Science Objectives

- Students will learn how short time intervals are measured.
- Students will learn about how the accuracy of time depends on the measurement instrument.
- Students will understand how to read a digital stopwatch.
- Students will practice calibrating a stopwatch.
- Students will learn the difference between split times and total elapsed time measurements.
- Students will practice using a stopwatch.

TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Insert a *Calculator* page

Teacher Tip: Students will need a piece of notebook paper, a marker, and a partner to complete some of the experiments.

Lesson Materials:

Student Activity

- Stopwatch_Student.doc
- Stopwatch_Student.pdf

TI-Nspire document

- stopwatch_en.tns

Vocabulary

- Stopwatch
- Accuracy
- Precision
- Measurement
- Interval
- Total elapsed time
- Split time
- Calibrate

About the Lesson

- In this activity, students will be measuring interval times using a stopwatch tool on their handheld.
- As a result, students will:
  - Understand how to measure time accurately using a stopwatch.
  - Understand that in experiments there are split times and a total elapsed time.
  - Understand that calibration is necessary for accuracy in stopwatches.

TI-Nspire™ Navigator™

- Send out the *stopwatch_en.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- *stopwatch_en.tns* document
- TI-Nspire™ Technology

Discussion Points and Possible Answers

It is a good idea to have an analog and digital clock to show students a variety of instruments used to measure time.

Have students read the background information stated on their activity sheet and practice using the stopwatch tool on their handheld using the following two examples.

Move to page 1.2.

Part 1: How To Use The Stopwatch

1. Press or enter to activate the stopwatch.
2. Press to reset the stopwatch to zero.
3. Press and observe the stopwatch. Now there are two new symbols on the bottom.
4. Press to pause the stopwatch.
5. Press to record a split time. Pressing L + + will also record the split time.
6. After pressing , the symbols at the bottom of the page will return to and .

Place students into groups of two. In pairs, students are to complete question 1 using the stopwatch tool.

Q1. One at a time, start the stopwatch and try to hit the pause button at exactly **0:00:6.73**. Record your stop times in the table.

Sample Answer:

	Time
Student 1	**0:00:6.79**
Student 2	**0:00:6.67**

Q2. Were either you or your partner able to stop the time at exactly 0:00:6.73? Why or why not?

Answer: Answers will vary. Most students will not be able to stop the measurement at exactly 0:00:6:73. Accuracy: the stopwatch measures time with extreme accuracy (hundredths of a second); student reaction time is not as accurate.

The time display on the stopwatch tool reads left to right.

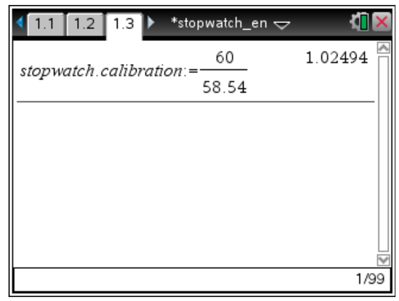
- The single numeric digit at the far left represents hours.
- The next two numeric digits represent minutes.
- The next two numeric digits represent seconds.
- The last digits to the far right represent hundredths of seconds.

Example: Stopwatch reading — 1:07:49.73

1 hour, 7 minutes, 49 seconds, and 73 hundredths of a second

Stopwatch Calibration

You might ask your students to calibrate the stopwatch tool against a real stopwatch. Have them follow these directions for calibration:



1. Run the stopwatch tool with a real stopwatch. Stop the tool when the real stopwatch reaches 60 seconds.
2. Insert a *Calculator* page. Divide the time on the real stopwatch by the time on the stopwatch tool.

   For example, if the tool shows 58.54 seconds when a real stopwatch shows 60 seconds, then the calibration factor is 60/58.54 ≈ 1.02494.
3. Store the value by pressing ctrl sto→, type **stopwatch.calibration**, and press enter.
4. Move back to the stopwatch on page 1.2 and press C to set the calibration factor.

TI-Nspire™ Navigator™ Opportunities

Use *Class Capture* to make sure that all students understand how to correctly start/stop and calibrate the stopwatch.

Teacher Tip: The first set of experiments measure the total elapsed time it takes each member of the student teams to complete different tasks.

Part 2: Total Elapsed Time

Students will use the stopwatch tool to complete the experiments in questions 3 and 4. They will determine the total elapsed time it takes for each person to complete the tasks.

