

Screen 01

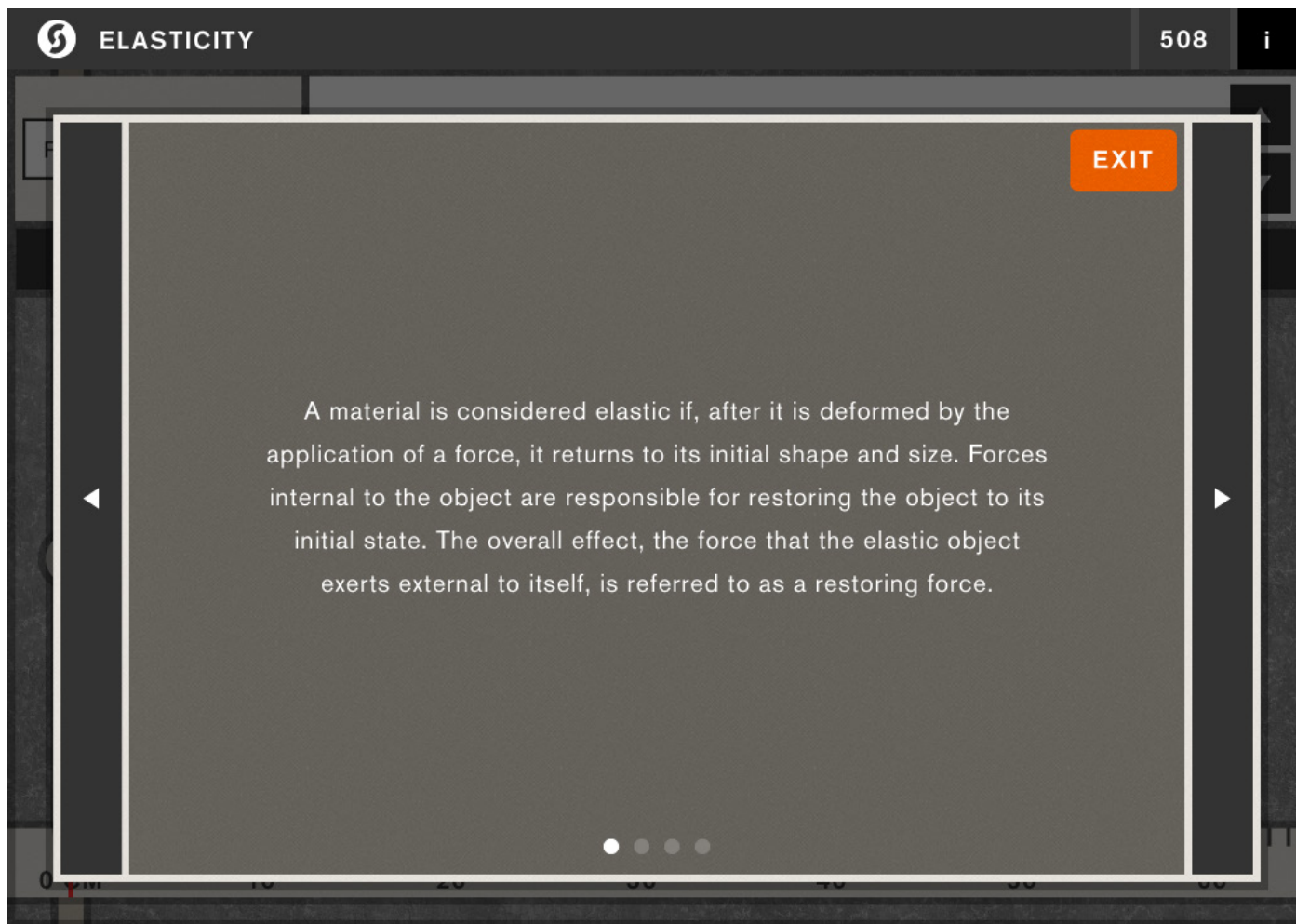
Note: the red comments in this document signify actionable items or require special attention.

Any of this content and messaging will be finalized by the content experts: the faculty.

The sentences within quotes in this document reflects the text on the screen.

“ELASTICITY”

“Press the ‘CONTINUE’ or ‘i’ button for the lab introduction. Press the ‘508’ button for accessibility keys.”

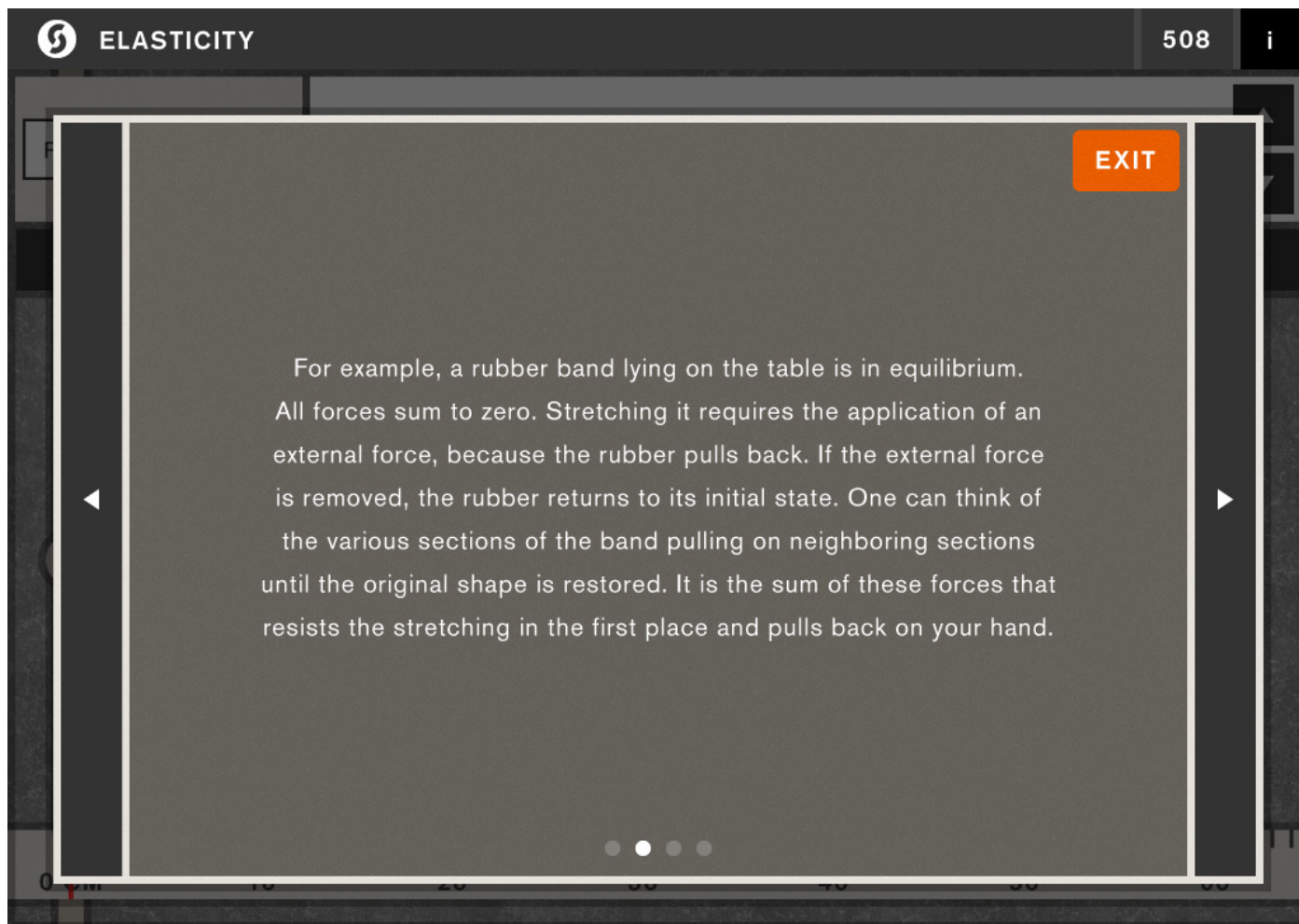


Screen 02

The introduction is self-guided, and the student can press the EXIT button when they're done and come back to the 'i' menu at any point during the lab.

