BARNABAS ROBOTICS

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Crazy Carousel

Tinker Robotics (K-2nd Grade)
Lessons 1, 2, & 3

Revision 1.03

LICENSE

REVISION HISTORY

Revision 1.03
Date: 1/15/2018
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Revision History
- 1.00: First revision
- 1.01: Updated materials list, Reformatted and NGSS standards
- 1.02: Added art curriculum
- 1.03: Amended roof, added new pictures, updates outline

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(TOC WILL BE INCLUDED IN PHASE 3)

PROJECT OVERVIEW

Project Description

Crazy Carousel Robot is a project within the Barnabas Tinker Series — an introductory robotics program providing an opportunity for young learners to engage with science, technology, engineering, and math (S.T.E.M.) in a fun and meaningful way. This project introduces elementary school students to valuable mechanical engineering and electrical engineering concepts as they design and build robotic and/or electronic creations from the ground up.

Prerequisites

This project was designed for grade levels Kindergarten through 5th grade and requires close adult guidance and supervision. Lesson plans may be adjusted to fit each teacher's classroom needs and/or students' learning objectives.

FULL COURSE MATERIALS LIST

Below is a list of all materials required for this activity along with sources to purchase and estimated costs *per student*:

ITEM	QTY	NOTES	HOW TO PURCHASE
AA Battery	1		
AA Battery Holder (Male)	1	male connectors	https://shop.barnabasrobotics.com/products/1-x-aa-1-5v-battery-holder-pin-connectors?_pos=1&_psq=battery%20holder%20pin&_ss=e&_v=1.0
Paper Plate	1	~7" in diameter	
Paper Bowl	1		
Two Winged Motor Coupling	1		Included with 9G DC Gear Motor
M2M Wires	2		https://shop.barnabasrobotics.com/products/40-x-pin-pin-jumper-wires?_pos=2&_psq=wires%20&_ss=e&_v=1.0
Micro-Breadboard	1		https://shop.barnabasrobotics.com/products/micro-breadboard?_pos=1&_psq=micro%20b&_ss=e&_v=1.0
On/Off Switch	1		https://shop.barnabasrobotics.com/products/sliding-breadboard-switch?_pos=1&_psq=switch&_ss=e&_v=1.0
9G DC Gear Motor	1		https://shop.barnabasrobotics.com/products/9g-dc-gear-motor-socket-connectors?_pos=1&_psq=9g%20dc&_ss=e&_v=1.0
Plastic Medicine Cup	1		Dolalr Store
Pipe Cleaners	2	Cut both in half to get 4 total	

Toilet Paper Roll	1		
Rectangular Sticky Foam	4	For battery holder, DC motor, coupling, and breadboard	
Small sticky foam square	1	For pom pom	
Plastic Animals	4		
Pom Pom	1	Put on top for decoration	
Crayons/markers	crayons/ student	Crayons break easily	
Pencils	1		
Hole puncher		To punch holes in paper bowl/roof	

CRAZY CAROUSEL- (LESSON 1 OF 3)

Lesson Overview

Topics Covered

- Centripetal Force
- Circular motion and speed
- DC motors

Disciplinary Core Ideas

- ETS1.A: Defining and Delimiting Engineering Problems
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

Energy (3rd Grade)

- PS3.B: Conservation of Energy and Energy Transfer

Learning Target(s)

Technical Skills

- Understanding how a basic circuit works to power a variety of robots on/off
- Transferring energy/movement from one object to another
- Fine motor skills to:

    - Assemble parts
    - Draw diagrams
    - Use scissors
    - Work with double-sided sticky foam tape

Life Skills

- Following Rules/Directions
- Getting the Teacher's Attention
- Following Directions/Instructions
- Listening
- Paying Attention to Detail
- Be patient
- Perseverance = pushing through when things become hard to do

Lesson Materials

- ❏ Tinker Sheets
- ❏ DC Motor
- ❏ Coupling
- ❏ AA Battery
- ❏ AA Battery Holder
- ❏ Medicine Cup
- ❏ Scissors
- ❏ Construction Paper
- ❏ Sticky Foam
- ❏ Pencil
- ❏ Markers

Key Vocabulary - Session 1

- Centripetal Force
- DC Motor

Lesson Prep

Lesson Summary

Introduction to robotics

- Learn about centripetal force through circular motion
- Create a detailed design for the robot
- Preparing parts for overall robot assembly
- Design theme for robot

Teacher Mindset

Understand that

- Students have the liberty of designing all robots in this lesson.

- this is a beginner class; some students first class
- pre-requisites are not required
- developmentally, students may struggle with fine motor skills
- students may have difficulty following rules
- students may become overzealous when robot begins to work

Instructors are encouraged to:

- celebrate successes even if they are an approximation
    - Approximation = when students give the teacher part(s) of a academic or social skill
        - For example, a student stands while working, but the unspoken expectation is that all students are seated. A teacher may choose to overlook the standing and reinforce that the student is on-task.
    - Teachers can focus on the part(s) of a skill that went well versus correcting the things that were not desired
        - This is not for every instance; teachers will use their discretion when correcting absence of a skill or its steps
- impose one's stress coping strategy
    - Students may engage in behaviors that tend to push a teacher's button. So as not to damage relationships, teachers are encourage to impose a strategy that calms them before interacting with the said student
        - Coping strategies are individual, but examples are praising other students, taking a deep breath, calling all students to attention and re-stating expectation, etc.
- use clear, specific, kid-friendly language when giving directions
- have fun!

Lesson Plan

Lesson Opening (5 min)

- Attention Grabber
    - Introduce self and topic of the class
        - Show excitement for teaching the group
        - Briefly tell students how you came about teaching the class
        - Let students know that they will be designing and building a robot that spins like a common carousel.
    - Discuss rules and procedures
        - For example:
            - Respect the teacher
            - Respect self and others
            - Respect the classroom and materials
    - Character Building Lesson
        - May refer to listed *life skills;* examples can include:

                - Follow instructions
                - Be patient
                - Perseverance = pushing through when things become hard to do
        - Seek student's prior knowledge
            - Ask students the questions below:
                - "Has anyone been to a fair or amusement park and seen a carousel?'
                - "Can you describe some of the things about the carousel?"
                - "Has anyone ever been on a carousel?
                - "What did it feel like?"
            - Affirm all answers, thank students for sharing, and tell them to keep all of the information in their minds as they go through the Crazy Carousel robot Lessons.
        - Demonstrate how the robot works using a completed sample of the Crazy Carousel.

