the train at 1,000 mph, just as it would if the train were stopped. But, relative to the ground, the bullet will travel at 2,000 mph, the speed of the bullet plus the speed of the train. So if the bullet hits something on the ground, it will hit it going 2,000 mph.

If you shoot the bullet off the back of the train, the bullet will still be moving away from you and the gun at 1,000 mph, but now the speed of the train will subtract from the speed of the bullet. Relative to the ground, the bullet will not be moving at all, and it will drop straight to the ground!!

THREE LAWS of MOTION: (7)

The famous First Law of Motion says that a body in motion tends to stay in motion and a body at rest tends to stay at rest unless acted on by an external force.

Whose Laws of Motion are these?

- **Rachel's**
- **Bob's**
- **Newton's**
- **Copernicus'**


(12) <stoppingpower.info>


(13) <mrsciencenut.net>

A: Newton's

Gravity.... It's A Drag!

Authors:
Kwang, Brenda – Colorado State University Extension, 4-H Youth Development – Douglas County
Brewer, Perry – Colorado State University Extension, 4-H Youth Development – Kit Carson County

Colorado 4-H Shooting Sports Curriculum Links: **Rifle:** Lesson 4: Section V**:** Teach before section VI "Sight Adjustment" **Pistol:** Lesson 4: Section IV**:** Teach before section V "Sight Adjustment" **Muzzleloading:** Lesson 1: Section VI: Subsection A4**:** Teach after "Parts of Rifle – Ramrod" **Shotgun:** Lesson 1: Section IV: Subsection F**:** Teach before "Shotshell Sizes & Shot Charges" **Archery:** Lesson 2: Section IV**:** Teach before "Moving Group to Desired Impact Point" -or- Lesson 4: Section I**:** Teach before "Setting up to Shoot with Sights"

NARRATIVE (14)

Gravity

One of the concepts of physics that impacts a projectile's (bullet, pellet or arrow) motion is gravity. Gravity is a force that pulls an object in a specific direction. On the planet earth that direction is towards the surface of the planet. The force of gravity has been calculated as 9.8 meters per second squared (about 480 miles per hour). What members need to understand is that this is a constant force on all objects on Earth. This means that gravity has the same ability to bring an object that is stationary to the Earth's surface as it does to bring an object in motion to the Earth's surface.


(3) Kwang, B. & Brewer, P. November 2010.

The Path of a Projectile

The path that a projectile will take will always be a parabola (arc). This is a physics principle that was developed by noted scientist Galileo. Prior to Galileo's observations and discovery, it was thought that a projectile would basically travel in a straight line until it ran out of momentum, or impetus, at which point it would drop straight to the earth. This is obviously not the case. Gravity is always pulling on the projectile arcing its path and creating a parabola that starts at the launch point (muzzle of a rifle or a bow face) and ends at the surface of the Earth. This parabola can be shortened if the projectile is intercepted by a target.


(3) Kwang, B. & Brewer, P. November 2010.

OBJECTIVES

4-H Shooting Sports members will learn a basic understanding of some the physics principals in shooting. Members will gain a basic understanding of the Science, Technology, Engineering and Mathematics that make shooting possible.

OBJECTIVES- cont.

1. Members will learn about some of the properties of gravity.
2. Members will learn about some of the properties of atmospheric drag.
3. Members will learn that gravity and drag need to be compensated in order to hit a target.
4. Members will learn that an arc trajectory is used to as compensation to the effects of gravity and drag.

(3) Kwang, B. & Brewer, P. November 2010.

MATERIALS

1. Ping Pong Paddle
2. Ping Pong Ball
3. Foam Core board or "ShowBoard" for ball target
4. Pencil or pen for marking on foam core board
5. Ruler
6. Markers for "embellishing" target board
7. Box Cutter

CONSTRUCTION

1. Using pencil and ruler mark out and score (cut) a target board (See pictures).
2. Cut out and score a wing that will be used as the target support.
3. Mark and cut out scoring targets in the board.
4. Target cut outs should be approximately 3 ½ inches in diameter.
5. Assign "score" values to targets. Higher values to the higher targets.
6. Embellish the target board as needed … let your creativity take over (or that of the kids!).

PROCEDURES (This activity will demonstrate how gravity and drag affect a bullet or arrow in flight. You will also learn some elements of sighting in your rifle or bow, as well as basic concepts of trajectories.)

1. Set up your target board (a long table would ideal but a hard floor would work too!).
2. Use your ruler to measure back about 3 feet from the board. This is where you will "shoot" from!
3. Take your ping pong paddle and ball and get behind the "shooting line". Bounce the ping pong ball on the table (or floor) and hit it with the paddle. Take a few practice shots then try to hit your targets. What do you have to do to the paddle to hit each target?
4. Move back another two feet and try again. Is it easier or harder to hit the targets? How does that change what you do with your paddle?
5. Move forward (closer than 3 feet) and try again. Is it easier or harder to hit the targets? How does that change what you do with your paddle?
6. Try timing yourself – see how many targets you can hit in 30 seconds. In 15 seconds. If you don't have a watch, count how many targets in a row you hit without a miss.

DISCUSSION QUESTIONS

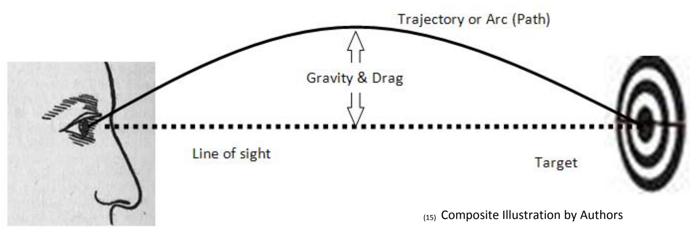
1. What did you observe about the path that the ball had to travel in order to hit the target?
2. How would you describe the path that the ball took?
3. Why do you think the ball had to travel this path in order to hit the target?
4. Do you think you can describe what are some of the forces are that effect the travel of the ball?
5. What would happen if you hit the ball harder?
6. How do you think this activity and your observations relate to shooting sports?

WHAT IS GOING ON

Physics plays a big part in ping pong (and in shooting!), no matter what your skill level might be. This experiment shows how the angle of your paddle affects ball trajectory as you try to hit the targets. The angle compensates for the effects of gravity and atmospheric drag on the ball (just like with a bullet being fired from a rifle!).

Trajectory is the path of the ball (or bullet) once it leaves your paddle – the ball makes an arc through the air (much like tossing a baseball will make an arc through the air). The trick is finding the right arc to make the ball land on a target. In shooting sports a rifle or a bow is sighted-in to take into account the effects of gravity and friction! A properly sighted in rifle will curve or arc the bullet into the target at a specific distance. (See illustration) A perfectly flat trajectory is not possible with a bullet! The instant the bullet leaves the muzzle of the rifle, or the arrow leaves the bow, the projectile begins to lose energy and slow down.

The vertical angle of the paddle is how much you "open" the face of the paddle to hit the ball – so a zero degree angle is when your paddle face is parallel to the board, and 90 degrees is when the face of the paddle is parallel to the table or floor. Hitting with a zero degree angle results in a "line drive" or no arc. Increasing the angle will give you a bigger arc in your trajectory, and hit the targets that are higher on the board.



(15) Composite Illustration by Authors

INCREASING YOUR S.T.E.M. KNOWLEDGE (FURTHER KNOWLEDGE) (7)

Atmospheric Drag: Drag is the forces or resistance that opposes the motion of an object for example molecules of air in the atmosphere. Molecules of air are composed of primarily oxygen, nitrogen, and water vapors.

Gravity: A force that tends to attract two objects to one another. Every time you jump, you experience gravity. It pulls you back down to the ground. Without gravity, you would float off into the atmosphere.

Trajectory: The path that a moving object follows over distance and time. For a few examples: The affects of gravity and drag on a bullet or arrow, or shooting a hoop in basketball.

Arc: The actual shape of the curved path that an object takes while in motion. The same examples can be used for trajectory above (basketball or bullet). The arc is the shape of the path and the trajectory is the actual path an object moves.

STANDARDS (8) (9)

Colorado Science Academic Standards (Physical Science)

Newton's laws of motion and gravitation describe the relationships among forces acting on and between objects, their masses, and changes in their motion - but have limitations.

Colorado Science Academic Standards (Physical Science)

Energy exists in many forms such as mechanical, chemical, electrical, radiant, thermal, and nuclear, that can be quantified and experimentally determined.

National Science Education Standards (Physical Science)

Content Standard B (5th to 8th grade) - Properties and changes in properties of matter … Motions and Forces … Transfer of Energy.

National Science Education Standards (Physical Science)

Content Standard B (9th to 12th grade) - Motions and Forces … Conservation of energy … Interactions of energy and matter.

Colorado State University Extension

4-H Shooting Sports
Science Blast!

