<u>Launcher Kit</u>: Ready, Set, Launch! Can it go the distance?

Activity Objectives:

- Build a "launcher" according to the blueprints and given procedures.
- Rotate "launcher" to reach targeted areas and demonstrate rotations (i.e., 45, 90, 180, 270, 360 degrees).
- Describe how the angle of the launcher (i.e., 30, 60, 90 degrees) affects the trajectory of the projectile.
- Explain the difference between clockwise and counterclockwise.
- Draw a diagram to represent the position of the "launcher" and the trajectory of the projectile.

Materials:

- **<u>Day 01</u>:** We Like to Move it!
  - Position Labels (North, South, East, West)
  - Card Sets
    - Rotation Direction Cards
    - Angle Measure Cards
    - Cardinal Direction Cards
  - Compass Direction Handout
  - Masking Tape
  - Rotation Recording Sheet
  - Cupid Shuffle Handout

- **<u>Day 02</u>:** What is This?
  - Group Role Cards
  - Launch Predictions Recording Sheet

- **<u>Day 03</u>:** Let it Go!
  - Ruler
  - Exploration Set 01 Handouts
  - Exploration Set 02 Handouts
  - Position Labels (North, South, East, West)
  - Rotation Direction Cards

    - Angle Measure Cards
    - “Launcher” Images

- **<u>Day 05</u>:** A-*maze*-ing Token Quest
    - Algorithm Creator Handout
    - A-mazing Token Quest Handout
    - Bear Manipulative (or some other manipulative where you can identify the front)

- **<u>Day 07</u>:** Humanitarian Aid—Launch Supplies and Debug System Errors
    - Geographic Maps A, B, C, and D
    - Icon Coding Cards (01 copy per group)
    - Students’ Launchers
    - Launch Sequence Maps – This is two pages (8 copies per group – two copies for each Map A, B, C, D if you would like two students recording the sketches)

<u>Day 01</u>: We Like to Move it!

- **Preparation:** *Have enough 2' x 2' squares taped on the floor for 2 - 3 students to use for the movement activity. Tape the perimeter of the square as well as the inner 1' x 1' squares. Label the cardinal directions using the position labels North, South, East, and West (Note: You will use these cards for the Coding activity). See Launcher Day 01, Slide 03 for diagram.*

LAUNCH: What Do You Notice?

- Tell students they will watch videos of different athletes. Explain that as they watch the video, they are to record their observations. After each video they will discuss what they notice.
- Tell students the first video is of Donnell Whittenburg, an American gymnast, on the parallel bars. Watch the video (Launcher Day 01, Slide 05).
    - Ask students what they noticed from the video clip. Possible responses:
        - *Donnell spun.*
        - *Donnell flipped.*
        - *Donnell went around in circles.*
        - *Donnell rotated.*
        - *Donnell did a 360.*
    - If students do not notice how Donnell moved, ask the following questions:
        - How did Donnell move?
        - How would you describe his rotation?
            - *A rotation is like a turn. Did you notice the gymnast turning, or rotating?*

- Inform students the next video is of figure skater practicing a specific movement. (Launcher Day 01, Slide 06).
    - Ask the students what they noticed from the video clip. Possible responses:
        - *She jumped.*
        - *She spun.*
        - *She twisted.*
        - *She rotated.*
        - *She hopped on one foot.*
        - *She landed backwards.*
    - If students do not notice how she moved, ask the following questions:

        - How did she move?
        - How would you describe her rotation?
            - *A rotation is like a turn. Did you notice the figure skater turning, or rotating?*

- Inform students the final video is of someone demonstrating an interesting jump. (Launcher Day 01, Slide 07).
    - Ask the students what they noticed from the video clip. Possible responses:
        - *He twisted*
        - *He was spinning*
        - *He was moving in a circle*
    - If students do not notice how he moved, ask the following questions:
        - How did he move?
        - How would you describe his rotation? If students say he spun in a circle, or turned all the way around, ask how they would describe that rotation.
- Ask students what directions we can rotate.
- Athletes also describe the DIRECTION of their turn. Ask students if they ever heard of the word **clockwise**. If so, ask what they think it means. Have students share their responses.
    - Show students images of a clock, and have students explain to their shoulder partner what clockwise means using the images of the clock. (Launcher Day 01, Slide 08).
    - Have 2-3 students share what clockwise means (moving in the same direction as the hands of a clock)
- Say to students "If clockwise is moving in the same direction as the hands of a clock, what would counterclockwise mean?" Have students discuss with their shoulder partner.
    - Show students images of a clock and explain to the class the meaning of counterclockwise (moving in the opposite direction, or counter to/against, the direction the hands of a clock move). (Launcher Day 01, Slide 09).
- After discussing the difference between clockwise and counterclockwise (aka anti-clockwise) have students watch the animations (Launcher Day 01, Slide 10) and ask students to think about what direction the objects in the animations are rotating: clockwise or counterclockwise (anti-clockwise). Tell students to discuss the directions with their elbow partners and explain how they knew which animations rotated clockwise and which rotated counterclockwise (anti-clockwise).
    - Additional suggestion: As the students identify the directional movements in the video, ask them to model the movement with hand gestures or body movements.
- Show the students the image (Launcher Day 01, Slide 11) of the tile spaces taped on the floor. Ask students what they notice about the tiles.

