

BLOWGUN PHYSICS



THEMES:

- Newton's Laws of Motion
- Advancement of Technology

GRADE LEVEL(s):

7th (5th-8th overlap)

DURATION:

- Total Activity: 2-3 days
- In-class Activity: 1 class period
- Outside Activity: 1 class period
- Conclusion & Extension Activity: 1 class period

SKILLS

- Identifying patterns
- Making Connections
- Gathering Information
- Constructing and Communicating
- Citing Evidence
- Comparing, Analyzing, Observing, Experimenting

BEST TIME FOR ACTIVITY:

Fall or Spring.

SUMMARY

Cherokee Technology

Students unpack the definition of technology and examine how technology has helped develop human civilization throughout history. Students are introduced to Newton's Laws of Motion to understand how the blowgun, a Cherokee hunting technology, works and can be innovated for specific uses. Students finish out this lesson with research or experiment based assignments to delve deeper into analysis of this technology.

OBJECTIVES AND CONNECTIONS

Students will experiment and make observations with Cherokee blowguns to fully understand Newton's Laws of motion, the continuity of change in technology throughout time, and develop arguments to demonstrate their deeper understanding of these concepts.

MATERIALS

Preparation

- Interactive Presentation Board OR Student Computers

Activity

*Materials designated with a * will be provided in the activity box.*

- Blowguns & darts*
- Foam board targets x 2*
- Data sheets*
- Clipboards & pencils
- Alcohol wipes





NORTH CAROLINA SCIENCE CORRELATIONS

- ✓ PS.7.1.1 Construct an explanation to summarize the motion of an object by its position, direction of motion, and speed in respect to some other object
- ✓ PS.7.1.2 Use models to illustrate the effects of balanced and unbalanced forces acting on an object (including friction, gravity and magnetism)
- ✓ PS.7.1.3 Analyze and interpret graphical data to summarize the motion of an object to show a change in position over a period of time
- ✓ PS.7.1.4 Analyze and interpret graphical data to summarize the motion of an object to show a change in distance over a period of time for a constant speed and variable motion
- ✓ PS.7.2.1 Construct an explanation to summarize how kinetic and potential energy contribute to the mechanical energy of an object.
- ✓ PS.7.2.2 Engage in argument from evidence to explain how energy can be transformed from one form to another, specifically potential energy and kinetic energy (models could include roller coasters, pendulums, or cars on ramps as examples.

NORTH CAROLINA SOCIAL STUDIES CORRELATIONS

- ✓ 6.H.2.3 Explain how innovation and/or technology transformed civilizations, societies and regions over time (e.g., agricultural technology, weaponry, transportation and communication).
- ✓ 7.G.1.1 Explain how environmental conditions and human response to those conditions influence modern societies and regions (e.g. natural barriers, scarcity of resources and factors that influence settlement).
- ✓ 8.H.3.1 Explain how migration and immigration contributed to the development of North Carolina.

TENNESSEE SCIENCE CORRELATIONS

- ✓ 5.PS2: Motion and Stability: Forces and Interactions
- ✓ 5.ETS2: Links Among Engineering, Technology, Science, and Society
- ✓ 8.PS2: Motion and Stability: Forces and Interactions
- ✓ 8.ETS1: Engineering Design

TENNESSEE SOCIAL STUDIES CORRELATIONS

- ✓ 5.27: Identify the cultures of the major Indigenous settlements in Tennessee (Archaic, etc.).
- ✓ 5.28: Identify the pre-colonial American Indian tribes residing in Tennessee.
- ✓ 6.02: Describe characteristics of hunter/gatherer societies (use of tools, weapons, etc.).
- ✓ 7.54: Explain the impact of geographic features on North American Indian cultures (tools, etc.).
- ✓ 7.55: Describe the diverse networks of North American Indian cultures (customs, etc.).
- ✓ 6-8. SSP.04: Construct and communicate arguments citing supporting evidence.
- ✓ 6-8. SSP.05: Develop historical awareness by identifying patterns of continuity and change over time, making connections to the present.

