Grade level: 9-12
Subjects: algebra, physics, chemistry
Time required: 45 minutes

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Exploring the Relationship Between Wavelength and Frequency
by – Lisa Blank, Math & Science Teacher, Lyme Central School, Chaumont, NY

Activity overview
Students will explore the relationship between wavelength and frequency of the visible portion of the electromagnetic spectrum graphically to understand the mathematical relationship that exists.

Concepts
Direct and Inverse Variations
Hyperbolic Graphs
Slope and Constants (speed of light in a vacuum, c)
Linear Regression
Spreadsheets Scatter Plots

Teacher preparation
Load the wavelengths.tns file onto all student calculators. Copy the step-by-step instructions below and the related handout,wavelengthsws.doc, for students to complete as they work through this activity. The wavelengtht.tns file is for the teacher to be able to view the results the students should obtain as they work through this activity. A worksheet key is also provided for teacher use, wavelengthkey.doc.

Classroom management tips
The instructor should direct students to open the wavelengths.tns file. Once students have opened the file, the teacher should monitor students, assisting them as they work through the steps provided in this activity. Students will likely need assistance if the instructor wants the students to modify axes and/or label the graphs. Remind students that ctrl G will remove the function window and the x, y variable choice windows from the bottom of the graph screen to provide larger viewing windows for the graphs.

A worksheet is provided with this activity for completion by students.

The graphing in this activity can be shortened by having students go back to the scatter plots already created and overlay their function graphs on top of the existing scatter plots. The instructions provided instruct students to create a second scatter plot for the function overlay. This may be beneficial for teaching the basics of graphing, but is redundant for students who are proficient at graphing with the Nspire. For example, steps 24-26 could be skipped if the students are instructed to return to the graph obtained after step 17. Steps could similarly be shortened for the remaining two scatter plots that are created.
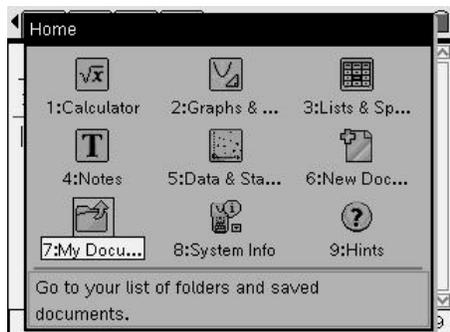
TI-Nspire Applications
Spreadsheets
Performing Basic Calculations in Spreadsheets
Scatter Plots
Linear Regression

Exploring Wavelength and Frequency
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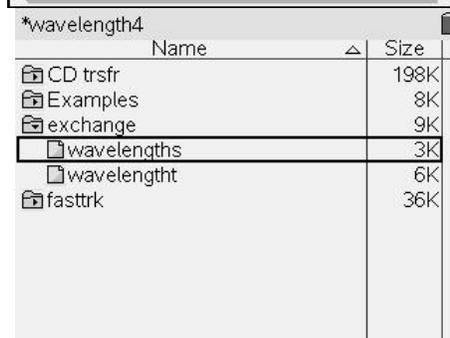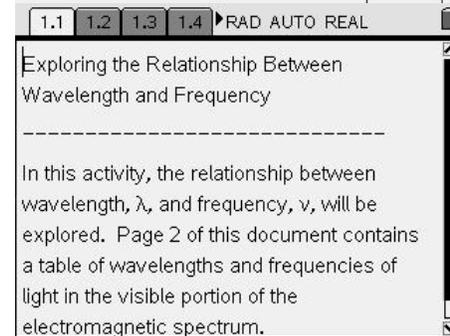
Step-by-step directions

1. At the home screen, select My Documents.

2. Browse to the folder titled wavelengths.

3. The first page of the document should appear as shown. Read this page to familiarize yourself with what this activity is about.

4. Move to the next page of the document by using ⓒ▷. On this page, you will find a spreadsheet with wavelength, λ, and frequency, ν, data for the visible portion of the electromagnetic spectrum.

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5. Move to the next page of the document by using (ctrl)(▷).
Read this page to get an overview of what you are to do on the
next few document pages.

| 1.1 | 1.2 | 1.3 | 1.4 ▶RAD AUTO REAL ▮

Next, you will graph this data using a graphs
and geometry page.

