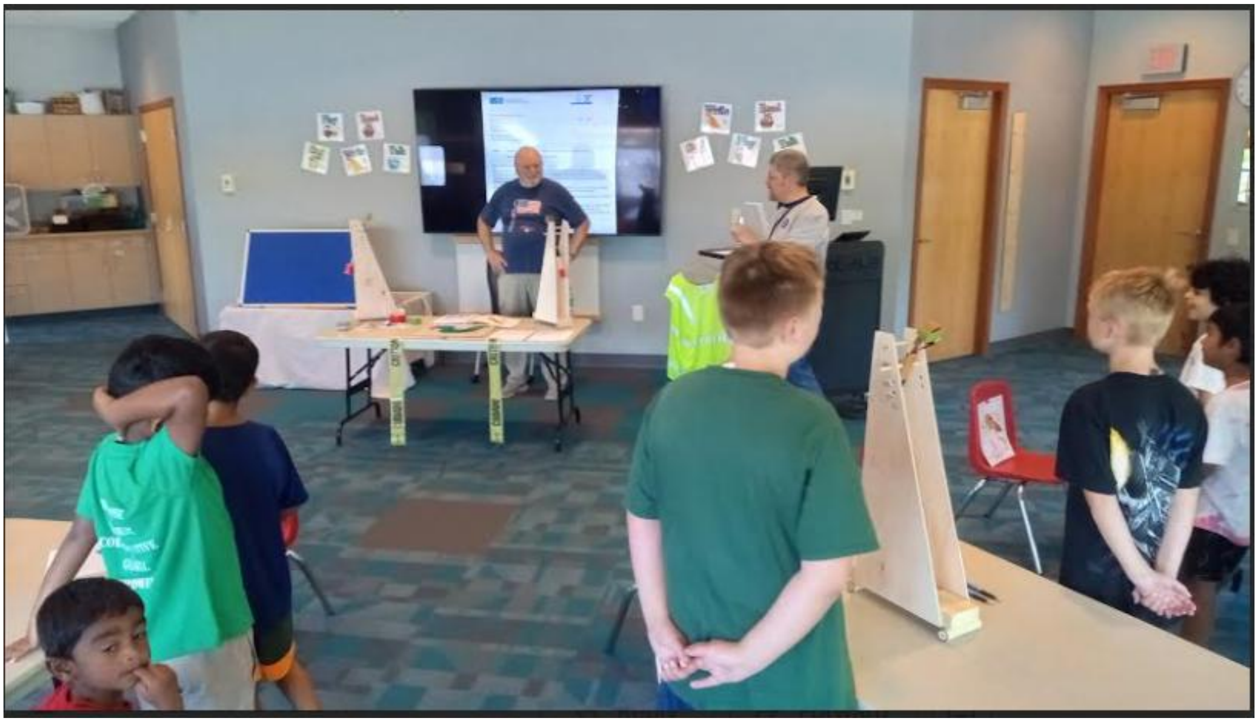
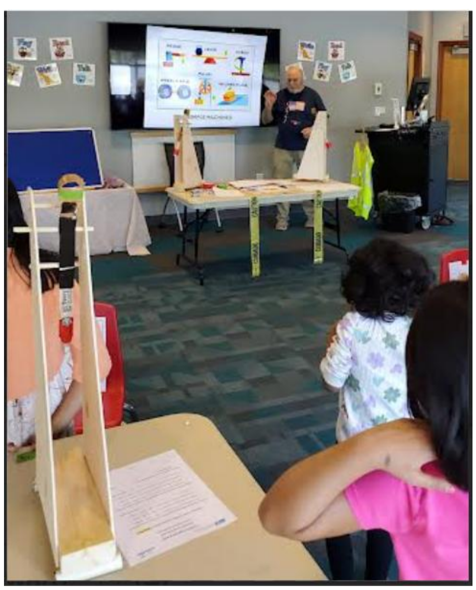
National Engineers Week Event having Energy Conversion with Catapults

This "Summer Fun for Everyone" Event on YouTube: https://youtu.be/gFE_SCYK_Sc?feature=shared



Tim Protiva, our CCPL Strongsville Branch Host, introduces Joe Yurko, leading todays event.