Introduction page 1:

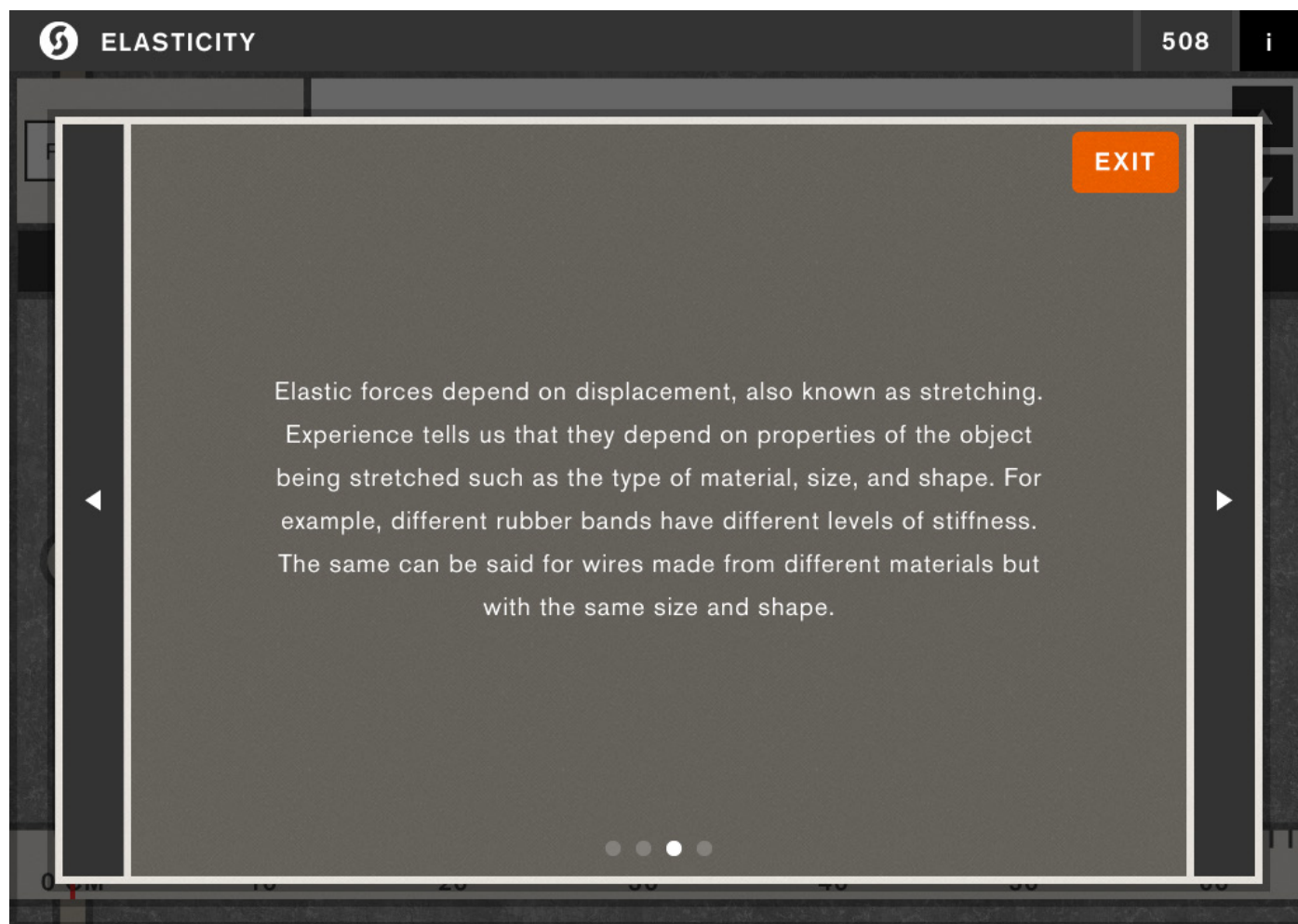
"A material is considered elastic if, after it is deformed by the application of a force, it returns to its initial shape and size. Forces internal to the object are responsible for restoring the object to its initial state. The overall effect, the force that the elastic object exerts external to itself, is referred to as a restoring force."



Screen 03

Introduction page 2:

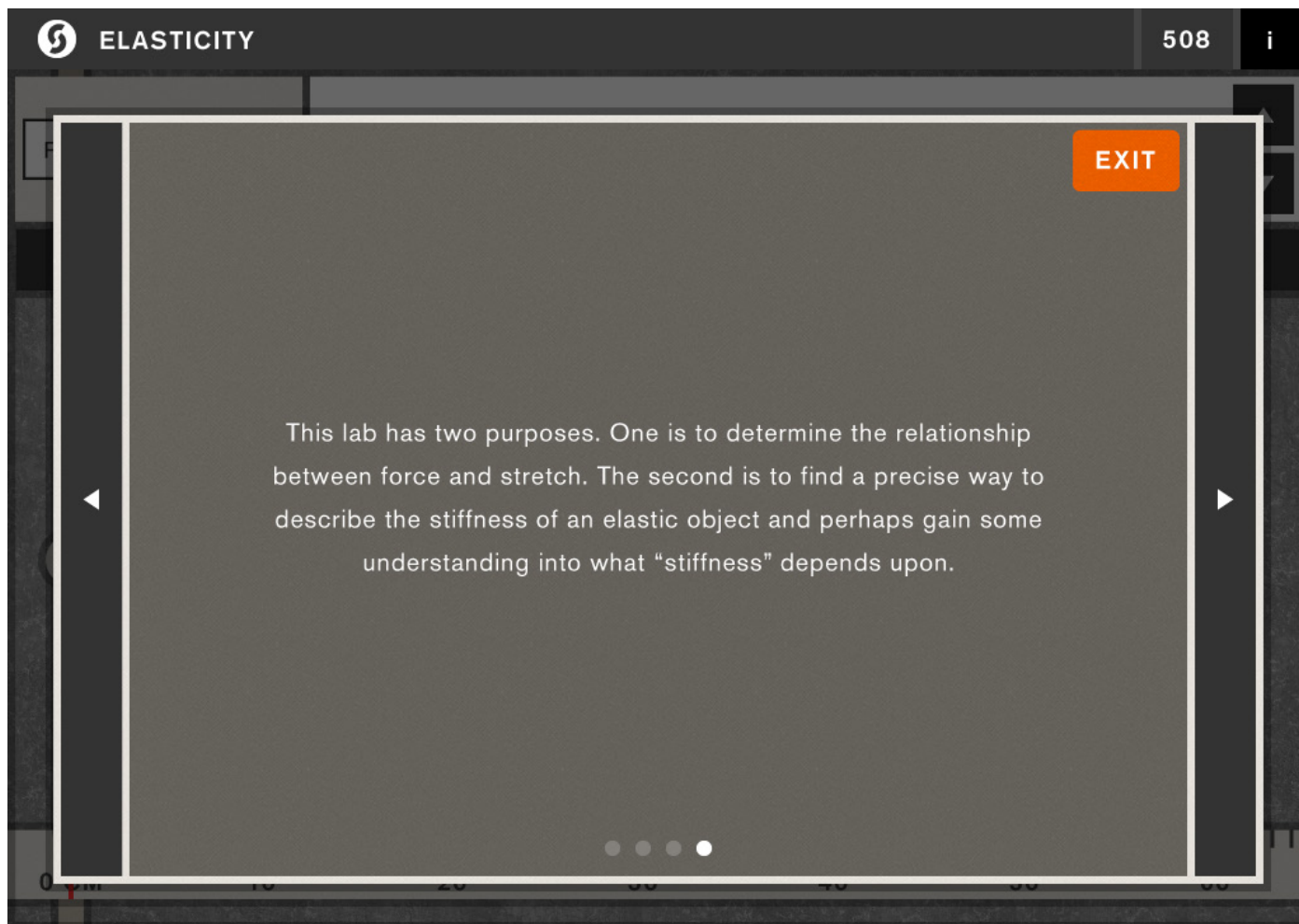
“For example, a rubber band lying on the table is in equilibrium. All forces sum to zero. Stretching it requires the application of an external force, because the rubber pulls back. If the external force is removed, the rubber returns to its initial state. One can think of the various sections of the band pulling on neighboring sections until the original shape is restored. It is the sum of these forces that resists the stretching in the first place and pulls back on your hand.”



Screen 04

Introduction page 3:

“Elastic forces depend on displacement, also known as stretching. Experience tells us that they depend on properties of the object being stretched such as the type of material, size, and shape. For example, different rubber bands have different levels of stiffness. The same can be said for wires made from different materials but with the same size and shape.”



Screen 05

Introduction page 4:

“This lab has two purposes. One is to determine the relationship between force and stretch. The second is to find a precise way to describe the stiffness of an elastic object and perhaps gain some understanding into what ‘stiffness’ depends upon.”

ELASTICITY 508 i

PROCEDURE 1 ▼

1. Move a BRASS spring from the equipment panel to the orange anchor on the left of the work area.

DATA TABLE A EQUIPMENT

0 CM 10 20 30 40 50 60

Screen 06

When the student closes the introduction, they will see the procedure instructions. The procedures, like Ohm's Law and Studying Electric Circuits, are anchored to the top of the work area. The DATA TABLE and EQUIPMENT panel are both dropdowns.

Procedure 1, Step 1:

"1. Move a BRASS spring from the equipment panel to the orange anchor on the left of the work area."

ELASTICITY

508

i

PROCEDURE 1 ▼

1. Move a BRASS spring from the equipment panel to the orange anchor on the left of the work area.

DATA TABLE A

EQUIPMENT CLOSE

BRASS SPRING

BRASS SPRING


ALUMINUM SPRING

FORCE METER

PARALLEL CONNECTOR

Screen 07

The student can access the equipment from the EQUIPMENT dropdown.