Select scatterplot for graph type and then you
must choose your spreadsheet columns for
your scatterplots variables x and y. Next
choose Zoom-Stat to view the data in an
appropriate viewing window. You may adjust
axes further using the grab hand and label

6. Move to the next page of the document by using (ctrl)(▷). This
page is a graph page, where you will make a scatter plot of the
wavelength and frequency data. This page must first be set up
in the appropriate format for creating such a graph.

| 1.1 | 1.2 | 1.3 | 1.4 ▶RAD AUTO REAL ▮

15 ↑

2

⊛ ▤ *f1*(x)=   ≫

7. Press (menu)., then select Graph Type from the pull-down
menu.

🔧 1: Tools   ▶ RAD AUTO REAL ▮
▥ 2: View   ▶
⌁ 3: Graph Type   ▶
⇥ 4: Window   ▶
⋀ 5: Trace   ▶
• 6: Points & Lines ▶
✎ 7: Measurement   ▶
⊙ 8: Shapes   ▶
⅄ 9: Construction   ▶
∴ A: Transformation ▶

2

⊛ ▤ *f1*(x)=   ≫

8. Next, select Scatter Plot.

🔧 1: Tools   ▶ RAD AUTO REAL ▮
▥ 2: View   ▶
⌁ 3: Graph Type   ▶ Ψ 1: Function
⇥ 4: Window   ▶ ⋏ 2: Parametric
⋀ 5: Trace   ▶ ⌁ 3: Scatter Plot
• 6: Points & Lines ▶
✎ 7: Measurement   ▶
⊙ 8: Shapes   ▶
⅄ 9: Construction   ▶
∴ A: Transformation ▶

2

⊛ ▤ *f1*(x)=   ≫

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Grade level: 9-12
Subjects: algebra, physics, chemistry
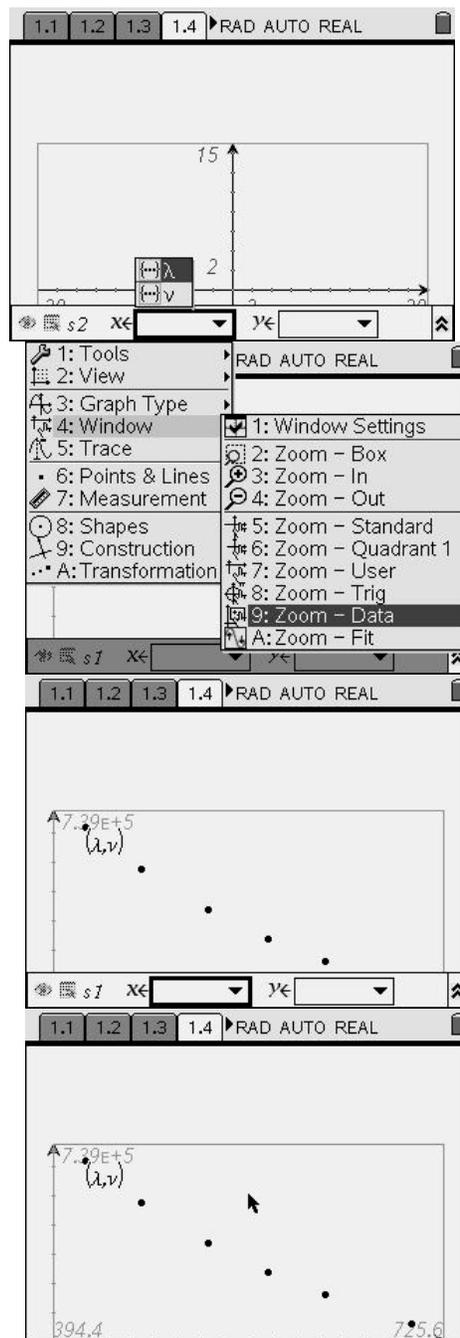Time required: 45 minutes

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9. The scatter plot window will appear. Select the x and y variables from your spreadsheet. With the box next to the x-variable darkened, press enter, or use a click at the center of the Nav Pad to make the choices for variable x appear. Move the cursor to highlight the appropriate variable, in this case λ, and press enter or click the center of the Nav Pad. If the box near the variable x is not darkened, press (tab) until the appropriate box is highlighted.
Next, use (tab) to move to the box for the y-variable, this time selecting ν.

10. In order to view the scatter plot, you must set up an appropriate viewing window. To do this, press (menu) and select Window, followed by Zoom-Data. (You can provide settings for the window using choice 1: Window Settings also.)