TENNESSEE LANGUAGE ARTS CORRELATIONS

- ✓ 8.SL.CC.1 Prepare for collaborative discussions on 8th grade level topics and texts; engage effectively with varied partners, building on others' ideas and expressing one's own ideas clearly.
- ✓ 8.SL.PKI.4 Present claims and findings in a focused, coherent manner with relevant evidence, valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.





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About this project:

The Seeking Paths in Nature (SPiN) project was developed through a partnership between Great Smoky Mountains National Park (GRSM) and the Cherokee Preservation Foundation. SPiN encompasses the focused efforts to enlighten the public, students, and GRSM employees on the history and cultural connections inherent between the Cherokee and the land, currently deemed as Great Smoky Mountains National Park, as well as surrounding communities.

Background Information:

The land of Great Smoky Mountains National Park lies on the traditional homeland of the sovereign nations of Cherokee, or Aniyuwiya*, (*pronounced “a-nee-ya-wee-ya”) meaning the Principal People. We recognize the Cherokee and their ancestors as the original and continuing stewards of this land, going back to time immemorial. The Cherokee have a deep, complex, and reliant relationship with the land. Their intimate knowledge and relationship with the land along with the seasonal availability of plants and animals has resulted in stories, medicinal remedies, foodways, arts, technologies, science, and many other practices that prioritize ecologically sustainable stewardship and partnership with the land. Many Cherokee continue these significant traditions.

Vast changes to the land came in the late 1700s when European immigrants, largely of Scotch-Irish heritage, moved to the Southern Appalachians. The massive influx of people and greediness led to disputes and conflicts between the Europeans and Cherokee, eventually resulting in the tribe being forced to sign over their lands first to Great Britain, and later to the United States. Though some found ways to remain on their traditional lands in the 1830s, most Cherokee were forced to move west. Nearly 16,000 Cherokee were forced to walk to newly appointed Cherokee lands located in present-day Oklahoma. This tragic journey is known as the “Trail of Tears” due to the deaths of approximately 4,000 Cherokee people. Since the arrival of settlers, there have been many impacts of colonization including wars, conflicts, disease, broken treaties, land resource exploitation, forced assimilation, and genocide. Despite it all, the Eastern Band of Cherokee Indians have persevered.

Today, the Cherokee live on just a small fraction of their traditional homelands known as the Qualla Boundary. They are revitalizing their culture through efforts such as language preservation, the arts, education, community building, natural resource management, and commercial enterprises. Currently, the EBCI Qualla Boundary adjoins a southern portion of Great Smoky Mountains National Park, and the Cherokee proudly proclaim: “Si O Tse Do Ha”*, (*pronounced “she oh tsay doe ha”) or “We’re Still Here!”



Acknowledgements:

Special thanks for contributions from the Cherokee Preservation Foundation, Friends of the Smokies (FOTS), Great Smoky Mountains Association (GSMA), Cherokee Central Schools, Eastern Band of Cherokee Indians (EBCI) Natural Resources, Museum of the Cherokee Indian (*in particular Dakota Brown and Dawn Arneach*), EBCI Speaker's Council [*Laura Pinnix, Roger Smoker, Bo Lossiah, Marie Junaluska, Mary Wachacha (in memoriam), and Dr. Hartwell Francis*]. For your insight, we thank Russ Townsend, EBCI Tribal Historic Preservation Office Program (THPO), and the many teachers who assisted in content creation and piloting [*Jessica Metz, Malia Crowe Skulski, Kaitlin Roberts, Matt Tooni, Lizzie Carver, Amanda Clapp, Nikki McCoy, Randi Neff, Max Lanning, Melissa Crisp, Judy Dulin, Michelle Whaley, and Brian Hardison*], community members *Louise & Butch Goings, Peggy Hill-Kerbow*. The National Park Service (NPS), AmeriCorps Project Conserve members, and Great Smoky Mountains National Park Education staff and interns.

Thank you to our project coordinators whose leadership and creative energy were vital to the success of this project. Jessica Metz led the project in 2014 – 2016, Julie Townsend (in memoriam) led the project from 2016-2019. For their seasonal terms as project assistants, we thank Jessica Stump, Natriefia Miller and Kahawis.

We dedicate this curriculum guide in the memory of Julie Townsend; her good humor, knowledge and relationships in the community are missed daily. Julie lived her life by the Cherokee concept of Gadugi - “we learn together” and it is with this intent that we offer these activities to you.