 ELASTICITY

508

i

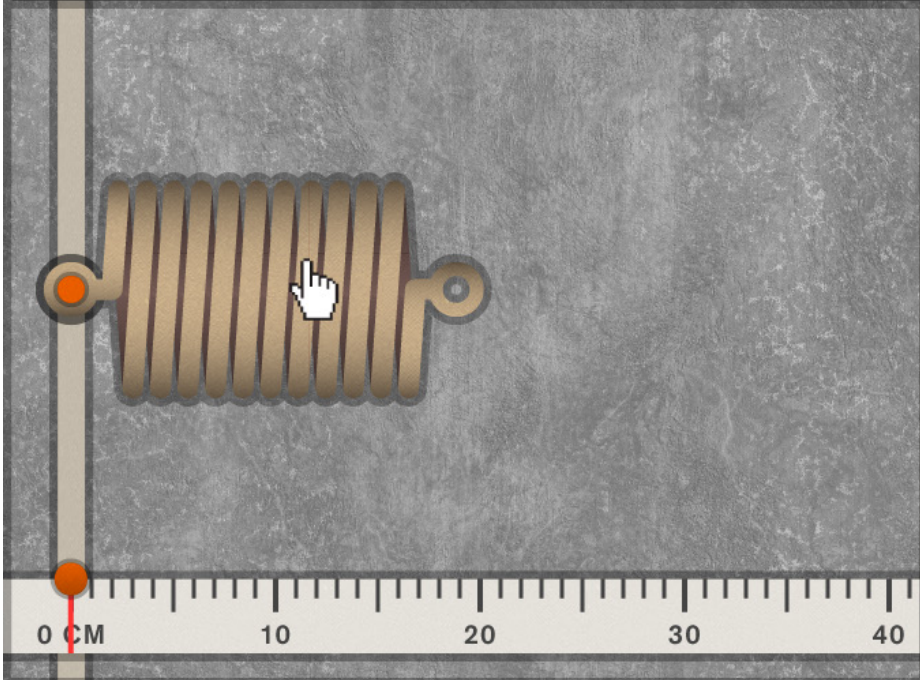
PROCEDURE 1 ▼

1. Move a BRASS spring from the equipment panel to the orange anchor on the left of the work area.

▲


▼


DATA TABLE A





EQUIPMENT

CLOSE


 BRASS SPRING

 BRASS SPRING

 ALUMINUM SPRING

 FORCE METER (N)
0 1 2 3 4 5

FORCE METER

 PARALLEL CONNECTOR

PARALLEL CONNECTOR

Screen 08

Each piece of equipment is a draggable button and will snap into position when it is near an anchor point. The equipment will not fully lock into place until the student releases the object.

ELASTICITY 508 i

PROCEDURE 1 ▼

1. Move a BRASS spring from the equipment panel to the orange anchor on the left of the work area.

DATA TABLE A

Press orange connector buttons to release connected equipment.

OK

EQUIPMENT CLOSE

BRASS SPRING BRASS SPRING

ALUMINUM SPRING

FORCE METER (N)

FORCE METER


PARALLEL CONNECTOR

Screen 09

When the first spring is placed on an anchor, there will be a message telling them that they can “Press orange connector buttons to release connected equipment.” This message will only display once.

A second message will display once, “Drag disconnected equipment back to the equipment panel to remove it from the work area.”

The ability to drag equipment back into the equipment panel will allow this lab to be completely self-guided, including the procedure menu. All items in the procedure menu will be open from the beginning.

 ELASTICITY

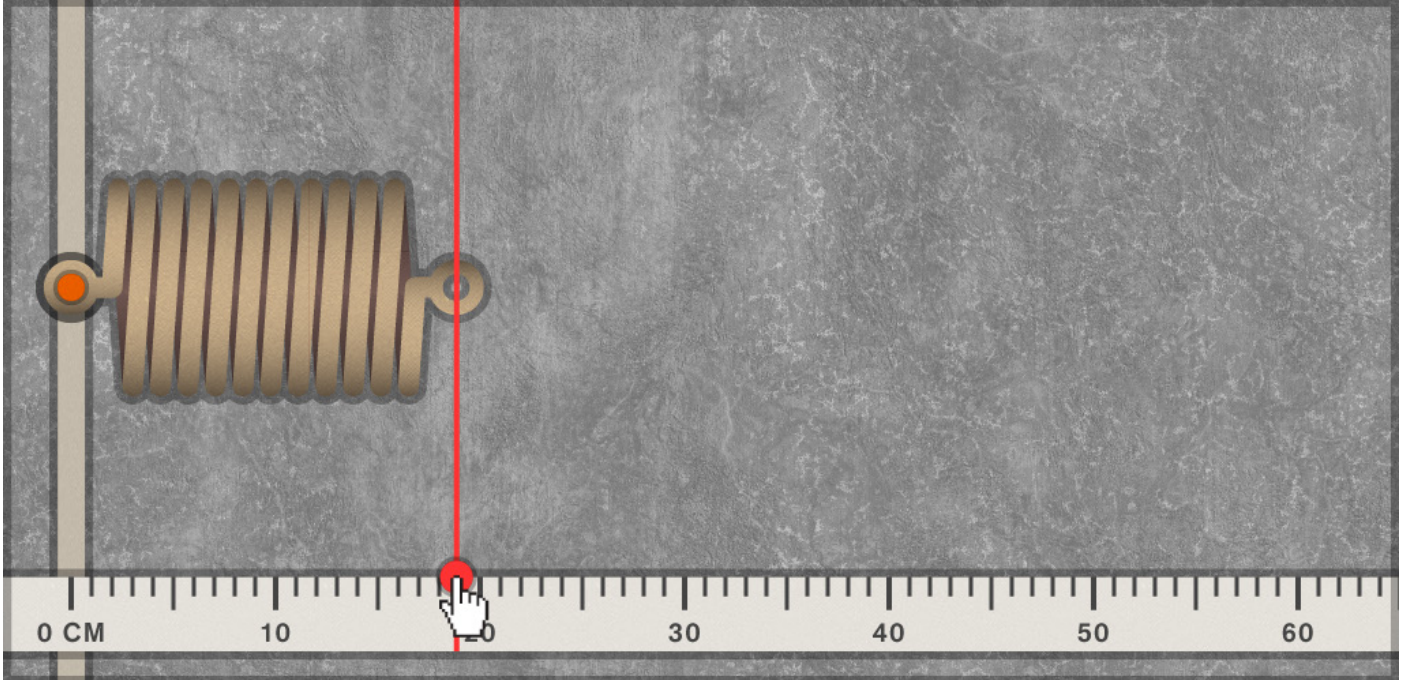
508 i

PROCEDURE 1 ▼

2. Move the orange marker on the ruler to the right edge of the spring. This will be your measurement for a 0 Newton force. This gives you a reference point to measure the stretch, and not simply the length, of the spring.

DATA TABLE A


EQUIPMENT



Screen 10

Procedure 1, Step 2:

“2. Move the orange marker on the ruler to the right edge of the spring. This will be your measurement for a 0 Newton force. This gives you a reference point to measure the stretch, and not simply the length, of the spring.”

 ELASTICITY

508

i

PROCEDURE 1 ▼

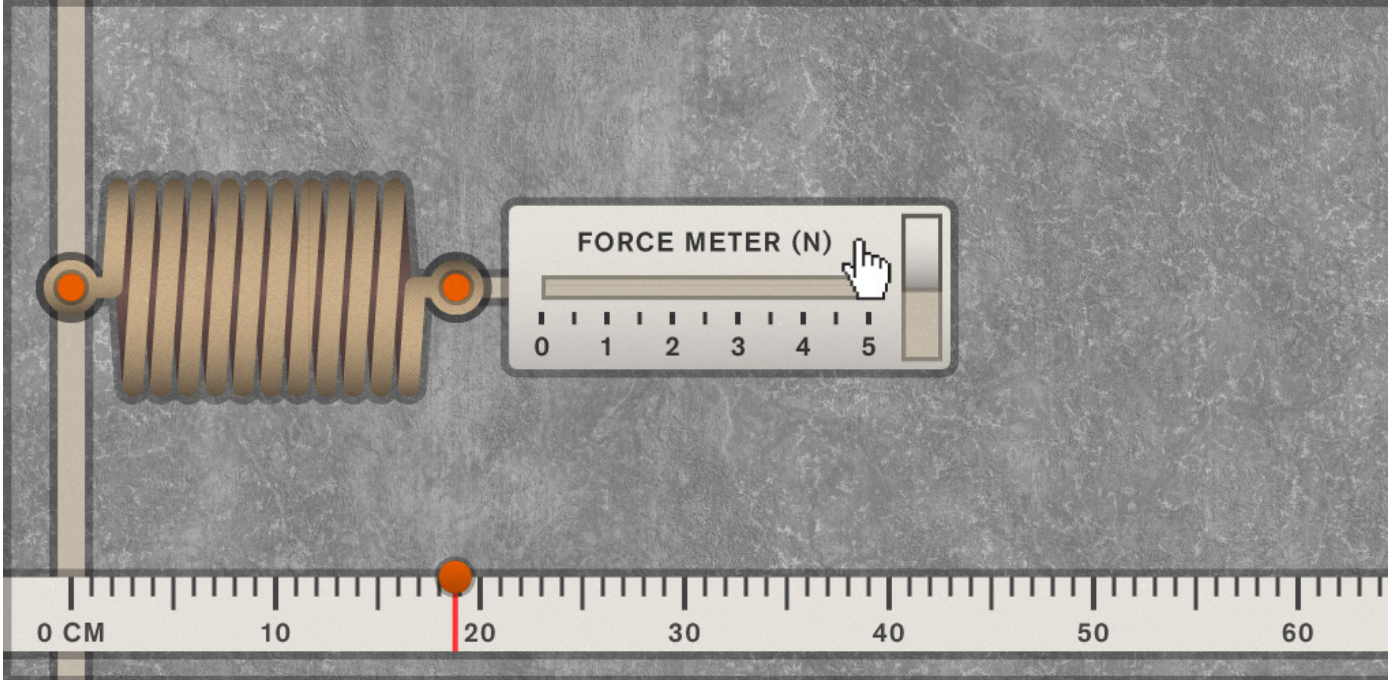
3. Move the force meter from the equipment panel to the right end of the spring.

▲

▼

DATA TABLE A

EQUIPMENT




0 CM 10 20 30 40 50 60

Screen 11

Procedure 1, Step 3:

“3. Move the force meter from the equipment panel to the right end of the spring.”

