

Activity 7

Now You See It, Now You Don't

Objectives

- ◆ To study the relationship between age and near point accommodation
- ◆ To predict a person's age based on near point accommodation
- ◆ To use technology to study an exponential regression
- ◆ To use technology to create a box-and-whisker plot
- ◆ To use technology to create a histogram

Materials

- ◆ TI-83 Plus
- ◆ Metric ruler or meter stick
- ◆ String length: 1.5 meters

Introduction

Have you ever noticed someone holding an object away from their face so that they can see it more easily? This may seem somewhat perplexing. Why would holding an object *further* away make it *easier* to examine?

Focusing one's eye when looking at a close object is referred to as *near point accommodation*. The focusing of one's eye is made possible by little muscles that pull on the eye, and therefore slightly reshape the lens. This causes the lens to focus the light on the sensitive cells of the retina.

Problem

Is near point accommodation related to a person's age?

Collecting the data

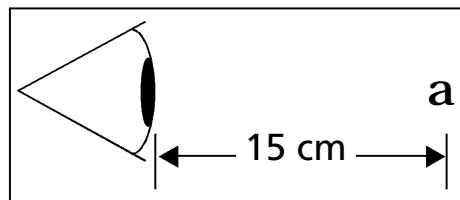
Near point accommodation data for subjects in the 35 - 64 age group is provided on the following page. You may also collect your own data at home on subjects in the same age group. Follow steps 1 through 4 to determine if near point accommodation is related to age.

1. Have your subject hold the letter shown at the right in front of his/her face. This page should be moved as close as the subject can move it and still keep the letter *a* in focus.

a

Note: If your subject normally wears glasses, then the glasses should be worn during this test (unless they are reading glasses, in which case the glasses should not be worn). If your subject wears bifocals, then the subject should wear his / her glasses and should view the letter *a* through the upper part of the glasses that are used for distance. If your subject wears separate glasses for distance and reading, then he / she should wear the glasses that are used for distance.

- Use a string to determine the distance from the front of the eye to the letter *a*. **Do not hold the string too close to the eye.** Holding the string along your subject's face, extend the string from the cornea (the front part of the eye) to the page with the letter *a*. In the example shown here, the near point accommodation is 15 centimeters.



- Record the result on the **Data Collection and Analysis** page. Be sure to indicate the age of the subject. Repeat this procedure with four other subjects.
- Submit your data to your teacher. Your teacher will collate the data from all members of the class.

Setting up the TI-83 Plus

Before starting your data collection, make sure that the TI-83 Plus has the STAT PLOTS turned OFF, Y= functions turned OFF or cleared, the MODE and FORMAT set to their defaults, and the lists cleared. See the Appendix for a detailed description of the general setup steps.

Entering the data in the TI-83 Plus

- Press **STAT** and select **1:Edit** by pressing **ENTER**.
- Enter the age of the subjects in **L1**.
- Enter the near point accommodation of the subjects in **L2**. (Make sure that the pairs of age and near point accommodation data match in each column.)
- Enter the near point accommodation of the 35 - 44 age group subjects in **L3**.
- Enter the near point accommodation of the 45 - 54 age group subjects in **L4**.
- Enter the near point accommodation of the 55 - 64 age group subjects in **L5**.

```

2001 CALC TESTS
1:Edit
2:SortA(
3:SortD(
4:ClrList
5:SetUpEditor

```

L1	L2	L3	3
35	14		
35	16		
36	15		
38	16		
40	20		
42	18		
44	28		

L3()=

L3	L4	L5	5
14	25	57	
16	29	61	
15	34	80	
16	52	72	
20	38	91	
18	53	108	
28	57	120	

L5()=58

Setting up the window

1. Press **WINDOW** to set up the proper scale for the axes.
2. Set the **Xmin** value by identifying the minimum value in **L1**. Choose a number that is less than the minimum.
3. Set the **Xmax** value by identifying the maximum value in each list. Choose a number that is greater than the maximum. Set the **Xscl** to 2.
4. Set the **Ymin** value by identifying the minimum value in **L2**. Choose a number that is less than the minimum.
5. Set the **Ymax** value by identifying the maximum value in **L2**. Choose a number that is greater than the maximum. Set the **Yscl** to 10.

```

WINDOW
Xmin=30
Xmax=65
Xscl=2
Ymin=0
Ymax=180
Yscl=10
Xres=1
  
```

Note: You may want to adjust the **Ymax** according to the data collected by your class.

