NATIONAL 4-H CURRICULUM
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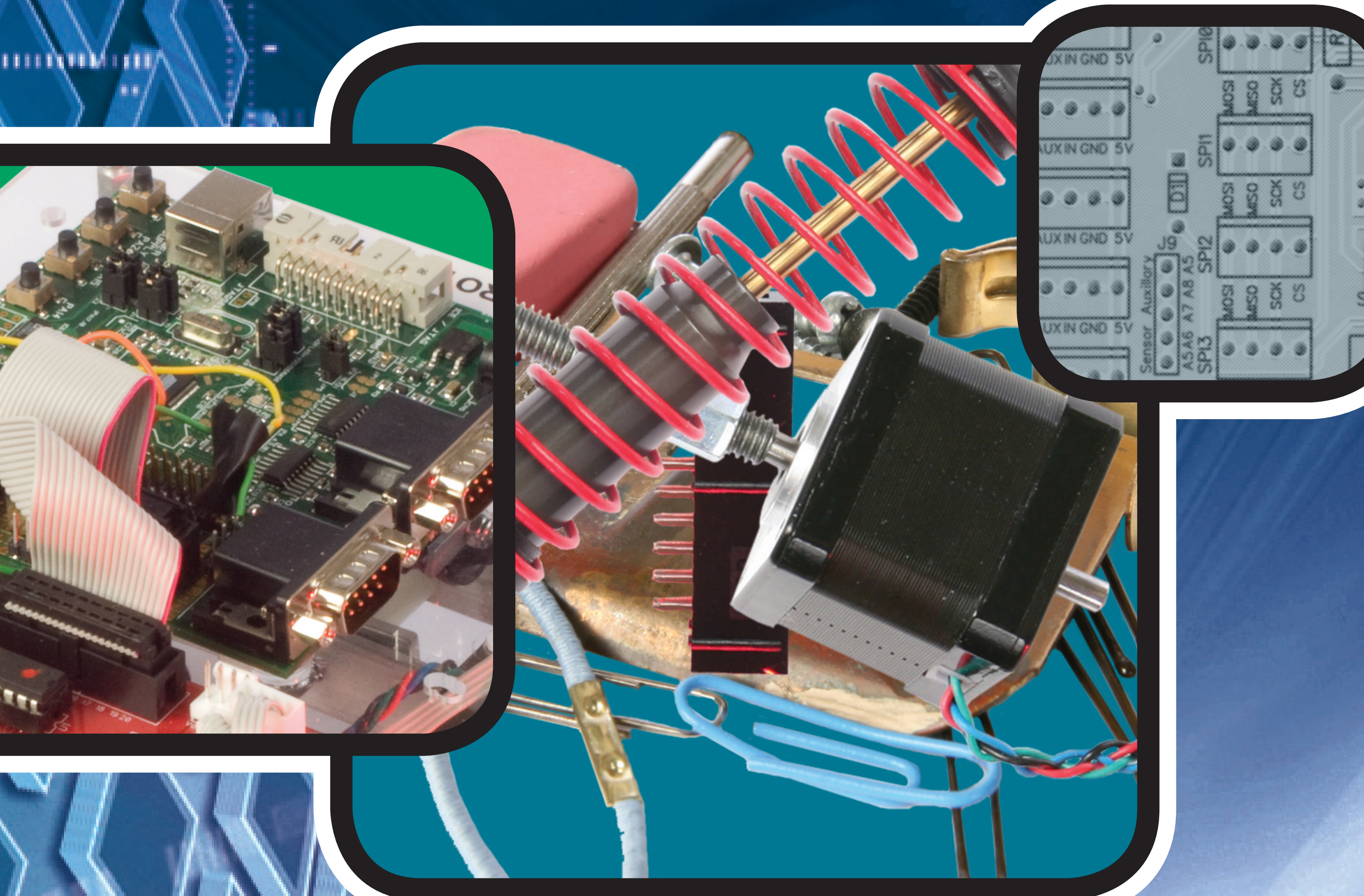
National 4-H Curriculum

# JUNK DRAWER ROBOTICS

## LEVEL 2: ROBOTS ON THE MOVE




4-H ROBOTICS: ENGINEERING FOR TODAY AND TOMORROW

## Acknowledgments – Junk Drawer Robotics

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4-H Robotics: Engineering for Today and Tomorrow

# Junk Drawer Robotics

## Level 2

## Robots on the Move

### Presenter's Activity Guide

# Junk Drawer Robotics Level 2

## Robots on the Move

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# Module 1: Get Things Rolling


## Overview of Activities in this Module

**To Learn**

Activity A — Slip N Slide
Activity B — Rolling Along

**To Do**

Activity C — Clipmobile Design Team

**To Make**

Activity D — Clipmobile Build Team

## Note to Leader

When two people don't seem to get along, we say there is friction between them. What is friction? In physics, we might think of friction as a resistance to motion or movement. What affects friction? The type of surface — is it smooth or rough? Is it stationary or already moving? (If it is moving, the object has momentum.) The mass or weight of the object also can affect the amount of friction.