- Lesson Roadmap
    - Students will learn about the force that helps objects move in a circle
    - Student will assemble some parts of an overall robot
    - Students will design a theme for their robots

Step 1: Introduction to Centripetal Force Activity (10 min)

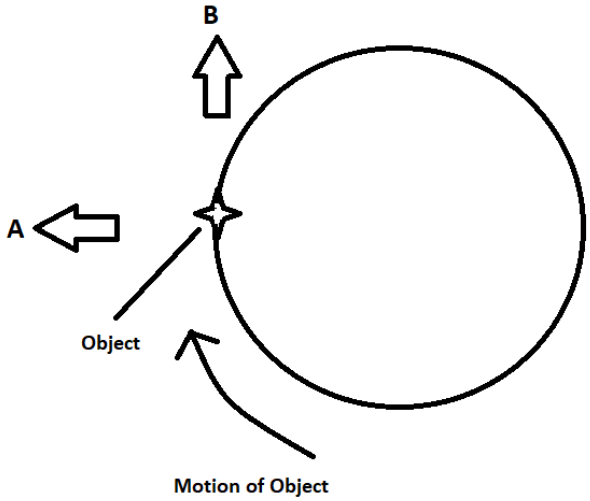
- Let students know that another name for a carousel is "Merry-Go-Round".
    - Carousel comes from the Spanish word "carosella", which means "little battle".
    - Carousels were actually invented during medieval times (during the time of knights) where knights would go in a circle and throw things at each other to prepare for battle.
    - Today you're going to make your very own version of a carousel.
- Explain that a carousel moves in a circular motion.
    - Tip: Demonstrate this by using a finger.
- Let students know that the reason why a carousel is able to continually move in circles is because of centripetal force.
    - Go on to add that the job of the centripetal force is to keep an object moving around a circle.
        - It does this because the force keeps pulling an object toward the center of the circle.
    - Further explain with the examples:
        - In a car the centripetal force is supplied by the seatbelt while the car is turning.
            - The seatbelt keeps you from flying out of the car while the car is changing direction.

- Let students know that in the Crazy Carousel, the centripetal force is supplied by the pipecleaners keeping the animals attached to the carousel and moving in the circle versus flying off into another direction.
  - Show sample of the Crazy Carousel pointing to the pipecleaners.

VOCABULARY WORD: *Centripetal Force* - The force that helps things move in a circle.

- Ask students, "What do you think would happen if those pipe cleaners disappeared all of a sudden? Answer...the animals would continue on the path in which they were moving.
- Ask students, "What would the path of the animal look like without a centripetal force guiding it around the circle? Answer...the animals would fly off and fall to the ground.
- Perform the activity below.

Crumple a piece of paper into a ball and draw the following diagram on the board:

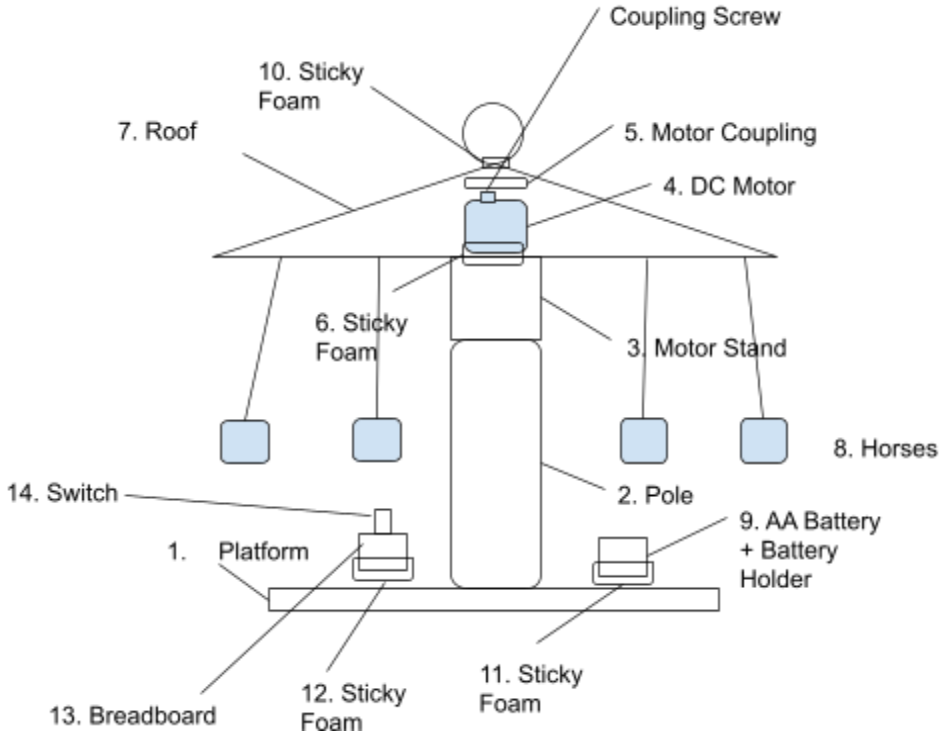


Explain that you intend to spin in a circle with your arm extended holding the crumpled piece of paper. At some point you will release the piece of paper. It is a good idea to tell your students when you plan to release the paper, i.e. "I will let go when I am facing that wall". Looking back at the diagram, ask the students if they think the paper will follow Path A or Path B path; have the students vote on which path they think the paper will travel. Afterwards, invite the class, or a few volunteers if the class is too large, to come up and take a turn. You should find that the paper will move along path B, continuing it's path of motion instead of moving directly away from you. We call the path the paper takes a tangent path. It is in line with the circle at the point of release.

You don't need to necessarily use the official terms like centripetal force, or tangent path when conducting the above activity. It is more important that the students grasp the concepts.

Step 2: Design (15 min)

- To highlight all of the components of the Crazy Carousel, draw the following diagram.
    - The drawing is complicated. (If you have a younger group of students, you can use numbers instead.)
- As you draw each part, provide the name of the part and explain its purpose.



Step 3: The DC Motor (5 min)

- Tell the group that they will be using a DC motor to make their carousel spin.
    - A DC motor is a motor that has two wires: Red = power and Black = GND (or ground).
        - If the positive (+) and negative (-) of a battery is attached to the two wires, the motor will begin spinning.
    - A DC motor is interesting because it can spin in either direction.
        - If you switch the positive (+) and negative (-) of a battery, the motor will spin in the other direction.

  VOCABULARY WORD: *DC Motor* - used to spin the carousel
- Pass out a DC motor, one AA battery, and one AA battery holder to students.

- Instruct them to look at the battery holder and ask "what do you notice about the holder"?
  - Answer...(+) and (-) markings on the inside of the holder
  - Answer...markings depicting the battery on the inside of the holder.
    - Have students visualize which way to put the battery in the holder.
- Instruct students to look at the battery and find the (+) for positive and the (-) for negative.
  - Explain that when putting a battery in a holder, (+) should match with (+) and (-) should match with (-).
  - Instruct students to put their batteries in their holders.
- Now, tell students to connect the motor wires with the battery holder wires.
  - Note: It does not matter how wires match up.
    - Students should see that the motor shaft spins.
      - They will have to look closely to see the direction of the spin.
  - Ask students, "what happens when the wires are switched?" Answer...the motor spins in the opposite direction.

