The Highlanders Present:

The K.I.L.T.S. Manual

(**K**its that **I**nspire **L**eadership and **T**eamwork in **S**TEM)

Materials Included:

Elementary K.I.L.T.S.:

3 - 8” X 8” pieces of tin foil
1 - Piece Styrofoam
50 - Rubber Bands
25 - Washer Weights
20 - Popsicle Sticks
1 - 6 inch Copper Tube
2 - Neodymium Magnets
1 - Easter Eggs
10 - Straws
3 - Plant Pots
3 - Name Labels
1 yard of Duct Tape
Paper Clips

Advanced K.I.L.T.S.:

2 - Cardboard Pieces
4 - 10 mL Syringes
4 - 10 mL Syringes with Hole
1 - 2 Meter Tube
20 - Toothpicks
2 - Superglue
50 - Zip ties
1 - Wire

Activities Included:

Easter Egg Drop
Shape Investigations
Keep the Boat Afloat!
A Different Lenz
Plant Life Cycle
Mechanical Hand

Extra K.I.L.T.S.:

6 - Rolls of Masking Tape
Extra Plant Pots
Extra Popsicle Sticks
Extra Tin Foil
Extra Super Glue

The K.I.L.T.S. Program!

Thank you for joining the Highlanders in the K.I.L.T.S. Program. K.I.L.T.S. stands for "Kits that Inspire Leadership and Teamwork in STEM". The Highlander's Mission Statement is: "To provide youth the opportunity to explore science, technology, engineering, and mathematics—through a hands-on experience and support in STEM."

Through the K.I.L.T.S. program, students will come together in small groups to complete a series of hands-on activities that demonstrate various scientific concepts. Each lesson plan provides an opportunity for students to work in groups and practice technical, teamwork, and leadership skills.

We have included various activities for different age levels and encourage collaboration between students of all ages.

The Highlanders believe that through the K.I.L.T.S. model, students will develop significant training and experience in the FIRST Core Values using STEM exploration as a method of doing so.

Once again, thank you for partnering with us to provide leadership and STEM opportunities to students across the world!

The FIRST Core Values

Discovery: *We explore new skills and ideas.*

Innovation: *We use creativity and persistence to solve problems.*

Impact: *We apply what we learn to improve our world.*

Inclusion: *We respect each other and embrace our differences.*

Teamwork: *We are stronger when we work together.*

Fun: *We enjoy and celebrate what we do!*

Learn More at: www.firstinspires.org teamInfo@highlandersfrc.com Fort Collins, CO

Lab Team Roles

Lab Team Roles allow for each student to have an input on the design and process of each experiment. Students will be responsible for a series of varying tasks for the duration of the experiment in order to grow facilitate interactions between students. Using roles commonly used in classroom lab settings, The Highlanders suggest assigning these roles to each team at beginning of each activity.

Facilitator:

- Helps team decide who will do each part of the activity
- Keeps track of time
- Quiets down team when the instructor is talking

Director:

- Keeps team on task during discussion
- Responsible for sharing the directions given by the instructor with their team

Materials Manager:

- Counts all the materials before each experiment
- Collects and keeps track of materials during the experiment
- Cleans up and returns materials when the experiment is completed

Easter Egg Drop

Gravity and Fundamental Forces

Procedure:

Form teams of three students, then assign them each a Lab Team Role.

Give the teams 5 - 15 minutes to brainstorm several ideas on how to protect the egg when it's dropped.

During the brainstorm session, meet with each team, ask them about their plans, and ask guiding questions.

Following the brainstorm session, allow the students to collect their materials and begin building. Encourage all students to contribute to the building process.

When teams are ready, begin the dropping portion of the experiment. Have each student observe how their egg lands, allow them to make improvements, and drop their eggs several times.

When trials are finished, have teams clean up their materials.

If time permits, come together as a class and discuss the extension questions.

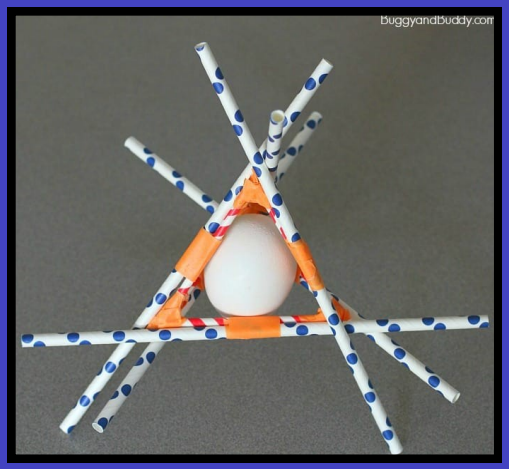
Materials:

Easter egg - 1
Popsicle Sticks - 20
Styrofoam - 1
Rubber bands - 50
Washers - 5
Masking Tape

Extension Questions:

What was the max height the egg was dropped without breaking?