Try this: Rub your hands together. What do you feel? First, you only feel the surface of your palms and fingers; then they get warm. In rubbing, the surface particles change the movement or kinetic energy into thermal energy or heat that you feel in your hands.

Friction can slow down or limit the movement of objects, but friction is also a useful tool when we need traction or gripping power. What we need to find is the right amount of friction for the current use. Do we need wheels and gears that can turn freely on their axes? Do we need wheels that can grip the road to move a robot forward or up a hill? Sometimes we need to both reduce and increase friction.

Uses of friction in everyday life can be seen when we walk or ride in a car. Have you slipped in spilled water, or on ice? Have you seen a car spin around on ice because it "lost its friction"? These are examples of where we need friction.

On the other hand, friction can make it too hard to move or slide some objects. Friction also can cause a number of concerns that we should try to deal with. These include making it hard to move things by having to use more force or energy to overcome friction; losing some of our energy to heat; and ruining some objects because the heat generated by friction makes them wear out. Engineers try to make moving objects as efficient as possible; that is, they try to convert as much energy into target work as possible.

What can we do? If we need to reduce friction, we can try to use lubricants, rollers, or sliders to move objects. For more grip, we might try new tires, surfaces with grooves, rubber soles on shoes, and cushion grips on handles.

In addition to the physical constraints of friction, the Design and Build Teams will also consider customer requirement constraints such as carrying capacity, cost limits, complexity, and efficiency in material usage.

## What you will need for Module 1: Get Things Rolling

- Robotics Notebook for each youth
- Trunk of Junk, see page 8
- Activity Supplies
  - Cardboard for ramp – at least one to share with the groups or one for each group
  - Paper clips, binder clips in different sizes, about 10-15 per group
  - Full boxes of paper clips (at least one per group)
  - Paper brads, about 5 to 10 per group
  - Clothespins or other fasteners, about 5-10 per group
  - Coffee stirrers, about 10-15 per group
  - Straws, about two to six per participant
  - Craft sticks (some with holes), about 10-15 per group
  - Toy wheels, at least four per group
  - Various kinds of tape (e.g., electrical tape, aluminum tape, duct tape, masking tape, and/or packing tape – 1 ½ to 2 inches wide, if possible)
  - Pieces of two or three different grits of sandpaper
- Toolbox
  - Scissors, a few to share with all
  - Small hacksaw (if needed)
  - Protractor to measure angles
  - Drill and bits

## Timeline for Module 1: Get Things Rolling

### Activity A – Slip N Slide

- Activity will take approximately 20 minutes.
- Divide youth into small groups of two or three.
- For each team, provide a box of paper clips and cardboard ramp with various surfaces attached.

### Activity B – Rolling Along

- Activity will take approximately 20 minutes.
- Divide youth into small groups of two or three.
- Add to supplies from Activity A: paper clips, drinking straws, coffee stirrers.

### Activity C – Clipmobile Design Team

- Activity will take approximately 20 minutes.
- Divide youth into groups of two or three.

### Activity D – Clipmobile Build Team

- Activity will take approximately 30 minutes.
- Use the same groups from Activity C, Clipmobile Design Team.

## Focus for Module 1: Get Things Rolling

### Big Ideas

- Friction
- Underlying physical science and mathematics concepts
- Engineering Design Constraints
  - Complexity
  - Efficiency
  - Capacity
  - Cost/Budget

### NSE Standards

- Form and function
- Motion and forces
- Abilities of technological design

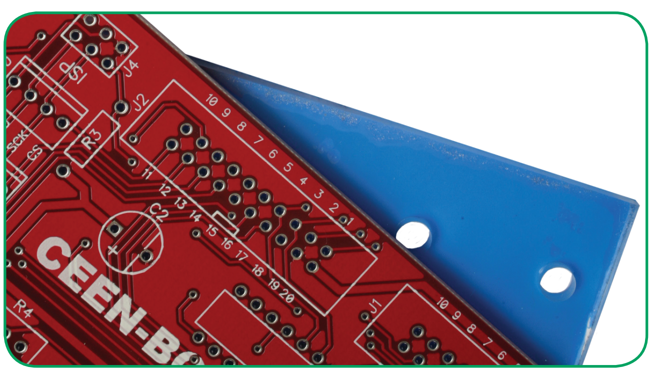
### Performance Tasks For Youth

You will explore movement and friction by testing a small box on a number of surfaces, looking at static friction and sliding friction.