What happens to a bullet fired on the moon? (16)

First, we know that the bullet has the same initial velocity on the moon as it does on the Earth--that is, it exits the gun at the same speed. But as soon as it leaves the gun, it's a different story. First, the moon bullet doesn't have to contend with air resistance--with so little friction, it can maintain its speed longer than the Earth bullet can (it's analogous to shooting a hockey puck across ice, which has very little friction, and shooting a puck across sand, which has a lot of friction. The puck will travel a lot farther on the ice!)
Now, there is the issue of gravity. Assuming your bullet doesn't hit anything (a pretty safe bet on the moon, but don't try this on Earth!) and forgetting about air resistance, the time it takes for the bullet to fall to the ground depends on its initial velocity, the angle at which you shoot it, and the force of gravity.

There are several formulas to calculate how long it would take for the moon's gravity to bring a bullet to the ground (and we may visit them in a later 4-H Shooting Sports Science Blast!). The simple answer is …..


(17) <www.raisethehammer.org>

Neglecting air resistance, the bullet will go about 6 times farther on the moon than on Earth!

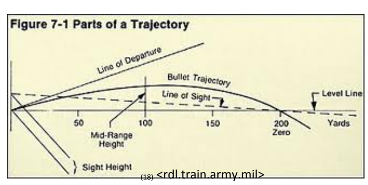
You might also ask, if the bullet were fired straight up, could it actually escape the moon's gravitational pull and fly off into space? To answer this, we have to compare the moon's "escape velocity" (the minimum velocity (speed) an object needs to escape the moon's gravity) to the bullet's initial velocity. The moon's escape velocity is about 2.38 km/s (about 5300 miles per hour), but a bullet typically travels at only 1 km/s (about 2200 miles per hour). So take cover--even in this case, what goes up must come down!

Four Fundamental Forces (7)

Gravity is the first of the four fundamental forces and is the weakest force of the lot! While it is a weak force, gravity's range is unlimited and is cumulative!

Which is NOT a Fundamental Force?

- **Gravity**
- **Electromagnetism**
- **Bacon**
- **Strong Nuclear Force**
- **Weak Nuclear Force**



(18) <rdl.train.army.mil>


(19) <www.space.com>

A: Bacon!!

Reactions … Hot Times!

Authors:
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Colorado 4-H Shooting Sports Curriculum Links: **Rifle:** Lesson 2: Section V**:** Teach after "Energy … I Need Energy" STEM Connection and before "Basics of Rifle Operation" lesson **Pistol:** Lesson 5: Section II**:** Teach after "Energy … I Need Energy" STEM Connection **Muzzleloading:** Lesson 1: Section I**:** Teach after "Energy … I Need Energy" STEM Connection **Shotgun:** Lesson 1: Section IV: Subsection C**:** Teach before "Powder Charge" **Archery:** None

<u>NARRATIVE</u> (20)

<u>Chemical Energy</u>

Chemical energy is the energy involved in the bond formed between two atoms. Each bond within a chemical compound involves different amounts of energy.

When one of these bonds breaks, a chemical reaction occurs and chemical energy is used. The bond is released and is either reused in forming new bonds with other atoms or enters the surrounding atmosphere as heat. You can't see chemical energy or touch it, but you can see it released when reactions occur.

A dramatic example of chemical energy is when a stick of dynamite explodes. The TNT molecule is converted to water, carbon dioxide and carbon monoxide. Many bonds are broken and the energy supplied by the bonds breaking provides the energy to form the new bonds. The excess energy creates the visible explosion along with heat.

Reactions that *give off* quantities of heat are called exothermic reactions. Our example of the explosion of dynamite is an exothermic reaction. This the same type of reaction that occurs when gunpowder is ignited in the barrel of a rifle.

Reactions that *require heat* to occur are called endothermic reactions. An example of an endothermic reaction is a chemical ice pack. When the pack is broken and the chemicals inside mix, the reaction draws heat from the environment, thus you feel cold.

OBJECTIVES
4-H Shooting Sports members will learn a basic understanding of some the chemical principals involved in shooting. Members will gain a basic understanding of the Science, Technology, Engineering and Mathematics that make shooting possible.

1. Members will learn that combining chemicals can cause reactions.
2. Members will learn that certain chemicals can store energy.
3. Members will learn that certain chemicals can speed up a reaction.
4. Members will learn that heat is generated from certain chemical reactions.
5. Members will learn that chemical reactions are used in shooting sports.

MATERIALS
1. Empty 20-oz plastic bottle (or other container)
2. Empty bottle to mix yeast (or other container)
3. 3% hydrogen peroxide solution (available at nearly any store). A higher percentage will result in a more energetic reaction!
4. Packet of active yeast (from the grocery store)
5. Liquid dishwashing detergent (any brand will work)
6. Warm water
7. Food coloring (optional, but it looks nice)
8. Aluminum turkey roaster pan (to catch spills)
9. Suitable thermometer to put into the chemical solution

CONSTRUCTION
1. Pour 1/2 cup hydrogen peroxide solution, 1/4 cup dishwashing soap, and a few drops of food coloring into the bottle. Swish the bottle around to mix the ingredients.
2. Set the bottle in the aluminum turkey roaster pan or some other place where you won't mind getting wet foam everywhere.
3. In a separate container, mix a packet of active yeast with a little warm water. Give the yeast about 5 minutes to activate before proceeding with the experiment.

PROCEDURES (This activity will demonstrate a chemical exothermic (creates heat) reaction and how this relates to the use of gunpowder or black powder in firing a bullet.)


(21) <farm4.static.flicker.com>

1. Place the thermometer into the hydrogen peroxide solution.
2. Note down the temperature of the solution after the thermometer has set in the solution for a minute.
3. Pour the yeast solution into the hydrogen peroxide solution.
4. Note down the time you started the experiment.
5. Observe the resulting reaction. What is going on?
6. Check the temperature after the reaction has started. Note down the temperature.
7. Once the reaction has stopped, note down the time.
8. Once the reaction has stopped, note down the temperature.

DISCUSSION QUESTIONS

1. What was the temperature of the hydrogen peroxide solution when you started?
2. What was the temperature of the solution after the reaction stopped?
3. How much time did the reaction take?
4. What were some of the things you observed about the reaction?
5. What do you think was in the bubbles?
6. How do you think this activity and your observations relate to shooting sports?

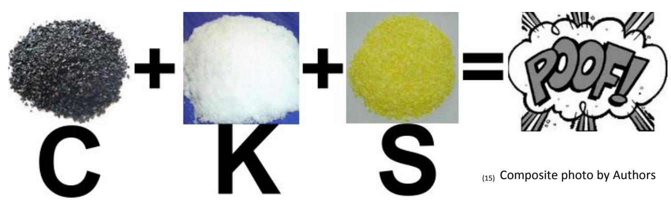
WHAT IS GOING ON

Hydrogen peroxide (H_2O_2) is a reactive (stored chemical energy or fuel like the carbon in gunpowder) molecule that readily decomposes into water (H_2O) and oxygen (O_2). In this experiment, yeast catalyzes (an oxidizer like the potassium nitrate in gun powder) the reaction so that it proceeds much more rapidly than normal. The dishwashing detergent captures the oxygen that is released, making foam. Food coloring is added to color the film of the bubbles so that you get colored foam. In addition to being a nice example of a decomposition reaction, the experiment is also exothermic, so heat is produced.


(22) <www.firearmsid.com>

In shooting sports, black powder or gunpowder consists of carbon (charcoal or sugar) which is a fuel and potassium nitrate (saltpeter or niter), which is an oxidizer and sulfur, which allows for a stable and consistent reaction. The carbon from the charcoal plus oxygen forms carbon dioxide and energy. The reaction would be slow, like a wood fire, except for the oxidizing agent. The saltpeter provides extra oxygen. The potassium nitrate (KNO_3), sulfur (S), and carbon (C) react together to form nitrogen and carbon dioxide gases and potassium sulfide (KSO_4). The expanding gases from the burning gunpowder, nitrogen (N) and carbon dioxide (CO_2) provide the propelling action to send the bullet down a rifle barrel.

While the chemical reaction in gunpowder is more energetic (reacts quicker) than the hydrogen peroxide reaction, both are exothermic in nature.



(15) Composite photo by Authors

INCREASING YOUR S.T.E.M. KNOWLEDGE (FURTHER KNOWLEDGE) (7)

Chemical Reaction: A process in which one or more substances are changed by the rearrangement of atoms or molecules into other substances.

Fuel: Fuel is any material that is burned or altered to obtain energy and to heat or to move objects. Fuel releases its energy either through a chemical reaction means, such as combustion, or nuclear means, such as nuclear fission or nuclear fusion.

Oxidizer: An oxidizer is a type of chemical which a fuel requires to burn quickly. Oxidizers provide extra oxygen to the reaction.

Decomposition Reaction: Chemical decomposition is the separation of a chemical compound into elements or simpler compounds.

Chemical Energy: The potential of a chemical substance to undergo a transformation through a chemical reaction or the ability to transform other chemical substances.

Molecule: The smallest particle of a substance that retains the chemical and physical properties of the substance. A molecule is usually composed of at least two atoms.