    - After discussing what they notice, ask the students to identify right angles. Point out where the right angles are and discuss the number of degrees in a right angle. (Launcher Day 01, Slides 12-15).
- Show Launcher Day 01, Slide 16 introducing Dimitri.
    - Emphasize the 90 degree rotations as the children think about rotating from North to East. Prompt them to think about how the rotation would be similar to or different from rotating from facing north to facing west.
    - Go through Launcher Day 01, Slides 17-19.
    - Show Launcher Day 01, Slide 20) and say instead of using N, S, E, and W we are going to use A, B, C, and D.
        - Ask students how many degrees they have rotated if they start at the center of the square and rotate from facing Point A to facing Point C. How do they know?
            - What direction did you rotate? (Launcher Day 01, Slides 21-22).
- Continue asking how many degrees and in what direction you would rotate if…
    - You rotated from facing point B to point C. (Launcher Day 01, Slide 23-25).
    - You rotated from facing point B to point C. (Launcher Day 01, Slides 26-28).
        - How is this rotation different from the previous rotation? How is it similar to the previous rotation?
- With each set of movements (Launcher Day 01, Slides 29-32), explain that you will demonstrate different types of rotations. Ask the students to THINK-PAIR-SHARE as they identify each of the movements. Encourage students to identify the direction of the rotation (clockwise or counter(anti)clockwise) and discuss the differences between the turns.
- Reinforce that a circle has a total of 360 degrees and that a full rotation is 360 degrees regardless of direction. Ask students to demonstrate this with their bodies. Ask students to talk to their elbow partners and describe how the characters do not all rotate all the way around.
- After reviewing 90, 180, 360, rotations, ask students to work with their partners to determine what a 270 degree rotation would look like.
    - Emphasize the series of 3 90 degree turns in the same direction.
    - Prompt students to consider how a 270 degree counterclockwise rotation is similar to a 90 degree clockwise rotation.
- **Explore**
    - Tell the students they are going to work with a partner or in a group of three and represent specific rotations by moving their bodies on the taped regions on the floor.
        - Demonstrate the activity using Launcher Day 01, Slides 33-44. Draw a card representing the starting point. Tell students they will stand on the center of the space (like Dimitri) and face the direction (cardinal direction).
        - Students will draw another card to indicate the direction of rotation.

        - Students will draw another card to determine the number of degrees of rotation.
        - Show students how to use the compass direction handout to help them determine their degree of rotation.
        - Handout Recording Sheet and remind students to check each other's direction of rotation and the number of degrees
- **Summarize** --Ask students to share their observations from the experience. Pose the question,
    - If we make a 90-degree rotation, will we always face the same way? For example, if we are facing north and we make a 90-degree rotation, will we face the same direction as we would if we were facing west and made a 90 degree rotation?

Cupid Shuffle

- Ask students if they know how to do the Cupid Shuffle. If someone does, ask them if they would be willing to demonstrate it to the class.
- Tell students we are going to watch a video of students doing the Cupid Shuffle. They will need to pay close attention to the steps to learn how to do the Cupid Shuffle.
- Play the video of the Cupid Shuffle a couple of times, Launcher Day 01, Slide 45 (a shortened version of the video clip is in the powerpoint, this link is of the full song: https://www.youtube.com/watch?v=E5kbLErB_VM
- Encourage students stand and do the Cupid Shuffle along with the video. Join in on the fun—call out the movements as you go. The link for the lyrics is https://video.search.yahoo.com/yhs/search?fr=yhs-itm-001&hsimp=yhs-001&hspart=itm&p=lyrics+to+the+cupid+shuffle&_guc_consent_skip=1580077936#id=9&vid=d97a4ad6b1de56e54d5f4d8e115997c4&action=view
- If more scaffolding is needed for the steps:
    - Play the first part of the video where the students move four times to the right. Have students describe the movement to their shoulder partner. Possible responses:
        - *They move to the right*
        - *They go four to the right*
        - *They take four steps to the right*
        - *"The right, the right, the right, the right"*
    - Play the next part of the video where the students move four times to the left. Have students describe the movement to their shoulder partner. Possible responses:
        - *They move to the left*
        - *They go four to the left*
        - *They take four steps to the left*
        - *"The left, the left, the left, the left"*

    - Play the next part of the video where the students kick their legs. Have students describe the movement to their shoulder partner. Possible responses:
        - *They kick their legs*
        - *They kick four times*
        - *They kick 4 times, alternating their right leg and then their left*
        - *They kick right, left, right, left*
    - Have the students stand and do the Cupid Shuffle along with the video.
- Play the part of the video where the students rotate, and have students describe the movement to their shoulder partner. Possible responses:
        - *They twist*
        - *They spin*
        - *They rotate*
        - *They rotate 90 degrees counterclockwise*
    - If students do not say "*They rotate 90 degrees counterclockwise*," ask questions until you elicit a description containing "rotate," "90 degrees," and "counterclockwise."
- Play the rest of the video and ask the students what they notice. Possible responses:
        - *They keep doing the same thing*
        - *They repeat what they were doing before*
        - *They keep turning around and doing the same steps*
- Introduce the vocabulary word "loop." Ask students if they have any ideas what it means. Possible responses:
        - *Going in a circle*
        - *Going around and around*
        - *Doing the same thing over and over*
        - *Repeating*
        - *Doing a pattern*
    - Question students until they describe going through certain steps and then starting over and doing those steps again. You may wish to share the official definition: "A sequence of instructions that is continually repeated until a certain condition is reached."
    - Ask students to describe the loop they noticed in the Cupid Shuffle video.

- Show Launcher Day 01, Slide 46 and hand out the blank grid and tell students they are going to work with their shoulder partner to teach the steps of the Cupid Shuffle. Students can come up with their own symbols to represent what is occurring for each step of the dance.
- Monitor the students as they work with their partner. Ask students to explain their symbols and thinking as you walk around the room. Designate 3-4 students to share with the class.
    - Have designated students share their grid with symbols and explain their thinking to the class using an Elmo.
    - Show a representation of the Cupid Shuffle (Launcher Day 01, Slide 47), and ask students to discuss, "How do these symbols represent the Cupid Shuffle?" with their shoulder partner. Have 2-3 students share with the class.
    - Show another a representation of the Cupid Shuffle (Launcher Day 01, Slide 48) and ask students to discuss, "What do the numbers and shapes mean?" with their shoulder partner. Have 2-3 students share with the class.
    - Show Launcher Day 01, Slide 49. Have students think-pair-share to discuss, "What do you think the border represents around these shapes?" Give the students time to think to themselves, then share with their shoulder partner. Have 2-3 students share with the class. (Note the border represents the loop)
- Introduce the word "algorithm" to the class. Ask students if they have any ideas what it means. Possible answers:
        - *Having rhythm when you dance*
        - *Something to do with computers*
        - *You do them in math problems*
        - *They are steps you have to follow*
    - Ask the students to remind you of what the symbols represented in the Cupid Shuffle. Possible responses:
        - *They tell you what to do*
        - *They give you the steps*
        - *Directions*
    - Tell students they just defined an algorithm! It is a sequence of steps to follow. It's also called a program in computer language.