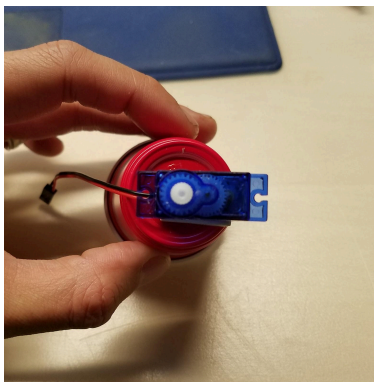
Step 4: Motor Assembly (5 min)

- Now that students have successfully seen how the battery powers their motor, tell students that they are now going to prepare to assemble the motor.
- Pass out a medicine cup, one marker, and one piece of double-sided sticky foam to each student
  - Let students know that the medicine cup will serve as a stand for their motor.

Before having your students adhere the motor to the cup have them make a small mark as close to the center of the cup bottom as possible. Then have them adhere the double stick foam to the motor and adhere the motor to the cup. While we would like the motor shaft to be as close as centered as possible, perfection is not expected or necessary. Do your best to mitigate student expectations.

- Tell students to turn the cup upside down (the base of the cup will be visible) and mark the center of the cup with the marker.
- Next, instruct students to stick the piece of double-sided sticky foam to the base of the DC motor.
  - Note: some students may not have used double-sided sticky foam before so instruct them to:
    - Peel off one piece of paper from one side of the foam.
    - Stick the side with the adhesive to the base of the DC motor.

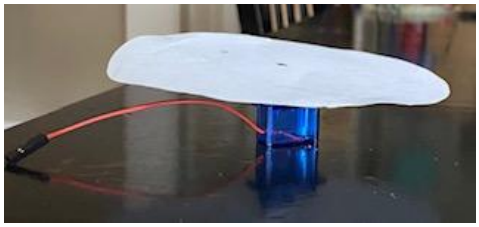
        - Students should now be looking at the side of the foam that still has paper attached to it.
    - Peel off the piece of paper from the other side of the foam.
    - Stick the DC motor to the center of the base of the cup.
        - Students should do their best to make sure that the motor is centered on the cup.

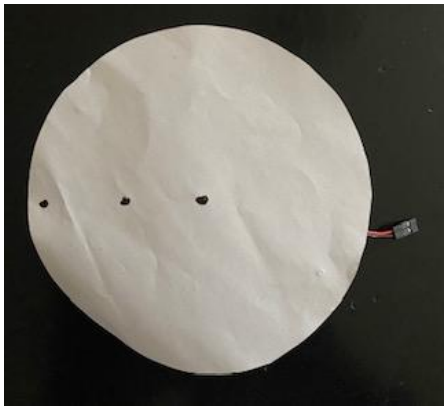


- With the motor secure on the cup, pass out a coupling to each student.
    - Tell students to snap the motor coupling onto the shaft of the DC motor.

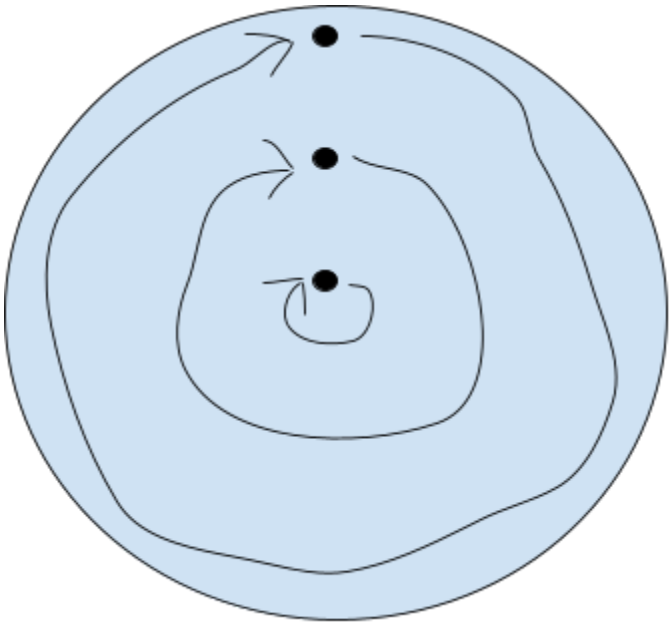
Step 5: Experimenting With Circular Motion And Speed (10 min)

- Now that students have seen their DC motor in action and to have students begin to understand circular motion and speed, give each student a piece of construction paper, scissors, a marker, and another piece of sticky foam.
    - Tell students to cut out an object/shape that is roughly 5” x 5”
        - Tip: show them a sample of roughly how big they can make these objects/shapes.
    - Let students know that the object/shape can be of their choice.
        - This can be as simple as a circle or triangle, or it can be the shape of something like an animal.
- Next, tell students to attach (lay flat) their creation to the coupling on the top of their motors using sticky foam with the “middle” of their object being the point of contact.
    - It does not need to be precisely in the middle, just approximately.
- Next, instruct students to place a small mark with a pen or pencil on the object far away from the middle, where the sticky foam has been placed.
    - Tell them to then place another mark just over the sticky foam.
    - And finally, tell them to place the last mark in between the two that were just placed.





- Now, instruct students to turn their motor on.
    - Prompt the students to look at each of the marks that they made as the motor is moving.
        - Ask, “Can you follow these marks with their eyes?”
        - Ask, “Which, if any, is easier to follow?”
        - Note: Students may find that the mark above the sticky foam hardly moves, so it is very easy to follow. The further away one of these marks is from the middle the more difficult it becomes to follow as it rotates. Why is this?
- Pass out Tinker worksheets to students.
    - Have each of the students sketch the path of each mark on their worksheets or a piece of paper.



The three arrows are the three paths for each dot. See that the inner dot has the shortest path, and the outermost dot as the longest path.

If the outer dot and the inner dot move around the circle in the same amount of time, this means that the outer dot is moving **faster** than the inner dot.

        - Note: The innermost mark may not move at all, or have a very small circular path. Now, because all of the marks travel in a circle in the same

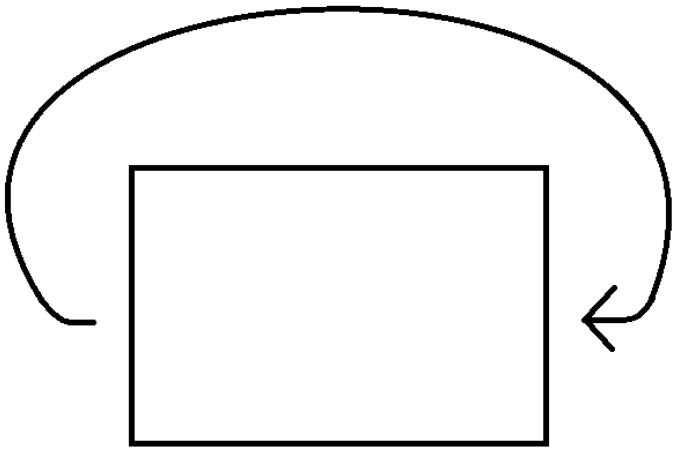
amount of time, then the marks travelling longer paths are also moving faster.
    - Note: This is always true of motion in a circle. Being near the edge of the circle as it is spinning means you will move faster than if you were near the middle of the circle.