Which design seemed to work the best? Why?



Shape Investigations

Geometry and Architecture

Procedure:

Form teams of three students, then assign them each a Lab Team Role.

Allow the students to collect their materials and instruct them to build the strongest shape they can. Encourage all students to contribute to the building process. Allow them to build for 5 - 15 minutes.

Call over the students. Demonstrate a square, a triangle, a cube, and pyramid (pictured below) made from paper clips and rubber bands. Bend the square/ cube into a rhombus. Show how the triangle/ pyramid do not bend. Explain how the 3-D shapes exaggerate the attributes of the 2-D shapes.

Allow the students to work together to build strong structures using the principles you showed them. During the building session, meet with each team and ask guiding questions.

When teams are finished, have them clean up their materials.

If time permits, come together as a class and discuss the extension questions.

Materials:

Popsicle Sticks - 20
Rubber Bands - 50
Paper Clips

Extension Questions:

Where do you see these shapes in your daily lives?

Why are triangles stronger than squares?

Keep the Boat Afloat!

Buoyancy and Mass

Procedure:

Form teams of three students, then assign them each a Lab Team Role.

Give the teams 5 - 15 minutes to brainstorm several ideas on how to best fold the tin foil boat.

During the brainstorm session, meet with each team, ask them about their plans, and ask guiding questions.

Following the brainstorm session, allow the students to collect their materials and begin building. Encourage all students to contribute to the building process.

When teams are ready, place each team's boat in a bucket of water or other container filled 3/4 full. Have the student add washer weights and observe their boat.

Allow them to make improvements and test several times.

When trials are finished, have teams clean up their materials.

If time permits, come together as a class and discuss the extension questions.

Materials:

Square of tin foil - 1
Washer Weights - 25
Duct Tape - 1 yard
Water Container - 1

Extension Questions:

At what point did the boats first begin to sink?

Which design seemed to work the best?

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A Different Lenz

Gravity and Magnetism

Procedure:

Form teams of three students, then assign them each a Lab Team Role.

Give the teams 5 - 15 minutes to hypothesize how they think the magnet will behave when dropped normally and if it will behave differently when it is drooped through the copper tubing.

During the discussion session, meet with each team, and ask them guiding questions (i.e. why would the magnet behave that way?).

Following the discussion time, allow the students to collect their materials and test dropping the magnets normally and through the tube.

Encourage all students to run several trials and discuss the differences in the magnets' behavior.

When trials are finished, have teams clean up their materials. If time permits, come together as a class and discuss Lenz's Law.

Materials:

6" 0.45 inch diameter Copper tube - 1

0.4" diameter neodymium magnet - 2

Lenz's Law:

This is caused by a principle called Lenz's Law. It says that when a magnet passes through a copper coil or tube, creates an electromagnetic field that pushes against the magnet as it slides down the tube.

Plant Life Cycle

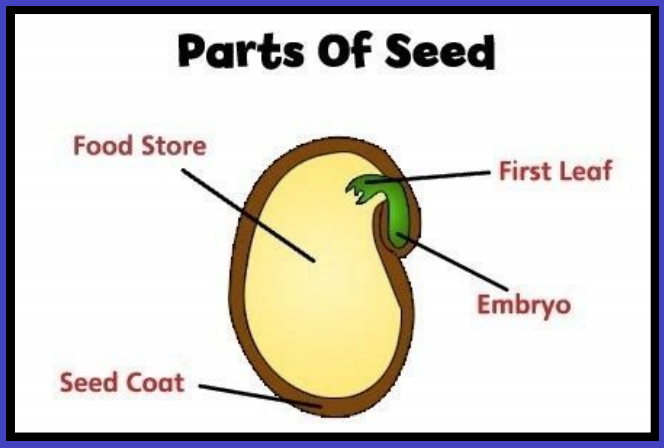
Life Science

Procedure:

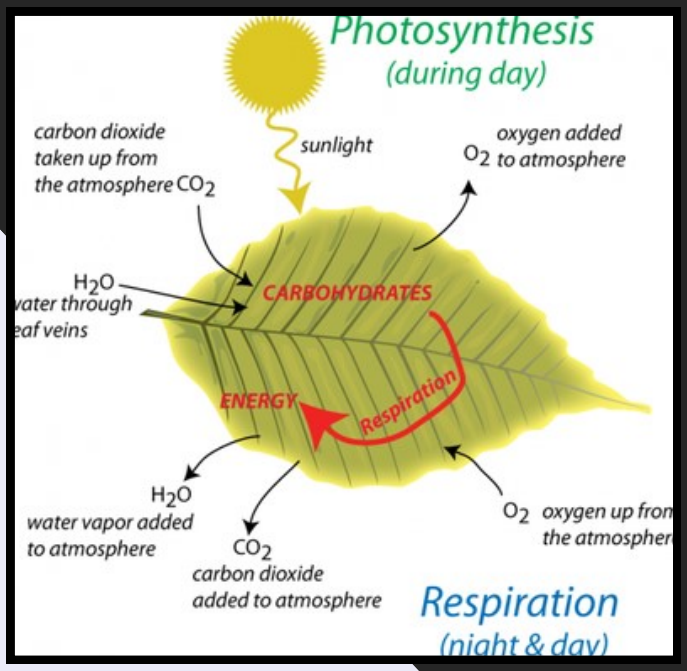
This activity will take several weeks. Form teams of three students, then assign them each a Lab Team Role. Ask them to remember their teams and switch up Lab Team Roles at each meeting. Ask the students what they think is inside of a bean. Following the discussion period, cut open a bean and show its components to the class. Allow the students to gather their materials. Encourage all students to contribute to the planting process. Direct them to come upfront in groups and fill the plant pot with 3/4 soil. Then demonstrate how to use your thumb to create a hole to plant the bean. Place the bean inside and cover it with the dirt pushed aside. The bean should be buried 1/4” deep. Water the plant with 1/3 cup of water. Finally, have the students write each of their names on one of the name labels and place it in their pot. Place each set of pots in a well lit area. Have the students water them every day, but not excessively or the plant may not grow. Once the plants begin sprouting, come together as a class to discuss the plant’s progress and its stage in its life cycle. Continue coming together as the plants reach different stages in and allow the students to experiment by changing the conditions of their plants.

Materials:

Plant Pots - 1
Name Labels - 1
Beans - 1
Watering Container
Potting Soil



Extension Questions and Activities:

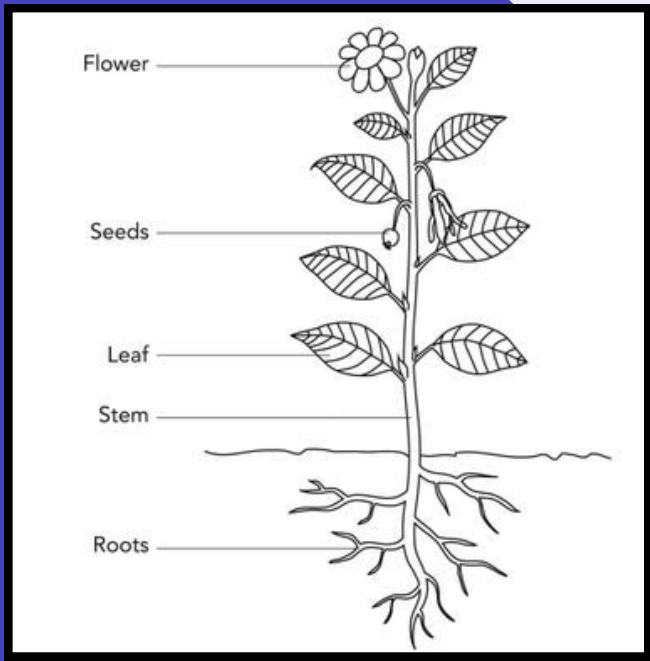


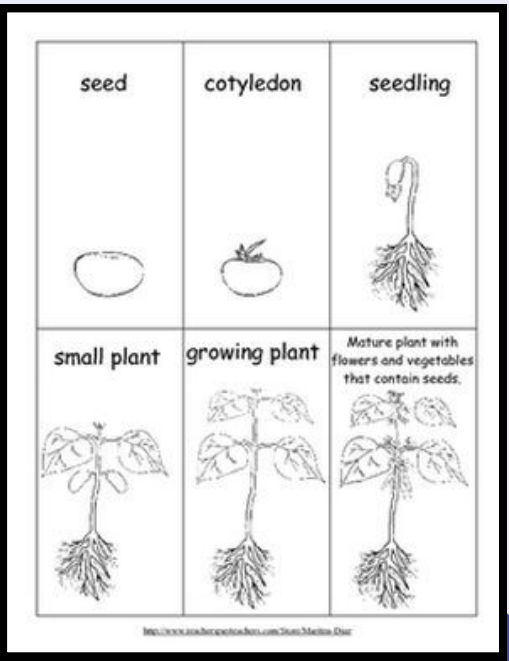
Water – Do bean plants grow better with a lot of water? A little water? Somewhere in between? Add different amounts of water to the plant each day to discover the ideal amount of water a bean plant needs to grow.

Fertilizer – Do fertilizers really help bean plants grow? Try different types of fertilizers and see which makes your bean plant grow the tallest and healthiest. Remember to grow one plant without fertilizer as a control.

Soil – Once your bean plants have shoots that are a decent size, try switching out some of the soil in your plant pots with different types of soil. You might want to try sand, dark soil, reddish soil, or whatever other types of earth you can find nearby. How does this change its growth patterns?

Sun – What would happen if you changed how much sun your plant gets? What is photosynthesis?





Allow students to compare the results of each group.

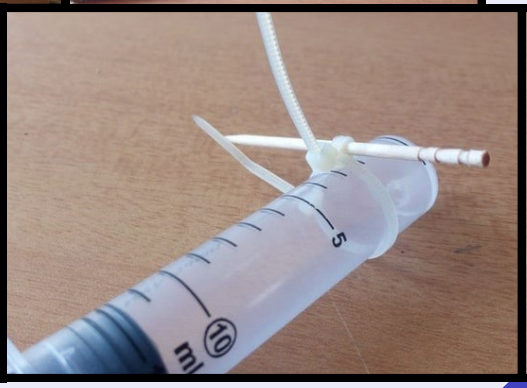
Mechanical Hand

Advanced Mechanisms, Hydraulics, and Design

This activity is for advanced students and will take a longer period of time. While it is suggested to use Lab Roles as an example, students should begin creating different and unique roles to better suit a larger team's dynamics. Have students form groups of eleven and decide on team roles. Will they assign individual roles or broader roles?

The Arm:

Show the students an image of the mechanical arm then allow them to collect their materials. The cutting templates are included in the K.I.L.T.S. Have students cut out each part, use a straight edge to trace them onto the cardboard, and mark the hole placement on the cardboard. Remind them to leave enough space for all the parts to fit. Then instruct them to cut out the cardboard pieces and reinforce the edges with masking tape. Have them assemble the arm using toothpicks as joints to hold together the parts.



Materials:

2 - Cardboard Pieces
4 - 10 mL Syringes
4 - 10 mL Syringes (marked with a black line and hole)
1 - 2 Meter Tube
20 - Toothpicks
2 packs - Superglue
50 - Zip ties
2 - Cutting Templates
Pen
Pen Cap
Masking Tape
A Pair of Scissors

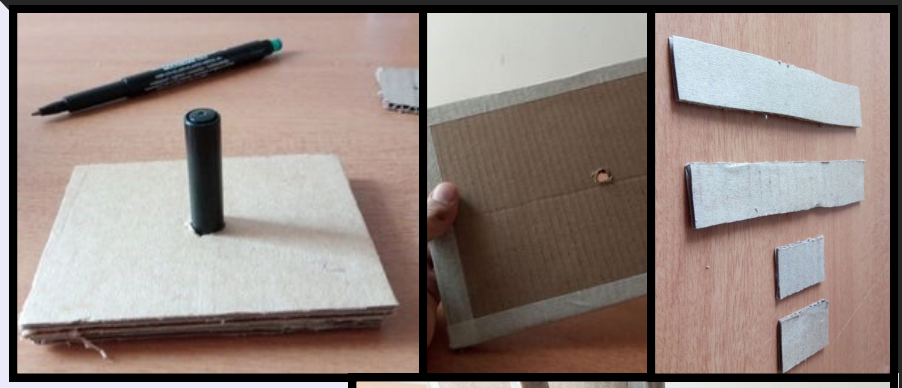
Setting up the Syringes:

Tie two zip ties together in a figure eight shape as shown above. Tighten one loop around the syringe and the second around a toothpick. Tighten them and clip the protruding zip tie piece.

