Note to the Teacher

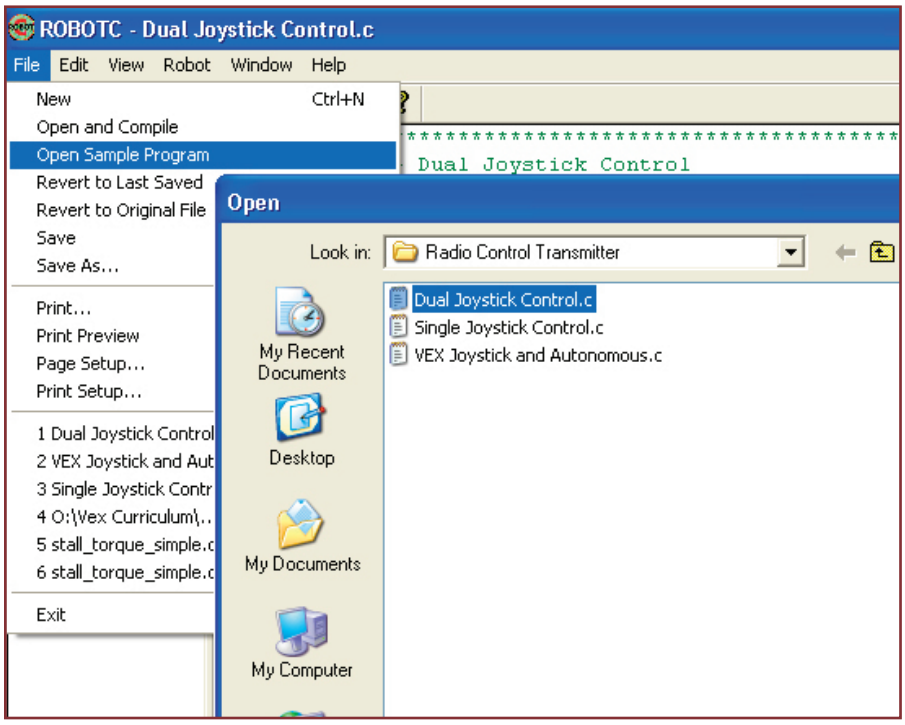
Overview

In this investigation, students will learn the relationship between current and work. Students will use the Vex Robotics System in a laboratory setting and conduct scientific inquiry-based experiments to determine how current draw is affected by traversing increasing inclines. Students will construct a modified Squarebot, which will require attaching a multimeter in series with the battery, crimping wires, and mounting the multimeter on the robot.

Students will gain an understanding of math and science concepts including work, power, and force. In addition, students will learn the definitions of voltage, current (including direct and alternating), and resistance, and how these concepts relate. Students will also learn how to use a multimeter to check for continuity and DC voltage. Students will learn how to crimp their own Vex connectors and what a series circuit is. Also, they will learn the factors that affect current draw in their robot, and the relationship between voltage, current, work, and time. Additionally, students will graph their experimental results and draw conclusions about the relationship of science concepts.

Please note

If you have ever downloaded ROBOTC firmware (or programs), you will now have to download a ROBOTC sample program, "Dual Joystick Control." Alternately, you can re-download the Vex Default Firmware.



- Select File/Open Sample Program
- Browse to Radio Control Transmitter/Dual Joystick Control and download it.
- Turn the robot on and off. The robot should now work with the remote control as it did out of the box.

Note that if you have never downloaded anything onto your VEX microcontroller, you can skip this step.

Note to the Teacher *continued*

VEX Kits and Accessories Needed

1. VEX Protobot Kit
2. Transmitter & Receiver Kit
3. VEX Microcontroller

Helpful Hints

This investigation consists of two activities: lesson setup and procedure. The investigation also includes many multimedia supplements.

- This investigation should take approximately 2 - 3 forty minute periods
- It is recommended that students work in cooperative teams of 3 students: one to run the radio control transmitter, one to record the readings, and one to time the robot
- Managing a classroom when multiple investigations are being done using multiple Vex systems but only one crystal frequency is not recommended
- It is recommended that teachers purchase additional crystal kits for a Vex classroom (see Unit 6 page 22 in the Inventor's Guide)
- If the students have access to a multimeter similar to the one presented in the videos, it will be easier for them to follow the video instructions. If students are using an alternate multimeter, make sure to tailor this material for your specific multimeter.
- In the Current Draw Lesson Setup video / PDF, an irreversible modification is made to the battery. This only needs to be done to one or two batteries!
- Make sure the multimeter is set up exactly as in the Current Draw Lesson Setup video / PDF; other methods may blow a fuse or produce inaccurate readings
- Work at floor level - robots can fall and break!