STANDARDS (8) (9)

Colorado Science Academic Standards (Physical Science)
Matter can change form through chemical or nuclear reactions abiding by the laws of conservation of mass and energy.

Colorado Science Academic Standards (Physical Science)
Atoms bond in different ways to form molecules and compounds that have definite properties.

Colorado Science Academic Standards (Physical Science)
Energy exists in many forms such as mechanical, chemical, electrical, radiant, thermal, and nuclear, that can be quantified and experimentally determined.

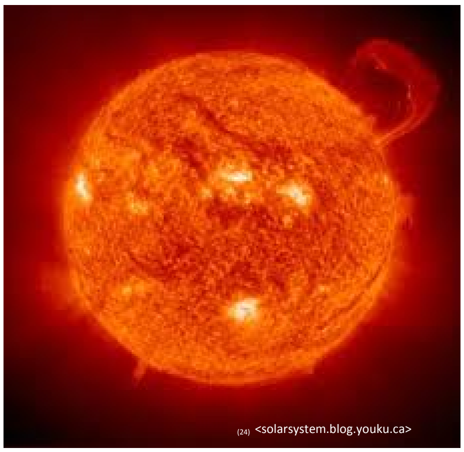
National Science Education Standards (Physical Science)
Content Standard B (5th to 8th grade) - A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample.

National Science Education Standards (Physical Science)
Content Standard B (5th to 8th grade) - Substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristic properties. In chemical reactions, the total mass is conserved.

What is the largest explosion? (23)

While there are larger examples, probably the most important "explosion" that affects us every day is the nuclear reaction that occurs in our Sun!

The Sun is the source of energy for the solar system, which makes life possible on earth. All the objects in the solar system revolve around the Sun. The Sun comprises 99 percent of the mass of the solar system. It rotates slowly on its axis and revolves around the galaxy. The Sun is just a star like many other stars that are visible to us at night. It is because of its closeness to the earth that it appears much bigger and brighter that all the others.


(24) <solarsystem.blog.youku.ca>

Did you know that the Sun is 4.5 billion (4,500,000,000) years old?

Did you know that the Sun was formed, like every other star, from a huge swirling cloud of gas called a nebula? The cloud contained all the matter which went together to form the sun and the solar system.

Did you know that at the centre of the Sun, hydrogen nuclei fuse into helium, releasing the energy upon which we depend? That energy is the result of an **exothermic** nuclear reaction.

Chemical Reactions: (7)

A combustion reaction is when oxygen combines with another compound to form water and carbon dioxide. These reactions are exothermic, meaning they produce heat.

What is a chemical reaction called that needs heat be performed?

- **Echinoderm**
- **Endothermic**
- **Edward**
- **Eukanuba**


(25) <blog.makezine.com>


(26) <www.lyyn.com>

A: Endothermic

Know Them Bones!

Authors:
Kwang, Brenda – Colorado State University Extension, 4-H Youth Development – Douglas County
Brewer, Perry – Colorado State University Extension, 4-H Youth Development – Kit Carson County

Colorado 4-H Shooting Sports Curriculum Links: **Rifle:** Lesson 6: Section I**:** Teach before "Shooting Positions" lesson **Pistol:** Lesson 2: Section I**:** Teach before "Pistol Shooting Positions" **Muzzleloading:** Lesson 3: Section III: Subsection A3**:** Teach before "Standard Shooting Procedure" **Shotgun:** Lesson 3: Section III: Subsection A2**:** Teach before "Stance" **Archery:** Lesson 2: Section II: Teach before "Archery Form Basics"

NARRATIVE (27)

BONES AND MUSCLES

Whenever you run, sit, walk, or even stand, your bones and muscles are working together in the activity. Bones are similar to the framework of a building; they provide the shape and protection. An adult body has about 206 bones. The number varies from person to person because of differences in the number of small bones. Some bones are responsible for movement, including bones in the hands, feet, and limbs. Other bones primarily give protection to the internal structures, such as the skull protecting the brain and the ribs shielding the heart, lungs, and liver. Muscles come in all shapes and sizes. The human body has about 650 muscles, which make up about 40 percent of a person's body weight.

SHOOTING POSITIONS

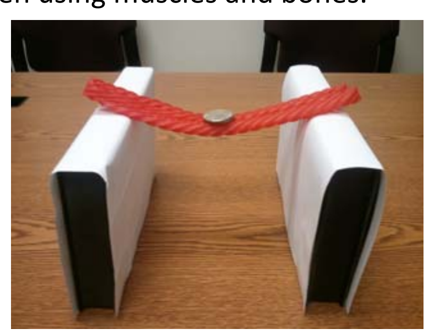
(28) <www.hunter-ed.com>

(28) <www.hunter-ed.com>

The basis of all sound shooting positions comes from several characteristics. First the body should be comfortable and relaxed. Most of the support of the rifle should come from the skeletal system or your bones. There should be minimal muscle activity or joint movement in a good shooting position. Furthermore the position and body should easily be aligned with the target so there is minimal use of muscles to center the sights on the target. Muscles can support weight for a limited time, however over time the muscled will become tired. To demonstrate and aid in thinking about this concept… lets do the muscles and bones activity.

OBJECTIVES:

- Members will learn and demonstrate the differences between using muscles and bones.
- Members will understand basic physiology of differences between using muscles and bones.
- Members will understand the science behind why one shooting position is steadier than another position.



MATERIALS:

1. Two equal size blocks or books
2. Red vines or Twizzlers – (just need to have hole in middle)
3. Wooden skewers
4. 10 quarters or other weights (washers will work too!)

PROCEDURE:

This activity will demonstrate the way muscles react and may get tired after a length of time. It will also demonstration how using your skeletal system may support items for a longer length of time.

Part One

1. Set two equal sized blocks or books on ends about the length of the Twizzlers apart.
2. Place three Twizzlers balanced between the blocks.
3. Place two quarters or weights on the middle of the Twizzlers.
4. Observe how long it takes for the quarters to fall.


(3) Kwang, B. & Brewer, P. November 2010.

Part Two

1. Now take the Twizzlers and cut off each of the ends so you can see the opening/hole in the middle of the candy.
2. Put a wooden skewer cut to the exact length in the middle of each of the three Twizzlers.
3. Place the three skewer stuffed Twizzlers balanced between the blocks.
4. Place two quarters or weights on the middle of the Twizzlers and observe.
5. Place 10 quarters or weights and observe.
6. Experiment with what other weight amounts the skewer stuffed Twizzlers can hold.
7. Experiment with blocks closer together and farther apart with just the muscles. Relate this to the stance within the shotgun discipline.

DISCUSSION QUESTIONS

1. What did you observe about the difference between the Twizzlers without skewers and the Twizzlers with skewers?
2. How could you relate this to the human body?
3. What would happen if you had more Twizzlers? More skewers?
4. What is the reason for the reaction of the Twizzlers alone with weights? What science is there?
5. How does this relate to your shooting positions? How does this relate to the shotgun stance?

WHAT IS GOING ON

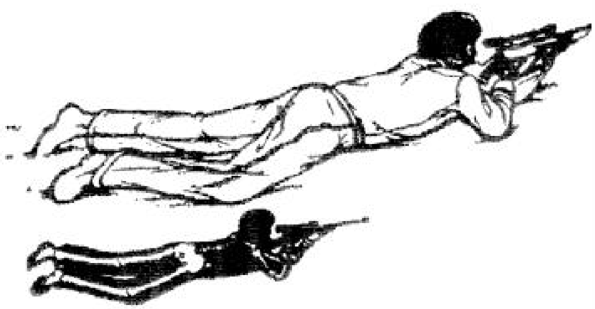
The Twizzlers represent the muscles in a human body and the skewers represent the bones in a human body. When a shooter aligns themselves into a shooting position if they are using mainly muscles to control their rifle it is not a steady position. It is correct that using mainly muscles will work for a moment or so, however after a bit of time the muscles will become tired and the position will fail. This is what you observed with the Twizzlers only holding the weights or quarters. After a bit of time the Twizzlers (muscles) let the quarters (rifle) fall out of position.

WHAT IS GOING ON- cont.

When aligning a shooting position, the basis should be on the skeletal bones with muscles helping for support. The second part of the experiment showed how bones (Skewers) and muscles (Twizzlers) working together can provide a steadier and long lasting positions.

In the shotgun discipline it is important to have good balanced stance for the position. A stance that your feet are too close together will be off balance and may not hold the weight of the rifle. A stance that your feet are too far apart will be using too many muscles and not allow flexibility in the swing of the stance.

ADAPTING TO MORE SHOOTING POSITIONS



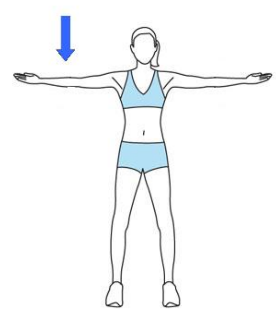
(29) <156.108.32.67/ssteam/national_curriculum/8_rifle/Basic%20Rifle%20L6%20Complete.pdf>

Looking at each of these positions, how much of the skeletal system is used?