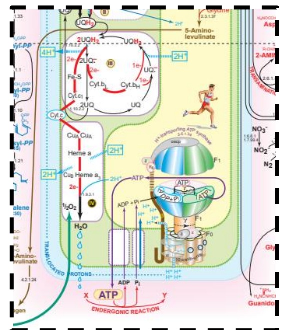
Summer Fun for Everyone with NSPE National Engineers Week

Introduction of Archimedes Simple Machines we will be using, followed by Sir Isacc Newton's First Law of Energy, Inertia: A body in motion will remain in motion unless acted upon by another force (Gravity)

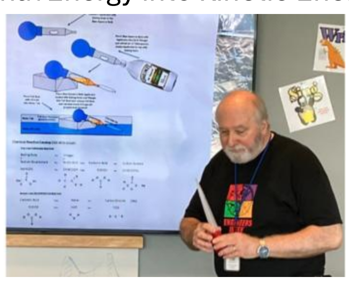
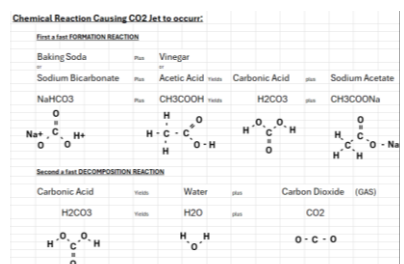
Newton's Laws have equations from physics that define projectile vector motion with force, direction and a trajectory path. We will not be using his equations but instead we will be launching a catapult projectile to score a hit on a target by using the original Trial & Error or Predictor-Corrector techniques!

Demonstrate Potential Energy and Gravity by dropping a book from 1 foot above a table and note the noise of its landing. Compare that energy level to dropping the same book onto the table from a 3-foot level. The higher elevation an object has gives it more Potential Energy. Potential Energy is what a body had at rest with an elevation. When the body is released and goes into motion Potential Energy is converted into Kinetic Energy. This is what our Catapults will do for us as we achieve our task.

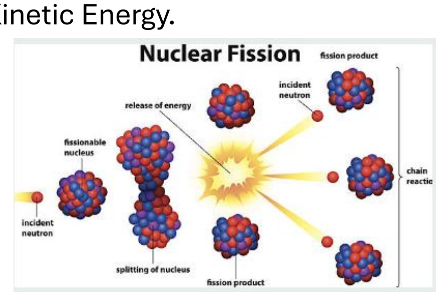
1. **Standard Catapult** (read before beginning the exercise):
   There are three forms of energy: They are as follows,
   a. **Internal Energy**, that be either biochemical, chemical, or nuclear.



i. **Biochemical Energy:**
Our bodies make biochemicals in our muscle cells for energy to make our muscles move. We convert Internal Energy into Kinetic Energy.

ii. **Chemical Energy:**
Last month we reacted vinegar and baking soda to make Carbon Dioxide to propel our foil boats in water. We convert Internal Energy into Kinetic Energy.

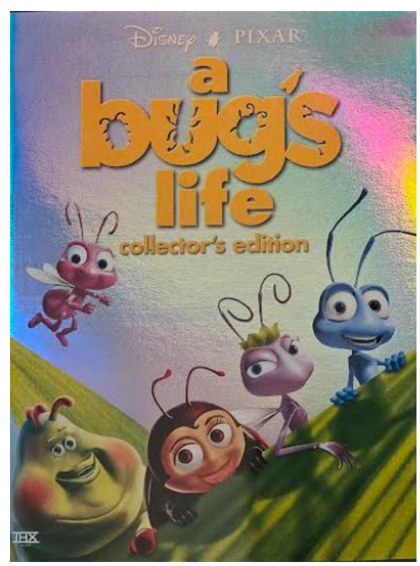



iii. **Nuclear Energy:**
Enriched Uranium 238 element reacts atomically to make heat to generate steam to turn a turbine and generate electricity. We convert Internal Energy into Kinetic Energy.

b. **Potential Energy**, this is a body of mass with an elevation above a ground level. Should that body of mass fall it will convert the potential energy into kinetic energy. We will be studying this conversion of potential energy into kinetic energy today with the catapult. A counterweight is elevated to a high potential energy level above the projectile on a lever arm. When the counterweight is released and drops, then its energy is converted into the kinetic energy of the projectile. Use book demonstration from low and high elevation drops to make a noise.

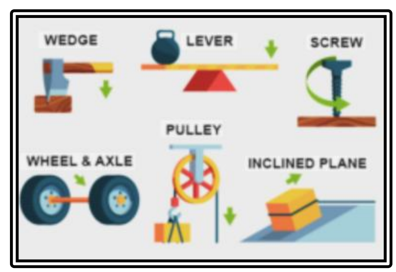
c. **Kinetic Energy**, this is a body of mass that is in motion. We will study this today with a trial and error process using catapults, projectiles and the trajectory paths they take towards their targets.