 ELASTICITY

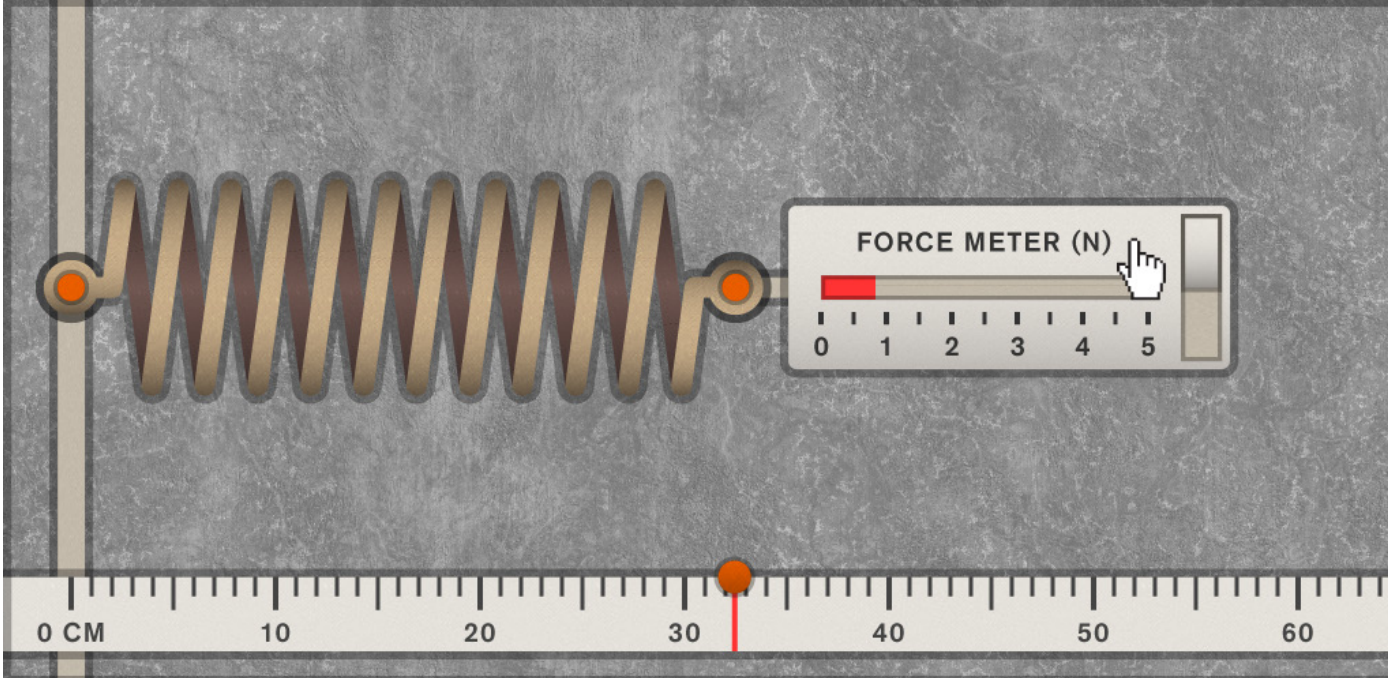
508 i

PROCEDURE 1 ▼

4. Press and drag the force meter to stretch the spring. Conduct an experiment where you stretch the spring to several different lengths. Enter the force and length measurement for each stretch point in DATA TABLE A. You will get better results with more data.

DATA TABLE A

EQUIPMENT



Screen 12

Procedure 1, Step 4:

“4. Press and drag the force meter to stretch the spring. Conduct an experiment where you stretch the spring to several different lengths. Enter the force and length measurement for each stretch point in DATA TABLE A. You will get better results with more data.”

The student can press on any part of the force meter then drag it horizontally. The ruler marker moves in relation to the extension of the spring.

ELASTICITY

508 i

PROCEDURE 1 ▼

4. Press and drag the force meter to stretch the spring. Conduct an experiment where you stretch the spring to several different lengths. Enter the force and length measurement for each stretch point in DATA TABLE A. You will get better results with more data.

DATA TABLE A


EQUIPMENT

Screen 13

When the student releases the force meter, it will lock in place. This will make it easier for the student to take measurements. Pressing the toggle button on the force meter will fully release the force meter, at which point the spring will collapse back to its resting position.

If the force meter is locked in position, the student can pick it back up and continue moving it in either horizontal direction.

The message “Press the toggle switch to release the force meter” will only display the first time the student uses the force meter.

 ELASTICITY

508

i

PROCEDURE 1

4. Press and drag the force meter to stretch the spring. Conduct an experiment where you stretch the spring to several different lengths. Enter the force and length measurement for each stretch point in DATA TABLE A. You will get better results with more data.

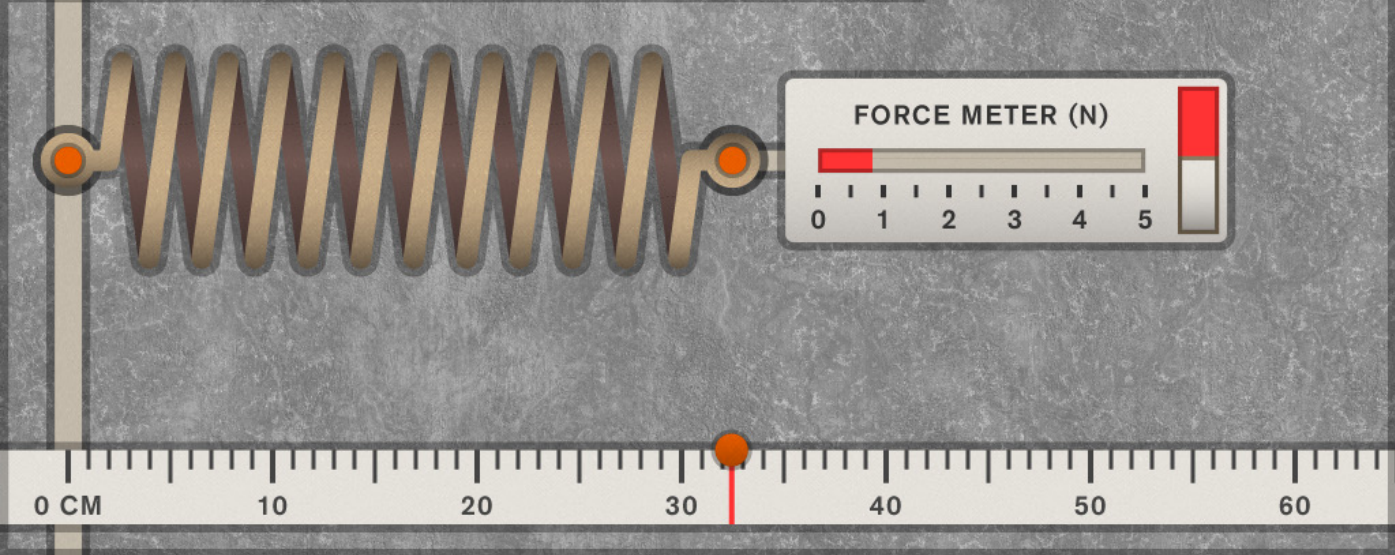
DATA TABLE A

ADD ROW

CLOSE

FORCE (N)	BRASS SPRING STRETCH (CM)
0	19


EQUIPMENT



The simulation shows a brass spring attached to a vertical stand on the left. A force meter is attached to the right end of the spring. Below the spring is a horizontal ruler with markings from 0 to 60 cm. The force meter has a scale from 0 to 5 N. The spring is currently stretched to a length of 19 cm, and the force meter shows a reading of 0 N.

Screen 14

The data table will start out with two rows, one for the 0 point and one for their first stretch. They can press the ADD ROW button to increase the number of data points in each table. The ADD ROW button will be disabled when 13 rows are present (including the 0 row).

 ELASTICITY

508

i

PROCEDURE 1

4. Press and drag the force meter to stretch the spring. Conduct an experiment where you stretch the spring to several different lengths. Enter the force and length measurement for each stretch point in DATA TABLE A. You will get better results with more data.

DATA TABLE A

ADD ROW

CLOSE

FORCE (N)	BRASS SPRING STRETCH (CM)
0	19
0.5	25.7
1	32.4
1.5	39.1
2	45.8
2.5	52.5
3	59.2
3.5	65.9
4	72.6
4.5	79.3
5	86

EQUIPMENT

FORCE METER (N)

2345

0 CM

10

20

30


40

50

60

Screen 15

This is an example of the max number of rows with most of them filled in.