You will test rolling friction by adding wheels (cylinders) or rollers as a way to overcome the overall friction of an item.

You will plan and design a vehicle to maximize its ability to coast based on considering the effects of friction. You will also consider constraints of capacity, efficiency, complexity, and costs in the design.

You will build or assemble a complex clipmobile, considering and addressing effects of friction and design constraints.



### STL

- Apply the design process
- Use of technology
- Core concepts
- Transportation technologies
- Manufacturing technologies

### SET Abilities

- Collect Data
- Draw/Design
- Hypothesize
- Observe
- Predict

### Life Skills

- Critical Thinking
- Keeping Records
- Sharing

### Success Indicators

Youth will be able to compare and select materials based on how they may affect sliding friction.

Youth will be able to demonstrate and discuss how rolling friction requires less force than sliding friction.

Youth will design a vehicle that will roll easily and meet the constraints listed.

Youth will build a vehicle to overcome friction and other constraints to roll freely down a ramp.

# Activity A – Slip N Slide

## Performance Task For Youth

You will explore movement and friction by testing a small box on a number of surfaces, looking at static friction and sliding friction.

## Success Indicators

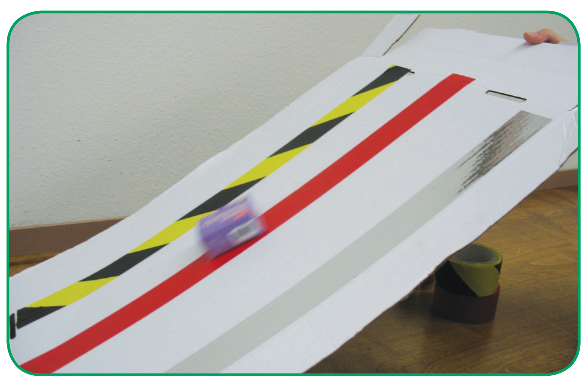
Youth will be able to compare and select materials based on how they may affect sliding friction.

### List of Materials Needed

- Robotics Notebook
- Trunk of Junk
- Activity Supplies
  - Cardboard ramp, about 12 inches by 36 inches – at least one to share or one per group
  - Box of paper clips (two per group)
  - Paper clips – 6-10 per group
  - Pieces of various tape (e.g., masking tape, packing tape, aluminum tape, duct tape), each piece about 10 inches long to attach to ramp
  - Sandpaper strips about 10 inches long — in fine, medium, and coarse grits — to attach to ramps
  - Protractor to measure ramp angle

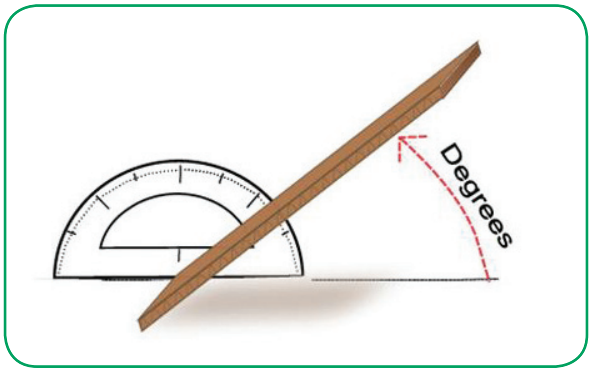
### Activity Timeline and Getting Ready

- Activity will take approximately 20 minutes.
- Divide youth into groups of two or three.
- Before the meeting, fasten strips of different types of tapes and/or sandpapers on the surface of the cardboard ramp so that items can slide down as the ramp is raised at one end. Depending on the size of the cardboard, you may be able to get four or five different surfaces on a ramp. On each ramp, leave a blank, uncovered strip of just the cardboard for a control run. Depending on the variety of tapes you have, you may place different types of tape or sandpaper on different cardboard ramps.
- Provide teams with a cardboard ramp, protractor, and box of paper clips.



## Experiencing

1. Share with youth the difference in static friction of an object at rest and that of sliding friction when it starts to move. Tell youth that they will be testing some objects to see how these starting sliding friction points can be different for a number of reasons. Ask the group if they have any ideas on how to measure the angle of the ramps. Share with them that they can use the protractors and have them figure out and practice measuring the ramp angles.
2. Youth will begin by testing their control (plain cardboard). Youth will place the box at the top of the plain cardboard "track." The youth will slowly raise the cardboard until the box begins to slide down the track. They will then record this angle and repeat the experiment two more times. This will be the control test, and the




angle used for comparison. This is a good time to have the youth predict if they think certain materials will allow the box to start sliding sooner (less of an angle) or not start sliding until at a higher angle.
3. Youth will then test a different material on their cardboard ramp, comparing these angles to the angle of the control test.