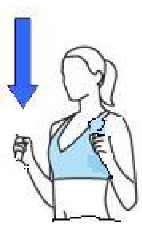
1. What position uses more bones?
2. What position uses more muscle?
3. Does this relate to how easy it is to shoot a higher score in each of these positions?

TEST YOUR STRENGTH

1. Try testing your muscles and bone support of the standing position. Stand with your arms out to our side. Have a partner push down on your arm.
2. How strong are your muscles in holding your position with arms out to your side?
3. Next bend your arm and place next to your side. This position is utilizing more of your skeleton and bones in support of the position. Have your partner push down on your hand.
4. How strong are your muscles and bones holding your position now?



(15) Composite photo from authors.



(15) Composite photo from authors.

INCREASING YOUR S.T.E.M. KNOWLEDGE (FURTHER KNOWLEDGE) (7)

Muscles: A body tissue composed of fibers capable of contracting to effect bodily movement.
Ligaments: A ligament is a tough band of connective tissue that connects various structures such as two bones. Ligaments also connect muscles to bones. "Ligament" is a fitting term; it comes from the Latin "ligare" meaning "to bind or tie."
Bone: Bones are rigid organs that form part of the endoskeleton of vertebrates. They function to move, support, and protect the various organs of the body, produce red and white blood cells and store minerals. Bone tissue is a type of dense connective tissue.
Cartilage: Cartilage is a stiff yet flexible connective tissue found in many areas in the bodies of humans and other animals, including the joints between bones, the rib cage, the ear, the nose, the elbow, the knee, the ankle, the bronchial tubes and the vertebral discs.
Vertebrate: Organisms that have a brain and a spinal cord that is surrounded by a protective set of bones and cartilages called vertebrae. Some examples of Vertebrates include most mammals, birds, amphibians, reptiles, and fish.

STANDARDS (8) (9)

Colorado Science Academic Standards (Life Science)
The human body is composed of atoms, molecules, cells, tissues, organs, and organ systems that have specific functions and interactions.

Colorado Science Academic Standards (Life Science)
Human body systems have basic structures, functions, and needs.

National Science Education Standards (Life Science)
Content Standard C (5th to 8th grade) – Structure and function in living systems.

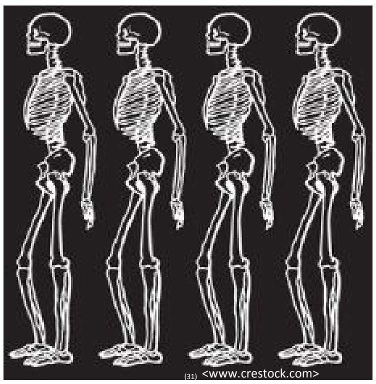
National Science Education Standards (Life Science)
Content Standard C (9th to 12th grade) – Matter, energy and organization in living systems.

4-H Shooting Sports Science Blast!

Bones are important to shooting!

How do I build strong bones? (30)

Our bones are often taken for granted, but they support our frame and carry us around our entire lives. Taking care of them is of utmost importance. Exercise helps us maintain strong bones, but so does the food we eat. Our bones need specific vitamins and minerals in order to maintain health, and knowing what foods provide these substances will help us make choices that will support them.



(31) <www.crestock.com>

High Calcium Foods

From the time you are young, you learn that foods high in calcium content help build strong bones. Calcium is a mineral that has several functions in the body such as maintaining the strength of the teeth, the health of the heart, and the health of the bones. According to a report from Colorado State University, if the body is low on calcium, PTH (parathyroid hormone) pulls calcium from the bones to make sure there is enough calcium in the body's fluids. The Center for Disease Control explains that the body cannot produce its own calcium, so we must take it in through our diet. Excellent food sources of calcium are dairy products, nuts and seeds such as almonds and sesame seeds, green vegetables such as broccoli, Brussels sprouts, collards and kale, and foods that have been fortified with calcium during processing. These foods often include breakfast cereals, orange juice and bread. Most manufacturers want to promote the health benefits of their foods, so they usually note on the label that it is fortified with calcium.

Vitamin D Fortified Foods

Eating all of the high calcium foods you can find will not help your bones very much if that calcium is not absorbed, and to help that absorption you need vitamin D. The National Institutes of Health Office of Dietary Supplements explains that vitamin D helps build strong bones by promoting the absorption of calcium in the intestines and by promoting the growth and restructuring of bones. Vitamin D is naturally found in fish such as tuna, salmon and mackerel. Cod liver oil is one of the best natural sources of the vitamin. It is found in smaller amounts in eggs and cheese. The food sources with the highest amounts of calcium are those that have been fortified with it. Since calcium is better absorbed with vitamin D, most milk products have vitamin D added. Other fortified food sources are breakfast cereals, juices and flour.

The Five Functions of Bones: (7)

Support: Bone holds you together by providing a structure for tissues and organs to form around. Bones also hold the body upright.

Which is NOT one of the five functions of bones?

- **Protection**
- **Movement**
- **Photosynthesis**
- **Mineral Storage**
- **Manufacture Blood Cells**

(32) <homeschooling.gomilpitas.com>

(30) <www.hunter-ed.com>

A: Photosynthesis

A Catapult FLING!

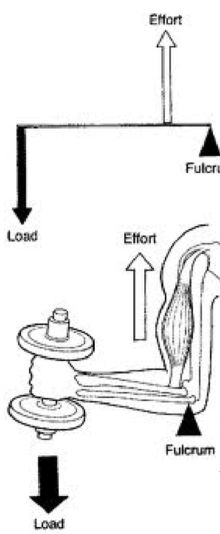
Authors:
Kwang, Brenda – Colorado State University Extension, 4-H Youth Development – Douglas County
Brewer, Perry – Colorado State University Extension, 4-H Youth Development – Kit Carson County

Colorado 4-H Shooting Sports Curriculum Links: **Rifle:** Lesson 1: Section III**:** Teach before Section IV "Eye Dominance" **Pistol:** Lesson 5: Teach before "Introduction to Other Pistol Types" **Muzzleloading:** Lesson 2: Section II**:** Teach before "Muzzleloading Arms" **Shotgun:** Activity 1 (Lever)**:** Lesson 3: Section III: Subsection A**:** Teach after "Know Them Bones" STEM Connection and before "Stance"**:** Activity 2 (Catapult)**:** Lesson 3.5 (Between Lessons 3 and 4): Teach in classroom before Lesson 4 **Archery:** Lesson 1: Section I**:** Teach with "Origins of Archery"

NARRATIVE (33)

SIMPLE MACHINES:

A **simple machine** is a mechanical device that makes work easier for us by allowing us to push or pull over increased distances. They help change the direction or magnitude of a force. Simple machines usually have few or no moving parts. In general, they can be defined as the simplest mechanisms that use mechanical advantage (also called leverage) to multiply force.



(34) <www.dynamicscience.com.au>


(35) <vnsharing.net>

A simple machine uses a single applied force to do work against a single load force. For example, a hammer uses the single applied force of the lever of the hammer to work against pulling the nail out (the single load force.) The work done on the load is equal to the work done by the applied force. They can be used to increase the amount of the output force, at the cost of a proportional decrease in the distance moved by the load. The ratio of the output to the input force is called the mechanical advantage. There is definitely a mechanical advantage to use a hammer to pull out a nail rather than using just your hands or arm to do so. Other examples of simple machines are pulleys, screws (an inclined plane), wheels or axles, and an axe (wedge).

CATAPULTS: (36)

A **catapult** is a compound machine used to throw or hurl a projectile a great distance without the aid of explosive devices—particularly various types of ancient and medieval siege engines. Although the catapult has been used since ancient times, it has proven to be one of the most effective mechanisms during warfare. The word 'Catapult' comes from the two Greek words "kata" (downward) and "pultos" (a small circular battle shield). Katapultos was then taken to mean "shield piercer".


(37) <www.amazon.com>

Catapults can be as simple as a sling shot to complex machines such as Ballistas (crossbows) which were used to launch large arrows during warfare. Catapults were used before the advent of gunpowder and cannon to breach enemy fortifications.

Today catapults are used to launch aircraft from aircraft carriers at sea. If you will look closely, you can find catapults in a variety of places. In Shooting Sports, you can find catapults used in shotgun games like trap and sporting clays! It is a catapult that launches the clay targets being shot!

Now let’s learn about simple machines and make our own catapult!

OBJECTIVES

4-H Shooting Sports members will learn a basic understanding of some the mechanical principals involved in shooting. Members will gain a basic understanding of the Science, Technology, Engineering and Mathematics that make shooting possible.

1. Members will learn that simple machines can multiply force.
2. Members will learn how to average measurements.
3. Members will learn basics of engineering or constructing a machine.
4. Members will learn the parts of a simple machine.
5. Members will learn how machines are used in shooting sports.

MATERIALS (Part 1 – Lever) (38)

1. One four (4) inch piece of one (1) inch dowel rod.
2. One 12 inch plastic or wood ruler.
3. Tape to secure the dowel from rolling.
4. Marker
5. Ten (10) washers.