Students are to:

- Record each reaction time EXACTLY as it reads on the stopwatch tool.
- Make sure one person is completing the task while the other person is starting and stopping the stopwatch.
- Each person must complete the task twice before switching with the other person.
- Remember to reset the stopwatch in between each measurement.

Q3. Using a plain sheet of paper and a marker, record the time it takes to draw a large number "8" using your dominant writing hand.

	Trial 1	Trial 2
Student 1		
Student 2		

Answer: Student stopwatch measurements will vary. Individual trial times will vary.

Q4. Now draw a large number “8” using your non-dominant hand.

	Trial 1	Trial 2
Student 1		
Student 2		

Answer: Student stopwatch measurements will vary. Individual trial times will vary.

Q5. Was it possible to get the same measurement twice on either of the tasks? Why or why not?

Answer: Student stopwatch measurements will vary. Individual trial times will vary. Accuracy: the stopwatch measures time with extreme accuracy (hundredths of a second), student reaction time is not as accurate. Measurement of individual trials will also vary based on different reaction times during each trial.

Teacher Tip: If students need more practice using the stopwatch, have them complete the following experiments:

1. Record the amount of time it takes to pick a pencil/pen off the floor while sitting at your desk.
2. Record the amount of time it takes to write all of the numbers from 1 to 10 on a piece of paper.

Part 3: Split Times

When using split readings on the stopwatch tool, students must first have the stopwatch running, and then press , the split button. Each time the split button is pressed, it records another split. Up to six split times can be displayed.

- Using the same partner, students are to determine the split times for the same tasks completed in Part 1.
- Each person will complete a total of six trials. **DO NOT** reset in between each trial. On the sixth trial, press .
- Record all times starting from the bottom, (the first split), and moving to the top, (the last split), which is the experiment's **total elapsed time**.

Students are given an *example* of how to record the split times shown on the stopwatch tool in the table on their activity sheet.

	Split 1	Split 2	Split 3	Split 4	Split 5	Split 6 (Total time)
Student	0:00:01.54	0:00:02.43	0:00:03.72	0:00:05.05	0:00:06.14	0:00:07.62

Q6. On the same piece of paper with your number "8" drawing, add a start line somewhere on the "8." This line will be where you will start and stop each of the split readings.

Trace the number "8" six times, from the start line and then back to it. Each time you hit the start line your partner will press . After the sixth time, your partner will hit the key to stop the stopwatch. Record all your times in the data table.

	Split 1	Split 2	Split 3	Split 4	Split 5	Split 6 (Total time)
Student 1						
Student 2						

<u>Answer</u>: Student stopwatch measurements will vary. Split times will vary. Check to be sure their times make sense.

Q7. Now trace the number "8" using your non-dominant hand.

	Split 1	Split 2	Split 3	Split 4	Split 5	Split 6 (Total time)
Student 1						
Student 2						

<u>Answer</u>: Student stopwatch measurements will vary. Split times will vary. Check to be sure their times make sense.

Using the data students collected in Q6, they will calculate the elapsed time differences between each split. To do this, students need to take the last elapsed time and subtract the previous split time. See the example below, which shows how to calculate the difference between split 5 and 6 (total elapsed time).

Example: Split 6 = 7.62 sec. Split 5 = 6.14 sec. Time difference = 7.62 – 6.14 = 1.48 sec

Q8. Press [scratchpad] to open the Scratchpad .Complete the following data table based on your data from Q6 of Part 2.

Elapsed Time Difference	Student 1	Student 2
Between Split 1 and 2		
Between Split 2 and 3		
Between Split 3 and 4		
Between Split 4 and 5		
Between Split 5 and 6		

Answer: Student stopwatch measurements will vary. Split times will vary. Check to be sure the answers make sense.

> **Tech Tip:** Students can also press [ctrl] [I] to insert a *Calculator* page instead of using the Scratchpad.

Student Inquiry

Students use their knowledge of stopwatches to answer questions 9 and 10 on the activity sheet.

Q9. Do you think that stopwatches are more or less accurate than clocks?

Answer: Stopwatches are more accurate than normal clocks. Stopwatches measure time in small intervals (hundredths of seconds).

Q10. Think of a scenario in which time measurement accuracy would be used in everyday life. Describe in detail how a stopwatch could be used in this scenario.

Answer: Scenarios will vary, but should include some activity where the accuracy of small intervals and precise time measurement are necessary. Examples of these include: athletic races and rates of reaction.

Wrap Up

When students are finished with the activity, retrieve the .tns file using TI-Nspire™ Navigator™. Save grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved. The Slide Show will be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test.