<u>Day 02</u>: What is this?

- **Launch**
  - Show images of various "launching systems." Launcher Day 02, Slides 51-53. Ask students to THINK-PAIR-SHARE:
    - What are these structures? How are they used? How do they work?
  - Identify each system and discuss the mechanisms. Show a video (Launcher Day 02, Slides 54-55. Note on Slide 55 begin the video at 1:37) of a system launching a projectile. Ask students to describe the similarities and differences in the systems.
- **Explore —**
  - Students will work in groups of three
    - Identify roles for each group and have students switch roles after each step: General Contractor [Reads directions, watches time, precision checks], Materials Supervisor/Construction Crew [Builds structure], Presentation Team [Records notes, shares findings with group]. (Launcher Day 02, Slide 56).
    - Distribute supplies to each group.
    - Ask the groups to match the materials to the image list and check that they have received all materials.
    - Use the items in your kits to build a system to launch a ping pong ball (Launcher Day 02, Slides 57-83).
  - Once students have finished their build, ask them to make predictions about the angle of the trajectory. Prompt them to record their answers on the recording sheet (Launcher Day 02, Slide 84). Monitor the groups and identify key students to share unique predictions and insights related to the three questions.
    - Why can we change this part of the launcher?
    - What would happen if we set the angle at 90 degrees?
    - Why would we want to set the angle at 30 degrees?
- Summarize--Share selected predictions about the angle of the launcher and the impact on the projectile's trajectory. Explain that they will explore the launcher in class on the next day.
  - Review the definitions of projectile and trajectory
    - A projectile is an object that is transported into space (Note: Not outer space), or the air, by an external force. After the object is launched, the only force acting upon the object is gravity.
    - Inform students the trajectory is the path followed by a projectile flying or an object moving through space (Note: Not outer space)

- Show the students how the launcher can be aimed at different angles. Ask the students to discuss their predictions for the trajectory of the projectiles. (Launcher Day 02, Slides 85-91)

<u>Day 03</u>: Let it Go!

- **Launch** --What is the engineering process?
    - Watch video (Launcher Day 03, Slide 94) that describes the engineering design process.
    - Show an image of the engineering design process and review with students (Launcher Day 03, Slide 95)
    - Explain that the students will use engineering thinking as they evaluate the accuracy and consistency of their launches. Tell students they will apply their knowledge of rotations and angle measures to make adjustments to the launcher and increase the accuracy of their projectile's landing.
        - Show the students how to change the angle of the launcher. Ask students how the angle of the launcher changes. Discuss the idea of steepness and how changing the angle increases or decreases the steepness.
            - Does this change make the launcher more steep or less steep?
            - Emphasize how the greater angle (0 - 90 degrees) makes the launcher more steep and the lesser angle measures make the launcher less steep.
    - Explain that students will need to measure the distance their ball launched.
- Watch video on Measuring tools (Launcher Day 03, Slide 97). After the video, ask students to THINK-PAIR-SHARE,
    - What are different types of measurement tools?
    - When do we use different types of measurement tools?
    - What are important ideas to remember when we are measuring with standard tools?
    - Why is it important to measure accurately?
        - What mistakes do you think people often make when measuring?
    - What could we measure when we are launching our projectiles?
    - Have students discuss the right tool for the job (Launcher Day 03, Slide 98) with their elbow partner. Have 2-3 students share their thinking.
    - Have students to identify the measurement of each object (Launcher Day 03, Slides 99-106)
    - Give each student a ruler and have them measure the length of their paper in both inches and centimeters (Launcher Day 03, Slide 107).
- **Explore** – Provide students with sets of directions to follow.
    - Set 01--students follow the steps and make observations about the results of the launch. (Launcher Day 03, Slides 108-112)
        - Prompt students to look for patterns in their results.

        - Ask students to think about why the ball travels higher/lower/farther/less distance when the launch angle is positioned in certain ways.
        - Introduce the idea of trajectory.
    - Set 02--students examine the steps and use problem solving strategies to determine how to debug the students' ideas in order to reach the target. (Launcher Day 03, Slides 113-117)
- **Summarize**
    - Show the "Geographic maps" and the image of the launcher. Ask the students to explain how they would rotate the launcher to accurately hit the targets.
    - See Geographic Maps in Launcher (Launcher Day 03, Slides 119-126)
        - Tell students they have noticed some communities are in need after flooding has blocked access to their community. Explain that local organizations have decided to launch medical supplies, food, and fresh water into the community. However, we will need to direct the launcher so that the supplies will land in a safe location. Point out the identified "safe landing site" is indicated by the medical aid symbol on the map.

        - Tell students the launcher is currently set and the direction the launcher is facing is shown by the brown arrow on the slide. Ask the students if they think the launcher is positioned correctly to reach the safe landing site. Prompt students to explain how they know.
        - Ask students to THINK-PAIR-SHARE,
            - How should we rotate the launcher to aim the supplies to reach those in need? What direction should we rotate the launcher to reach the landing site? How many degrees should we rotate the launcher?
            - Is there another way to rotate the launcher? How do you know?
        - On Slide 127 prompt students to explain how they should adjust the angle of the launcher "arm" to reach the community in need. Review their exploration activities and reinforce connections between the angle of the launcher "arm" and the arc and distance of the projectile.
    - As you discuss the humanitarian aid introductory activities, review the terms: angle, distance, steepness, launch, projectile as you share the students' ideas and experiences. Reinforce the relationship between the angle measure and the launch.

<u>Day 04</u>: AR Exploration

Introduction to NEWTON and Building Contraption Projects in Augmented Reality

Launch: Three-part task (10-12 min.)