Students Will be Able to:

1. Apply the scientific process and collect data from their investigation
2. Modify a battery and place it in series with a multimeter
3. Use a protractor to create a testbench for their robot
4. Measure current output while the robot climbs inclines at increasing angles
5. Graph their experimental data and explain the results
6. Use a multimeter to test continuity and check DC voltage
7. Modify a battery and place it in series with a multimeter

Note to the Teacher *continued*

How to Use the Lesson Materials

1. Review all the lesson materials thoroughly. Be sure to read the Helpful Hints section of this document; it contains important information.
2. The following teaching materials and supplementary multimedia are included with this investigation:
   - **a.** Overview / Video Preview: Serves as an introduction to the investigation; recommended for use before beginning the investigation
   - **b.** Overview / Guides / Note to the Teacher: Highlights all of the investigation content, summarizes the lesson goals and procedures, and makes suggestions about how to teach this material
   - **c.** Overview / Guides / Note to the Student: Highlights all of the investigation content, summarizes the lesson goals and procedures, covers key math and science topics, and the resources available to the students; recommend distributing prior to investigation
   - **d.** Overview / Quiz / Checking for Understanding: Designed to be assigned at the end of the investigation; covers topics including work, power, force, series circuits, direct and alternating current, factors that affect current draw, and using a multimeter
   - **e.** Overview / PowerPoint / Lesson Guide: Summarizes the investigation and provides an overview of current
   - **f.** Background / Helper Link / Current: Defines current, presents Ohm's law, and provides an example with respect to current; recommend assigning before lesson
   - **g.** Background / Helper Link / Voltage: Defines voltage, presents Ohm's law, and provides an example with respect to voltage; recommend assigning before lesson
   - **h.** Background / Helper Link / Resistance: Defines resistance, presents Ohm's law, and provides an example with respect to resistance; recommend assigning before lesson
   - **i.** Background / Resources / Multimeter Guide: Provides a guide to teach students how to use a multimeter to test for continuity and read DC Voltage; includes two videos and a PowerPoint slide show; recommend that students review this before the lesson or setup
   - **j.** Background / Resources / Crimping Guide: Provides a guide to constructing custom connector cables for the Vex Robotics System and includes detailed instruction on how to use a crimping tool; includes a slide show and a PowerPoint presentation; recommend that students review this before the lesson or setup
   - **k.** Background / Resources / Current Worksheet (xls or PDF): Includes tables, graphs and sample data for the lesson; note that you should choose whether to print and hand out the PDF for students to complete, or whether you want students to use a computer to modify the xls (Excel) document
   - **l.** Lesson / Videos / Current Draw Lesson Setup: A video on assembling the modified Squarebot for the lesson; includes modifying a battery, attaching a multimeter in series with a battery, and mounting a multimeter on Squarebot; note that this is a companion to the Current Draw Lesson Setup PDF
   - **m.** Lesson / Videos / Current Draw Lesson Procedure: A video presenting the lesson procedure; note that this is a companion to the Current Draw Lesson Procedure PDF; there is important procedure information

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in the PDF that is not present in the video

n. Lesson / Printable PDF / Current Draw Lesson Setup: A PDF on assembling the modified Squarebot for the lesson; note that this is a companion to the Current Draw Lesson Setup video

o. Lesson / Printable PDF / Current Draw Lesson Procedure: A PDF on the lesson procedure; note that this is a companion to the Current Draw Lesson Procedure video; there is important procedure information in this PDF that is not present in the video

3. Modify and add to these lessons in the way that will best serve your classroom.
4. It is recommended that before beginning the lessons, have your students review all the material in "Background" and in "Overview / Guides / Note to the Student". This will refresh their memory on many topics and provide good reference material for when they begin the lesson.
5. Teach the lesson, drawing on lesson materials where appropriate. You may wish to being the lesson by having your students view the "Video Preview", then hand out the "Note to the Student". Then, you can review current, voltage and resistance. Use the included multimedia videos and PowerPoint slides to teach students how to use a multimeter, make a custom Vex connector, and prepare for the lesson. View the "Lesson Guide" presentation. Use the printable PDFs as a procedural guide for the lesson.
6. Assign the "Checking for Understanding" quiz.

Description of the Lesson

Students will work in teams of 3 to construct a modified Squarebot with a multimeter attached. Students will use this robotic platform to determine the relationship between work and current. There are two parts to this lesson: current draw setup and procedure.

CURRENT DRAW / Setup

To begin this investigation, students will work in teams of 3 and construct a modified Squarebot. Students will connect a battery in series with a multimeter and mount this on their modified Squarebot. Using this system, students will be able to monitor the current draw of their robot. Remember, this construction will irreversibly change a battery.

Once students have constructed their modified Squarebot, you may begin the lesson. Use the "Background / Resources / Current Worksheet" (PDF or xls) as a worksheet for this lesson.

CURRENT DRAW / Lesson Procedure

The team will use the radio control transmitter to move the robot along planes of increasing incline. The students will need to monitor current output and track the time it takes the robot to go up the incline. The students will need to graph their data and evaluate it to find the relationship between work and current. The hypothesis is that current draw is directly related to the amount of work the robot does.