11. A scatter plot should then appear.

12. To view more of this graph, first hide the entry boxes at the bottom of the screen by pressing (ctrl) G, which acts as a toggle to hide or reveal entry boxes for graphs.
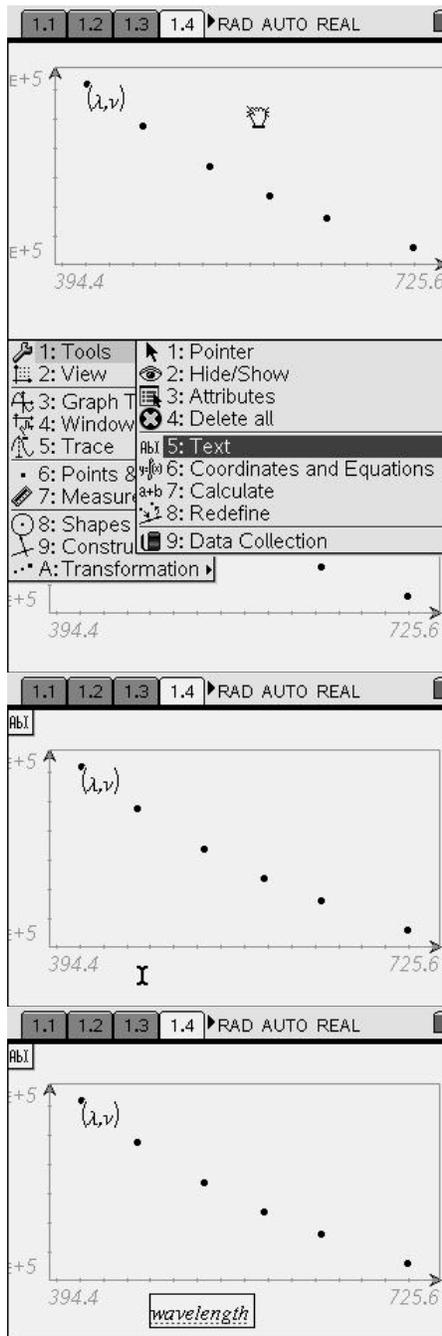
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13. Next, you can adjust the graph by moving it upward. Move the arrow to an open region of the graph and press (ctrl) to grab onto the graph and drag it to a more desirable location on the screen. (Note that the grab hand is located at the center of the Nav Pad.)

14. Labels may now be labeled using the text tool. You can access this by pressing (menu) and selecting Tools followed by Text.

15. The text cursor will appear. Move it to the desired location using the Nav Pad and press (enter).

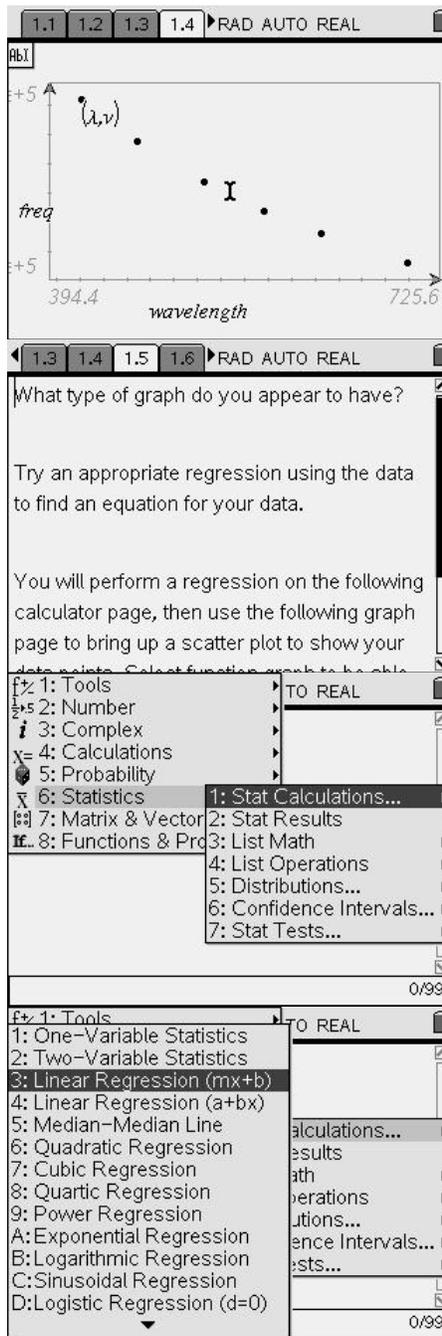16. A text box will appear, in which you may type the appropriate axis label. Label the x-axis.

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17. Repeat this procedure to appropriately label the y-axis.

18. Move to the next page of the document by using (ctrl)▷.
Read this page to give you direction for the next pages of this document.

19. Move to the next page of the document by using (ctrl)▷.
This is a calculator page on which you are to determine a linear regression equation for the graphed data. To do this, press (menu) and choose Statistics, followed by Stat Calculations.