CONSTRUCTION (Lever Experiment)

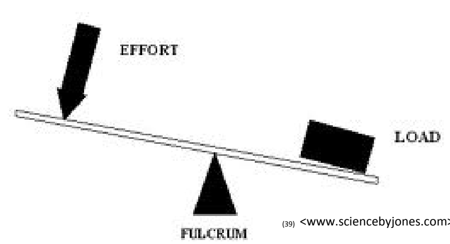
1. Place the dowel rod piece on a table or other flat surface.
2. Use the tape to secure the rod to the table.
3. Place the ruler across the dowel rod section.
4. Adjust the ruler on the dowel rod section to where the ruler balances on the dowel rod. Place a mark on the ruler at this point.

PROCEDURES (Levers use distance to make heavy objects easier to move. The goal of this experiment is to demonstrate how a lever reduces the amount of force needed to move objects. In Shooting Sports, a lever can be used to work the action of a rifle … Like the action of a lever action rifle!)

PARTS OF A LEVER

Fulcrum: Point about which a lever turns or pivots
Effort arm: Distance from fulcrum to point where force is applied
Load arm: Distance from fulcrum to point where load is applied

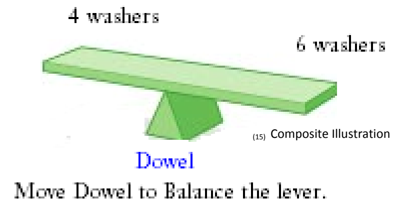
FIRST CLASS LEVER



(39) <www.sciencebyjones.com>

1. Use 5 washers as the load. Place the load at the very end of the ruler.

2. Place washers one by one on the opposite end of the lever. How many washers must be added to exactly balance or begin to tip the load washers on the other end?
3. Remove one of the washers and move it to the other side with the 5 washer load. Adjust the lever to again balance the load. Measure the distance between the current balance point and the old balance point.
4. Remove another one of the washers and move it to the side with the 6 washer load. Adjust the lever to again balance the load. Measure the distance between the current balance point and the old balance point.
5. Repeat moving washers to the load end of the lever and adjusting the lever to balance. Do this until all ten washers are on the load side. Can you balance all ten washers?



(15) Composite Illustration by Authors

<u>DISCUSSION QUESTIONS</u> (Lever Experiment)

1. Which position of the ruler required the least number of added washers to tip the load?
2. Can you make a plot graph of the number of washers used to balance the load versus the distance from the fulcrum to the end of the effort arm?
3. Can you predict using your graph what distance is required to lift the load washers if an eleventh washer is added to the load?
4. How do you think balance may be important to shooting a rifle or shotgun?
5. How do your observations of the lever relate to shooting sports?

<u>WHAT IS GOING ON</u> (Lever Experiment)

Levers lift objects easiest when the fulcrum is as close to the load end as possible. There are four components of a lever system: **1)** the lever (a bar or rod), **2)** the fulcrum, **3)** the load, and **4)** the force used to balance the load.

(40) < www.physikunterricht.at>

There are three possible ways of ordering the load, fulcrum and the force, which corresponds to the three different classes of levers. A ***first class*** lever has the fulcrum placed between the load and the balancing force. A ***second class*** lever has the load located in the middle and the fulcrum and the balancing force on opposite ends. Examples of second class levers: a wheelbarrow, hand truck, wrench, nutcracker, and the handle to a pencil sharpener. A ***third class*** lever has the balancing force in the middle with the load and fulcrum on opposite ends. Commonly used third class levers include arms, legs, cranes, catapults, and fishing poles.


(41) <gunsofold.com>

In shooting sports it is important to consider the balance of a firearm. When shooting in positions, it critical to consider the balance point of the rifle. By placing your arm and hand close to the balance point of the rifle, it will be easier to control the movements of the rifle. Also levers are used as part of, or to work the actions of firearms. Think of a lever action rifle or the pump lever on some air rifles.

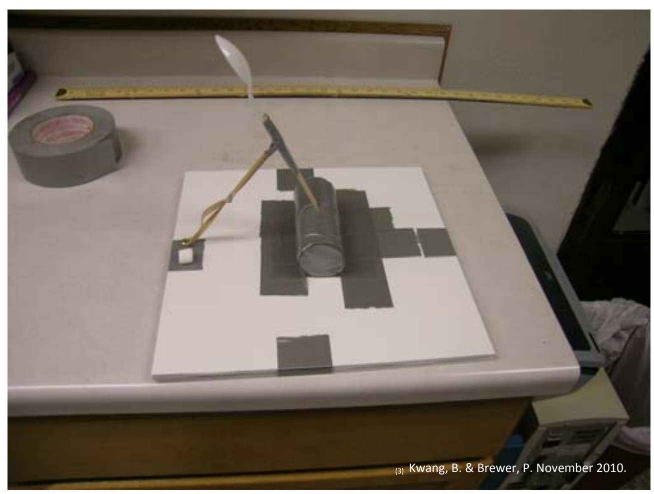
MATERIALS (PART 2 – Catapult) (42)

1. Plastic Spoon
2. Rubber Band
3. Duct Tape
4. Craft Stick
5. Brass Paper Fastener (or Paper Clip)
6. Box Cutter Knife
7. Marker
8. Foam Core Board or Cardboard (for base of catapult)
9. Toilet paper or paper towel tube
10. Ruler
11. Marshmallows (Your Ammunition!)
12. Tape Measure (to measure distance of shots)

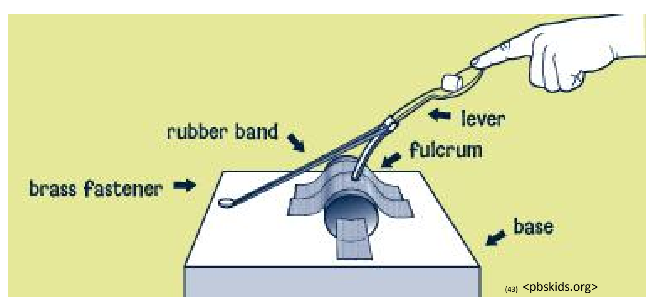

(3) Kwang, B. & Brewer, P. November 2010.

CONSTRUCTION/ENGINEERING (Catapult Experiment)

1. Create a 12 inch by 12 inch base out of foam core board or cardboard (you may have to double the thickness of the base for added support. If you do use the duct tape to secure both pieces together.)
2. Wrap duct tape around the paper tube. This will provide added support to the tube.
3. Attach the toilet paper tube (or paper towel tube) to the base. This is your fulcrum.
4. Tape the handle of a plastic spoon to the end of a craft stick. This is your lever.
5. Use the box knife to make a hole in the top of the tube and insert the lever. Secure with tape.
6. Punch a hole in the base in front of the tube (using the knife), and attach a brass fastener or paper clip.
7. Wrap a rubber band around the brass fastener (paper clip) then around the middle of the lever (so that there is tension as you pull it back). Tape in place.


(3) Kwang, B. & Brewer, P. November 2010.

PROCEDURES (This experiment will demonstrate how catapults work and will give members an understanding of the uses of simple machines prior to the use of gunpowder and cannons.)



(43) <pbskids.org>

1. Use your hand and fingers to pull back the lever of your catapult. Get a feel for how far

back you can pull back the lever.
2. Now release the lever. Note how the lever springs back because of the rubber band.
3. Load a marshmallow on the spoon at the end of the lever arm and draw the lever back.
4. Release the lever and observe how the marshmallow flies!
5. Now for the test. Take five shots using the catapult. After each shot measure and record the total distance each marshmallow flew.
6. Now for more fun- more engineering! Can your marshmallow catapult hit a target? How can you make the marshmallow fly farther … or higher? Try changing the length of the rubber band or the position of the lever.
7. Shotgun shooters: Practice your "point-bang-follow through" exercise on the flinging marshmallows to simulate your shooting range procedures in this discipline.

DISCUSSION QUESTIONS (Catapult Experiment)

1. What is the AVERAGE distance for the five shots you took with the catapult? To figure the average, use these formulas:
   $S_1 + S_2 + S_3 + S_4 + S_5 = X$ (Where S = Shot Distance in inches.)
   X divided by 5 (the total number of shots you took) = Average distance in Inches
2. Were you able to increase the distance of your shots by adjusting your catapult?
3. How much more distance were you able to average after you adjusted your catapult?
4. What "Connections" can you make to other Shooting Sports STEM Activities you have experienced?
5. How do you think this activity and your observations relate to shooting sports?

WHAT IS GOING ON (Catapult Experiment)

When you use your catapult to launch a marshmallow you are transforming Potential into Kinetic Energy. To review, Potential Energy can be defined as stored energy and Kinetic Energy can be defined as energy of motion.

When you pull back on the rubber band, tension is created and stored in the stretched band. When the spoon is stretched back against the rubber band, the spoon as well as the marshmallow has its greatest Potential Energy.