 ELASTICITY

508 i

PROCEDURE 1 ▲

PROCEDURE 1

PROCEDURE 2 ▲

PROCEDURE 3

PROCEDURE 4

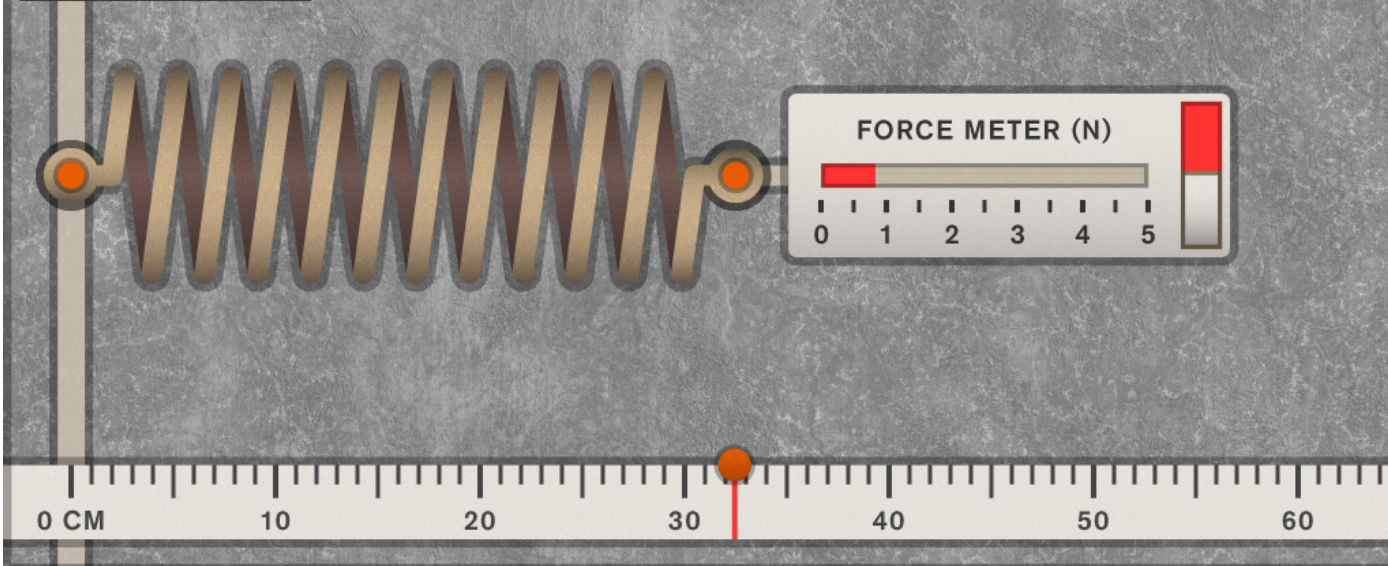
4. Press and drag the force meter to stretch the spring. Conduct an experiment where you stretch the spring to several different lengths. Enter the force and length measurement for each stretch point in DATA TABLE A. You will get better results with more data.

▲

▼

DATA TABLE A

EQUIPMENT



The image shows a virtual lab interface for an elasticity experiment. A spring is attached to a vertical stand on the left and a force meter on the right. The force meter has a scale from 0 to 5 N, with a red needle pointing to approximately 1.5 N. Below the spring is a horizontal ruler with a scale from 0 to 60 cm. A red dot on the ruler indicates the current position of the spring's end, which is at approximately 32 cm.

Screen 16

Since this lab is completely self-guided, the student will need to use the procedure drop-down to continue to the next procedure.

ELASTICITY 508 i

PROCEDURE 2 ▼

1. Move an ALUMINUM spring from the equipment panel to the orange anchor on the left of the work area.

DATA TABLE B

EQUIPMENT **CLOSE**

BRASS SPRING BRASS SPRING

ALUMINUM SPRING

FORCE METER (N)

0 1 2 3 4 5

FORCE METER

PARALLEL CONNECTOR

0 CM 10 20 30 40

Screen 17

Each procedure will have its own work area, giving the student a fresh start with the material placement.


Note: It could be an option to only have the equipment available that is needed for each procedure. So, on Procedure 2, the brass springs and parallel connectors wouldn't need to be there.

Procedure 2, Step 1:

"1. Move an ALUMINUM spring from the equipment panel to the orange anchor on the left of the work area."

Procedure 2, Step 2:

"2. Move the orange marker on the ruler to the right edge of the spring to set your stretch reference point."

 ELASTICITY

508

i

PROCEDURE 2 ▼

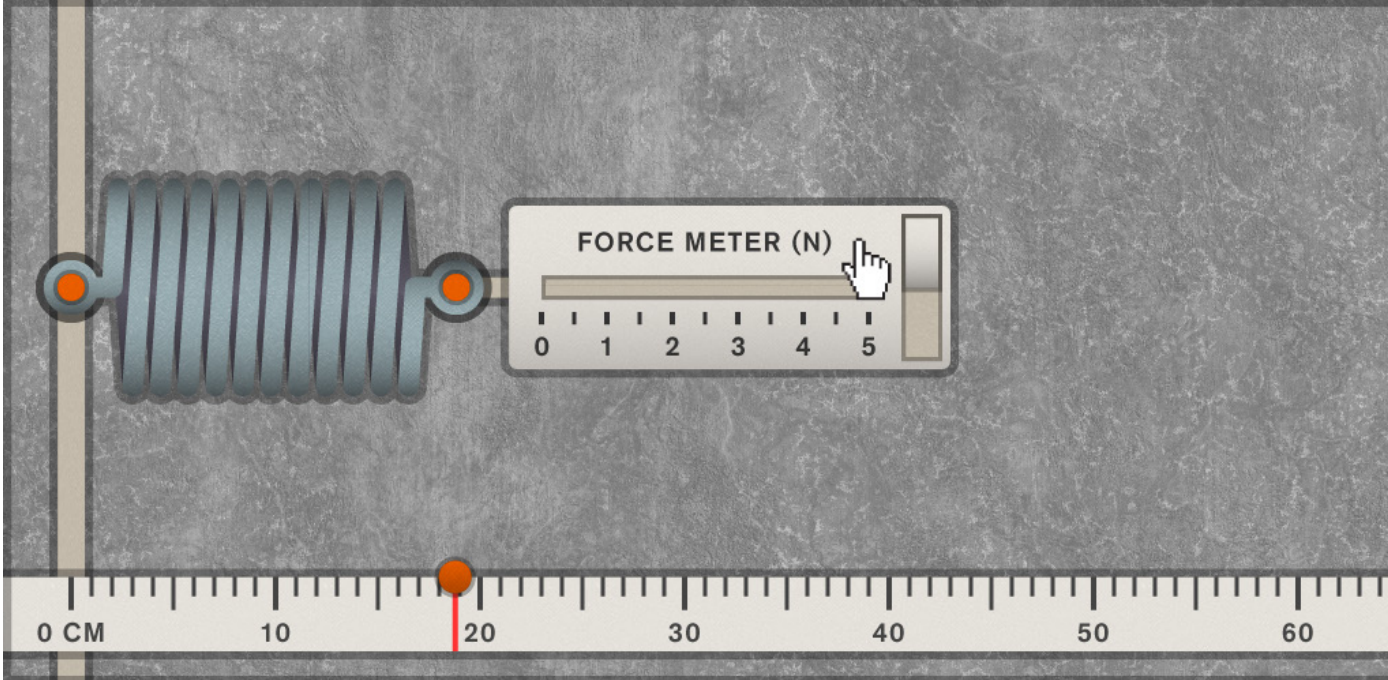
3. Move the force meter from the equipment panel to the right end of the spring.

▲

▼

DATA TABLE B


EQUIPMENT



Screen 18

Procedure 2, Step 3:

“3. Move the force meter from the equipment panel to the right end of the spring.”

 ELASTICITY

508

i

PROCEDURE 2 ▼

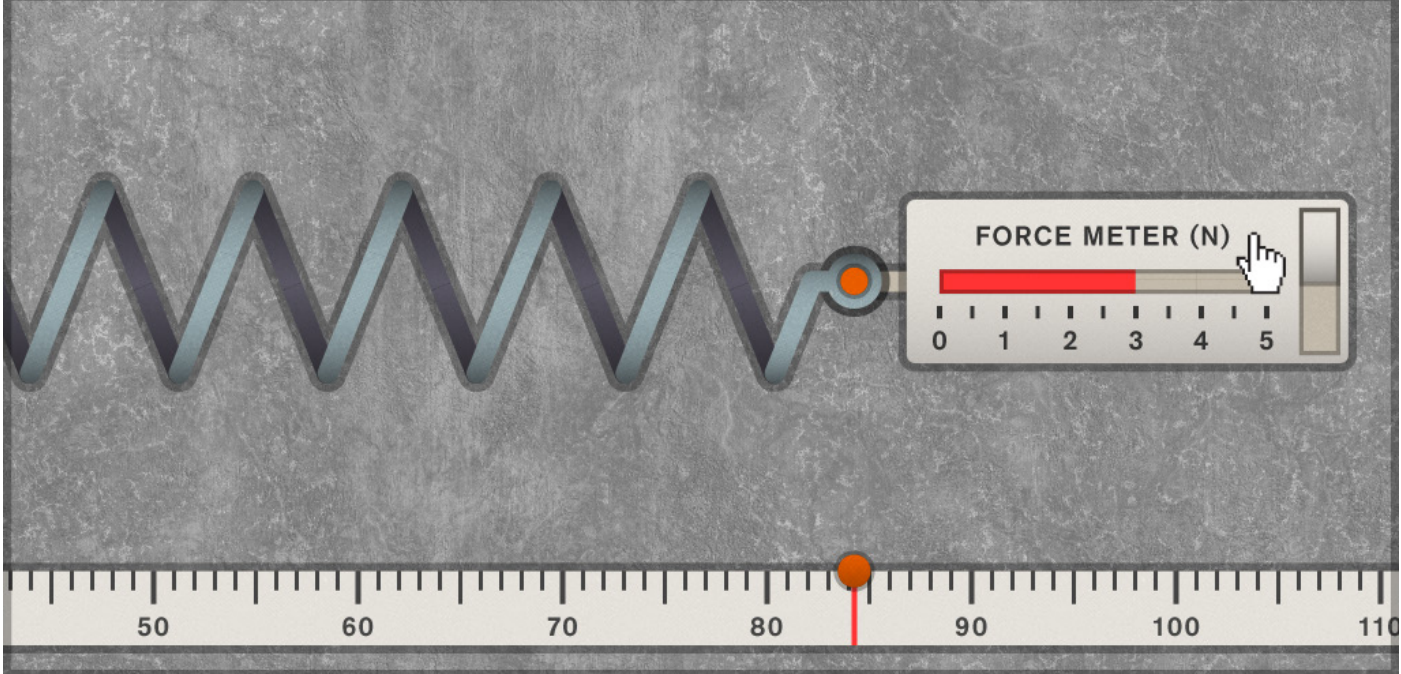
4. Collect force and stretch data as you did in Procedure 1. Enter the measurements in DATA TABLE B.