We acknowledge that the spelling of Cherokee words included in these documents may differ slightly, as there are variations of Cherokee dialects within EBCI.



NATURAL RESOURCES
EASTERN BAND OF CHEROKEE INDIANS



IN-CLASS ACTIVITY

VOCABULARY AND DEFINITIONS



Grade Level: 5-8

Subject Area: Science

Activity time: 45 minutes

Setting: Classroom

Skills: Analyzing, Listening,
Listing, Organizing

Materials: Computer(s)
with internet connection

Objectives:

- 1) Become familiar with the vocabulary associated with the lesson.
- 2) Understand the cultures associated with the Great Smoky Mountains National Park.
- 3) Recognize that technology has played a role in the development of the cultures.
- 4) Understand that the laws of physics applies both to ancient and modern technologies.
- 5) Learn about how local materials were utilized in evolution of tools.

Vocabulary:

- **Acceleration** - the change in velocity ($a = V_f - V_i/t$)
- **Acceleration constant due to gravity on Earth** - ($g = 9.8 \text{ m/s/s}$)
- **Atlatl** - a device for throwing a spear or dart that consists of a rod or board with a projection (such as a hook) at the rear end to hold the weapon in place until released
- **Blowgun** - weapon consisting of a long tube through which an arrow or dart is propelled by the force of breath
- **Darts** - thin object with fletching, designed to be launched by hand such that a sharp, often weighted point will strike first
- **Force** - something that changes the motion of an object ($F = ma$)
- **Fulcrum** - the point on which a lever pivots and rests or is supported
- **Gravity** - the force of attraction between two objects that have mass
- **Kinetic energy** - energy of motion
- **Lever** - a stiff bar for lifting a weight at one point of its length by pressing or pulling at a second point
- **Newton's 1st Law** - states that an object either remains at rest or continues to move at a constant velocity, unless acted upon by a force
- **Newton's 2nd Law** - states that the force acting on an object is equal to the mass of the object multiplied times the acceleration of the object ($F = ma$)
- **Newton's 3rd Law** - states that when one object exerts a force and a second object, the second object simultaneously exerts a force equal in magnitude and opposite in direction on the first object
- **Physics** - a science that deals with matter and energy and their interactions
- **Projectile Motion** - a form of motion experienced by an object that is thrown near the Earth's surface and moves along a curved path under the action of gravity only (assuming negligible air resistance)
- **Spring** - an object that stores mechanical energy and can be deformed by a force then return to its original shape after the force is removed
- **Velocity** - the speed of an object in a given direction ($V = d/t$)
- **Work** - the displacement of an object in the direction of an applied force ($W = Fd$)



IN-CLASS ACTIVITY

BLOWGUN PHYSICS LESSON



Background:

What is technology?

Technology is often used to refer to the latest cell phone or tablet, but its true definition is much broader. Tech-nology is defined by Merriam Webster as “a capability given by the practical application of knowledge.” In other words, technology is any invention or innovation that allows us to accomplish a task or goal more efficiently or effectively.

How long has technology existed?

Human technology has been around as long as people have. From the creation of the wheel to the Hubble Space Telescope people have always engineered technological solutions when problems present themselves.

The Cherokee blowgun is an example of hunting technology. One of the problems the Cherokee faced was how to bring down small game like birds, rabbits, and squirrels with stealth and ease. For this they used a special piece of hunting technology called the blowgun. A blowgun is a long, narrow tube used to propel light projectiles (darts). Through the hunter’s forced exhalation (breath) they are able to propel the dart with desired speed and force. Blowguns have been used for at least 2,000 years by peoples throughout much of the world. Blow-guns are still used today by some Cherokee, both for hunting and in shooting competitions. They are also used to this day by wildlife specialists to tranquilize animals for research or medical purposes. The Cherokee and their ancestors crafted blowguns from river cane (a botanical cousin of bamboo). River cane is scarce, with only about 2% of the original population remaining due to development.

How are blowguns and darts constructed?