Step 6: Art Design and Ideation (10 min)

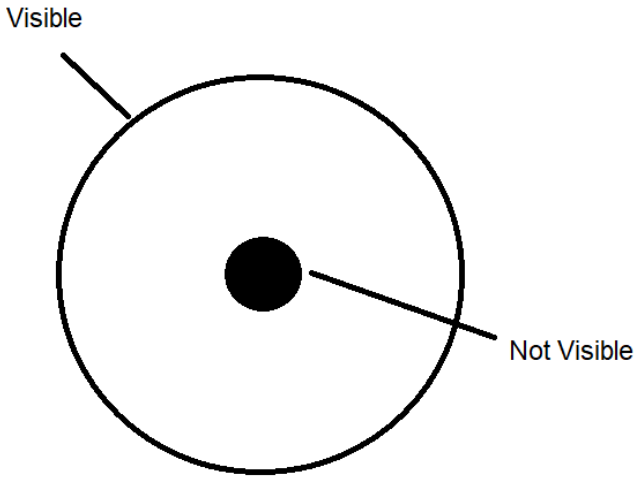
- Tell students that in the next lesson they will have the opportunity to decorate sections of their carousels and that there are some things that they must consider before starting to decorate.
    - Let them know that they will decorate the top of the roof, the pole and the platform.
        - Tip: Go back to the diagram drawn earlier and point to the three parts that students will be decorating.
    - In preparation for that, tell students to begin to think of a design or theme for their carousel.

One thing worth mentioning to the students is that while they could decorate each part independent of each other (reference drawn diagram with all parts) they can also have a consistent theme between all of the parts. For example a student could make a carousel themed to look like a tree. The platform could be the roots/ground. The pole can act as the trunk, and the roof can act like the leaves and branches.

- Explain to students that the "actual" area that they have for decorating is one of the things that they have to consider.
    - First, inform students that the toilet paper roll will be cut on the bottom so that it is easier to tape to the platform.
        - Tell them that it will be seen but it will flare out at the bottom.
        - Note: This is particularly helpful now as students need to sketch their design on their worksheet, like so:



- Second, explain that the platform will also have some of its surface obscured.
  - This is because the pole (toilet paper roll) must sit on the base:



- With this in mind, have the students sketch their designs on their worksheets. Here is a sketch of a tree idea:

REFLECTION (5 min)

To reflect on the information presented in the lesson, ask students to following questions:

- "What did you learn today?"
  - Possible answers:
    - *The DC motor spins in both directions.*
    - *That knights got in a circle, like a carousel, when they were getting ready for battle.*
- "What was hard about today's lesson?"
  - Possible answers
    - *I don't understand centripetal force.*
- "How did you work through the things that were hard?"
  - Possible answers:
    - *I didn't; I still don't understand.*
- "Did anyone have to ask for help?"
  - Possible response:
    - *Yes.*
  - *Explain that sometimes when help is needed, help is not available. So the best thing to do is to ask a neighbor OR wait patiently OR find something else to do while you're waiting. Sounds like some of you did just that. Awesome!*
- "What was most fun about today's lesson?"
  - Possible answers:
    - *Making the motor spin.*
    - *Drawing how I want my carousel to look.*

CRAZY CAROUSEL- (Lesson 2 of 3)

Lesson Overview

Topics Covered

- Color
- Pattern

Disciplinary Core Ideas

- ETS1.A: Defining and Delimiting Engineering Problems
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

Energy (3rd Grade)

- PS3.B: Conservation of Energy and Energy Transfer

Learning Target(s)

Technical Skills

- Understanding how industrial design impacts decorating a robot
- Fine motor skills to:
    - Use markers
    - Use scissors
    - Work with scotch tape

Life Skills

- Asking For Help
- Making Decisions
- Using One's Imagination/Being Creative
- Thinking creatively
- Sharing materials
- Perseverance = pushing through when things become hard to do

Lesson Materials

- ❑ Tinker Sheets
- ❑ Markers
- ❑ Construction paper
- ❑ Paper plate
- ❑ Paper bowl

- ❏ Toilet paper roll
- ❏ Scotch tape
- ❏ Scissors

Key Vocabulary

- Industrial Design
- Pattern

Lesson Prep

Lesson Summary

Introduction to robotics

- Students will use their industrial design skills
- Students will explore color and pattern
- Students will decorate parts of their robot

Teacher Mindset

Understand that

- this is a beginner class; some students first class
- pre-requisites are not required
- developmentally, students may struggle with fine motor skills
- students may have difficulty following rules
- students may become overzealous when robot begins to work

Instructors are encouraged to:

- celebrate successes even if they are an approximation
    - Approximation = when students give the teacher part(s) of a academic or social skill
        - For example, a student stands while working, but the unspoken expectation is that all students are seated. A teacher may choose to overlook the standing and reinforce that the student is on-task.
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- impose one's stress coping strategy
    - Students may engage in behaviors that tend to push a teacher's button. So as not to damage relationships, teachers are encourage to impose a strategy that calms them before interacting with the said student
        - Coping strategies are individual, but examples are praising other students, taking a deep breath, calling all students to attention and re-stating expectation, etc.

- use clear, specific, kid-friendly language when giving directions
- have fun!

Lesson Plan

Lesson Opening (5 min)

- Attention Grabber
    - Welcome students back to class
        - Share the plan for the day
        - Let students know that this lesson will focus on designing and decorating their Crazy Carousel robot.
        - Continue to show excitement for teaching the group
    - Review rules and procedures
        - For example:
            - Respect the teacher
            - Respect self and others
            - Respect the classroom and materials
    - Character Building Lesson
        - May refer to listed *life skills;* examples can include:
            - Thinking creatively
            - Sharing materials
            - Perseverance = pushing through when things become hard to do
        - May also address limit-testing behaviors you have witnessed in the prior lesson by way of teaching a more appropriate replacement behavior.
    - Seek student's prior knowledge
        - Ask students the questions below:
            - "What are the three parts of the carousel that you get to decorate?"
        - Affirm all answers and thank students for sharing
    - Once again, show (and quickly demonstrate) how the robot works using a completed sample of the Arcade Bot