20. Next, choose Linear Regression (mx+b).

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Grade level: 9-12
Subjects: algebra, physics, chemistry
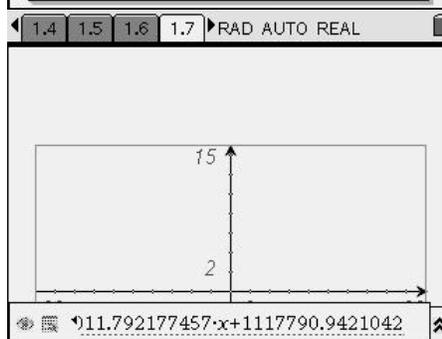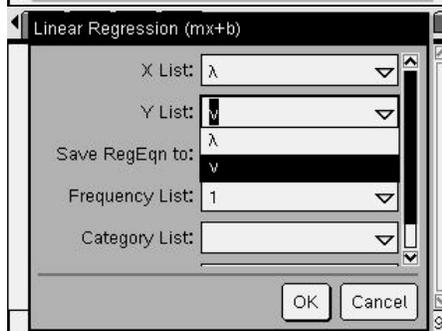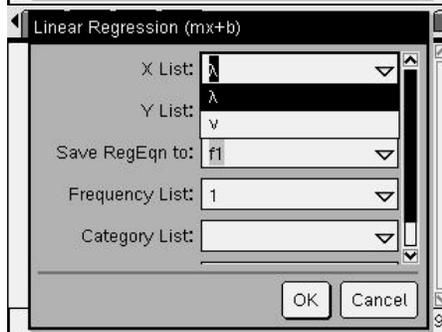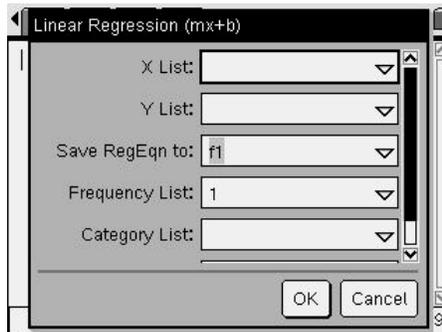Time required: 45 minutes

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21. Next a window will appear in which you must choose the column from the spreadsheet for the data to be represented by x.

22. You must also choose the appropriate spreadsheet column for y.

23. Select "OK" at the bottom of the screen after choosing the appropriate x and y lists. The linear regression equation results will appear. These results are automatically saved to f(1) for function graphing.

24. Move to the next page of the document by using (ctrl)(▷). The scatter plot will be reconstructed. This time, the regression equation will also be viewed on the graph.

Exploring Wavelength and Frequency
Grade level: 9-12
Subjects: algebra, physics, chemistry
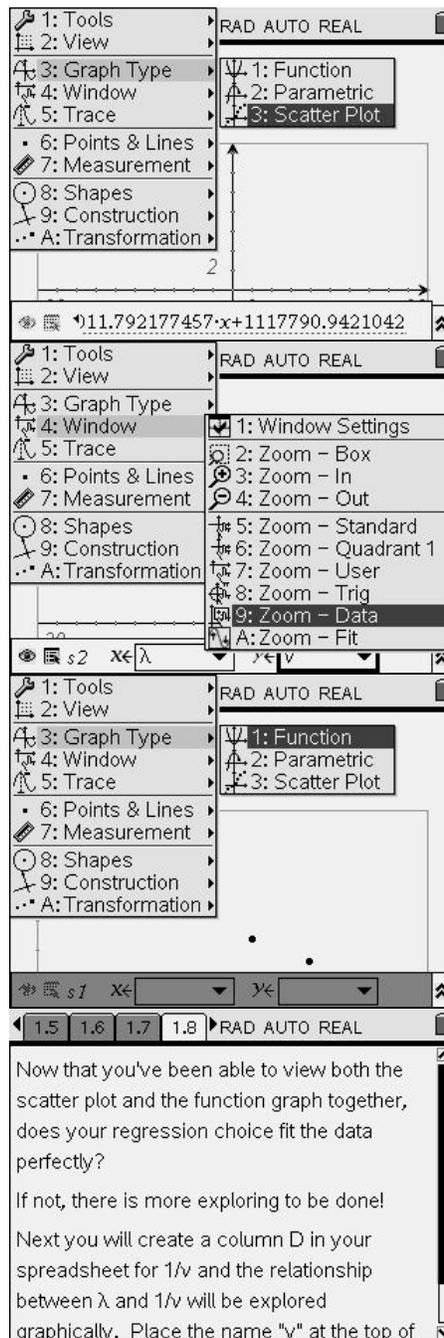Time required: 45 minutes

25. First, recreate the scatterplot.

26. Remember to obtain an appropriate viewing window.

27. When the scatter plot is complete, press (menu) and select Graph Type, Function. A window will appear at the bottom of the screen. Your cursor should appear after the equal sign. Using your Nav Pad, arrow up ▲ to reach the appropriate equation, $f(1)$. This will provide the equation. Select (enter), which will activate the regression equation, causing it to appear on the graph. Remember that you can hide the entry boxes at the bottom of the screen by pressing (ctrl) G.

