Name:	Date:

MISSION	1	Measure	*Materials & Instructions*

Your first mission is to measure the width of the hallway outside your classroom using only a robot and a graphing device.

You need:

- ❏ 1 Norland Calculator Robot (Your "wheels" for this mission)
- ❏ 1 Graphing Calculator (Robot brains)
- ❏ 1 Meter Stick

Instructions

Write a simple program (see Programming Instructions if needed) for your robot on your graphing calculator. Name your program **GO**.

```
PROGRAM: GO
   : Send ({222})
   : Get (R)
   : Disp R
   : Stop
```

These commands instruct the robot to move forward until its bumper runs into something. Attach your graphing calculator to the robot and run GO. You have fifteen minutes to experiment using the robot and a meter stick in the classroom before you measure the hallway. Remember, the meter stick cannot leave the classroom and the width of the hallway must be measured using the movement of the robot. Time will be displayed in centiseconds (1/100 second) on the graphing calculator's screen after each run, i.e. 524=5.24 seconds. On the following page are tables to help you record your data. Decide ahead of time how to label the columns and rows.

Accuracy of Measurement Grading Scale:

Within 0 to ≤10 cm	**A**
>10 to ≤20 cm	**B**
>20 to ≤30 cm	**C**
>30 cm	**Try again**

Name:			Date:
MISSION	**1**	Measure	***Data***

Inside the classroom:

Trials		
Total		
Average		

Outside the classroom:

(No meter sticks allowed)

Trials		
Total		
Average		

Name:	Date:
MISSION 1 Measure	***Results***

1. What is your estimate of the width of the hallway in centimeters?

2. What was the speed or rate of your robot?

3. The bumper is at the front of the robot. How did you account for this in your measurement of the hallway?

4. What calculations did you use to determine the width of the hallway?

Extension:

Using the speed of the robot, determine your height in centimeters. Write your results with initials on the board. When the entire class has their measurements displayed, determine the mean, mode, median, and range for the data.

- Convert your height to feet and inches. How tall are you?
- Design an advanced robot program to automatically measure distance.

Name:			Date:
MISSION	**1**	**Measure**	***Programming Instructions***

Turn on your graphing calculator. Press [PRGM], use the arrow to highlight NEW. Press [ENTER], then spell out [GO] by pressing the appropriate keys. Press [ENTER]. You're ready to enter the first command for the program.

Line 1: Press [PRGM], use the arrow to highlight **I/O**. Use the arrow to scroll down to **B: Send(**. Press [ENTER]. Press [2nd] and then press [{] for an open brace. Type in [2][2][2]. Close the braces and parentheses by pressing [2nd], [}], then [)]. Press [ENTER]. The first line should appear as:

:Send ({222})

Line 2: Press [PRGM], use the arrow to highlight **I/O**. Use the arrow to scroll down to **A: Get(**. Press [ENTER]. Press [ALPHA], then [R]. Press [)], then [ENTER]. The second line should appear as:

:Get (R)

Line 3: Press [PRGM], then use the arrow to highlight **I/O**. Use the arrow to scroll down to **3: Disp**. Press [ENTER]. Press [ALPHA], then press [R]. Press [ENTER]. The third line should appear as:

:Disp R

Line 4: Press [PRGM] and **CTL** will be highlighted. Use the arrow to scroll down to **F: Stop**. Press [ENTER]. The fourth line should appear as:

:Stop

Press [2nd], then [QUIT].

To run the program, attach the graphing calculator to your robot and connect the link cable. Make sure the robot and calculator are both switched on. Press [PRGM] and use the arrow to scroll down to **: GO**. Press [ENTER]. Place the robot on the floor, then press [ENTER] again and the robot will move forward until the bumper hits something.

Calibration for Straight Line Travel

The following program enables you to correct wheel speed so that your robot goes straight.

• Run the **CALI** program. (Press [PRGM] and use the arrow to scroll down to **: CALI**. Press [ENTER]. Place the robot on the floor, then press [ENTER] again.) Press [ZOOM]. Note which way the robot veers and press the bumper to stop the robot.

• Slow down the faster wheel of the two wheels by pressing the button under the DN on that side. Due to the design of the electronics, you may have to change this 70-100 units to see much speed change.

