SAMPLE

Kiwi Co

Robot Crawler

TEACHER GUIDE

Lesson Overview

SAMPLE

Students will explore science and engineering concepts by building a motor-powered robot in small groups.

SECTION 1 is the build-intensive part of the project. Students will construct different components of the robot crawler: the motor, body, and legs.

SECTION 2 features an experiment, in which students will test modifications to their robot and the impact on speed. As they race robots, they'll conduct multiple trials, measure times, and compare variables.

SECTION 3 features a design challenge, which encourages students to use innovation, critical thinking, and problem-solving skills. They'll use friction to optimize their robot's design, so it's able to drag as much weight as possible. In doing so, students will generate multiple solutions to an engineering problem while reflecting on success and failure points.

SECTION 4 is optional and offers discussion topics to evaluate student takeaways. It also includes two activities to extend student investigation and reuse some materials from the project.

Use these time estimates for planning. Keep in mind they'll vary depending on how quickly your students work and how much exploration they do.

50-75 minutes

SECTION 1: Discovering Mechanics

1.A Motor Build
Students connect and test the motor assembly.

1.B Robot Body Build
Students make a robot body to house the motor.

1.C Robot Leg Build
Students construct two legs to attach to their robot body.

40-55 minutes

SECTION 2: Exploring Speed and Time

2.A Racing Robots
Students learn how to create a fair test and gather data.

2.B Speed Experiment
Students test variables of their robot design and compare the impact on speed.

40-55 minutes

SECTION 3: Investigating Friction

3.A Box Build
Students construct a box for their robot to pull.

3.B Strength Design Challenge
Students redesign the robot to drag as much weight as possible.

optional!

SECTION 4: Wrap-Up

Robot Decoration
Students add an artistic flair to their robot.

Robot Locomotion
Students redesign their robot to move in a completely different way.

SECTION 1: Discovering Mechanics

In this section, students will:

- Build a motor assembly
- Make a robot crawler that's able to walk
- Experiment with linkages

By the end, students should be able to:

- Demonstrate a device that converts electrical energy to motion
- Make observations about the robot crawler's movement

Hand out this card:

Robot Leg Build

Follow these steps:

1. Have the groups check that all the materials listed on the Robot Leg Build card are at their workspace.
2. Have the groups follow the instructions on the card to complete their robot crawler.
3. ⚠ Instruct students to turn off the motor if their robot gets jammed. The motor will overheat if it's left on while jammed.
4. Use the discussion questions on page 19 to reflect on this build with the class.

Build time:

20-30 minutes

Troubleshooting tips:

In Step 1

Make sure the brads are loose enough to let the leg pieces move freely.

In Step 6

Double-check that you're using the small cranks. The large crank won't rotate properly in the bottom leg hole and will jam.

In Step 6

Check that the cranks are pointing in opposite directions. If they're pointing in the same direction, the robot won't take steps and will do a push-up motion instead.

In Step 7 8

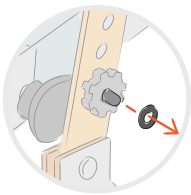
The leg and wheel are tricky to attach. Encourage one student to hold the robot body, while another student slides the pieces on.

In Step 8

Check that the tube and dowel are still centered in the body.

In Step 9

The gears will loosen with time, so add o-rings to keep them in place if needed.



In Step 11

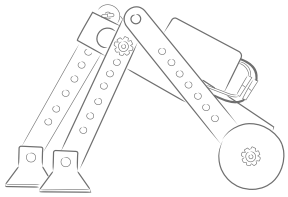
If the wheel doesn't spin, loosen the foam gear or o-ring that holds it in place.

SAMPLE

Speed Experiment Worksheet

Place your robot crawler at your start line and time how fast it is. For each test, time your robot twice and find the average.

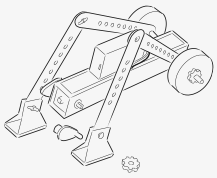
Test #1

SET UP YOUR ROBOT	TEST AND OBSERVE How long did it take the robot to cross the finish line?
 **Cranks:** Small **Hole:** Top	**Trial 1:** _____ seconds **Trial 2:** _____ seconds **Average:** _____ seconds **I observe . . .**

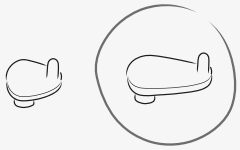
Test your robot twice to see if the times are the same.

Add the times for your two trials, then divide by 2.

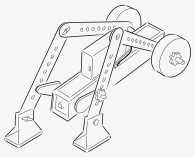
Get ready to experiment more!



Take off the gear, leg, and small crank.



Find the large crank and press it onto the motor shaft.



Put the leg back on the crank, then the gear. Then repeat for the other leg.

Flip to the back to keep testing.

Discussion Time!

Notes For The Teacher

A. The rotation of the motor is constant, but adjusting the length of the legs changes how much distance the robot will cover in the same amount of time.