When the spoon is let go then the Potential Energy is then converted into Kinetic Energy. The Potential Energy of the spoon is then transferred into Kinetic Energy of the marshmallow as described by Newton's first law: An object in motion (in the spoon) tends to stay in motion (flying through the air after the spoon was stopped.) unless an external force is applied to it (for example, gravity, which will eventually ground your marshmallow.)

In Shooting Sports, a bow and arrow is an excellent example of a catapult! The bow limbs and string are used to store energy which is transferred to the arrow when it is released. In fact a type of catapult called a Ballista was developed to shoot large arrows out of a machine that looked like a large crossbow! The history of the catapult and all its variations are basically the evolution of the bow and arrow. The same basic principles of simple machines present in a bow and arrow are present in all catapults.

INCREASING YOUR S.T.E.M. KNOWLEDGE (FURTHER KNOWLEDGE) (7)

Fulcrum: The point or support on which a lever turns. The position of the fulcrum, relative to the positions of the load and effort, determines the type of lever.
Load: The resistance or weight sustained by a machine.
Effort: The force needed by a machine in order to accomplish work on a load.
Resistance: A force, such as friction, that operates opposite the direction of motion of a body and tends to prevent or slow down the body's motion.
Balance: a state of equilibrium or equal distribution of weight or amount.
Acceleration: The rate of change of the velocity (speed) of a moving body. An increase in the magnitude of the velocity of a moving body (an increase in speed) is called a positive acceleration; a decrease in speed is called a negative acceleration.
Inertia: The resistance of a body to changes in its momentum. Mass can be considered a measure of a body's inertia.
Momentum: A quantity that expresses the relation of the velocity of a body to its energy.
Newton's Laws of Motion: The three laws proposed by Sir Isaac Newton concerning the relationships between force, motion, acceleration, mass, and inertia. These laws form the basis of classical mechanics and were critical in defining the concepts of force, mass, and inertia. **Newton's first law** states that a body at rest will remain at rest, and a body in motion will remain in motion with a constant velocity, unless acted upon by a force. This law is also called the law of inertia. **Newton's second law** states that a force acting on a body is equal to the acceleration of that body times its mass. **Newton's third law** states that for every action there is an equal and opposite reaction. Thus, if one body exerts a force on a second body, the first body also undergoes a force of the same strength but in the opposite direction. This law lies behind the design of rocket propulsion, in which matter forced out of a rocket engine at high speeds creating an equal force driving the rocket forward.

STANDARDS (8) (9)

Colorado Science Academic Standards (Physical Science)
Newton's laws of motion and gravitation describe the relationships among forces acting on and between objects, their masses, and changes in their motion.

Colorado Science Academic Standards (Physical Science)
Identify and calculate the direction and magnitude of forces that act on an object, and explain the results in the object's change of motion.

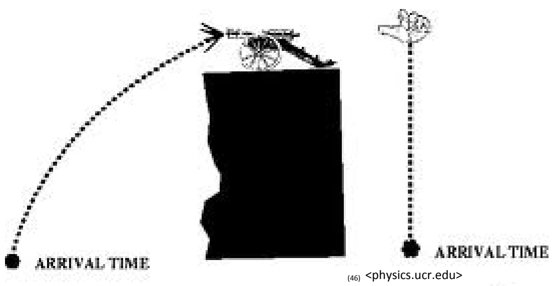
National Science Education Standards (Physical Science)
Content Standard B: (5th to 8th grade) – Motions and forces. Transfer of Energy

National Science Education Standards (Physical Science)
Content Standard B: (9th to 12th grade) – Motions and forces. Interactions of energy and matter

Which hits the ground first, a shot bullet or a dropped bullet? (45)

Suppose you could shoot a rifle and arrange for a second bullet to be dropped from the same height at the exact moment when the first left the barrel. Which would hit the ground first? Nearly everyone expects that the dropped bullet will reach the dirt first, and Aristotle would have agreed. Aristotle would have described it like this. The shot bullet receives some forced motion from the gun. It travels forward for a split second, slowing down rapidly because there is no longer any force to make it continue in motion. Once it is done with its forced motion, it changes to natural motion, i.e. falling straight down. While the shot bullet is slowing down, the dropped bullet gets on with the business of falling, so according to Aristotle it will hit the ground first.

Luckily, nature isn't as complicated as Aristotle thought! To convince yourself that Aristotle's ideas were wrong and needlessly complex, stand up now and try this experiment. Take your keys out of your pocket, and begin walking briskly forward. Without speeding up or slowing down, release your keys and let them fall while you continue walking at the same pace.



(46) <physics.ucr.edu>

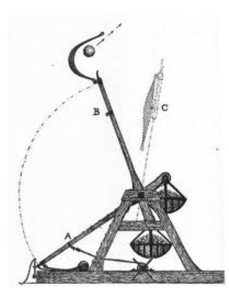
You have found that your keys hit the ground right next to your feet. Their horizontal motion never slowed down at all, and the whole time they were dropping, they were right next to you. The horizontal motion and the vertical motion happen at the same time, and they are independent of each other. Your experiment proves that the horizontal motion is unaffected by the vertical motion, but it's also true that the vertical motion is not changed in any way by the horizontal motion. The keys take exactly the same amount of time to get to the ground as they would have if you simply dropped them, and the same is true of the bullets: both bullets hit the ground simultaneously!

SIX TYPES OF SIMPLE MACHINES: (7)

A lever is a simple machine that consists of a rigid object (often a bar of some kind) and a fulcrum (or pivot). Applying a force to one end of the rigid object causes it to pivot about the fulcrum, causing a magnification of the force at another point along the rigid object.

Which of these machines is NOT a simple machine?

- Wheel and axle
- Robot
- Inclined Plane
- Airplane
- Wedge
- Screw
- Pulley



(47) <www.cs.wright.edu>


(48) <nageen.com>

A: Airplane & Robot

Colorado State University

Extension

Supplemental Information Sheets:

COLORADO SHOOTING SPORTS LEARN BY DOING

COLORADO 4-H SHOOTING SPORTS PROJECT – **S.T.E.M. CONNECTIONS**
Supplemental Certified Shooting Sports Leader Information Sheet
Building an Ear Plug "Shooter"

Researched & Provided by:
Kwang, Brenda – Colorado State University Extension, 4-H Youth Development – Douglas County
Brewer, Perry – Colorado State University Extension, 4-H Youth Development – Kit Carson County

The physics of shooting is based on the principles of the motion of projectiles. This motion and a variety of other physics concepts can be illustrated by building and using an "Ear Plug Shooter". This device is simple in construction and can be used by both adult volunteers and 4-H Shooting Sports members.

(3) Kwang, B. & Brewer, P. November 2010.

<u>WHAT WILL YOU NEED:</u> (49)

(3) Kwang, B. & Brewer, P. November 2010.

1. PVC pipe – ¾ inch by 36 inches long
2. Wooden dowel rod – ½ inch by 36 inches (The straighter the better!)
3. Pair of foam ear plugs (either tethered or individual)
4. Clear plastic tape
5. Unsharpened pencil (ram rod!)
6. Other projectiles (confetti or paper punch confetti!)

(A word of caution here: Do not use "hard" projectiles with your ear plug shooter! And as you know, in 4-H Shooting Sports you will not point a firearm at a person. This applies to your ear plug shooter too!)

<u>CONSTRUCTION AND USE:</u>

Construction is simple. Wrap one layer of clear plastic tape around one end of the dowel rod. This will aid in creating an air seal when you "fire" your shooter.

Choose one end of the PVC pipe as the "muzzle" of the shooter. This is where you will "load" the ear plug. Use the pencil to push the ear plug down the muzzle. (Use your safety training here and do not point the muzzle at you or others!) Put the tape wrapped end of the dowel rod 2 – 3 inches into the "breech" of the tube. Are you ready to fire? Do you have a safe target? Point the muzzle of the shooter at the target and with one swift continuous movement push the dowel "piston" down the barrel of your shooter. The result will be a satisfying "pop" as the ear plug exits the muzzle of the shooter!

You can emulate a shotgun by inserting one ear plug a short distance down the muzzle. Then place some confetti into the muzzle followed by the second ear plug. Use the pencil to push the "shotgun shell" into the barrel. When fired, the confetti will scatter much like the shot from a shotgun!

Have your members try shooting for distance, consistency or accuracy! Have your members shoot several times. You can then ask them to record and graph the results of their efforts. This will reinforce their math skills while having fun learning about the physics of shooting!

Physics and Shooting Introduction

Researched & Provided by:
Kwang, Brenda – Colorado State University Extension, 4-H Youth Development – Douglas County
Brewer, Perry – Colorado State University Extension, 4-H Youth Development – Kit Carson County

GENERAL PRINCIPLES: (50)

The physics of shooting is based on the principles of the motion of projectiles.

Gravity

One of the concepts of physics that impacts a projectile's motion is gravity. Gravity is a force that pulls an object in a specific direction. On the planet earth that direction is towards the surface of the planet. The force of gravity has been calculated as 9.8 meters per second squared. What members need to understand is that this is a constant force on all objects on Earth. This means that gravity has the same ability to bring an object that is stationary to the Earth's surface as it does to bring an object in motion to the Earth's surface.