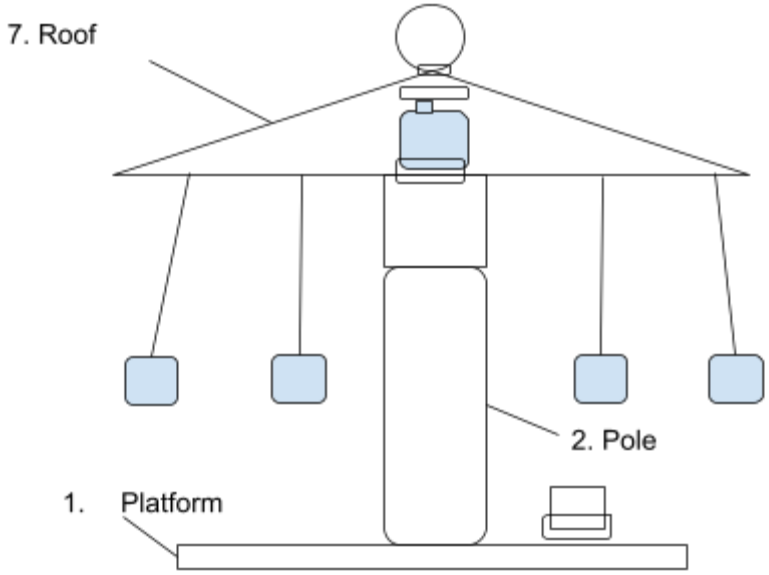
- Lesson Roadmap
    - Students will learn about industrial design
    - Students will learn about color and pattern
    - Students will decorate parts of their robot

Step 1: Review Design(10 min)

- Begin today's lesson with helping students to recall information from the last lesson and setting the tone for the lesson today:
    - Say, "In our last lesson we focused on the movement of your robot."

    - Let students know that today, they will be focusing on industrial design - being an artist - and having the opportunity to decorate their carousel.

  VOCABULARY WORD: *Industrial Designer* - Career person who focuses on how things look.
    - Ask, "What did you come up with as a theme or design for your carousels?"
        - Celebrate all responses!
- Briefly, go over the design from lesson 1 with the students.
    - Engage them by asking, "Do you remember the three parts of the carousel that require decoration/design?" Answer...roof, pole, and platform.



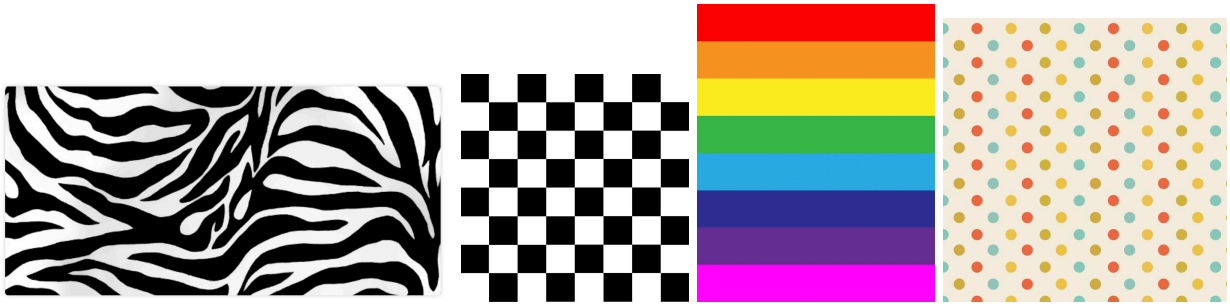
- Reiterate for students that they will focus on the three parts of the carousel that will be decorated.
    - Tell them that they will be using one paper plate for the platform, one paper bowl for the roof and a toilet paper roll for the pole.
        - Tip: Feel free to hold up each part to assist students with planning their carousel decoration.

Step 2: Art Design (10 min)

- Explain to students that as the industrial designer of their carousel, they have full creative license to decorate it the way that you want.
- Remind students that in the last session they sketched out their design.
- Let them know that today they are going to focus on color and pattern to enhance the design of their pieces.

    - Explain that In order to create a pattern they need to begin with at least two colors.
        - Say, “Color and pattern go hand in hand.”
- Ask, “Who knows what a pattern is?
- Take the time to define for the class what a pattern is.
    - Say a pattern is any shape, color, or line that repeats itself.
    - Also point out that pattern is all around us in nature, in our house, in our schools, our neighborhoods, and even on the clothes that we wear.

  VOCABULARY WORD: *Pattern* - A shape or color that repeats itself
- Tell students that if they’ve ever been on or seen a carousel, think about the colors that they saw.
    - Ask, “Did any of them make a pattern?”
    - Ask, “Were there animals on the carousel?”
    - Ask, “What kind of patterns did you see on the zebra, horse, unicorn?”
- Tell students to think about the pattern on a zebra.
    - Notice how the black & white stripes create a pattern; without the black stripes there would be no pattern.
- Tell students to remember that they will need at least two colors for a pattern when they are decorating their carousel.
    - Note: Consider drawing a variety of patterns on the board as examples.



To inspire the class, you could draw a few different patterns either line, shape, or color on the whiteboard. If your class is small enough, invite them to finish a pattern that you have started.

Challenge the kids to find a pattern in the classroom. Ask the class if anyone is wearing a pattern to raise their hand.

Step 3: Decorate (25 minutes)

- Pass out a paper bowl (roof), paper plate (platform), and toilet paper roll (pole) to each student.
- Tell students that they have the next 25 minutes to decorate (roof, platform, and pole) remembering to incorporate color and pattern.
    - Note: have samples of each - roof, platform, and pole - to use as examples.
- Let students know that they can choose to decorate each piece with one pattern, two patterns, or choose a different pattern for each piece.
    - The choice should be up to the student.
- For decorating the pole, place different colors of construction paper, scotch tape, and pairs of scissors at each table.
    - Allow students to choose a piece of construction paper to decorate and cover the toilet tissue roll (pole).
    - Demonstrate how to lay the toilet paper roll onto the paper.
    - Tell students to cut the paper so it is wide enough to cover the entire roll.
    - Instruct students to decorate the paper with their pattern.
        - Remind students that the bottom of their pole will be cut into tabs for easy adherence to the platform.
    - Once it is decorated, tell students to wrap the paper around the roll and to use scotch tape to hold the ends together.

- When decorating the roof, students can use any color and/or pattern of their choosing.
    - Tell them that it is sometimes difficult to color the lip of the bowl due to the ridges.
    - Let students know that four small holes will be punched into the lip and to please consider that when decorating.
    - Pass out a small piece of double-sided sticky foam and a pom pom to each student.
        - Let students know that they can add a small pom pom to the top of their roof using the sticky foam.

- Let students know that decorating their platforms, they have the same creative license to decorate as they choose.
    - Remind them of the space in the middle of the bowl that will be covered by the pole when decorating.