▲

▼

DATA TABLE B

EQUIPMENT




Screen 19

Procedure 2, Step 4:

“4. Collect force and stretch data as you did in Procedure 1. Enter the measurements in DATA TABLE B.”

At a certain point, the spring will need to expand beyond the original work area to take the longer measurements, especially in Procedure 2 (two brass springs in series). This is an example of the screen scrolling so that the force meter and ruler marker (current measurement reading) always stay in view.

 ELASTICITY

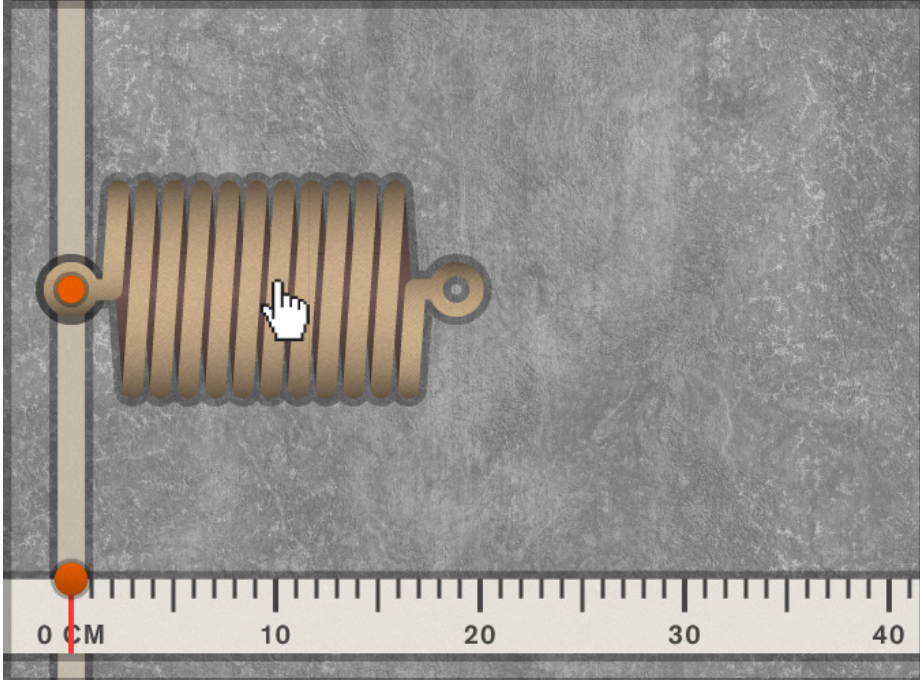
508

i

PROCEDURE 3 ▼


1. Move a BRASS spring from the equipment panel to the orange anchor point on the left of the work area.


DATA TABLE C





EQUIPMENT


CLOSE


BRASS SPRING


BRASS SPRING


ALUMINUM SPRING



FORCE METER


PARALLEL CONNECTOR

Screen 20

Procedure 3, Step 1:

“1. Move a BRASS spring from the equipment panel to the orange anchor point on the left of the work area.”

 ELASTICITY

508i

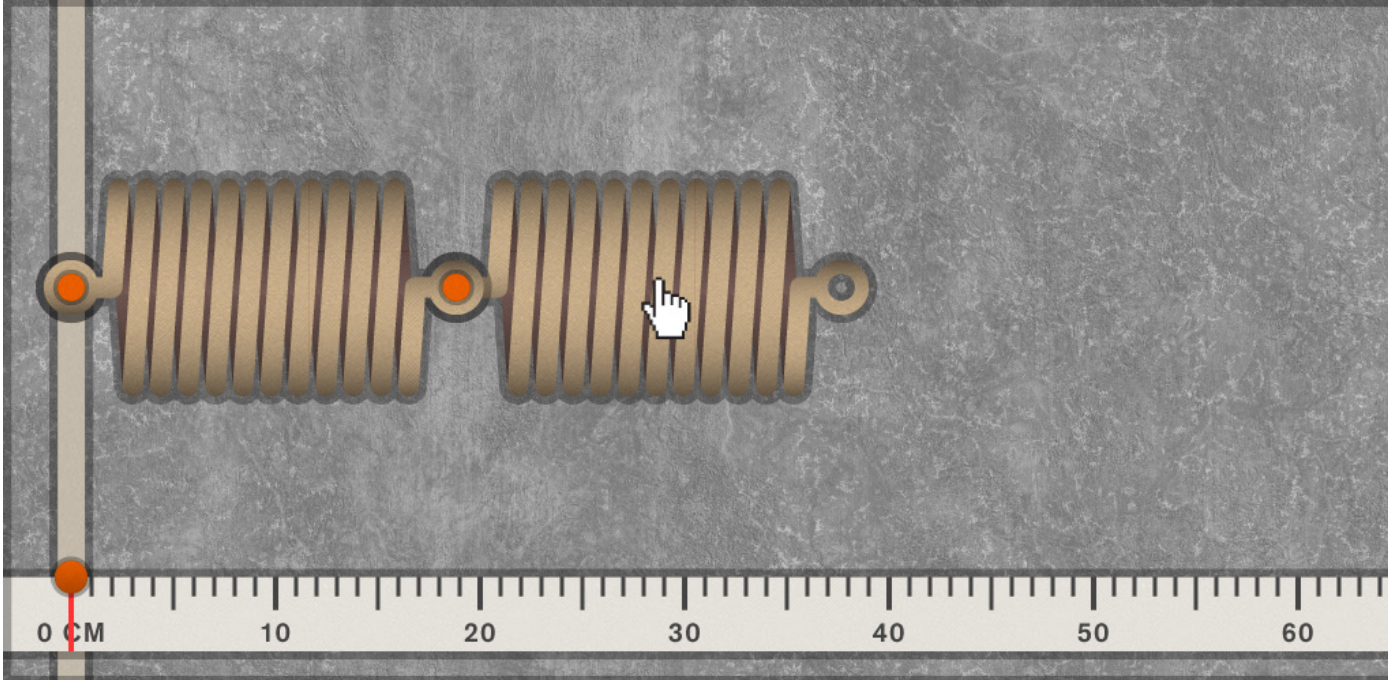
PROCEDURE 3 ▼

2. Move a second brass spring from the equipment panel to the right end of the first brass spring. This is called a series connection.

▲▼

DATA TABLE C


EQUIPMENT



Screen 21

Procedure 3, Step 2:

“2. Move a second brass spring from the equipment panel to the right end of the first brass spring. This is called a series connection.”

 ELASTICITY

508

i

PROCEDURE 3 ▼

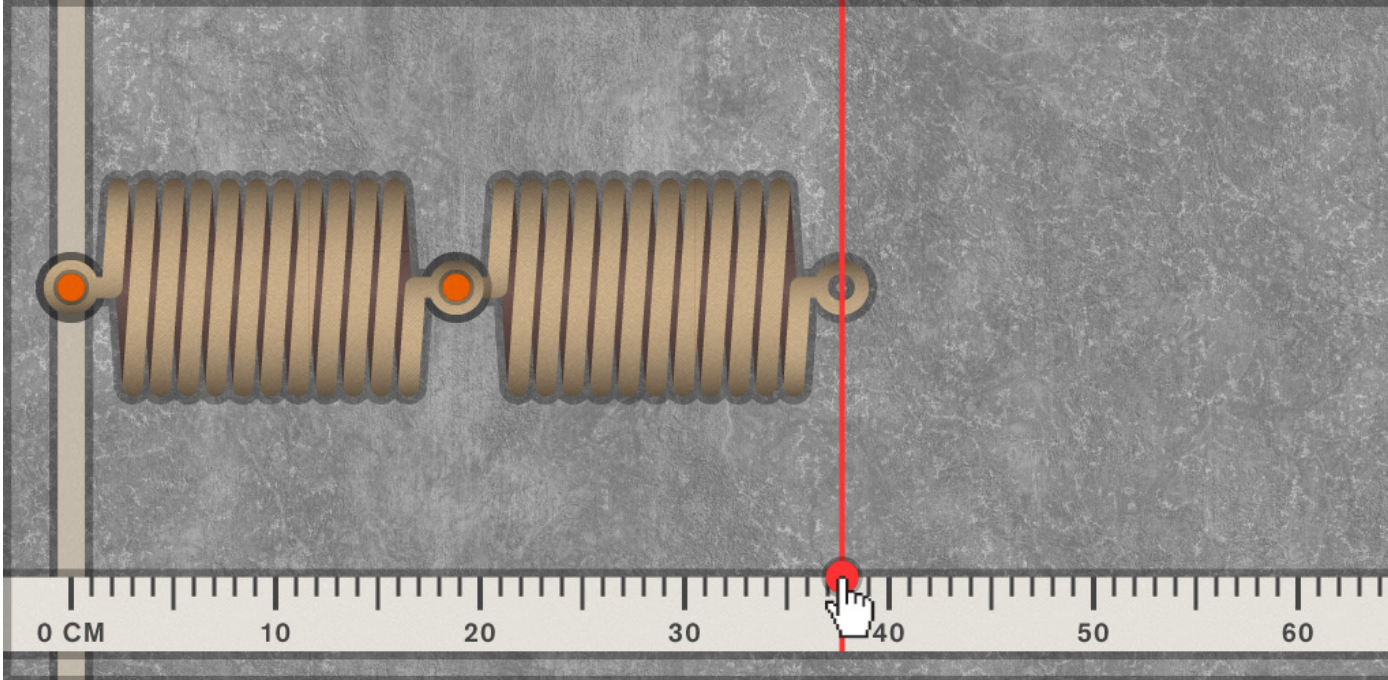
3. Move the orange marker on the ruler to the right edge of the second spring to set your stretch reference point.