Momentum

Momentum is another physics concept that impacts the motion of a projectile. Momentum is expressed as mass times velocity. It is used to calculate the amount of force an object produces when it is in motion. It is often referred to as linear momentum.

(51) <www.istockphoto.com>

The Path of a Projectile

The path that a projectile will take will always be a parabola (arc). This is a physics principle that was developed by noted scientist Galileo. Prior to Galileo's observations and discovery, it was thought that a projectile would basically travel in a straight line until it ran out of momentum, or impetus, at which point it would drop straight to the earth. This is obviously not the case. Gravity is always pulling on the projectile arcing its path and creating a parabola that starts at the launch point and ends at the surface of the Earth. This parabola can be shortened if the projectile is intercepted by a target.

Energy

Energy comes in several types. Stored energy (potential energy) based on the mass of an object, and kinetic energy (the energy of motion or momentum). Energy can be derived several different ways including chemical energy reaction (as in burning gunpowder) and elastic energy (in a bow string). Energy is always conserved (meaning energy cannot be created or lost). Energy can be transferred between objects (between burning gunpowder and the rifle bullet).

Researched & Provided by:
Kwang, Brenda – Colorado State University Extension, 4-H Youth Development – Douglas County
Brewer, Perry – Colorado State University Extension, 4-H Youth Development – Kit Carson County

Gun Recoil (52)

Gun recoil is a result of *momentum conservation*, which is an extremely important fundamental principle. Newton was talking about momentum conservation when he wrote "every action has an equal and opposite reaction".

Momentum Conservation

Momentum characterizes an object's resistance to change in motion. If this is motion along a straight line, we call it *linear momentum*; if it is rotational motion we call it *angular momentum*. The basic idea is the same: moving things like to keep moving, and to change their motion we have to apply a force. If no force is present, momentum doesn't change, in other words, it is conserved.


(53) <www.lib.niu.edu>

Now, you might point out that a bullet coming out of a gun has a huge force on it from the exploding gunpowder. True enough, and that force is what propels the bullet forward. However, if you look at a bullet *and* gun together (say while the bullet is still in the barrel but already heading out at full speed), you can say there is no *net* force on the bullet-gun *system*. So the momentum of the bullet plus gun should be conserved.

If the bullet has mass m_b and speed v_b out of the gun, it has momentum p_b given simply by

$p_b = m_b v_b$

in the forward direction. To balance this momentum (and keep the net momentum of the bullet-gun system zero), the gun recoils with momentum in the opposite direction:

$p_g = -p_b$ or $m_g v_g = -m_b v_b$

Although the bullet's mass is small, its speed is quite large, so it released with large momentum. The gun has much larger mass, so the recoil speed is much smaller, but still large enough to give a serious kick against the shooter's shoulder.

Example: Winchester .308

Let's look at an example. A Winchester .308 cartridge launches a bullet of mass 150 grains (1 grain = 64.8 mg) with a speed of 2820 ft/s (1 ft = 30.5 cm). In metric units, then, p_b = 8.4 kg m/s. This rifle has a weight of about 8 lbs, or a mass of m_g = 3.8 kg. That means the recoil speed of the rifle will be:

$v_g = - p_b/m_g = -2.2$ m/s

This ***primary recoil*** is noticeable, but not the main recoil that one feels.

Secondary Recoil

There are actually two distinct recoils from a gun: the first, primary recoil, which I've described above, conserves momentum of the gun-bullet system. However, the larger ***secondary recoil*** comes slightly later, when the bullet leaves the muzzle: then the hot expanding gas behind the bullet shoots out of the muzzle, and the muzzle recoils further like a rocket. This is, again, conservation of momentum, but in this case is the *gas* momentum out of the barrel that makes the secondary recoil. Gun manufacturers make baffles that reduce the flow of gas out of the muzzle to reduce secondary recoil. Primary recoil cannot be reduced, since it is simply associated with the forward momentum of the bullet.

Equations

- linear momentum: $p = mv$

Summary

- The total momentum of a system is conserved if there are no outside forces acting on it.
- Gun recoil results from conservation of total momentum of the bullet-gun system: the backward recoil gun momentum balances the forward bullet momentum to maintain zero total momentum.
- Gun recoil actually has two parts: primary recoil from the escaping bullet and secondary recoil from the escaping gas behind the bullet.

COLORADO 4-H SHOOTING SPORTS PROJECT – **S.T.E.M. CONNECTIONS**
Supplemental Certified Shooting Sports Leader Information Sheet
Building an ATLATL (55)

Researched & Provided by:
Kwang, Brenda – Colorado State University Extension, 4-H Youth Development – Douglas County
Brewer, Perry – Colorado State University Extension, 4-H Youth Development – Kit Carson County

Original Design and diagrams by: **Todd Oppenheimer**, Certified 4-H Shooting Sports Leader – Eagle County, Colorado

Wooden darts were known at least since the Middle Paleolithic). While the atlatl is capable of casting a dart well over 100 meters, it is most accurately used at distances of 20 meters or less The atlatl is believed to have been in use by Homo sapiens since the Upper Paleolithic (around 30 000 years ago). In this period, elaborate pieces, often in the form of animals, are common. The earliest known example is a 17,500 year-old atlatl made of reindeer antler and found in France.

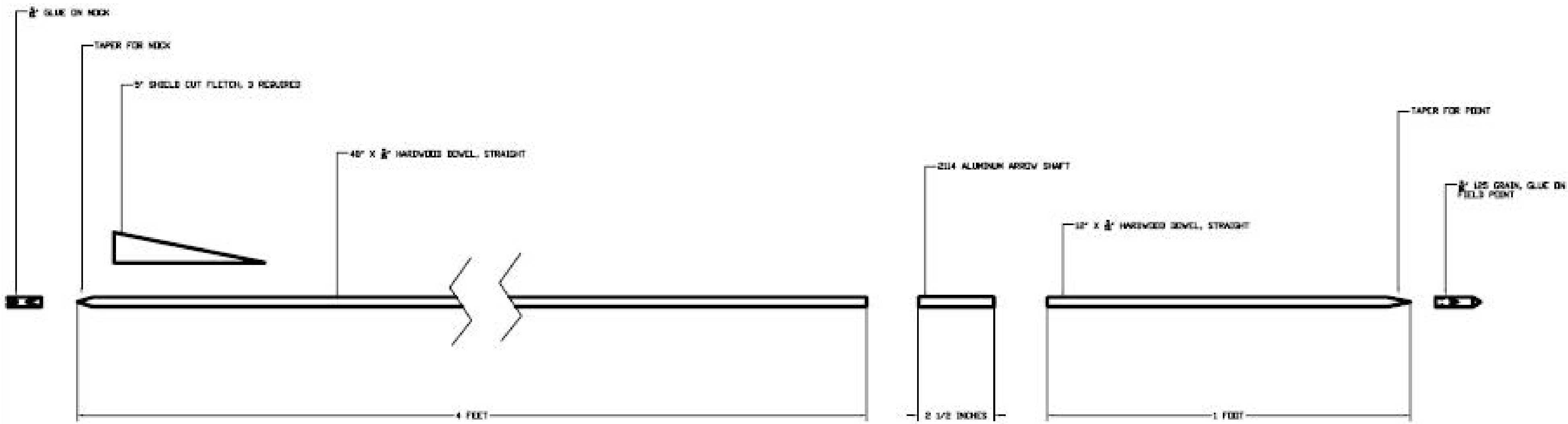
The atlatl was used by early Native Americans as well. It seems to have been introduced during the immigration across the Bering Land Bridge, and despite the later introduction of the bow, atlatl use was widespread at the time of first European contact. The people of New Guinea and Australian Aborigines also used spear throwers. Australian Aboriginal spear throwers are known as *woomeras*.

As well as its practical use as a hunting tool, it may also have had social effects. The device was a social equalizer in that it requires skill rather than muscle power alone. Thus women and children would have been able to participate in hunting.

In modern times, some people have resurrected the spear thrower for sports, throwing either for distance and/or for accuracy. Throws of almost 260 m (850 ft) have been recorded. There are numerous tournaments, with spears and spear throwers built with both ancient and with modern materials.

The Atlatl is sometimes used in modern times for hunting. In the U.S., the Pennsylvania Game Commission has given preliminary approval for the legalization of the atlatl for hunting certain animals. The woomera is still used today by some Australian Aborigines for hunting in remote parts of Australia. Yup'ik Eskimo hunters still use the Atlatl, known locally as "nuqaq" (nook-ak), in villages near the mouth of the Yukon River for seal hunting.