2. Today we will be learning how to adjust the settings for range and elevation on a miniature standard catapult for best team accuracy. Have you seen the Disney Pixar Movie “A Bug’s Life?” The basic story line is that ants are industrious creatures that build for the future and store foods from the fall for the winter. On the other hand, grasshoppers are just the opposite and will move from location to location just consuming the food available with no plan for the future. When the grasshoppers demand food from the ants, the ants build a mechanical bird to scare the grass-hoppers away from their food supply. Our first task for today is to learn how to operate a catapult for accuracy like the ants learned how to operate a mechanical bird to protect their food and scare off the grasshoppers! After you experiment with the catapult range and elevation settings through a trial & error process or a prediction & correction process throwing objects at targets, you will have three try’s at scoring points on a target. The team with the highest



score will be the winner of Exercise # 1, and the most successful ant colony at protecting their food supply for the coming winter from the invading grasshoppers.

3. Standard Catapult understandings:
   a. **Mechanical Simple Machines (6):** These devices are basic tools used to make work easier by changing the direction or the magnitude of a force. Most catapults use the Lever (the main arm of the catapult), Pulley (used to cock the catapult into position to load the projectile), Wheel & Axel (the pivot point of the catapult arm or lever), and the Inclined Plane (used to move the projectile into the catapult bucket).
   b. Some of these simple machines were developed by a Greek mathematician, physicist, engineer, and inventor known as **Archimedes** who lived in Syracuse, Italy from 287-212 BC.
      i. **Lever:** a rigid bar that pivots around a fixed point called a fulcrum (i.e., a seesaw)
      ii. **Pulley:** a wheel with a groove that a rope runs around, used to change the direction of force or reduce the force needed to lift something (i.e., a cargo ship's hoist or crane)
      iii. **Wheel & Axel:** a wheel that rotates about a rod at its center (axel) reducing friction (i.e., a bicycle wheel)
      iv. **Inclined Plane:** a rigid flat surface that is sloped like a ramp, allowing objects to be moved to different heights with less force (i.e., a wheelchair ramp)
      v. **Wedge:** a hard object that tapers to a thin edge, used to separate objects or hold them together (an ax, a knife, or a log splitter)
      vi. **Screw:** an inclined plane wrapped around a cylinder, used to hold objects together or to move them apart (i.e., a wood screw, a bolt, a jar lid, or a car jack screw)
      vii. Diagram of Simple Machines:

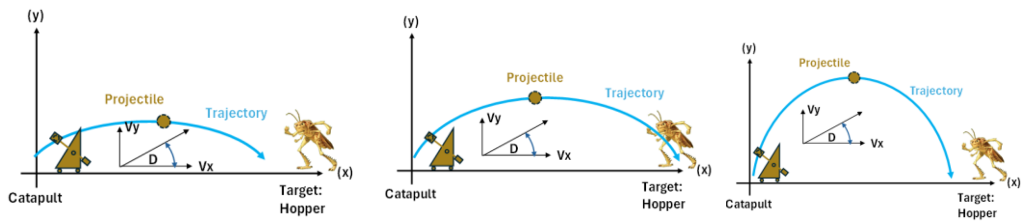


   c. The background Physics of a catapult's projectile and trajectory: By **Sir Isaac Newton** (1643-1727), studied physics, mathematics, and astronomy in London, England. We will see his laws in action but will not apply the equations. We will learn by trial and error how these laws work:
      i. **First Law (Inertia):** an object in motion (like a projectile) will stay in motion with the same speed and direction unless acted upon by a force like gravity. In the case of a projectile this means its horizontal velocity remains constant (disregarding air friction).
      ii. **Second Law (F = m a):** the acceleration (a) of an object is directly proportional to the net force (F) acting on it and inversely proportional to its mass (m). In projectile motion, the primary force is **gravity (g),** causing a constant downward acceleration (approximately 9.8 m/s/s or 32.2 ft/s/s).

iii. **Third Law:** For every action there is an equal and opposite reaction. While the law is not directly used to calculate trajectory, it is important for understanding how forces interact in more complex situations.