REFLECTION (5 min)

To reflect on the information presented in the lesson, ask students to following questions:

- "What did you learn today?"
  - Possible answers:
    - *Learning about patterns.*
- "What was hard about today's lesson?"
  - Possible answers
    - *Coming up with my idea for a pattern for my carousel.*
- "What helped you to think of a pattern for your carousel?"
  - Possible answers:
    - *I thought about the fair.*
    - *I thought about the zoo.*
    - *I just wanted to use my favorite colors.*
    - *I remembered my birthday party.*
  - Possible response:
    - *You all chose great things to help you with your industrial design.*
- "What was most fun about today's lesson?"
  - Possible answers:
    - *Decorating!*
    - *Coloring!*
    - *Wrapping the toilet paper roll!*

CRAZY CAROUSEL- (Lesson 3 OF 3)

Lesson Overview

Topics Covered

- DC motor unit
- Breadboard
- Switch circuit
- switch

Disciplinary Core Ideas

- ETS1.A: Defining and Delimiting Engineering Problems
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

Energy (3rd Grade)

- PS3.B: Conservation of Energy and Energy Transfer

Learning Target(s)

Technical Skills

- Understanding how a basic circuit works to power a variety of robots on/off
- Transferring energy/movement from one object to another
- Fine motor skills to:
    - Assemble small parts
    - Connect wires

Life Skills

- Asking For Help
- Listening Carefully
- Problem Solving
- Following Rules/Directions

Lesson Materials

- ❏ Tinker Sheets
- ❏ DC Motor Unit
- ❏ Wires
- ❏ Breadboard
- ❏ AA Batteries & Battery Holder
- ❏ Switch
- ❏ Decorated parts: pole, platform, roof
- ❏ Sticky Foam
- ❏ Tape
- ❏ Pipe cleaners
- ❏ Plastic animals
- ❏ Markers
- ❏ scissors
- ❏ Hole punch, pencil, or other object to punch holes in paper bowl

Key Vocabulary

- Breadboard
- Switch

Lesson Prep

Lesson Summary

Introduction to robotics

- Preparing parts for overall robot assembly

Teacher Mindset

Understand that

- Students have the liberty of designing all robots in this lesson.
- this is a beginner class; some students first class
- pre-requisites are not required
- developmentally, students may struggle with fine motor skills
- students may have difficulty following rules
- students may become overzealous when robot begins to work

Instructors are encouraged to:

- celebrate successes even if they are an approximation
    - Approximation = when students give the teacher part(s) of a academic or social skill
        - For example, a student stands while working, but the unspoken expectation is that all students are seated. A teacher may choose to overlook the standing and reinforce that the student is on-task.

    - Teachers can focus on the part(s) of a skill that went well versus correcting the things that were not desired
        - This is not for every instance; teachers will use their discretion when correcting absence of a skill or its steps
- impose one's stress coping strategy
    - Students may engage in behaviors that tend to push a teacher's button. So as not to damage relationships, teachers are encourage to impose a strategy that calms them before interacting with the said student
        - Coping strategies are individual, but examples are praising other students, taking a deep breath, calling all students to attention and re-stating expectation, etc.
- use clear, specific, kid-friendly language when giving directions
- have fun!

Lesson Plan

Lesson Opening (5 min)

- Attention Grabber
    - Welcome students back to class
        - Share the plan for the day
        - Let students know that this lesson will focus on putting all parts together and using a breadboard and switch to build a circuit.
        - Continue to show excitement for teaching the group
    - Briefly review rules and procedures
        - For example:
            - Respect the teacher
            - Respect self and others
            - Respect the classroom and materials
    - Character Building Lesson
        - May refer to listed *life skills;* examples can include:
            - Paying attention to detail
            - Listening
            - Perseverance = pushing through when things become hard to do
        - May also address limit-testing behaviors you have witnessed in the prior lesson by way of teaching a more appropriate replacement behavior.
    - Seek student's prior knowledge
        - Ask students the questions below:
            - "When you think of a switch, what comes to mind?"
        - Affirm all answers and thank students for sharing
    - Once again, show (and quickly demonstrate) how the robot works using a completed sample of the Arcade Bot

- Lesson Roadmap
    - Students will construct robot with parts from previous lessons
    - Students will learn about creating circuits using a breadboard and switch
    - Students will assemble all parts for a working Crazy Carousel robot

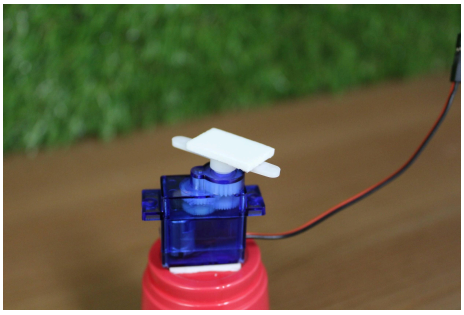
Step 1: Preparing the Platform (10 min)

- Let students know that today's lesson will pick up where the last one left off.
- Inform them that carefully following the steps will help them with building a working Crazy Carousel robot.
    - Note: all 3 parts from the last lesson should be completely decorated as well as the DC motor should have the coupling attached and ready to be used for assembly.
- Pass out scissors and scotch tape to each student.
- Tell students that they will be starting with the pole explaining that it will be taped to the platform.
    - Instruct students to take the decorated toilet paper roll/pole and cut from 4 or 8 vertical slits at the base of the pole.
        - Explain to students that they should make sure that the slits are spaced evenly apart.
            - Tip: make the first cut; then make the second cut opposite of that cut; the 3rd and 4th cut should be made between the 1st and 2nd cuts. To make eight cuts, simply make cuts midway between each existing cut.
        - Tell students that this will allow each cut on the bottom of the pole to be folded up and flat, creating tabs, and taped to the platform with ease.
            - Having slits makes it easier to stick the pole to the platform.
    - After tabs have been formed, Instruct students to securely tape the tabs to the platform.
        - Tip: use a small piece of tape on each tab.

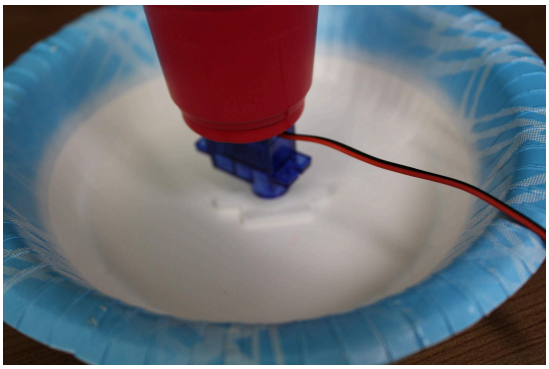


Step 2: Preparing the Roof (10 min)

- Next, tell students to put their platform/pole aside as they will now be working with their decorated roof and mounted DC motor/coupling unit.
- Now, pass out a piece of double-sided sticky foam
    - Peeling off one piece of paper, instruct students to place the sticky side of the foam down on the top of the coupling/propeller.



    - Then, tell students to remove the piece of paper on the top side of the foam.
        - Instruct them to carefully center their mounted motor with the foam over the roof and adhere the motor to the underside of the roof (inside of the bowl).



    - Instruct students to poke four holes in the lip of the bowl.
        - Tip: if a hole punch is not available, students can use a pencil.
        - Tip: students should not poke/punch the hole close to the edge but rather centered on the lip.

TIDBIT

A hole puncher works really well for this.

- Tip: these four holes should be as evenly spaced apart as possible for an even spin when the animals are attached to the roof.
    - Tip: make the first punch; then make the second punch opposite of that cut; the 3rd and 4th punch should be made between the 1st and 2nd punches.
- Now, with the roof attached to the mounted motor:
    - Tell the students to get their pole & platform piece.
        - Instruct them to place the bottom of the medicine cup onto the top of the pole.
            - Instruct students to push down slightly so that the fit is snug.