- Part I: Ask the students if they know what augmented reality is and if they have used it before. Show the video: https://youtu.be/_bbAA_o9dBA [Launcher Day 04, Slide 134] (Note this link is subject to change)
    - Ask students what they noticed as they watched the video.
    - Explain the video shows an example of augmented reality on a tablet.
    - Ask students how they think augmented reality works. Possible prompts: What do you think augmented reality could be used for? Where do you think it could be used? Have students share their ideas and record them on the board. Possible responses include:
        - *It is for showing things that are not real.*
        - *It is for putting animal faces and stickers on video chats and pictures.*
        - *It is used for helping drivers.*
        - *It is used by pilots.*
        - *It helps you find things like stores when walking around.*
        - *It can make books come alive.*
        - *It can make games.*
        - *It can teach/show you how to build or fix something.*
        - *It can show you something invisible (like how hot or cold something is).*
        - *It works with phones/tablets.*
        - *It uses the camera to take a picture.*
        - *It works with special glasses.*
    - Once students made several hypothesis or expressed ideas about what augmented reality can be used for and how it works, use a "think-pair-share" strategy to prompt the students to pose questions or form ideas about augmented reality. What are they wondering? Listen to the students as they share ideas with a partner or small group. If students have difficulty generating questions, provide an example:
        - *Can it show up anywhere?*
        - *Does it have to be used on a tablet or phone?*
        - *How do things get made?*

- *Can other people see it or do they know it's there?*
- *Is it real?*

Allow the students to share their ideas with a partner or in small groups for 2 minutes. Then share with the class.

Part II: Show video of a Rube Goldberg Contraption to 1:19 https://www.youtube.com/watch?v=VdSSOAtIrYU [Launcher Day 04, Slide 135]

- Ask the students to turn and talk to a partner or their tablemates for 2-3 minutes about what they notice from watching the video.
- Tell students this is a Rube Goldberg Contraption. Ask students why they think people imagine and sometimes build Rube Goldberg Contraption s, and what they need to know to build one. Extend their thinking by asking follow-up questions such as:
  - What are 5 examples of how math and science is used in a Rube Goldberg Contraption.
  - How long does it take to build one?
  - What steps would you take to build one?
  - What happens if part of it doesn't work?
- Listen to students' responses and conversations. Select students or groups to share 5 – 7 ideas about Rube Goldberg Contraption s.
- Key points to focus on during discussion:
  - A Rube Goldberg Machine is a fun Engineering Solution to a puzzle or problem.
    - To build one you have to figure out what problem you are solving.
    - You need to come up with or imagine ideas for a solution.
    - You need to plan your solution by coming up with a list of steps, parts, and by drawing your idea before you make it.
    - You need to build it or pieces of it.
    - You need to test it.
    - Then you need to improve it over and over until it works as the best it can.
  - Making a Contraption can take a lot of time, and it might be hard to find the parts

- Part III: Connect Augmented Reality to Making Engineering and Engineering to Rube Goldberg Contraptions
  - Explain to students that using AR (augmented reality) allows them to build a virtual contraption
    - You can do it faster,
    - You can still see how it will look in the real world
    - You can practice using all the things you will need to build one like a ruler
    - You can make lots of changes to improve it fast

- And you can use parts that can be hard to find (ex. robot truck or a hot air balloon)

Explore: Introduction to NEWTON (30 – 40 min.)
Show students the 2-3 min getting started video (Launcher Day 04, Slides 136-138). Note: The information below is further description of what's described in the video clips on slides 136-138

- Divide students into groups and give them 4 cards (Anchor, Start, Ramp, and Bucket)
- Explain the function of the workspace Mats and the cards (2 min)
- Walk students through the following in order (5 min)
    - Scanning the Mat
        - Unlock the iPad and find the Newton AR app
        - Select the app
        - Once the app has loaded, hover the iPad camera over the area where the cards are for a few seconds till the orange play area disappears
        - Once the scanning is done, a set of buttons will appear on screen
    - Placing and detecting the Anchor Card
        - Place the Anchor Card in any square on the mat
        - Once the play area has been scanned, in the middle of the screen, a crosshair icon will appear
        - Scan the Anchor Card by placing the icon near the middle of the Anchor Card. The card will highlight blue once the card has been scanned
        - TIP 01: You may need to move closer/farther away and/or rotate the iPad left/right around the card for the app to scan it
        - TIP 02: The Anchor Card needs to be scanned first before scanning any other card. If the app shows a red error message when scanning other cards, go back and scan the anchor card again
    - Placing and scanning the cards
        - Place the Start, Ramp, and Bucket Cards in any squares on the mat
        - To scan these cards, place the crosshair icon near the middle of the card. Objects will appear on top of the card on the screen to show that the card has been scanned
    - Quitting and Restarting
        - To exit the app or start over, double-click the home button, press on the Newton AR window, and swipe up. Click on the NEWTON AR app again to restart and repeat previous steps (i.e., Scanning the Mat, Placing and Detecting the Anchor Card, Placing and Scanning the Cards)
- Have students place the cards and do the following: (5-10 min)
    - Move the cards (Pressing Update to move their AR design)