B. When the legs are attached at the top hole, they take bigger steps and move a longer distance in the same amount of time, and the robot walks faster. In contrast, the robot will take smaller steps if the legs are attached at the bottom hole.

C. The large crank puts the leg further from the axis of rotation — the motor shaft. This creates a larger rotation and allows the robot to take bigger steps. In contrast, the small crank has a smaller rotation, so the robot will take smaller steps.

D. Finding the speed differences between hole heights may call for more precise timekeeping and is a great exercise for a more in-depth exploration. Otherwise, focus on the crank sizes to see a more drastic speed difference.

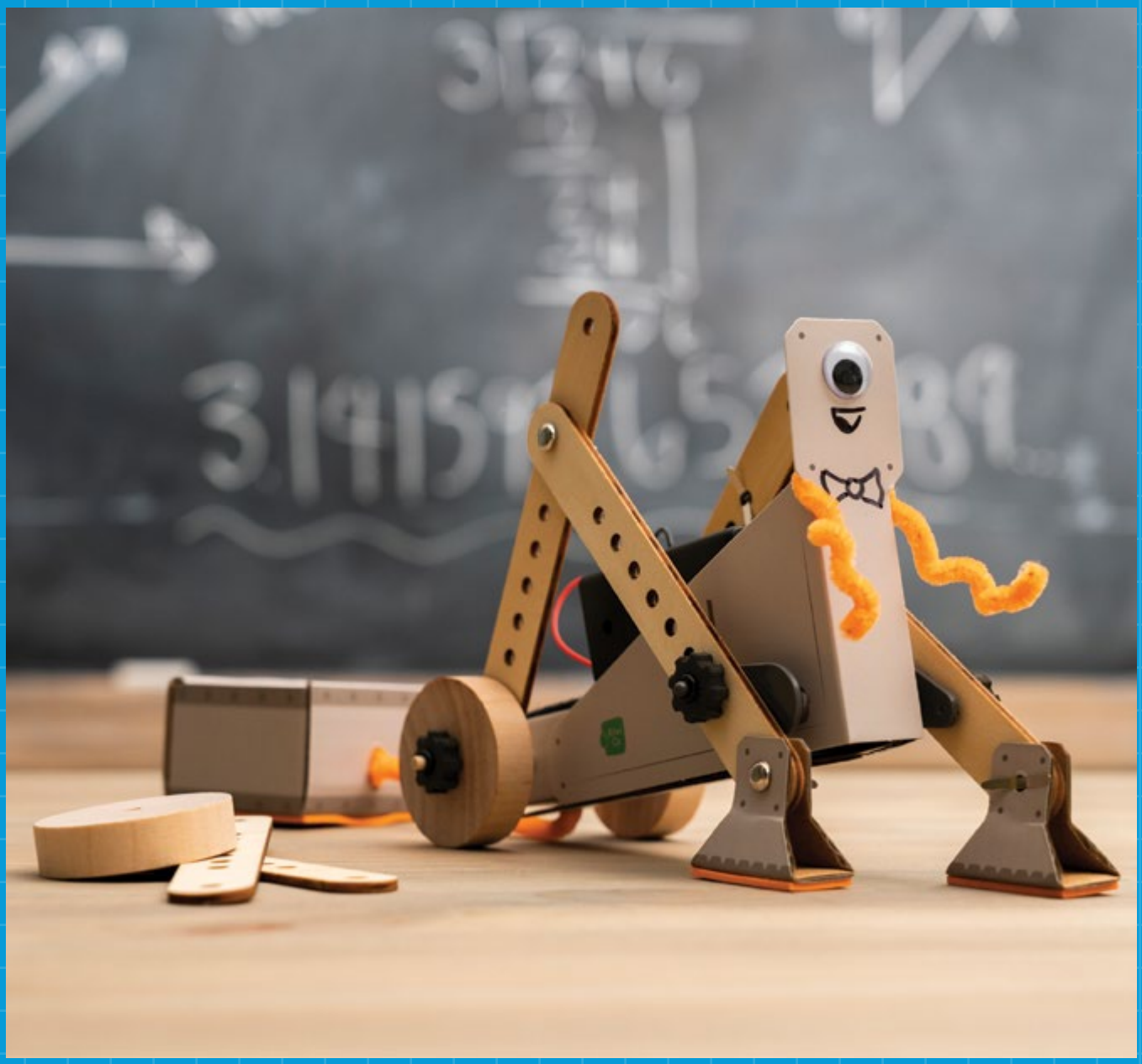
E. As an extension to the worksheet, students can calculate speed for each trial. Introduce them to the formula speed = distance / time, where distance is in inches and time is in seconds.

Thought-Starters

How does changing the size of the cranks affect how the robot walks?

How does changing which hole the legs go in affect the robot's movement?

You wrote down average times and "I observe" statements. Why is it helpful to have both quantitative and qualitative observations?



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