28. Move to the next page of the document by using (ctrl) ▷. Read this page for information regarding what is to be done next.

Exploring Wavelength and Frequency
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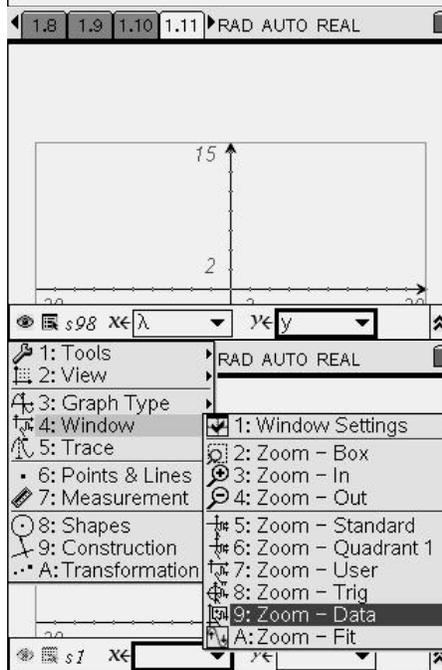
29. Move to the next page of the document by using (ctrl)▷.
Move your cursor to the right of D and type in the letter y. In
the light grey space directly beneath D, type (=)1/ν and select
(enter). The D column of the spreadsheet should then fill in with
the values for 1/ν for each of the colors of visible light listed in
the spreadsheet.

	A	B λ	C ν	D y	E
◆				◀=1/ν	
1	violet	422	710900		
2	blue	469	639659		
3	green	526	570342		
4	yellow	577	519931		
5	orange	625	480000		

y:=1/ν

30. Move to the next page of the document by using (ctrl)▷.
Read this page for instructions.

Again, you will create a scatter plot graph,
this time using wavelength and $\dfrac{1}{\text{frequency}}$.
Explore the relationship as before, creating a
regression equation.

31. Move to the next page of the document by using (ctrl)▷.
This is a graphs page on which you will create a new scatter
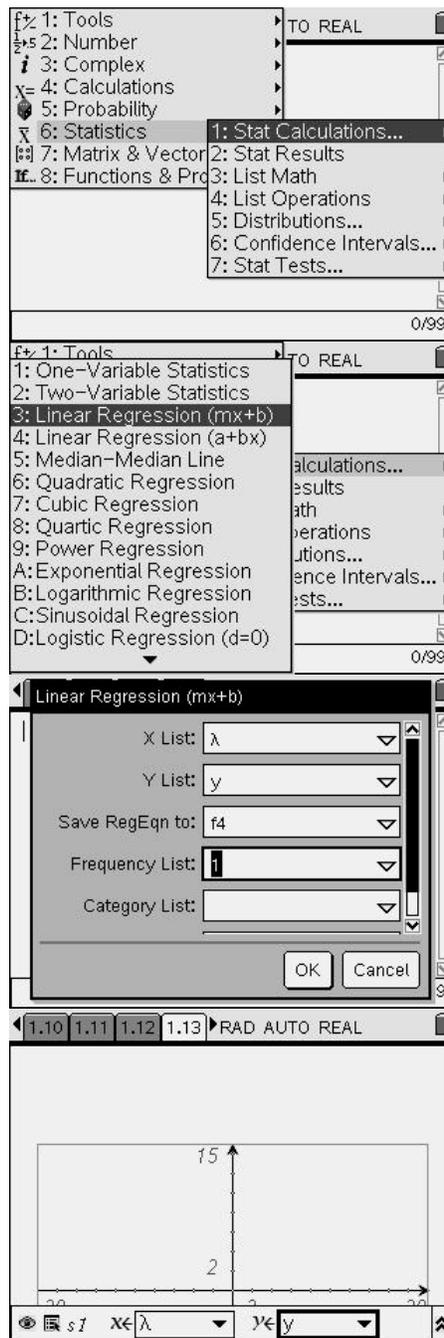plot. On this page, select the appropriate data columns from
the spreadsheet as shown.

32. Obtain an appropriate viewing window.

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33. Move to the next page of the document by using (ctrl) ▷.
This is a calculator page on which you will again perform a
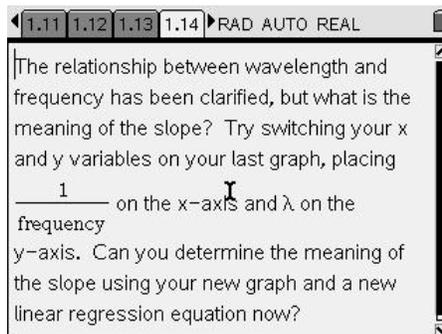linear regression.

34.