## Sharing and Processing

As the facilitator, help guide youth as they question, share, and compare their observations. Before they share with the group, have youth reflect on the activity in their Robotics Notebook. Use more targeted questions as prompts to get to particular points. There is no one right answer.

- Ask each group to prepare a summary of its results and form a hypothesis about why changing the surface area had an effect on how the box would slide. Ask each group to share with everyone.
- If the data differed among the groups, discuss why that might be.
- What had the greatest effect on the sliding friction?
- What had the least effect on the sliding friction?
- Why do you think it was important to repeat the same test more than once? How many times should a test be repeated?

## Generalizing and Applying

- If you wanted to have more grip or traction (more friction), what type of tape or material could you use?
- If you wanted to reduce the friction, what type of tape or material could you use?
- Youth can apply what they have designed in Activity B.

# Activity B – Rolling Along

## Performance Task For Youth

You will test rolling friction by adding wheels (cylinders) or rollers as a way to overcome the overall friction of an item.

## Success Indicators

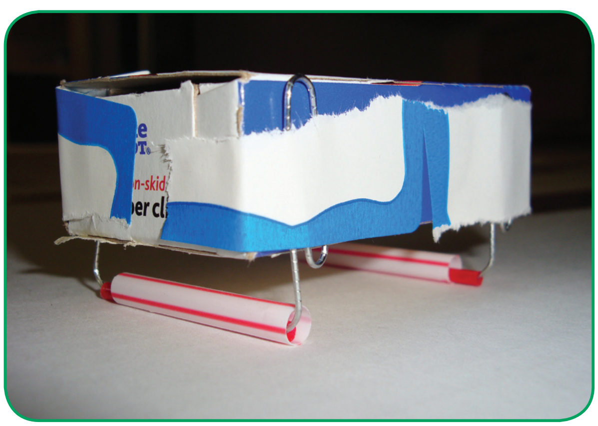
Youth will be able to demonstrate and discuss how rolling friction requires less force than sliding friction.

### List of Materials Needed

- Robotics Notebook
- Trunk of Junk
- Activity supplies — same as for Activity A plus
  - Coffee stirrers (straws)
  - Drinking straws, different-sized diameters, if possible – two to four per group
  - Paper clips — six to eight per group
  - Cardboard ramp with different surfaces to test – one per group or some to share

### Activity Timeline and Getting Ready

- Activity will take approximately 20 minutes.
- Divide youth into groups of two or three.
- Provide each team with supplies.



### Experiencing

1. Share with the group that in the last activity they were exploring sliding friction, and in this activity they will be looking at rolling friction. Ask if anyone can describe what the difference might be. There are no right or wrong answers — have the youth discover through active discussion. Generally, rolling friction is with wheels or cylinders and with spheres or balls. Each of these items will have much smaller touch areas between the surfaces and that — in part — plus other factors will reduce the friction. Share that in the next tests they will be using rollers to try to get the box to move more freely down the ramp.
2. Members will create axles and cylinder wheels using paper clips and pieces of drinking straws and/or coffee stirrer straws. The members will bend the paper clips so part of the paper clips can be mounted to the box with tape and part can hang down for an axle. Using short pieces of straws, slide them onto the paper clip axles. If there are different sizes of straws, members might want to try each one or try putting one straw inside another. They can try one or more axles.
3. Members will test the effect of rollers and wheels. Members will place the box of paper clips on the control (plain — no tape or sandpaper) part of the cardboard, and slowly raise the cardboard until the box of paper clips begins to roll down. They will then measure the angle at which the box of paper clips begins to move.

4. Members will then test the rollers and wheels on different types of surfaces, repeating the same steps as above.
5. Members should repeat each test three times making sure their readings are accurate.

## Sharing and Processing

As the facilitator, help guide youth as they question, share, and compare their observations. Before they share with the group, have youth reflect on the activity in their Robotics Notebook. Use more targeted questions as prompts to get to particular points. There is no one right answer.

- Ask the groups to prepare a summary of their results and form a hypothesis about why the boxes rolled better or worse than in the first activity without the rollers. Ask each group to share with everyone.
- How did rolling make a difference on the different surfaces versus sliding on the surfaces?
- Share your experience in making axles and wheels (cylinders).
- What do you think would improve the axles and wheels?

## Generalizing and Applying

- Where have you seen or heard about using rollers to move heavy loads?
- Youth can apply what they have learned in Activity C.