The designs for your own atlatl are on the next pages! More detailed designs are at: www.co4hshooting.org/2010_atlatl_drawings.html



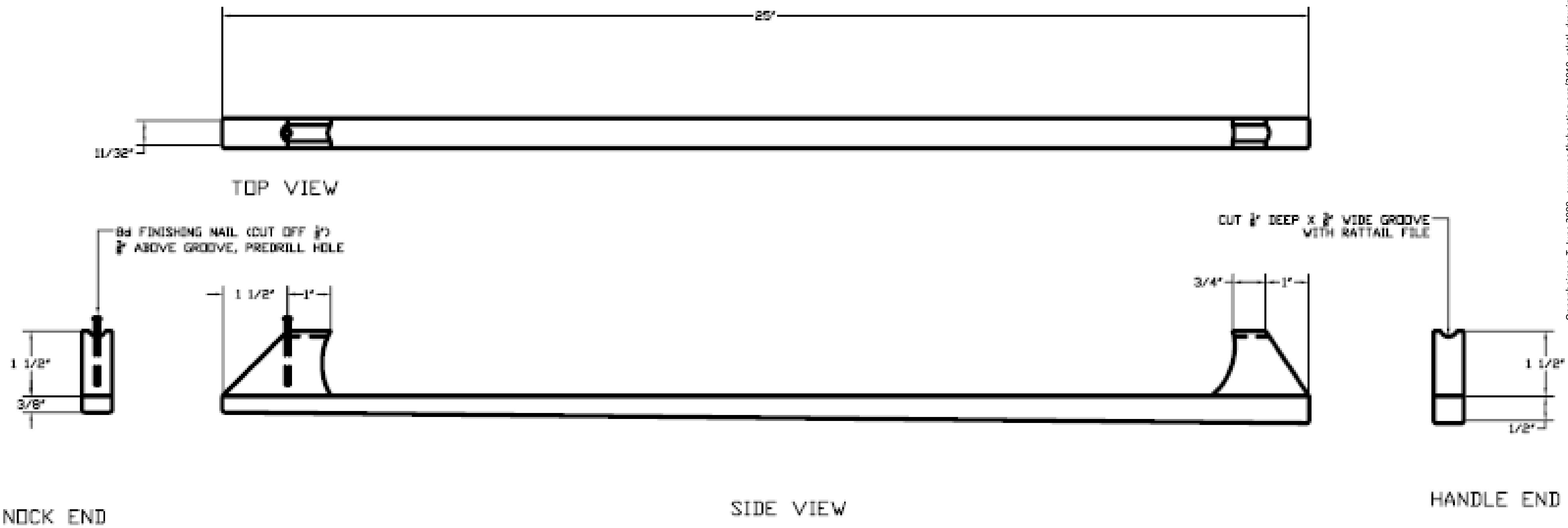
ATTACH DOWEL SECTIONS AND ALUMINUM CONNECTOR AS WELL AS FILED POINT AND NOCK WITH 5 MINUTE EPOXY CEMENT.

NOCK, FLETCHING, FIELD POINTS AS WELL AS SHAFT TAPERING TOOLS CAN BE PURCHASED FROM ANY TRADITIONAL ARCHERY SUPPLY STORE (3 RIVERS ARCHERY IS ONE SOURCE).

CAUTION!!! ATLATL THROWING STICKS AND DARTS ARE NOT TOYS AND SHOULD BE USED WITH EXTREME CARE AND SUPERVISION. DARTS CAN BE THROWN 100 YARDS AND SHOULD ONLY BE USED ON AN APPROPRIATE SIZE RANGE. EXERCISE ALL REQUIRED RANGE AND SAFETY MEASURES.

ATLATL THROWING DART - EXPLODED VIEW

(58) Oppenheimer, T. June 2009. < www.co4hshooting.org/2010_atlatl_drawings.html>



SELECT HARDWOOD MATERIAL (OAK, MAPLE, ETC) WITHOUT SPLITS OR CRACKS.
USE WATERPROOF GLUE (TITEBOND III) OR 5 MIN. EPOXY TO JOIN PIECES TOGETHER.
ROUND OFF ALL EDGES AND SAND TO REMOVE SPLINTERS AND SHARP EDGES.
FINISH WITH WOOD STAIN AND VARNISH IF DESIRED.

CAUTION!!! ATLATL THROWING STICKS AND DARTS ARE NOT TOYS AND SHOULD BE USED WITH EXTREME CARE AND SUPERVISION. DARTS CAN BE THROWN 100 YARDS AND SHOULD ONLY BE USED ON AN APPROPRIATE SIZE RANGE. EXERCISE ALL REQUIRED RANGE AND SAFETY MEASURES.

ATLATL THROWING STICK

(58) Oppenheimer, T. June 2009. < www.co4hshooting.org/2010_atlatl_drawings.html>

Evaluations:

4-H Member Shooting Sports S.T.E.M. Survey (59)

Please tell us how often you did these things before your 4-H Shooting Sports experience and how often you know/do them now.

For example: If you did not usually work out problems before your Shooting Sports experience, but now you usually do, answer like this:

	Before 4-H Shooting Sports, I…				Now, I…			
	Almost never	Not usually	Usually	Almost always	Almost never	Not usually	Usually	Almost always
1. work out problems	☐	☑	☐	☐	☐	☐	☑	☐

Directions: Please check one box in the Before Shooting Sports column **and** check one box in the Now column to answer questions 1 to 8.

	Before 4-H Shooting Sports, I …				Now, I …			
	Almost never	Not usually	Usually	Almost always	Almost never	Not usually	Usually	Almost always
1. work out problems in Shooting Sports (math and others)	☐	☐	☐	☐	☐	☐	☐	☐
2. Knowledge of Science (STEM) Careers in Shooting Sports	☐	☐	☐	☐	☐	☐	☐	☐
3. Know how science relates to shooting sports	☐	☐	☐	☐	☐	☐	☐	☐
4. Use Technology in Shooting Sports	☐	☐	☐	☐	☐	☐	☐	☐
5. Demonstrate Science in shooting sports to others	☐	☐	☐	☐	☐	☐	☐	☐
6. Knowledge of science basics/principles in shooting sports	☐	☐	☐	☐	☐	☐	☐	☐
7. I want to learn more hands-on things about science, technology, engineering or mathematics.	☐	☐	☐	☐	☐	☐	☐	☐
8. I understand how to observe or compare science in shooting sports	☐	☐	☐	☐	☐	☐	☐	☐

Please tell us about yourself.

12. How many years have you been in 4-H Shooting Sports? _______________

13. How old are you? ______________

14. I am a: girl ☐ boy ☐

15. How have you changed because of 4-H Shooting Sports ?

____

____

Please Return the Survey to your local Extension Office as completed but before September 1st of each 4-H Year.

(Extension Offices please return to the State 4-H Office as these are completed. No later than September 5th each year.)

4-H Leader Shooting Sports S.T.E.M. Survey (60)

Please tell us how often you did these things before your 4-H Shooting Sports experience and how often you know/do them now.

For example: If you did not usually work out problems before your Shooting Sports experience, but now you usually do, answer like this:

	Before 4-H Shooting Sports, I…				Now, I…			
	Almost never	Not usually	Usually	Almost always	Almost never	Not usually	Usually	Almost always
1. work out problems	☐	☑	☐	☐	☐	☐	☑	☐

Directions: Please check one box in the Before Shooting Sports column **and** check one box in the Now column to answer questions 1 to 8.

	Before 4-H Shooting Sports, I …				Now, I …			
	Almost never	Not usually	Usually	Almost always	Almost never	Not usually	Usually	Almost always
1. work out problems in Shooting Sports (math and others)	☐	☐	☐	☐	☐	☐	☐	☐
2. Knowledge of Science (STEM) Careers in Shooting Sports	☐	☐	☐	☐	☐	☐	☐	☐
3. Know how science relates to shooting sports	☐	☐	☐	☐	☐	☐	☐	☐
4. Use Technology in Shooting Sports	☐	☐	☐	☐	☐	☐	☐	☐
5. Demonstrate Science in shooting sports to others	☐	☐	☐	☐	☐	☐	☐	☐
6. Knowledge of science basics/principles in shooting sports	☐	☐	☐	☐	☐	☐	☐	☐
7. I want to learn more hands-on things about science, technology, engineering or mathematics.	☐	☐	☐	☐	☐	☐	☐	☐
8. I understand how to observe or compare science in shooting sports	☐	☐	☐	☐	☐	☐	☐	☐

Please tell us about yourself.

12. How many years have you been involved in 4-H Shooting Sports? ______________

13. How many years have you been a 4-H Shooting Sports leader? ________________

14. I am: female ☐ male ☐

15. How have you changed because of 4-H Shooting Sports ?

____

____

Please Return the Survey to your local Extension Office as completed but before September 1st of each 4-H Year.

(Extension Offices please return to the State 4-H Office as these are completed. No later than September 5th each year.)

Possible S.T.E.M. Connections to Come:

- Careers related to Shooting Sports and S.T.E.M.
- Balance and Engineering of the Shooting Sports.
- Ballistics…. The Science Guys of CSI!
- Sea Level…. Am I shooting in the Ocean?
- Shotgun Shooters… The mathematicians on the fly!
- The Science behind gauges of shotguns
- History of science and shooting

References:

References:

1. Why Stem - www.4-h.org/youth-development-programs/4-h-science-programs/ - November 2010.
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