▲

▼

DATA TABLE C

EQUIPMENT



Screen 22

Procedure 3, Step 3:

“3. Move the orange marker on the ruler to the right edge of the second spring to set your stretch reference point.”

ELASTICITY
508
i

PROCEDURE 3 ▼

4. Move the force meter from the equipment panel to the second spring.

▲
▼

DATA TABLE C
EQUIPMENT

FORCE METER (N)

012345

0 CM

10

20

30

40

50

60

Screen 23

Procedure 3, Step 4:
 “4. Move the force meter from the equipment panel to the second spring.”

ELASTICITY

508

i

PROCEDURE 3

5. Collect force and stretch data as you did in Procedure 1 and 2. Enter the measurements in DATA TABLE C.

DATA TABLE C

ADD ROW

CLOSE

FORCE (N)	BRASS SPRINGS SERIES STRETCH (CM)
0	37.7
0.5	51.1
1	64.5
1.5	77.9
2	91.3
2.5	104.7
3	118.1
3.5	131.5
4	144.9
4.5	158.3
5	171.7

EQUIPMENT

FORCE METER (N)

012345

0 CM102030405060

Screen 24

Procedure 3, Step 5:
“5. Collect force and stretch data as you did in Procedure 1 and 2. Enter the measurements in DATA TABLE C.”

24

ELASTICITY

508

i

PROCEDURE 4

▼

1. Move a BRASS spring from the equipment panel to each of the orange anchor points on the left of the work area.

▲

▼

DATA TABLE D

EQUIPMENT

Screen 25

Procedure 4, Step 1:

“1. Move a BRASS spring from the equipment panel to each of the orange anchor points on the left of the work area.”

Since Procedure 4 needs the springs to be in parallel, there are two anchor points.

ELASTICITY

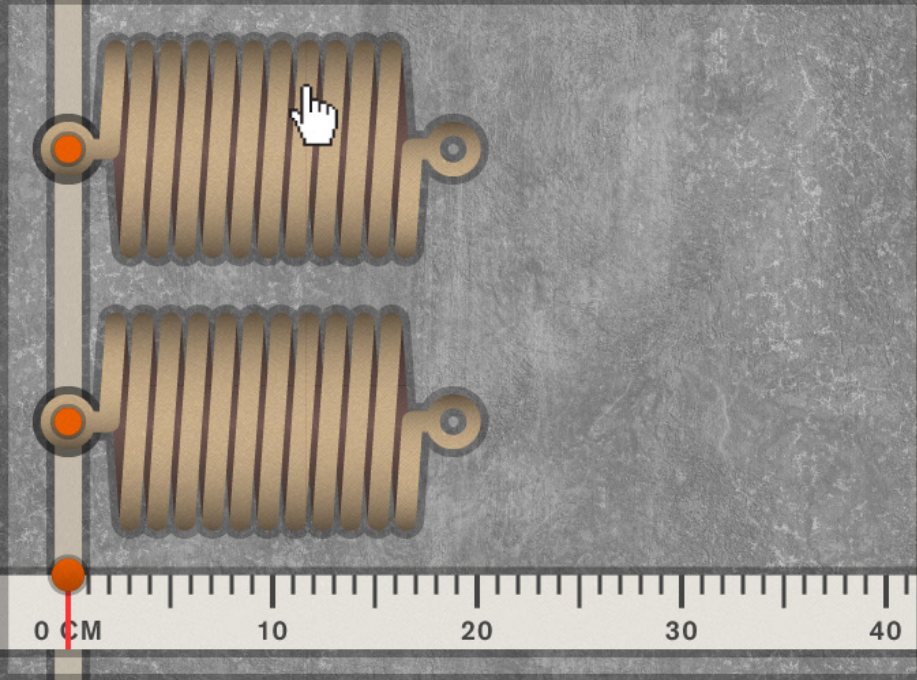
508

i

PROCEDURE 4

1. Move a BRASS spring from the equipment panel to each of the orange anchor points on the left of the work area.

DATA TABLE D



EQUIPMENT

CLOSE

BRASS SPRING

BRASS SPRING

ALUMINUM SPRING

FORCE METER

PARALLEL CONNECTOR

Screen 26

-

ELASTICITY

508

i

PROCEDURE 4

▼

2. Connect the two springs with the parallel spring connector from the equipment panel.

▲

▼

DATA TABLE D

EQUIPMENT

CLOSE

BRASS SPRING

BRASS SPRING

ALUMINUM SPRING


FORCE METER (N)
0 1 2 3 4 5
FORCE METER

PARALLEL CONNECTOR

Screen 27

Procedure 4, Step 2:

“2. Connect the two springs with the parallel spring connector from the equipment panel.”

 ELASTICITY

508i

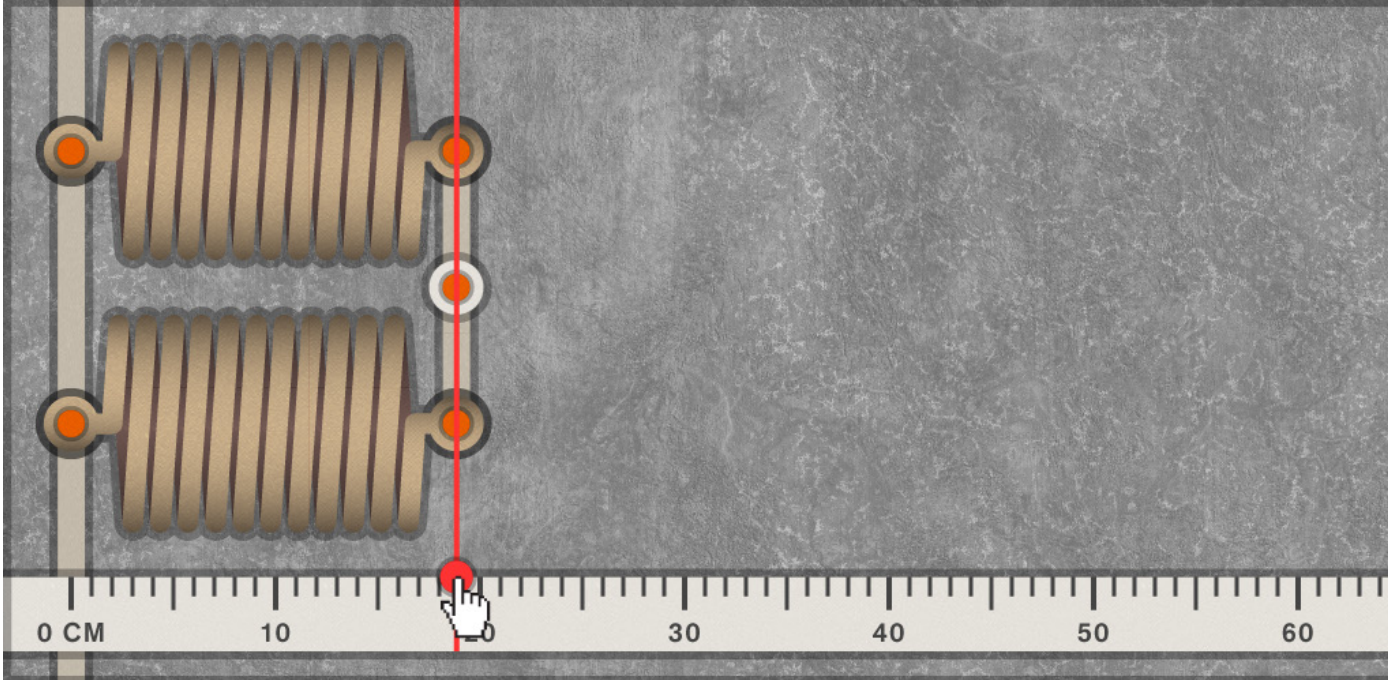
PROCEDURE 4 ▼

3. Move the orange marker on the ruler to the right edge of the springs to set your stretch reference point.

▲▼

DATA TABLE D

EQUIPMENT



Screen 28

Procedure 4, Step 3:

“3. Move the orange marker on the ruler to the right edge of the springs to set your stretch reference point.”

ELASTICITY
508
i

PROCEDURE 4 ▼

4. Move the force meter from the equipment panel to the parallel spring connector.

▲
▼

DATA TABLE D

EQUIPMENT

FORCE METER (N)

012345

0 CM

10

20

30

40

50

60

Screen 29

Procedure 4, Step 4:

“4. Move the force meter from the equipment panel to the parallel spring connector.”