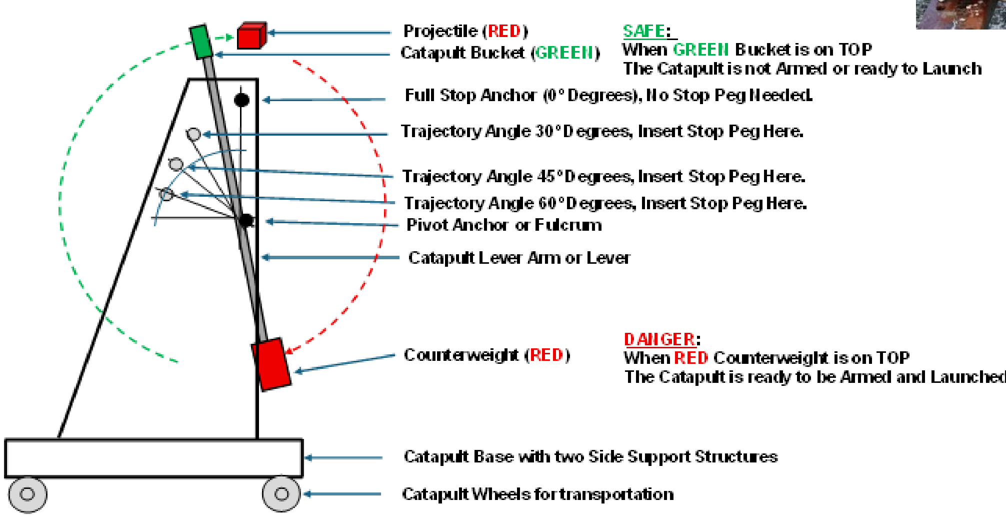
d. Newton's equations for predicting projectile trajectory are shown below. We will do our work today using a trial & error or prediction & correction techniques:

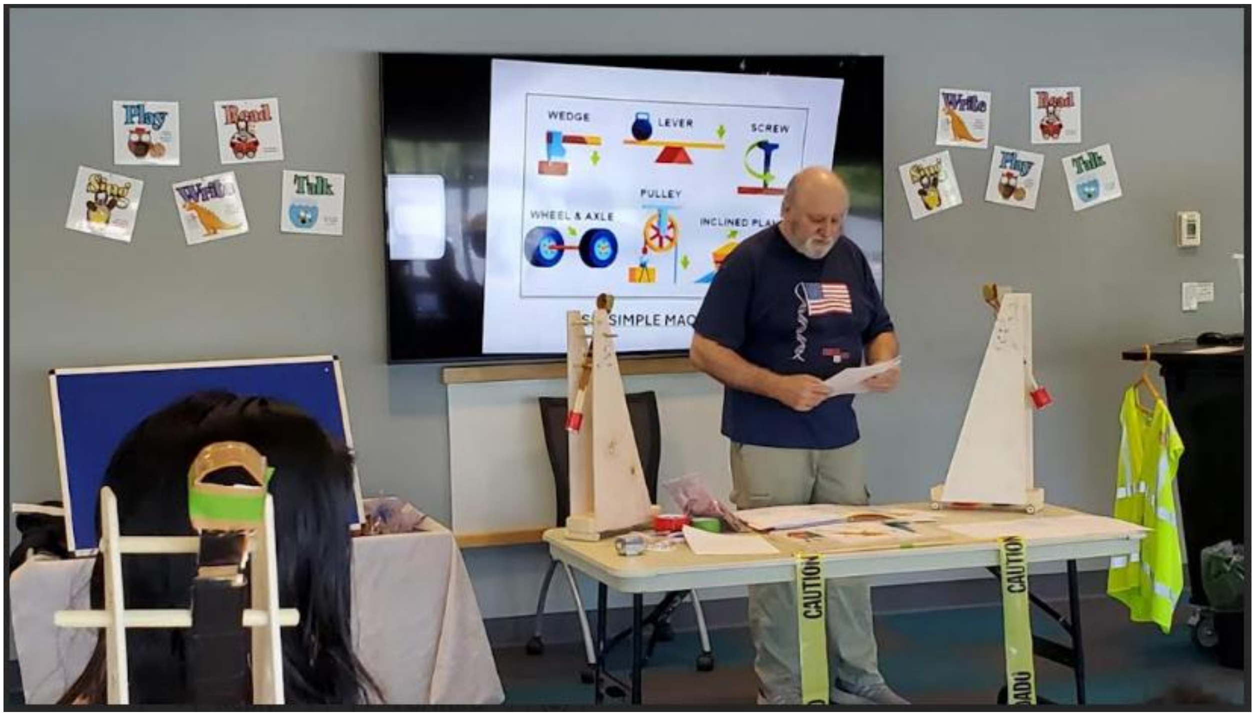
i. **The range X** of projectile from catapult with release velocity V and angle of elevation D.
ii. **The time** in seconds it takes the projectile to hit the target is: **$T = X / V_x$**
iii. **The vertical displacement** of the projectile when it hits the target is: **$V = 2 V_y / g$**
iv. **The angle of elevation (D):** $X = V^2 \sin 2D / g$ or **$\sin 2D = gX / V^2$**
v. Comparing Parabolic Trajectories with varying angles of elevation:

e. 

f. We will practice catapulting the projectile several times at a target (Hopper) so you can predict hitting the target with the object using the settings you have chosen. Become familiar with the parts of the catapult so you can better understand how to use it.