35. Select the appropriate data columns from the spreadsheet.

36. Move to the next page of the document by using (ctrl) ▷.
Set up the scatter plot again. Choosing x and y variables as
shown. Adjust your viewing window and the graph and label
axes as appropriate.

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37. Move to the next page of the document by using (ctrl)(▷).
Read this page! It contains a key question for this activity!

The relationship between wavelength and frequency has been clarified, but what is the meaning of the slope? Try switching your x and y variables on your last graph, placing $\frac{1}{frequency}$ on the x–axis and λ on the y–axis. Can you determine the meaning of the slope using your new graph and a new linear regression equation now?
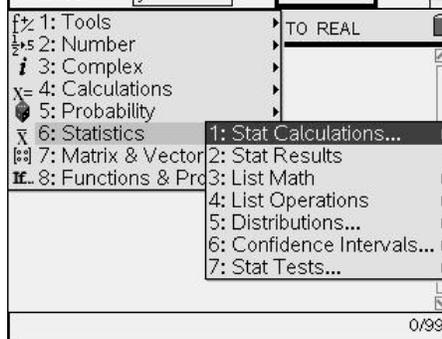
38. Move to the next page of the document by using (ctrl)(▷).
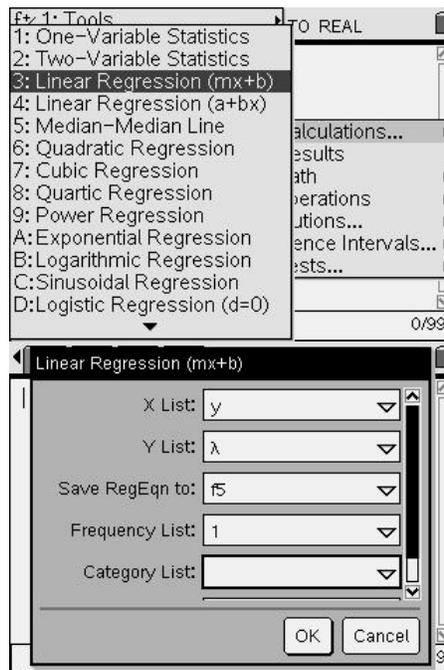Create a new spreadsheet with x and y variables as shown.
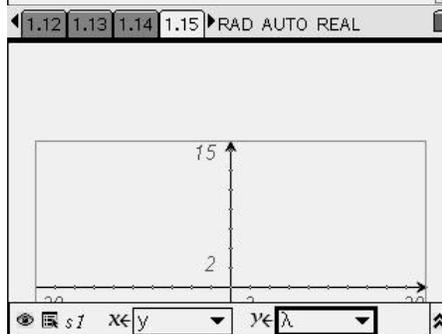
39. Obtain an appropriate viewing window.
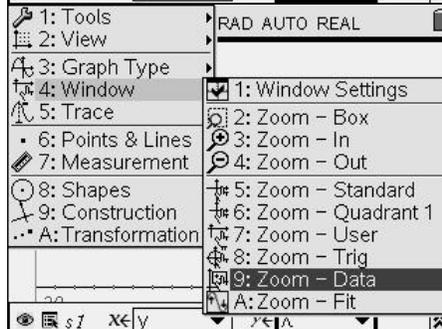
40. Move to the next page of the document by using (ctrl)(▷). On this new calculator page, determine the linear regression equation for the new graph.

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41.

42. Remember to choose appropriate x and y list values from your spreadsheet and select "OK". You may proceed on to graph the final resulting regression equation over the corresponding scatter plot if desired or instructed to do so.

Assessment and evaluation *(NOTE: this section can be separate or included in the step-by-step directions.)*
- *Collect the student questions and assess them for understanding.*
- *Follow up with a similar activity, providing somewhat decreased instruction to check for understanding of the process and concepts involved. A good example to have students test would be the relationship between energy and frequency. The constant involved in this relationship is h, Planck's constant.*
- *If students need re-teaching of the concepts involved, the relationship between energy and frequency could be studied with thorough details and guidance from the teacher. (Such an activity will soon be developed for the exploration of this relationship.)*
- *Optional: Answers to student questions in the Student TI-Nspire document and/or student worksheet*

Activity extensions
- *Study relationships between energy and frequency, and/or the relationship between energy and wavelength.*
- *This study involves only the visible portion of the electromagnetic spectrum. Data studied could be expanded to include microwaves, radio waves, x-rays, gamma radiation, UV radiation, and IR radiation.*
- *This activity provides an excellent opportunity for math and science teachers to work cooperatively in the study of the electromagnetic spectrum and mathematical relationships, including direct variation, inverse variation, and in understanding the meaning of slope.*

Student TI-Nspire Document
wavelengths.tns

Activity Title Goes Here
by: author name goes here
Grade level: secondary
Subject: mathematics
Time required: 45 to 90 minutes