        - Move the Bucket Card to a different square on the mat
        - Hover the crosshair icon over the new positioned Bucket Card and wait til the icon turns blue and the card highlights blue
        - Select the Menu button located on the bottom right corner of the screen
        - Press the Update button. The button will highlight blue once selected. The image of the bucket will relocate to the new location
    - Rotate the cards (Pressing Update to rotate the AR design)
        - Shift the card two square left/right/up/down
        - Rotate the Card 90 degrees clockwise (counterclockwise)
        - Hover the crosshair icon over the new positioned Bucket Card and wait til the icon turns blue and the card highlights blue
        - Select the Menu button located on the bottom right corner of the screen
        - Press the Update button. It will highlight blue once selected. The image of the bucket will relocate to the new location and rotate 90 degrees from its previous position
    - Get up and view their cards from multiple angles (Pressing Update if anything is a little off)
    - Select a card and change its design parameter values
        - <u>Moving Around Objects</u>:
            1. The Edit Tool can be found near the top left of the screen. The Edit Tool should already be chosen and highlighted in blue
            2. In the Edit Tool, you can move around objects and change the size of the objects that you added to the play area
            3. To edit a specific object, like the Start Tube you added first, hover the crosshair icon over the object
            4. When the icon turns blue, press the select button found in the lower-left corner of the screen
            5. On the bottom of the screen, the name of the Start Tube you selected (Start1) and an Edit Menu with options to change and move the object will show up
            6. To see all the options the edit menu has, swipe left and right on the menu
            7. To move the tube up and down, select the Up and Down button in the menu
            8. In the new window, you can either swipe the yellow slider left and right to move the tube up and down or use the +1, +5, -1, -5 buttons to move the tube
            9. Point the camera at the Start Tube and use either method in Step 20 to see how the tube moves. Press the Reset to Zero button to see how the tube moves back to its original spot
            10. Use the tool to move the Start Tube up 0.3
            11. Press the OK button to leave that window

12. Press the Left and Right button
13. Use the yellow slider or the +1, +5, -1, -5 buttons to see how the Start Tube moves left and right
14. Use the tool to move the Start Tube to the left 0.2 (-0.2)
15. Press the OK button to leave that window
16. Press the Forward and Backward button
17. Use the yellow slider or the +1, +5, -1, -5 buttons to see how the Start Tube moves Forward and Backward
18. Use the tool to move the Start Tube forward 0.1
19. Press the OK button to leave that tool
20. Explore the other tools within the menu. Once you are done changing the Start Tube, press the X button on the top right corner of the screen to exit the Edit Menu
21. To move the other objects you added to the play area, start by repeating Steps 01 - 05

- Changing Sizes of Objects:
    1. Still in the Edit Tool, you will now change the size of the Bucket. Hover the crosshair icon over the Bucket and when the icon turns blue, press the select button
    2. On the bottom of the screen in the Edit Menu, swipe left until you see the Height and Depth button. You will use these buttons to change the size of the Bucket
    3. Select the Height button in the menu
    4. Use the yellow slider or the +1, +5, -1, -5 buttons to see how the Bucket gets taller or shorter
    5. Use the tool to make the Bucket 1.5 tall
    6. Press the OK button to leave that window
    7. Select the Depth button in the menu
    8. Use the yellow slider or the +1, +5, -1, -5 buttons to see how the bucket gets thinner and wider
    9. Use the tool to make the bucket 1.3 wide
    10. Press the OK button to leave that tool
    11. Explore the other tools within the menu. Once you are done changing the b=Bucket, press the X button on the top right corner of the screen to exit the Edit Menu
    12. To change the size of the other objects you added to the play area (if given the option to), start by repeating Steps 01 - 05
- (Time Permitting) Measure distances in real world.
- Show students how to start/stop the contraption
    - The Start Tube is where the Rube Goldberg magic begins. To start the contraption, press the Play button on the lower right corner of the screen. You should notice that from the bottom of the tube, pink balls are falling out!

        - To stop the contraption, press the Stop button that replaced the start button on the lower right corner of the screen
- Show students how to record and save a video (2-3 min)
    - To record the screen, press down on the upper right corner of the screen and swipe down.
    - In the drop-down window, select the button that looks like a record symbol/target. The button will turn white once the recording has started
    - Swipe up to dismiss the drop-down menu and record within the app.
    - Press the Play button and angle your camera so the screen captures and records your entire machine
    - To stop recording, press down on the upper right corner of the screen and swipe down and press the same button as before
    - The video will be found in the Photo app on the iPad
- Have the students work together and use what they learned to design a 3 piece contraption that takes marbles from the start, down the ramp, and into the bucket. The bucket must hold at least 3 marbles.
- While playing/simulating the contraption, have students narrate and record a video. The video will showcase what they did, describe their changes, and what they found out in NEWTON.
    - Tips for recording videos:
        - Always state your name and the challenge at the beginning of the recording.
        - Show the entire workspace by walking around and recording it.
        - Practice using engineering and programming terms to describe what you did.
        - Practice using numbers and measurement terms/units to describe what you did.
        - Talk about the parts you used.
        - Talk about if the contraption worked the first time.
        - Explain how you fixed it, or how would you fix it.
        - Record the design working, or what you have if it's not working
        - At the end of the recording, have one of your tablemates hold your tablet while you stand next to your creation
- Have students save the video.

TIPS as students explore the software environment of NEWTON:

- Take time scanning the surface, so it really detects things before moving on.
- Make sure students stay out of each other's way during the scanning, so it will work better.
- Always remember to include and scan an anchor in the corner of the mat.
- You may need to move close to the cards (1-2 feet to detect them).
- You should make sure the cards are not covered while your trying to use them.

- Try not to point the camera/tablet all around the class. Keep it mostly pointed at your workspace. This helps prevent issues were the workspace location is lost and has to be identified again.
- The table and floor work well for this activity.
- Remember to tell students to not cover the camera with their finger or the case ect.

Summarize

- Have students discuss their 3-piece contraption design and its successes and what they had to fix.
- Ask students what they learned about the software environment for NEWTON.

<u>Day 05</u>: A-maze-ing Token Quest

Launch

- Explain to students they will be doing an "A-maze-ing" Token Quest. Hand out the Quest map to students-one per shoulder partner pair. (Launcher Day 05, Slide 141)
- Tell students they will be working with their shoulder partner to create a series of steps to move through the maze. Explain to students they will start next to the dark square that says "5." Tell students the striped squares are the exits, and their path must be on the gray squares. (Launcher Day 05, Slide 141)
- Hand out the Algorithm Creator Handout. Tell students they will use the algorithm creator sheet to keep track of their steps and to keep a count of the number of tokens they collect.
    - Explain the algorithm creator. Tell the students that when they describe the movement, they will use the degree of rotation and the direction (clockwise or counterclockwise/anti-clockwise). Explain that they always need to move forward, and they cannot reverse steps. Students they will need to add the previous total to the tokens collected in the step they are on.
    - Make up an example and demonstrate how to do the running total.