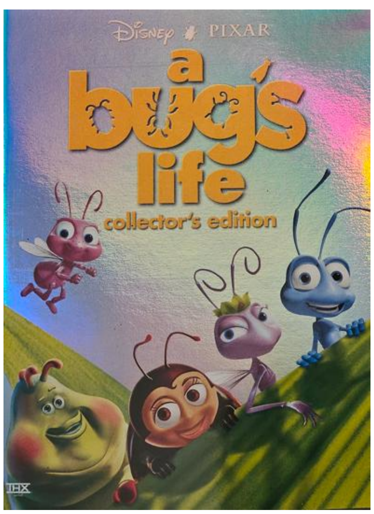
i. (Top) Full Stop Anchor (0^0 degrees)
ii. Trajectory Angles (30^0 degrees, 45^0 degrees, 60^0 degrees)
iii. Catapult Arm or Lever
iv. Bucket holding the Projectile (top end of the catapult arm)
v. Pivot Anchor or Fulcrum (midway of catapult arm)
vi. Counterweight (RED and at the bottom end of the catapult arm)
vii. Catapult base with two side support structures and wheels



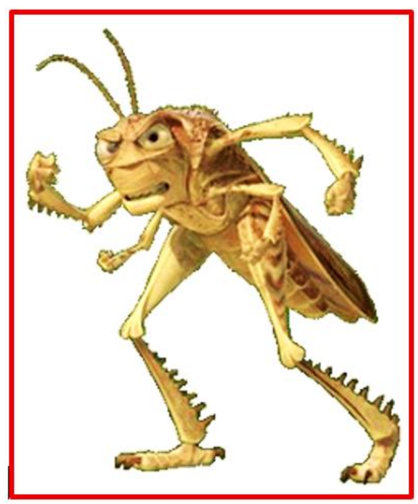


Explanation of how we will operate the catapult safely and score the target hits.

Students begin looking at their Catapults as their purpose or task is explained



The Ant Colony on the Ant Hill



HOPPER, Leader of the Invading Grasshoppers

Our event theme today will follow the Disney Pixar story of "A Bug's Life!"

We will be a colony of ants on a hill that stores our fall harvest of foods in the hill for winter. We are threatened by the invasion of the Grasshoppers that save no food and only invade areas that have food for them to eat and then leave for the next food supply. Our purpose in protecting our winter food supply is to build a Catapult and launch projectiles at the Leader of the Grasshoppers known as HOPPER to scare him off our ant hill and onto his next invasion!

Simple Catapult Target Practice launching projectiles at the red chair with HOPPER Target.

Students take 3 shots at Target HOPPER for scoring against other Ant Colony Team Tables!

Half Time, Tim reads an activity book, “Is This a Butt or a Face?” to the students!

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1. Our first U.S. President, General George Washington, promoted Military Engineering that applied the accurate projectile and trajectory equations to cannon fire during the American Revolutionary War of 1776 and with our victory over a British king the U.S. became an independent nation with a democratic republic. So, when you are in school the first activity you do in the morning is to make your "Pledge of Allegiance" to the U.S. Flag by saying, " "I pledge allegiance to the Flag of the United States of America, and **to the Republic** for which it stands, one nation under God, indivisible, with liberty and justice for all." We have celebrated our democratic republic of government each day for the last 237 years from 1788 to 2025.

2. **Have a very Happy Fourth of July Celebration and enjoy a safe and fun Summer of 2025!**

Wrapping up the event, tallying scores and passing out certificates to the students for their participation

Our "Summer Fun for Everyone" event volunteers:

Front Row: **Tim Protiva and Valerie Congdon**

Back Row: **Mike Galgoczy, John Juchnowski, Joe Yurko, and Gary Peck**

Not Shown**: Rosanne McCay-Brunello**

Joe Yurko awarded Tim Protiva with the NSPE & OSPE Appreciation Letter for NEW Program

Walking past Strongsville Square to Mitchell's Ice Cream from the CCPL Strongsville Branch

Arrival at last! Note the temperature at this time was 90.+F

Refreshment and Reward for everyone just a moment away…

Happy faces after a refreshing treat of ice-cold ice cream on a 90+F day!

Next event…THE FOURTH OF JULY FIREWORKS!!!