1. First by removing the interior joints using embers from a fire. The embers burn through the joint and then a stick is used to push the ember to the next joint until all joints are removed.
2. Next, the crafter will smooth the inside of the blowgun using a piece of river cane with an arrowhead attached to scrape out the inside. Natural oils from green river cane are applied to the inside of the blowgun to smooth the way for the darts.
3. Next, the blowgun is straightened over several days by warming it near the fire and holding it in place to straighten.
4. Darts are made of hardwood like locust, oak, or hickory.
5. Fletching is made of the downy tufts of dried Scottish thistle carefully twisted onto the dart with string. The fletching catches the air creating an air lock inside the blowgun, forcing the dart through the blowgun when blown.

Practice makes perfect

The blowgun requires stealth and precision of the hunter. A Cherokee child would grow up using a smaller blowgun as a toy to initiate their training. By the time the child was 8 or 9 they could successfully hunt small game like rabbits, squirrels, and birds. As they grew to be more skilled they could use longer blowguns to hunt larger animals like turkeys by shooting the dart through the bird’s eye. Blowgun hunting required stealth, patience, and practice.

How does a blowgun work?

You might be surprised to learn that Cherokee and other blowgun users were utilizing for thousands of years what would later be described by Sir Isaac Newton in 1686 as the three laws of motion. These three laws form the basic principles of modern physics.





(in-class activity cont'd)

Laws of Motion:

- Law 1: Law of **Inertia**: Objects at rest remain at rest and objects in motion remain in motion unless acted upon by a force.
- Law 2: Law of **Acceleration**: Force equals mass times acceleration. $F = ma$
- Law 3: Law of **Action and Reaction**: For every action there is an equal and opposite reaction.

Experiment with using the blowgun and darts to better understand these laws. Record your observations on the data sheet provided.

Procedure:

1. Review key terms with class before performing activity using videos and class discussions.
2. Ensure students understand what technology means, how it applies to past and present tools, and how it has evolved over time.
3. Share with students, information about the historic use of blowguns and how they are manufactured. The video below is a wonderful addition if time permits.
4. Lead students to be able to explain Newton's laws and how they apply to the physics of a blowgun.

Videos and Presentations:

- Davy Arch (Eastern Band Cherokee) Video 9min long
https://www.youtube.com/watch?v=-WewedPqi_k
- Use this Ted Ed talk by Joshua Manley instead. Newton's Three Laws with a bicycle.
https://youtu.be/JGO_zDWMkvk
- Powerpoint Presentation (in kit)

References:

- <https://visitcherokeeanation.com/blog/cherokee-hunting>
- <https://www.theonefeather.com/2012/07/learning-about-blowguns-darts/>
- <https://exarc.net/issue-2013-3/at/hunting-cane-traditional-cherokee-blowguns-and-darts>
- <https://www.blueridgeheritage.com/artist/bob-reed/>
- Museum of the Cherokee Indian, Cherokee, NC. Weapons exhibit and live interpretive demonstrations. 2016.
- <https://shiyo.org> - Cherokee Language app for students



OUTDOOR ACTIVITY

BLOWGUN PHYSICS DEMONSTRATION



Grade Level: 5-8

Subject Area: Science

Activity time: 75 minutes

Setting: Outdoors

Skills: Analyzing, Applying, Calculating, Classifying, Communicating, Comparing, Discussing, Gathering information, Hypothesizing, Measuring, Predicting, Summarizing

Materials:

- blowguns and darts
- alcohol swabs
- clip boards & pencils if data is taken
- targets

Introduction:

Review the idea of projectile motion, in which a projectile (dart) follows a curved path due to the force of gravity pulling it toward the ground. Students will have to consider this concept when experimenting with various forces, angles, and distances.

Procedure:

Using a blowgun is simple. (Remind students of steps listed inside)

1. A dart is loaded into the proximal (or close) end of the gun with sharp tip loaded first.
2. Blowgun is held upright and parallel to ground. (Do not let far end dip or dart will slide downwards).
3. The shooter grasps the near end with their dominant hand, clasp tightly the end of the blowgun to create a seal.
4. Shooter takes a breath.
5. The shooter's mouth is pressed against their hand, and with a quick and forceful exhale the dart is launched.
6. (TIP: Practice these steps without blowgun or dart first - with hand in fist to simulate airflow).