Explore

- Give the students time to create their first algorithm/program through the maze. (Launcher Day 05, Slide 142)
    - Walk around the classroom asking students to walk you through their maze. When they tell you the directions, move the bear manipulative (or some other manipulative so students are aware of the direction its facing) exactly as they tell you to. When an error occurs, say, "Hmm. That movement wasn't what you meant, was it? That means there's a "bug" in the algorithm. You'll need to debug it." The students may ask you what to do. Use probing questions help them discover what they need to "debug."
    - Ask two groups to demonstrate their route through the maze using their algorithm. Have them place the maze on the Elmo. While one student reads the steps of the algorithm, the other student should be moving the bear through the maze.
    - Tell the students the next challenge you want them to do is to build an algorithm/program that includes a loop. (Launcher Day 05, Slide 143)
    - Walk around the classroom asking students to walk you through their maze. When the tell you the directions, move the bear exactly as they tell you to. When an error occurs, say, "Hmm. That movement wasn't what you meant, was it? That means there's a "bug" in the algorithm. You'll need to debug it." The students may ask you what to do. Use probing questions to help them discover what they need to "debug."
    - Have one group share their algorithm/program with the class in the same was as before.
    - Show students Mikel's program/algorithm for the maze. Ask the students to work with their partner and see if they can figure out what the symbols mean and then try to do Mikel's program/algorithm. (Launcher Day 05, Slide 144)

- When you can tell many groups are finding a problem, come back together as a class and ask them what they noticed. Call on students to explain the problem and show the movement using the Elmo.
- Tell students to get back together with their partner to "debug" the program. Ask students what they think "debug" means. Possible answers:
  - *Fix the problem*
  - *Find the problem*
  - *Make it work*
  - *Get rid of the stuff you don't want like bugs*
- Have students recall your use of the word "debug" as they were making their original mazes. Ask them to explain what it means based on the teacher's use of it earlier. After the discussion, reinforce that to "debug" something means to find and remove any problems or errors.
- Encourage students to move the car through the maze according to Mikel's algorithm/program. Change anything that needs to be "debugged."

Summarize

- As a summary, ask the students to describe rotation in degrees and direction. Ask them what an algorithm is. Ask what a loop is. Ask what it means to debug an algorithm/program.
- Use students' examples to demonstrate each of the vocabulary terms and the processes. (Launcher Day 05, Slide 145)
- Highlight use of rotations and number of forward or backward movements to describe the commands.

<u>Day 06</u>: Rover Programming

Launch: Explain to students they are going to learn to program some parts of the AR environment involving more complex tasks like moving, delivering, sorting, starting, and stopping. Inform students that today we are going to program a robotic dumptruck/rover.

Exploration 1 Rover Programming Challenge: How can we write a program to move a truck through a maze in NEWTON?

- Show the videos for this challenge
    - Part 1: Finding the program tool and changing something: https://youtu.be/89VH8muAmnE (Launcher Day 06, Slide 148)
    - Part 2: Adding steps to the program: https://youtu.be/YdjpkuuhGeY (Launcher Day 06, Slide 149)
    - Part 3: Repeating and ending repeated steps (Loops): https://youtu.be/hI2lzMFg8Es (Launcher Day 06, Slide 150)
    - Part 4: Program a rover through a maze: https://youtu.be/EzzOoiR0oRQ (Launcher Day 06, Slide 151)
- The information below is detailed explanation (additional background) of how to do the steps described in the video clips
- To get started, as a refresher:
    - Before going into the app, find the Anchor Card and the Rover Card. Place them next to each other.
        - The cards you ***need*** for this activity are:
            - Anchor
            - Rover
            - Block Cards 1-3
    - Unlock the iPad and find the Newton AR app
    - Select the app
    - Once the app has loaded, hover the iPad camera over the area where the cards are for a few seconds till the orange play area disappears
    - Once the scanning is done, a set of buttons will appear on screen
    - To exit the app or start over, double-click the home button, press on the Newton AR window, and swipe up. Click on the NEWTON AR app again to restart and repeat Steps 02 - 05

As a fresher on how to add the AR Cards:

- Once the play area has been scanned, in the middle of the screen, a crosshair icon will appear
- First, you will need to scan the Anchor Card by placing the icon near the middle of the Anchor Card. The card will highlight blue once the card has been scanned
    - TIP 01: You may need to move closer/farther away and/or rotate the iPad left/right around the card for the app to scan it
    - TIP 02: The Anchor Card needs to be scanned ***<u>first</u>*** before scanning any other card. If the app shows a red error message when scanning other cards, go back and scan the anchor card again
- To scan the other cards, place the crosshair icon near the middle of the card. Objects will appear on top of the card on the screen to show that the card has been scanned

- Scan the Rover Card

As a trail run using the programming tool within the NEWTON App, go through the steps below:

1. You can find the Program Tool near the top left of the screen
2. Place the icon near the middle of the Rover & press the select button on the bottom left corner of the screen
3. Select the Program Tool. The tool is selected when it is highlighted blue
4. In the program popup window, you will see a Game Object section on the left, a Steps List section on the right, and a menu filled with action step options at the bottom of the screen
5. Under Game Object, you will see a list of contraptions within the play area that can be programmed. To choose the Rover, select “SensorCard2.” The Rover is ready to program once the button turns yellow
6. Select the preprogrammed step (Go Forward) in the Step List, and change the number of times it occurs to 15
7. Press the Play button on the lower right hand corner of the screen to run the program
8. To return to the program popup window after running the program, select the back button on the lower left side of the screen
9. Select the preprogrammed step (Go Forward) in the Step List, and change the number of times it occurs to 5
10. Press the Play button on the lower right hand corner of the screen to run the program
11. Return to the program popup window by selecting the back button
12. Select the preprogrammed step (Go Forward) in the Step List, and change the number of times it occurs to 30
13. Press the Play button on the lower right hand corner of the screen to run the program
14. Return to the program popup window by selecting the back button
15. In the menu bar at the bottom of the screen, there are a set of action steps that can be used to make the Rover move in many different ways
16. Swipe left and right along the menu bar to see all the programming options for the Rover
17. To add a step to the Step List, press the step you want to do in the menu. The step will be added to the Step List
18. Add a Turn Right step to the Step List
19. Press the Play button on the lower right hand corner of the screen to run the program
20. The steps you programmed the Rover to follow are listed on the bottom of the screen. The app will highlight which step the Rover is on as it moves
21. Return to the program popup window by selecting the back button
22. What if you want the Rover to repeat the steps you made over and over again forever? To have the steps repeat, add the “Go to Action #” to the Step List
23. Select the Go to Action # Step in the Step List, and change the step it goes back to repeat to Step 01
24. Press the Play button on the lower right hand corner of the screen to run the program
25. Return to the program popup window by selecting the back button

26. If you do not want the loop to go on forever (only a certain number of times), add the "Do Next Action #" step to the Step List
27. Drag the Do Next Action # step in Step 4 to Step 3. Notice how the Go to Action # step moved to Step 4. Leave the number of times the Do Next Action # step occurs at 1
28. Press the Play button on the lower right hand corner of the screen to run the program. Notice how the program only does the loop once
29. Return to the program popup window by selecting the back button
30. Select the Do Next Action # step in the Step List, and change the step so that it repeats the loop 3 times
31. Press the Play button on the lower right hand corner of the screen to run the program
32. Return to the program popup window by selecting the back button
33. To add steps to the Step List, swipe left along the Step List until the +Steps button appears.
34. Press the +Steps button to add Step 05 – 07
35. Add Tilt Bed Action to Step 5
36. Add Go Forward Action to Step 6. Change the step so that the step happens 15 times
37. Add Level Bed Action to Step 7
38. Press the Play button on the lower right hand corner of the screen to run the program
39. Return to the program popup window by selecting the back button
40. To delete a step, go to the Step List and click on the step you want to delete, and press the delete button in the new popup window. The step will disappear
41. To exit the Programming Tool, press the Edit Tool

- Fun Time!
  - Add Block Cards 1, 2, and/or 3 to the card mat (they do not need to be beside each other)
  - Scan the cards into the AR play area
- Present the problem and the rules
  - Objective: The Rover must successfully go around the cubes without hitting them.
  - The truck starts on its card
  - The truck must stay on the workspace mat
  - The truck must not knock over or run into the cubes
  - Instructions that the truck can follow in the program
    - The truck can turn right (90 degrees)
    - The truck can turn left (90 degrees)
    - The truck can go forward by any # of units (just so happens a unit is 1 cm)
    - The truck can tilt the bed to empty it

        - The truck can level the bed again
        - The truck can wait for any # of seconds
        - The truck can go back to any instruction step in the program (Go to Action Step)
        - The truck can repeat a loop of steps x number of times before breaking the loop and moving on to the next steps outside the looped steps (Do Next Action #)
- Show students the puzzle mat and have them use a toy car to develop the steps of their maze program and write it down on their paper.
- Have students measure the distances precisely with a ruler/tape measure/meterstick for each forward movement.
- Note: There is more than one "right/working" program, so students should not worry if their solution is different.
- Have students put their programming instructions into NEWTON "code" using the programming tool.
- Have students run their program, and show it completed the challenge.
- Have students use the record tool to record their program of their rover moving through the maze to the finish. Below is a refresher of the tips for recording videos:
    - Always state your name and the challenge at the beginning of the recording of the video (in this case "Boxy Fox and the aMAZING Rovers").
    - Show the entire workspace by walking around and showing it.
    - Practice using engineering and programming terms to describe what you did.
    - Practice using numbers and measurement terms/units to describe what you did.
    - Talk about the parts you used.
    - Talk about what you did to program the Rover.
    - Did it work the first time?
    - How did you fix it, or how would you fix it?
    - Finally show the program working, or what you have if it's not working
    - Have a tablemat hold your tablet while you stand next to your creation

Exploration 02 (time permitting): Driving in Circles (10 – 15 min.)

- Explore using a programming loop
    - Ask students how they would program the rover to go in a complete square and end where it started?
    - Ask how students would write the steps so the rover does it 2 times in a row, 3 times, 4 times. Explain to students that this would be a very lengthy program if they wrote it out each time.
    - Ask students if they were writing instructions on paper how would they get someone to repeat steps (by telling them to go back and repeat the specific steps over and over). Explain to students this is called a loop.
    - Loops reuse instructions over and over making writing some programs easier.

- Have students start with the rover on the mat and take off all of the other cards except the anchor.
- Have students program the rover to go in a full square and end up back where it started.
- Have students use a loop to make it follow the square forever on its own.
- Ask students what is the least number of steps they could write to accomplish this task.
- Have students take a video of their program.

<u>Day 07</u>: Humanitarian Aid—Launch Supplies and Debug System Errors

- Preparation
  - Tape down different Geographic maps around the classroom (Launcher Day 07, Slide 155-158. Use the masking tape to mark x's on the floor where the students should place their launchers and the direction they should have the launcher arm initially facing.
    - See Slide Preparation for an example classroom set up (Launcher Day 07, Slide 154).
- **Launch --**
  - Share the video story about the candy drop during World War II (Launcher Day 07, Slide 160).
  - Ask students to think about how the pilots and crews would need to use precision to successfully land their aid packages on their desired targets.
  - Make connections to the previous experiences with the launcher and AR tools.