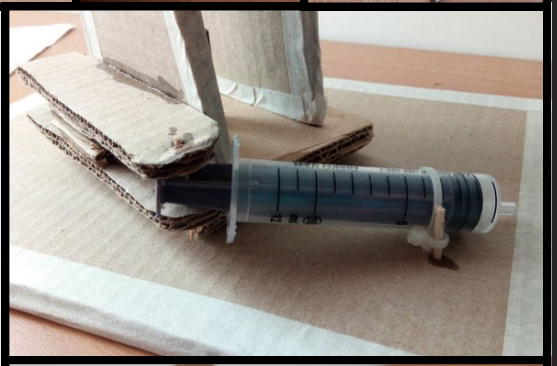
Learn More at: www.instructables.com/id/CARDBOARD-Robotic-Hydraulic-Arm/

Fort Collins, CO

The Base:

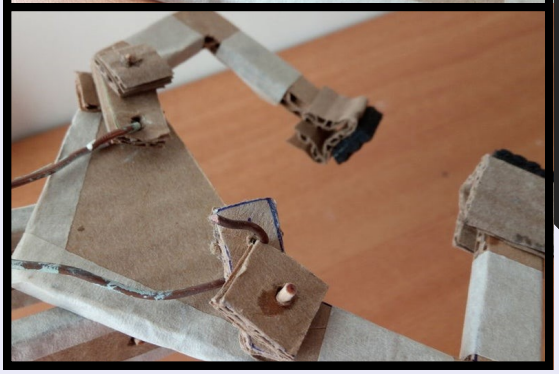


Poke a hole with a pen cap through the large cardboard base and create a smaller base that attaches to the arm. Use super glue to attach it to the arm. Remind the students that a little usper glue goes a long way and to not get any on themselves. Super glue the pen cap to the larger base. Once the arm is dry, place the smaller base on the pen cap. Attach a syringe using toothpicks and zip ties.



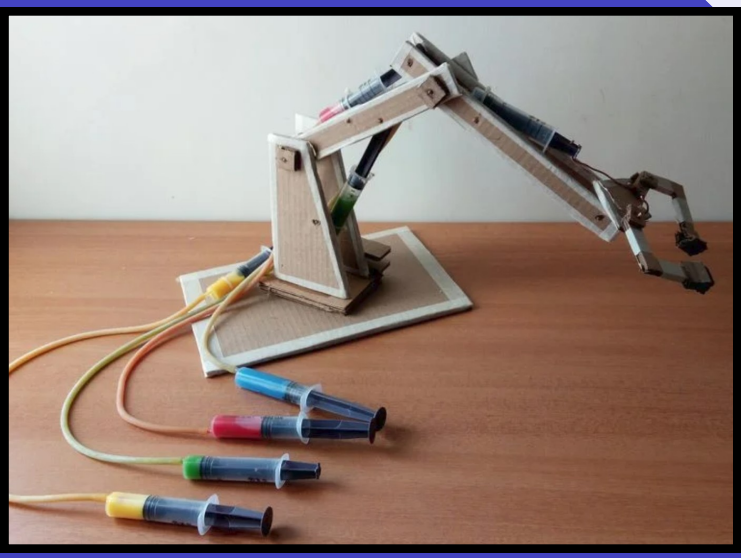
The Claw:

Assemble the claw as pictured to the right. Attach the wire to the left side of the claw, thread it through the syringe, then attach it to the right side of the claw. Trim any excess wire. Remind your students to use masking tape to strengthen the cardboard and the connection.



Finishing Touches:

Cut the tubing in 4 equal lengths and attach them to the syringes on the hand. Fill the four syringes without a hole with water. Press the valves until water quirts out for maxiumum pressure. Attach the syringes to the tubing and press them. The arm should move. Reinforce the arm with masking tape and super glue. Have students discuss how the arm moves.



Who Are We?

The Highlanders (Team 4499) are a community-based team that began in 2013 through a 501(c)3 nonprofit, Neaera Robotics in Fort Collins, CO. We are a team of 11 students from grades 7-12, 8 different schools, and 4 different cities. We build a robot to meet a different challenge each year and compete in a robotics competition put on by FIRST, an organization working to promote STEM education through *coopertition* —a combination of cooperation and competition — in students from ages 5 to 18. Our team's mission is: "To provide youth the opportunity to explore science, technology, engineering, and mathematics—through hands-on experience and support in STEM" (and to have fun building robots while we do it!)