ELASTICITY

508i

PROCEDURE 4

5. Collect force and stretch data as you did in Procedure 1, 2, and 3. Enter the measurements in DATA TABLE D.

DATA TABLE D

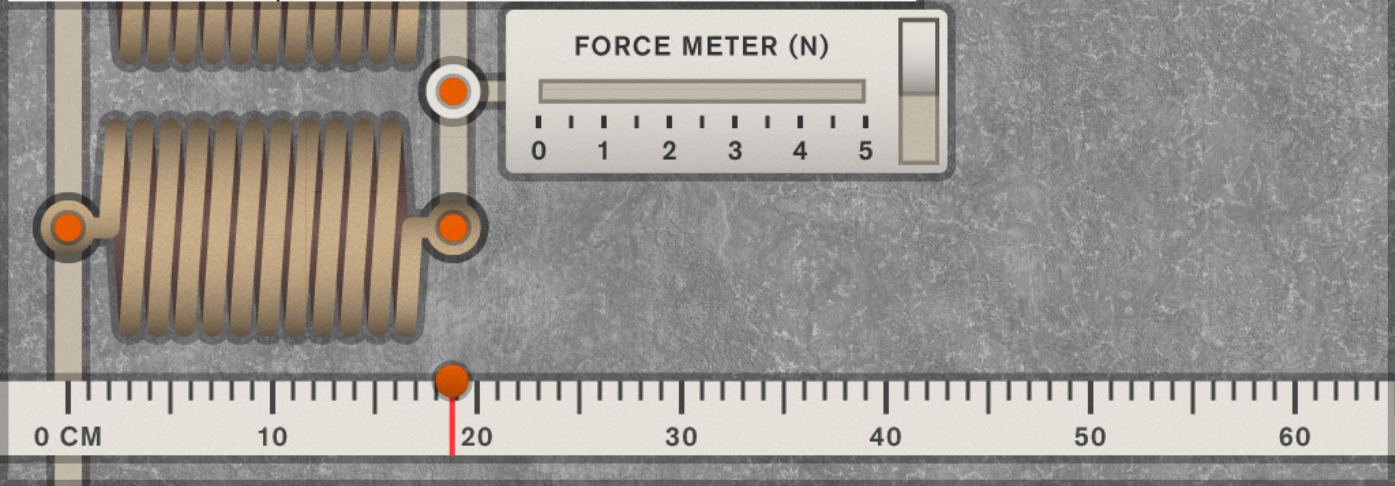
ADD ROW

SAVE TABLES

CLOSE

FORCE (N)	BRASS SPRINGS PARALLEL STRETCH (CM)
0	19
0.5	22.4
1	25.7
1.5	29.1

EQUIPMENT



Screen 30

Procedure 4, Step 5:
“5. Collect force and stretch data as you did in Procedure 1, 2, and 3. Enter the measurements in DATA TABLE D.”

ELASTICITY

508

i

PROCEDURE 4

6. When you have finished collecting the data from all four procedures, press the SAVE TABLES button on DATA TABLE D, then use the data tables to complete the graphs and answer the questions in the discussion forum.

DATA TABLE D

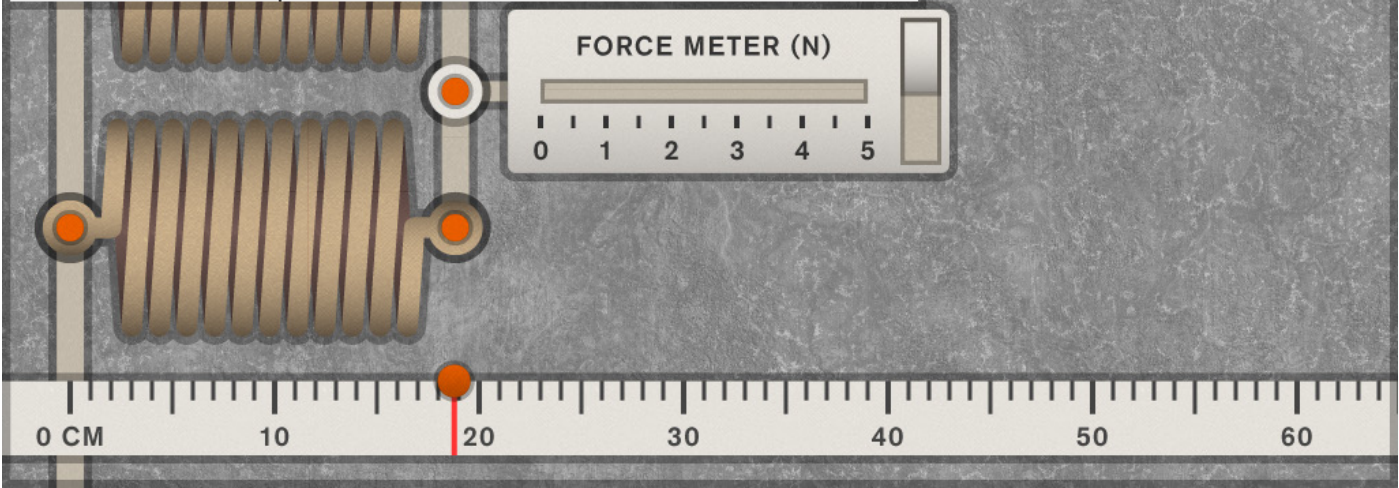
ADD ROW

SAVE TABLES

CLOSE

FORCE (N)	BRASS SPRINGS PARALLEL STRETCH (CM)
0	19
0.5	22.4
1	25.7
1.5	29.1

EQUIPMENT



Screen 31

Procedure 4, Step 6:
“6. When you have finished collecting the data from all four procedures, press the SAVE TABLES button on DATA TABLE D then use the data tables to complete the graphs and answer the questions in the discussion forum.”

The screenshot shows the 'ELASTICITY' simulation interface. At the top, there is a header bar with the title 'ELASTICITY', a page number '508', and an information icon 'i'. Below the header, there is a 'PROCEDURE 4' dropdown menu. To the right of the dropdown, there is a text box containing the instruction: '6. When you have finished collecting the data from all four procedures, press the SAVE TABLES button on DATA TABLE D, then use the data tables to complete the graphs and answer the questions in the discussion forum.' Below this, there is a 'DATA TABLE D' section with buttons for 'ADD ROW', 'SAVE TABLES', and 'CLOSE'. The table has two columns: 'FORCE (N)' and 'BRASS SPRINGS PARALLEL STRETCH (CM)'. The 'FORCE (N)' column has values 0, 0.5, 1, and 1.5. The 'BRASS SPRINGS PARALLEL STRETCH (CM)' column is empty. To the right of the table is an 'EQUIPMENT' section. In the background, there is a visual representation of a brass spring being stretched by a weight, with a ruler showing a stretch of approximately 18 cm. A white error message box is overlaid on the table, stating: 'NOT ENOUGH DATA. You do not have enough data points in DATA TABLE D of Procedure 4 to effectively answer the questions in the discussion forum. Please collect more force and stretch measurements before continuing.' with an 'OK' button.

ELASTICITY 508 i

PROCEDURE 4 ▼

6. When you have finished collecting the data from all four procedures, press the SAVE TABLES button on DATA TABLE D, then use the data tables to complete the graphs and answer the questions in the discussion forum.

DATA TABLE D **ADD ROW** **SAVE TABLES** **CLOSE** **EQUIPMENT**

FORCE (N)	BRASS SPRINGS PARALLEL STRETCH (CM)
0	
0.5	
1	
1.5	

NOT ENOUGH DATA

You do not have enough data points in DATA TABLE D of Procedure 4 to effectively answer the questions in the discussion forum. Please collect more force and stretch measurements before continuing.

OK

Screen 32

If the student tries saving the tables without enough information in one of their tables, a message like this will display:

“NOT ENOUGH DATA

You do not have enough data points in DATA TABLE D of Procedure 4 to effectively answer the questions in the discussion forum. Please collect more force and stretch measurements before continuing.”

The message will change based on which table/procedure has incomplete data.

The screenshot shows the 'ELASTICITY' simulation interface. At the top, there's a header with a logo, the title 'ELASTICITY', a page number '508', and an information icon 'i'. Below the header, a procedure dropdown is set to 'PROCEDURE 4'. A text box contains instruction 6: 'When you have finished collecting the data from all four procedures, press the SAVE TABLES button on DATA TABLE D, then use the data tables to complete the graphs and answer the questions in the discussion forum.' Below this, there's a section for 'DATA TABLE D' with buttons 'ADD ROW', 'SAVE TABLES', and 'CLOSE'. A table is visible with two columns: 'FORCE (N)' and 'BRASS SPRINGS PARALLEL STRETCH (CM)'. The table has four rows with values 0, 0.5, 1, and 1.5 in the first column. To the right of the table is an 'EQUIPMENT' section. A large white message box with an orange border is centered on the screen, displaying the text: 'TABLES SAVED', 'Your data tables have been saved to the location you selected. Use the tables to complete the graphs and answer the questions in the discussion forum.', and an 'OK' button. In the background, a brass spring is shown hanging from a stand, with a ruler below it indicating a stretch of approximately 18 cm.

ELASTICITY 508 i

PROCEDURE 4 ▼

6. When you have finished collecting the data from all four procedures, press the SAVE TABLES button on DATA TABLE D, then use the data tables to complete the graphs and answer the questions in the discussion forum.

DATA TABLE D **ADD ROW** **SAVE TABLES** **CLOSE** **EQUIPMENT**

FORCE (N)	BRASS SPRINGS PARALLEL STRETCH (CM)
0	
0.5	
1	
1.5	

TABLES SAVED

Your data tables have been saved to the location you selected. Use the tables to complete the graphs and answer the questions in the discussion forum.

OK

Screen 33

If the student saves the tables and all of them have enough data, this message will display:

“TABLES SAVED

Your data tables have been saved to the location you selected. Use the tables to complete the graphs and answer the questions in the discussion forum.”