TIDBIT

Some toilet paper rolls are wider than others, making the red cup harder to fit on one of the larger toilet paper rolls. If this is the case for you simply make vertical cuts on the top of the toilet paper roll before attempting to put the cup on.

Step 3: Completing Body Assembly (10 min)

- At this point, students will most likely take time to admire their robot - celebrate with them!
- With the four pieces properly assembled:
    - Pass out two pipe cleaners, four animals, and a pair of scissors to each student.

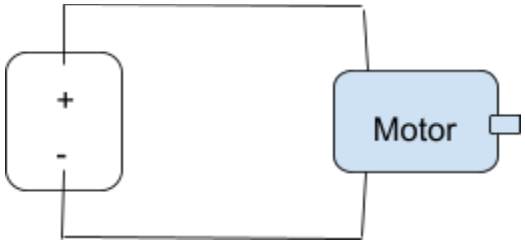
BEST PRACTICE

Students may have particular preferences regarding the type of animals they want. Consider this when planning to distribute the animals. Strategize beforehand on how to do so with the least amount of disruption possible.

- Explain to students to fold each pipe cleaner in half and to cut the pipe cleaner at the fold.
- Tell students to thread a pipe cleaner through a one hole in the roof.
    - Instruct students to fold the pipe cleaner back on itself and twist together so that it stays put.
    - Then instruct them to wrap the other end around one plastic animal.
- Students should perform these steps three more times until all animals are in place.

Step 4: Circuits (5 min)

- Now that the body has been assembled, students will have the opportunity to power their Arcade Bot.
- Return the AA battery and AA battery holders to students.
- Draw the diagram below on the board.
    - Instruct students to copy the DC motor circuit on their Tinker worksheets.

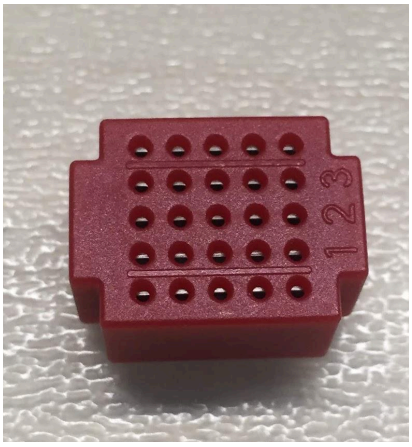


    - Review the diagram using your finger to highlight the path of electricity.
        - Start at the positive end of the battery moving clockwise to the motor, through the motor and back to the negative end of the battery in a continuous loop.
- Refresh students' memory of how to connect the battery holder to the DC motor (from first lesson).
    - Remind them to connect one motor wire with one battery holder wire and to do the same with the other two wires.
- Tell students to put the battery into the holder.
- Now, instruct them to see if they can turn on their carousel using both the DC motor and AA battery holder wires.
    - Now, challenge students to make the motor spin in both directions.

        - Hint: Flip the wire connections.
        - Instruct students to disconnect the circuit by unplugging the wires.
- Pass out one piece of double-sided sticky foam to each student.
- Tell students to adhere the AA battery holder (with battery in it) to the bottom of their platform using double-sided sticky foam.
    - Tip: when placing the battery, students should aim to adhere the holder in close proximity to the pole.

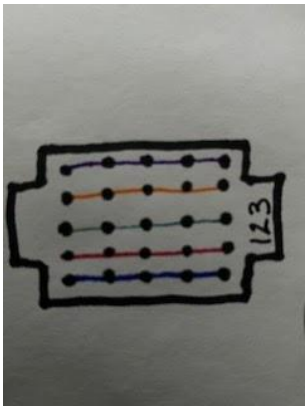
Step 5: Introducing the Mighty Breadboard (5 min)

- Explain to students that in order not to have to connect and disconnect wires to turn a robot's power on/off, engineers use a special tool to wire robot hearts called a breadboard.
  VOCABULARY WORD: *Breadboard* - A tool to connect wires together
- Draw the breadboard on the whiteboard.
    - Instruct students to draw the breadboard on their worksheet.
        - Explain that they must make sure to turn it horizontal (or hamburger).
        - This is the opposite of vertical (or hotdog).



Step 6: Connected or Not Connected (10 min)

- Pass out one breadboard to each student.
- Go on to explain the rules of the breadboard.
    - If holes are on the same row, they are connected.
    - If holes are on a different row, they are not connected.
- Using 5 different color markers, draw lines across the 5 rows of holes.
    - Instruct students to do the same with their breadboard drawing on their Tinker worksheets.



- With the drawn breadboard on the whiteboard make some examples of breadboard connections.
    - Draw a wire that is placed in two holes on the breadboard. Then see if the students can figure out if the wire is connected to itself or not.
    - Give a few examples for the students.

One way of helping the students understand the difference between rows and columns is to say that the rows can be walked across while the columns must be climbed.

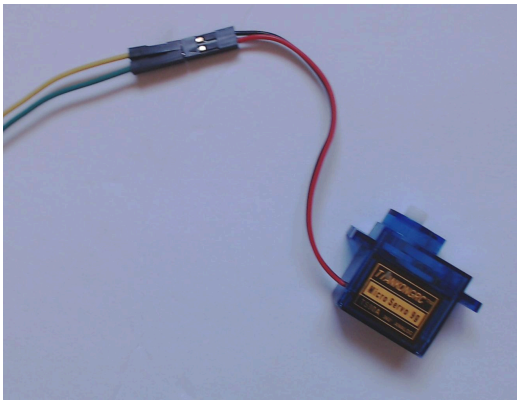
If your students are doing a good job identifying connected/not connected from the examples above consider the following activity.

Draw two wires on the breadboard (preferably two different colors) with the two being connected to each other on one end but not the other. Then ask the students if they can tell where a third wire would need to be placed so that all wires are connected on both ends.

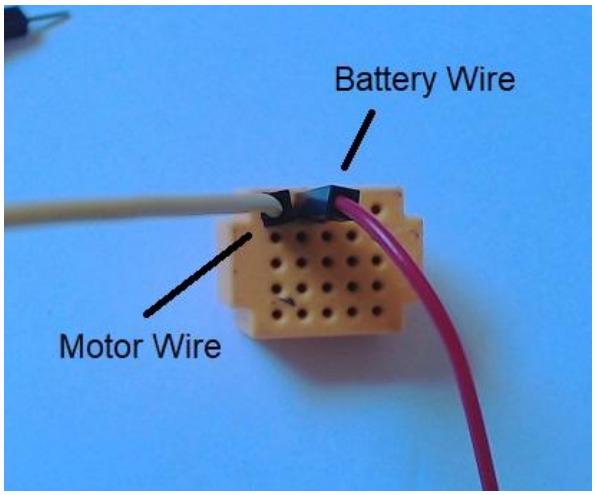
Step 7: Making A Breadboard Connection (10 min)