- **Explore**
  - Exploration 01
    - Show students the icon coding cards (Launcher Day 07, Slides 162-165). Ask the students what they notice about the different types of icon coding cards. Tell students to discuss their ideas with their groupmates.
    - Discuss the meaning of the icon coding cards and how they represent movements for their launcher (Launcher Day 7, Slide 165).
    - Show students a sequence of coding cards (Launcher Day 07, Slides 167-177). Ask students to talk to their elbow partners and discuss how they should move the launcher based on the sequence of the cards.
      - Identify students to model each movement represented by the coding sequence on the cards. Discuss each of the movements represented by the icon coding cards.
      - Emphasize whether or not the angle of the launch "arm" needs to be adjusted and how they know based on the coding card sequence.
- Exploration 02
  - Show students the different areas around the classroom they will go to to launch the humanitarian aid. Explain they will sequence a set of icon coding cards to reflect the steps the group must take to aim the launcher to hit their target on the geographic maps (Maps A, B, C, and D)
    - Review that the direction of the arrows on the floor show where the launcher is initially facing.
    - Remind students they need to aim for the map that is connected to the starting point marked on the floor. Be sure you have labeled the map and the "starting x".

                - You may choose to use the compass rose at the x to support learners in identifying the starting direction. Consider how the actual directions are reflected in your classroom. You may need to discuss how the directions are constant. The “north” position may not always be at the “top”. Emphasize this point as you support students in connecting the compass rose on the recording sheet to the compass rose on the floor of the classroom.
    - Have students use their icon coding cards (Launcher Day 07, Slide 179) and sketch the icons for each map (Launcher Day 07, Slide 180), and ask students to draw what they think will happen and how the launcher will rotate based on the set of coded movements on their recording sheets.
    - Tell students to test each of their codes and debug their systems, if necessary (Launcher Day 07, Slide 181).
        - Monitor the groups’ work
            - How would you sequence the coding cards based on this diagram?
            - How would you use the drawing to help you sequence the movements?
            - What would you add to the drawing to help us make stronger connections?
    - Ask a group who identified an error in their sequence to share their debugging process.
        - Tell students to turn and talk to their elbow partner,
            - How was your experience similar to or different from this group’s experience?
            - How would you have debugged their program?
- **Lesson Summary:** Launch Code Debugging
    - For each slide (Launcher Day 07, Slides 183-188), have students discuss in their groups the coding sequence needed to debug so the launcher could hit the target. Have students share.
- Exit Activity—Reflection
    - What strategies did you use to complete the “Humanitarian Aid” challenge?
    - How did you determine the direction and angle of the launcher in reaching your target?

<u>Day 08</u>: Launcher App AR Measurement Challenge

<u>Students Should Have</u>:

- Newton AR Launcher Cards
- iPad with NEWTON AR app
- Assembled Launcher
- AR Launcher Worksheet
- Paper direction indicator (optional)
- Tape measure (optional)

<u>Getting Started</u>:

1. Before going into the app, watch the Launcher Day 08 Video or go through the step by step instructions within NEWTON AR App Launcher Written Instruction. Find the Mascot Card, Piston Card, and Launcher Card and attach them to the launcher as shown in the Launcher Day 08 video or the written instructions and place launcher with cards on a flat surface (e.g., table, floor)
    0. The cards you ***<u>need</u>*** for this activity are:
        0. Mascot Card
        1. Piston Card
        2. Launcher Card
1. Unlock the iPad and find the Newton AR app
2. Select the NEWTON-AR app
3. Choose Sandbox Mode Button on screen
4. Once the app has loaded, hover the iPad camera over the area where the launcher and cards are for a few seconds till the orange play area disappears
5. Scan the Mascot Card FIRST and then the Launcher/Piston Card
6. Once the scanning is done, a blue circle with the word “heading” and a red circle with the word “angle” will appear on screen; both measure angles. If the angle measurements don’t show, then get closer to the cards until they do. (Note: try to hold the cards on screen) (You will know everything will have scanned once the measurements show up on the cards (besides the mascot card) and if you rotate the camera towards the area the launcher is pointing at and see a ski ball machine)
7. Select the Launcher Sandbox Button on the top of the screen. A set of buttons will appear on screen.
8. To exit the app or start over, double-click the home button, press on the Newton AR window, and swipe up. Click on the NEWTON AR app again to restart and repeat Steps 02 - 07

<u>Using the Launcher to Measure</u>:

1. You and your group should choose one person to hold the ipad and one person to move and position the launcher, change it's angle, change it's direction. (Make sure the plunger is NOT pulled back; you will not need to do that for AR).
2. Tests: Each group will play around with the Launcher Angle and Launcher Power (Launch Power is within the App, Angle is by adjusting the physical Launcher) to hit an array of targets presented within the AR environment.
3. For practice and to familiarize themselves with the functions of the Launcher Mode, have students make the following adjustments to the Launcher and then have them fire the ball to allow them to observe where the ball lands and to see if it hits one of the designated targets
    0. Launcher Angle 0 deg, Launch Power 1
    1. Launcher Angle 0 deg, Launch Power 4
    2. Launcher Angle 30 deg, Launch Power 2
    3. Launcher Angle 30 deg, Launch Power 3
    4. Launcher Angle 45 deg, Launch Power 2
    5. Launcher Angle 45 deg, Launch Power 4
    6. Launcher Angle 60 deg, Launch Power 3
    7. Launcher Angle 60 deg, Launch Power 4
4. Process for Each Test
    0. Set the angle of the launcher
    1. Set the direction of the launcher
    2. Scan the cards on the launcher with the ipad (don't move the launcher now)
    3. Record the launch angle and power on your worksheet for each Test
    4. Press the Update Firing Solution Button to update where the ball will be launched from
    5. Press the Fire button and see what happens. Draw a picture of the path of the ball on your worksheet (include classroom object if you want)
    6. Measure where you think the virtual ball landed with a tape measure and write it down (time permitting)

<u>Using the Launcher to Play Ski Ball/Darts</u>:

1. Set the Heading, Launch Angle, and Power Level
2. Scan the Cards on the Launcher
3. Press the Update Firing Solution Button to update where the ball will be launched from
4. Press the Fire button to launch the balls.
5. Re-aim your launcher to whichever ski ball machine you want, and repeat step 01 - 04 to aim at a different location
6. Try to get the highest score! Record a video for proof :)