Materials: Phoenix 1

*wavelength4

Name △	Size
CD trsfr	198K
Examples	8K
exchange	9K
wavelengths	3K
wavelengtht	6K
fasttrk	36K

1.1 1.2 1.3 1.4 ▸RAD AUTO REAL

Exploring the Relationship Between
Wavelength and Frequency
_____

In this activity, the relationship between
wavelength, λ, and frequency, ν, will be
explored. Page 2 of this document contains
a table of wavelengths and frequencies of
light in the visible portion of the
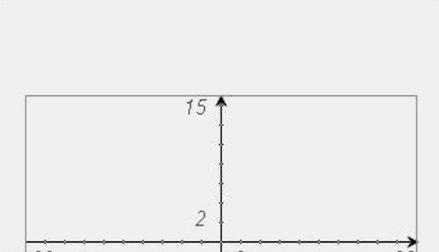electromagnetic spectrum.

1.1 1.2 1.3 1.4 ▸RAD AUTO REAL

	A	B λ	C ν	D	E
1	violet	422	710900		
2	blue	469	639659		
3	green	526	570342		
4	yellow	577	519931		
5	orange	625	480000		

A1 |

1.1 1.2 1.3 1.4 ▸RAD AUTO REAL

Next, you will graph this data using a graphs
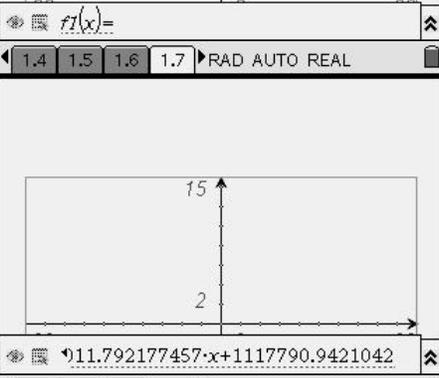and geometry page.

Select scatterplot for graph type and then you
must choose your spreadsheet columns for
your scatterplots variables x and y. Next
choose Zoom−Stat to view the data in an
appropriate viewing window. You may adjust
axes further using the grab hand and label

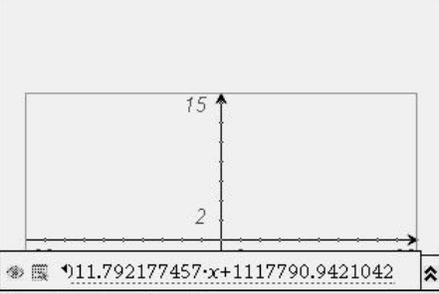
1.1 1.2 1.3 1.4 ▸RAD AUTO REAL

15
2

$f1(x)=$

1.3 1.4 1.5 1.6 ▸RAD AUTO REAL

What type of graph do you appear to have?

Try an appropriate regression using the data
to find an equation for your data.

You will perform a regression on the following
calculator page, then use the following graph
page to bring up a scatter plot to show your

1: Tools
2: Number
3: Complex
4: Calculations
5: Probability
6: Statistics
7: Matrix & Vector
8: Functions & Programs

TO REAL

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1.4 1.5 1.6 1.7 ▸RAD AUTO REAL

15
2

$11.792177457 \cdot x + 1117790.9421042$

1.5 1.6 1.7 1.8 ▸RAD AUTO REAL

Now that you've been able to view both the
scatter plot and the function graph together,
does your regression choice fit the data
perfectly?

If not, there is more exploring to be done!

Next you will create a column D in your
spreadsheet for 1/ν and the relationship
between λ and 1/ν will be explored
graphically. Place the name "y" at the top of
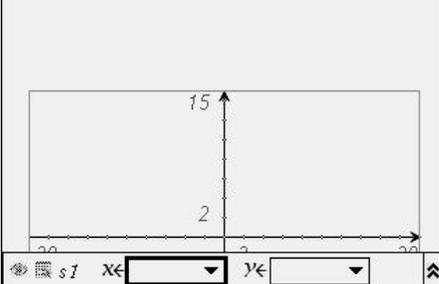