Have students split into 2 groups, each group will get either a 5' blowgun or a 3' blowgun and clipboards with data sheets.

1. Each group will experiment with various amounts of force, angles, and distances to try to improve their accuracy on a target. Students should complete data sheet either individually or as small groups.
2. After a predetermined amount of time, they will switch to the other length of blowgun and complete data again.

Drawing Conclusions

Most students will conclude that the longer length (5') blowgun is more accurate and the angle that the blowgun is held at must be adjusted depending on the distance from the target.

Extension activities:

- Have students design their own experiments that test various hypotheses (Example: design an experiment that measures accuracy, such as distance from bull's eye, to determine the most accurate lengths and distances from target).
- Have students research other weapons used by Native Americans, such as the atlatl, and how it compares to the blowgun.
- Have students research how else river cane was used by Cherokee and their ancestors and why it is nick-named "Cherokee plastic". (baskets, etc.)
- Pair with rivercane mapping or timeline activity to make connections to evolution of other weapons and tools, ecological concepts.



All Student Names: _____

Date: _____

Blowgun Physics Student Data Sheet

Laws of Motion:

Law 1: The Law of Inertia – Objects in motion tend to stay in motion and objects at rest tend to stay at rest.

Observed in Activity:

Law 2: The Law of Acceleration - The acceleration of an object is directly proportional to the net force exerted and inversely proportional to the object's mass. Force equals mass times acceleration. $F = ma$

Observed in Activity:

Law 3: The Law of Action and Reaction - For every action, there is an equal and opposite reaction.

Observed in Activity:

Conclusions Based on Observation:

1. Which length of blowgun appeared to travel faster? _____ Explain.

2. Which length of blowgun appeared to be more accurate? _____ Explain.

3. Which length of blowgun propelled the dart the farthest? _____ Why do you think that is?

4. Which struck with more force? _____ How could you tell?

5. Did you notice the effect that distance had on blowgun force and accuracy?

6. What animals would you suggest hunting with the blowgun?

7. Which would you prefer to use? Why?

8. Use the other side of this sheet to design an experiment to scientifically test observations 1-4. Include a chart to record data.

All Student Names: **ANSWER KEY**

Date: _____

Blowgun Physics Student Data Sheet

Laws of Motion:

Law 1: The Law of Inertia – *Objects in motion tend to stay in motion and objects at rest tend to stay at rest.*

Observed in Activity: The dart will remain at rest inside the blowgun until acted on by the force of blowing, which causes the dart to project out of the blowgun when it overcomes the force of friction. The dart will continue on its path until it hits another object or the force of gravity pulls it to the ground.

Law 2: The Law of Acceleration - *The acceleration of an object is directly proportional to the net force exerted and inversely proportional to the object's mass. Force equals mass times acceleration. $F = ma$*

Observed in Activity: The force of the dart is equal to the mass of the dart multiplied by its acceleration, or change in velocity.

Law 3: The Law of Action and Reaction - *For every action, there is an equal and opposite reaction.*

Observed in Activity: The force of blowing on the dart in the blowgun is equal and opposite to the force of friction holding it in place.

Conclusions Based on Observation:

1. Which length of blowgun appeared to travel faster? Explain.

Answers will vary--students should have supporting evidence to account for their answer. Generally, the shorter length will result in a reduction in friction.

2. Which length of blowgun appeared to be more accurate? Explain.

Answers will vary--students should have supporting evidence to account for their answer. Generally, the longer length will increase accuracy due to the projectile having increased time stabilizing its path.

3. Which length of blowgun propelled the dart the farthest? _____ Why do you think that is?

Answers will vary--students should have supporting evidence to account for their answer.

4. Which struck with more force? _____ How could you tell?

Answers will vary--students should have supporting evidence to account for their answer (drag/velocity).

5. Did you notice the effect that distance had on blowgun force and accuracy?

Answers will vary--students should have supporting evidence to account for their answer concerning gravity.

6. What animals would you suggest hunting with the blowgun?

Answers will vary--students should have supporting evidence to account for their answer.

7. Which would you prefer to use? Why?

Answers will vary--students should have supporting evidence to account for their answer.

8. Use the other side of this sheet to design an experiment to scientifically test observations 1-4. Include a chart to record data.