• Press [ZOOM] and the speed of the wheel should change. Press the bumper and continue adjusting the speed until the robot goes straight. For simplicity, it's best to change the speed of just one wheel.

• Once your robot is going straight make a note of which wheel was adjusted and the correction number. To leave the **CALI** program press [ON], then [1], then [CLEAR].

• Edit the **CORRECT** program. (Press [PRGM], then use the arrow to highlight **EDIT**. Use the arrow to scroll down to **: CORRECT**. Press [ENTER].) If you had to slow the left wheel, change "255" in the program Line 1 to the appropriate value. If you slowed the right wheel, change the "0" in program Line 4 to the appropriate value. To insert numbers, press [2nd], then [INS]. To finish, Press [2nd], then [QUIT].

• Run the **CORRECT** program and press the bumper to stop the robot. Your correction is now set in the robot's memory until the power switch is turned off. Whenever you switch on the robot, run the **CORRECT** program to reestablish the wheel correction.

Calculating Speed (Rate) of Your Robot

After your robot is running as straight as possible, do some trial runs using a meter stick or ruler. Use the front bumper as a starting and ending point reference. Run several trials. Use page 3 of Mission 1 to record your data.

- For a meter stick, run 100 cm trials.
- Average the trials.

Background:

DERT Formula: **D**istance **E**quals **R**ate × **T**ime or d=rt or rt=d

If you are traveling in a car at a constant speed of 60 mph (rate) for 3 hours (time), you'll cover a distance of 180 miles, rt=d or 60 × 3 = 180 miles.

If you know the distance traveled (d) and you know elapsed time (t), you can calculate the rate (r) or speed using the same formula. By algebraic transformation, d/t=r. If you travel 200 miles in 4 hours, what is your average speed (rate)? If your robot travels 100 cm in 5 seconds, what is its speed (rate)?

- Divide the distance traveled by the average time to obtain the speed of your robot (d/t=r). For example, 100 cm/5.67 sec = a speed or rate of approximately 17.64 cm/sec. Your robot travels 17.64 cm every second.

____________ / ____________ = ____________

distance average time (sec.) rate or speed (cm/sec.)

Measure the hallway yourself with a metric tape measure or meter stick. Students work well in pairs for this activity. If robots veer to one side or the other, adjust the rubber bands on the wheels or see instructions on page 5 along with the Calibrate Program at *http:www.smallrobot.com/speed/htm* (Also see HELP SHEET on next pages.)

Data tables are partially blank for students to choose their own labels and methods. A more directed approach would be to label the first table across the top with TRIALS, 100 CENTIMETERS, 200 CENTIMETERS. Number of trials could be listed down the first column. TRIALS, TIME, and DISTANCE could be used in the second table with the first column again labeled with number of trials.

Students can be left to invent ways to solve this problem on their own or they can be given some review on proportions or the DERT formula (distance = rate × time or d=rt). Also see the HELP SHEET on page 6. After the initial use of the meter sticks, it's helpful to store them away to avoid less mathematical solutions.

When measuring the hallway, the length of the robot (from the front bumper to the back) needs to be taken into account. This can be measured beforehand, calculated out in the hallway by running the robot the short distance of its own length, or sometimes an adjusted starting point can be used.

In the extension activity, one way to measure height is to have students lie on the floor with their feet against the wall and use the robots to measure how many seconds tall they are. Then use the DERT formula to convert to distance/height.

Height data can be organized in a stem-and-leaf plot.

Transfer a Program

To transfer a program from one calculator to another:

- Securely connect a link cable between the two calculators.
- RECEIVE Calculator: Press [2nd], then [LINK]. Use the arrow to highlight **RECEIVE**. Press [ENTER]. Wait for the other calculator to be set up and to send you the program/s.
- TRANSMIT Calculator: Press [2nd], then [LINK]. Use the arrow to scroll down to **3:Prgm...** Press [ENTER].
- Using the scroll arrow move the indicator arrow to the program/s to be transferred. Press [ENTER]. A program is selected if it has a black square in front of it.
- Use the scroll arrow to highlight "TRANSMIT". Press [ENTER]. The programs should be transmitted to the RECEIVE calculator.

The use of this function is suggested for transferring large programs (like CALI) only and not to eliminate programming practice for students.