1.6 1.7 1.8 1.9 ▸RAD AUTO REAL

	A	B λ	C ν	D y	E
				=1/ν	
1	violet	422	710900		
2	blue	469	639659		
3	green	526	570342		
4	yellow	577	519931		
5	orange	625	480000		

y:=1/ν

1.7 1.8 1.9 1.10 ▸RAD AUTO REAL
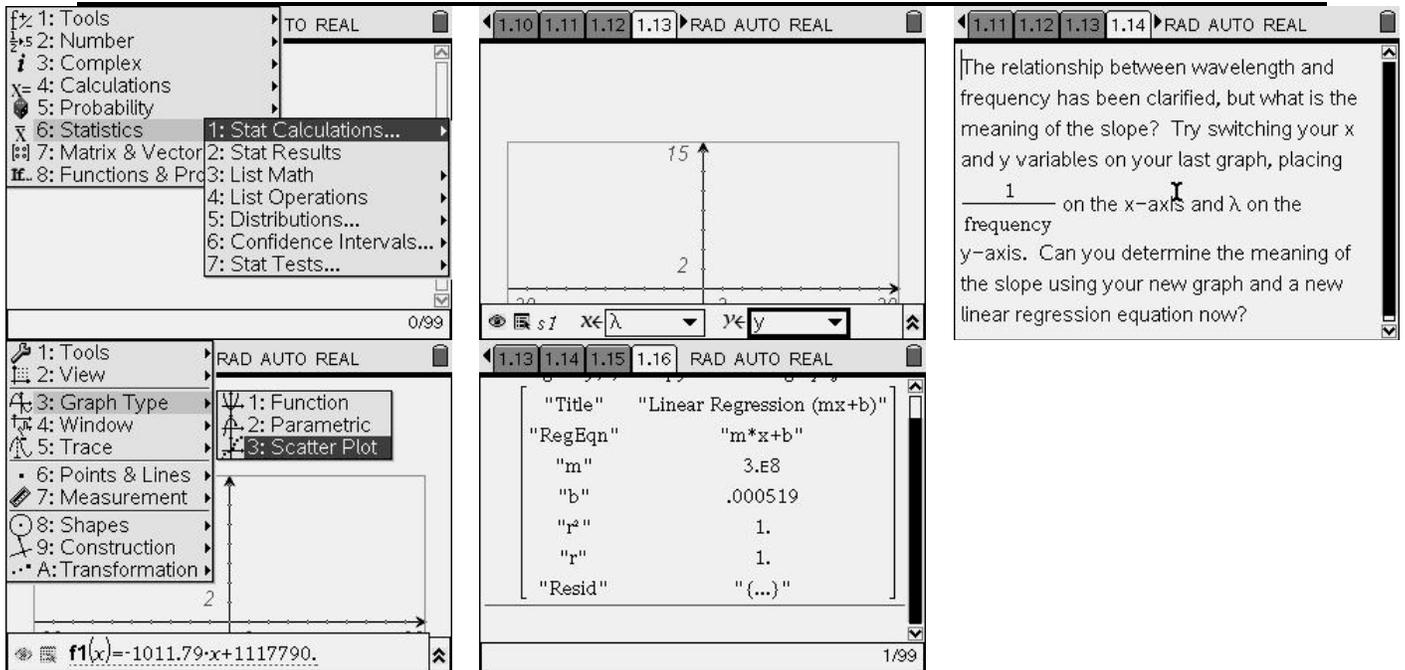
Again, you will create a scatter plot graph,
this time using wavelength and $\frac{1}{frequency}$.
Explore the relationship as before, creating a
regression equation.

1.8 1.9 1.10 1.11 ▸RAD AUTO REAL

15
2

s1 x◂ ⬇ y◂ ⬇

Activity Title Goes Here
by: author name goes here
Grade level: secondary
Subject: mathematics
Time required: 45 to 90 minutes

Materials: Phoenix 1

TEXAS INSTRUMENTS

1: Tools
2: Number
3: Complex
4: Calculations
5: Probability
6: Statistics   1: Stat Calculations...
7: Matrix & Vector   2: Stat Results
8: Functions & Pro   3: List Math
   4: List Operations
   5: Distributions...
   6: Confidence Intervals...
   7: Stat Tests...

TO REAL

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1.10 | 1.11 | 1.12 | 1.13 ▶ RAD AUTO REAL

15

2

$x \leftarrow \lambda$ $y \leftarrow y$

1.11 | 1.12 | 1.13 | 1.14 ▶ RAD AUTO REAL

The relationship between wavelength and frequency has been clarified, but what is the meaning of the slope? Try switching your x and y variables on your last graph, placing $\dfrac{1}{\text{frequency}}$ on the x-axis and λ on the y-axis. Can you determine the meaning of the slope using your new graph and a new linear regression equation now?

1: Tools
2: View
3: Graph Type   1: Function
4: Window   2: Parametric
5: Trace   3: Scatter Plot
6: Points & Lines
7: Measurement
8: Shapes
9: Construction
A: Transformation

RAD AUTO REAL

2

$f1(x) = -1011.79 \cdot x + 1117790.$

1.13 | 1.14 | 1.15 | 1.16   RAD AUTO REAL

"Title"	"Linear Regression (mx+b)"
"RegEqn"	"m*x+b"
"m"	3.E8
"b"	.000519
"r²"	1.
"r"	1.
"Resid"	"{...}"

1/99