"How Does the Cannon Work?": A Pre-Visit Activity for Tragic Prelude

Discover how the cannon can also be used to explain science! This lesson will get your class ready to see the cannon in action when you come out and visit Mahaffie!

Standards addressed with this activity:

(Next Generation Science Standards)

> MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
>
> MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second and Third Laws), frame of reference, and specification of units.]

Background: Sir Isaac Newton went to Cambridge University and was most interested in mathematics, physics and astronomy. In 1672 he published his greatest work, the Mathematical Principles of Natural Philosophy, which included his laws of motion and explained how gravity could apply to objects everywhere in the universe.

STEP ONE: Review Newton's Laws of Motion. Refer to them when answering the questions that follow.

FIRST LAW OF MOTION: Every object in a state of rest or a uniform state of motion remains in that state until an external sufficient force is applied to it. (For example, this baseball will stay on the tee until the player hits it with the bat.)

Question: Give two reasons why the ball will slow or stop once it is hit by the bat.

1. _____
2. _____

(Possible answers): gravity, friction, a player's glove, hitting a wall

SECOND LAW OF MOTION: The rate of change in momentum is directly proportional to the resultant force acting on it. (For example, the boy may kick the ball with less force to simply pass the ball to a teammate, but he may kick it with more force if he wants to score the winning goal.)

Question: Evan (the soccer player) passed the ball to a teammate who was 25 feet away. The goal is now 50 feet away. How many times harder will Evan kick the ball?

(Answer): Twice as hard so that the goalie cannot intercept it

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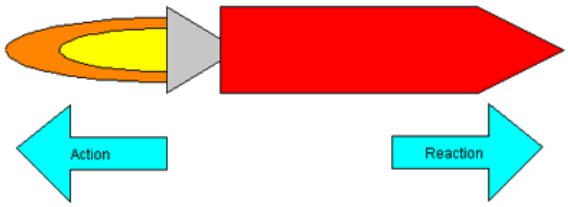
THIRD LAW OF MOTION: For every action, there is an equal, and opposite, reaction.



Question: If the 12 pound shell is fired from the 450 pound carriage holding the Howitzer, why doesn't the carriage rock *backward* as far as the shell travels *forward through the air?*

(Answer): The 12 pound mass of the shell is much easier to move than the 450 pound carriage with the same force. Therefore, with the same force, the shell will move much farther forward than the carriage will move backward.

STEP TWO: Go to this interactive website to see Newton's Laws of Motion in action: http://science.discovery.com/games-and-interactives/newtons-laws-of-motion-interactive.htm

Some notes on the interactive website:

- The worm has inertia, and keeps going even when the apple stops, until he runs into the wall. (Newton's First Law)
- A bigger worm can pull the same mass faster, or the same size worm can pull a smaller mass faster. (Newton's Second Law)
- The force of the rocket pushes down and the rocket launches up(Newton's Third Law)

STEP THREE : Apply your knowledge of Newton's Laws of Motion to a cannon being fired.

Standards addressed with this activity:
(Next Generation Science Standards)

- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions**.**

Background: Until the time of cannons, warfare was limited to hand-to-hand combat and guns. Rifles fired in a mostly straight line from the muzzle to the target. The shooter had to aim slightly higher for longer distances to compensate for the drop of the bullet as it traveled through the air. Before cannon use, troops could hide behind structures and be protected. More strategy was needed to effectively harm the enemy. With the use of cannons, warfare changed dramatically.

The 1921 Mountain Howitzer was used by both Confederate and Union forces during the Civil War and its advantage over other cannon of their time was that the Mt. Howitzer was extremely mobile. When you visit Mahaffie Stagecoach Stop and Farm, as part of the Tragic Prelude Program, you will witness the firing of a 12-pounder Howitzer cannon. You will be able to see all three laws of motion as they apply to the firing of the cannon. You will also see the variety of ordnance that could be used for the best application for each engagement.

Think Critically: Why would armies with cannons have an advantage over armies who did not?

(Answer: The cannon could be fired to travel in an arc, allowing the payload to clear their own troops, clear obstacles, and yet reach the enemy.)

Activity: Can you identify Newton's Three Laws of Motion in each of the following steps of firing the cannon? (One of the Laws is used twice!) Put a number 1, 2, or 3 at the end of each statement to identify the proper Law.

1. The cannon ball is launched out the front of the cannon while the carriage rocks backward from the explosion. **(3)**
2. The cannonball rests in the barrel until the explosion occurs. **(1)**
3. The shell travels farther by loading more gunpowder in the "charge". **(2)**
4. The shell stops moving forward when it hits the target. **(1)**

Some advantages the 1821 Mountain Howtizer has over other forms of artillery:

- Capable of firing a variety of loads
    - Cannonball- used to weaken walls, or any solid object.
    - Canister- could be packed with projectiles which explode over or near the target.
- Fired in an arc (over troops on the same side, or obstacles, like piles of rock used for cover by the enemy)
- Highly portable on any terrain, even on mere footpaths in the mountains-could be broken down into three loads for pack animal transport. However, their shorter range made them unsuitable for dueling with other larger, but more cumbersome, field artillery.
- The shell could be designed to go off on impact, or with a timed fuse.

Other cool facts about Mountain Howitzers:

- Produced by only three companies in America:
    - Cyrus Alger Co. of Boston, MA
    - Nathan P. Ames Co. of Boston, MA
    - Tredegar Iron Works of Richmond, VA
- A Howitzer cannon lost by Free-State troops in the fighting in 1850s Kansas was later used in Civil War by Missouri Confederates.
- The angle of elevation could be altered by moving a wooden wedge forward under the rear end of the cannon. This changed the trajectory of the shot.