- Now that students have an understanding of how the breadboard works, let them know that they will be using it to turn on their carousel.
- Pass out two loose wires to each student.
- Let them know that attaching the breadboard will be in two steps:

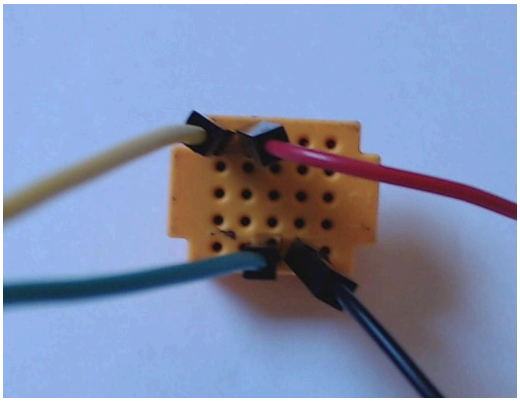
- First, tell students to start by attaching one loose wire to each of the ends of the motor's wires:



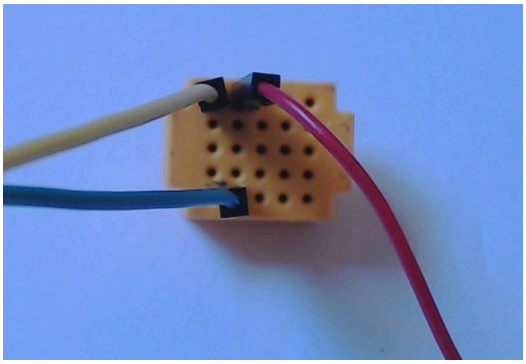
- Second, let students know that they will be placing each of those wires on the breadboard.
  - Remind students that in total they have 4 wires: 2 wires that are attached to the motor, and 2 that are coming from the battery holder.
  - Tell them that they will start with one of the wires attached to the motor, and one that is attached to the battery holder.
    - These two wires need to be placed on the same row of the breadboard:



  - Next, instruct students to place the remaining 2 wires in a row together
    - Explain that these last two wires need to be on a different row; not in the same row as the previous two wires.

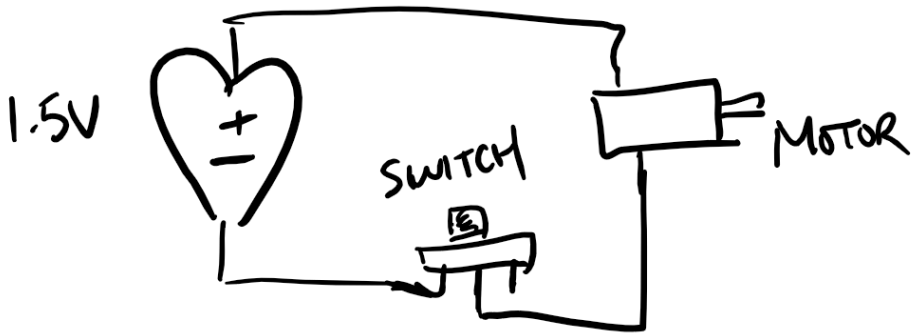


    - Students' carousels should begin spinning.
        - Tell them that to stop the carousel from spinning, simply disconnect one of the wires.
- In preparation for adhering the breadboard, tell students to remove all wires from the breadboard.
    - Pass out a piece of double-sided sticky foam to each student.
        - Instruct them to adhere the breadboard to the platform.
        - Tip: place breadboard opposite the battery holder.

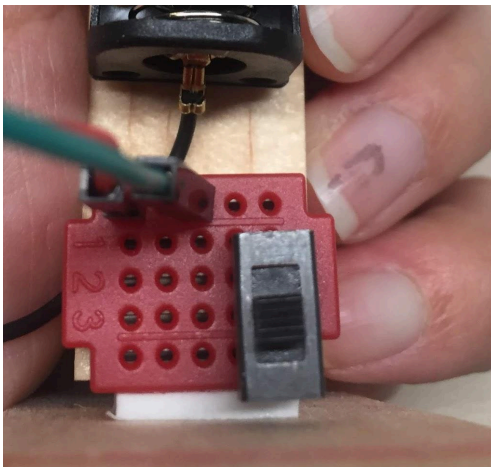


Step 8: Switch - Bonus Material (10 min)

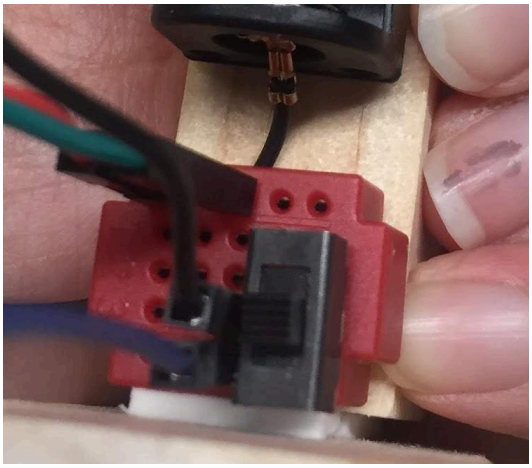
- Say to students, “At this point, you turn your carousels on and off by connecting and disconnecting wires on their breadboards.”
- Let students know that if they add a switch, they can turn their carousels on and off with the switch versus using the wires.
- Draw a new circuit that shows a switch.



- Explain that the way a switch works is that the top part toggles/slides back and forth.
    - Go on to explain that when the switch slides to the left side, the middle and left pins are connected.
    - Further explain that when it is slid to the right side, the middle and right pins are connected.
- Pass out a switch to each student.
    - Instruct them to look at the switch locating the piece that moves side-to-side and the pins.
- Provide students with the instructions for inserting the switch:
    - First, tell students to insert the switch by making sure that all three pins are on different rows.
        - Suggestion: bottom, right corner.
    - Next, tell students to place the positive (red) wire of the battery holder next to one of the motor wires on the same row of breadboard.
        - Caution students to be sure that these wires are not on a row with the switch.



- Now, instruct students to place the other motor wire on the breadboard in the same row as the middle pin of the switch.
- Last, tell students to place the negative (black) battery holder wire on the breadboard in the same row one as of the outside pins of the switch.
- Try it out and have fun!



REFLECTION (5 min)

To reflect on the information presented in the lesson, ask students to following questions:

- "What did you learn today?"
    - Possible answers:
        - *I learned about the breadboard.*
        - *The switch lets me turn my carousel on and off.*
        - *I learned about the rows being connected on a breadboard.*
- "What was hard about today's lesson?"
    - Possible answers
        - *The switch was so small!*
        - *Remembering where to connect the wires.*
- "How did you work through the things that were hard?"
    - Possible answers:
        - *I listened.*
        - *I kept trying.*
- "Over the last three lessons, you all have done a fantastic job of persevering. When things got tough, you did not give up and/or you asked for help. This is something that I want you to remember always - perseverance!"
- "What was most fun about today's lesson?"
    - Possible answers:
        - *Watching my animals fly!*
        - *Putting all the parts together!*
        - *Playing with the switch!*