Answer questions 1 and 2 on the **Data Collection and Analysis** page.

Graphing the data: Setting up a scatter plot

You can analyze the data in several different ways. You will need to set up a scatter plot and model the data by graphing a line of best fit (exponential regression). You can then use the data collected to predict a person's age based on their near point accommodation.

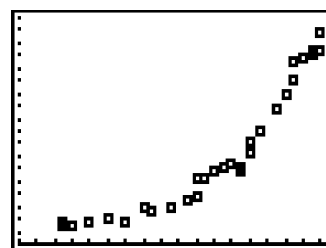
1. Press **2nd** **[STAT PLOT]** and select **1:Plot1** by pressing **ENTER**.
2. Set up the plot as shown by pressing **ENTER** **ENTER** **2nd** **[L1]** **ENTER** **2nd** **[L2]** **ENTER** **ENTER**.
3. Press **GRAPH** to see the plot.

```

STAT PLOTS
1:Plot1...Off
  [L1] [L2]
2:Plot2...Off
  [L3] [L4]
3:Plot3...Off
  [L5] [L6]
4:PlotsOff
  
```

```

Plot1 Plot2 Plot3
Off Off
Type: [ ] [ ] [ ]
      [ ] [ ] [ ]
Xlist:L1
Ylist:L2
Mark: [ ] + .
  
```



Analyzing the data

Finding a best fit line

1. Find an exponential regression equation for the data. Press **STAT** and move the cursor to the **CALC** menu.

```

EDIT 0:100 TESTS
1:1-Var Stats
2:2-Var Stats
3:Med-Med
4:LinReg(ax+b)
5:QuadReg
6:CubicReg
7↓QuartReg
  
```

2. Press the up arrow **▲** or the down arrow **▼** to select **0:ExpReg** and press **ENTER**.

```

EDIT 0:100 TESTS
7↑QuartReg
8:LinReg(a+bx)
9:LnReg
0:ExpReg
A:PwrReg
B:Logistic
C:SinReg
  
```

3. Press **2nd** **[L1]** **,** **2nd** **[L2]** **,**.

```
ExpReg
```

4. Press **VARΣ** and move the cursor to the **Y-VARS** menu.

```
ExpReg L1,L2,
```

5. Select **1:Function** by pressing **ENTER**.

```

VARS 0:100 Y-VARS
1:Function...
2:Parametric...
3:Polar...
4:On/Off...
  
```

6. Select **1:Y1** by pressing **ENTER**.

```

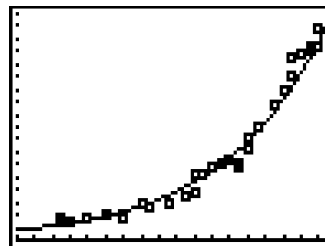
FUNCTION 0:100
1:Y1
2:Y2
3:Y3
4:Y4
5:Y5
6:Y6
7↓Y7
  
```

```
ExpReg L1,L2,Y1
```

7. Press **[ENTER]** to calculate the exponential regression and paste the function in **Y1**.

```
ExpReg
y=a*b^x
a=.5539307996
b=1.092480652
```

8. Press **[GRAPH]** to see the exponential regression.



Answer questions 3 and 4 on the **Data Collection and Analysis** page.

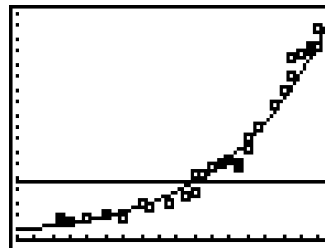
Determining age based on the near point accommodation

If a person has a near point accommodation of 47 cm, how old is that person likely to be according to the data?

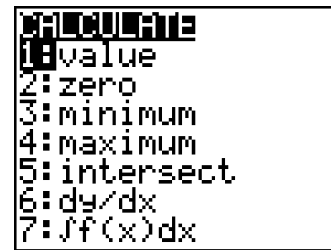
1. Press **[Y=]** and move the cursor to **Y2=**. Enter **47**, the near point accommodation.

```
Y1= P1ot2 P1ot3
\Y1=.55393079963
669*1.0924806524
581^X
\Y2=47
\Y3=
\Y4=
\Y5=
```

2. Press **[GRAPH]** to see the intersection of the two lines. The x value of the point where the two functions intersect is the predicted age of the person if their near point accommodation is 47 cm.

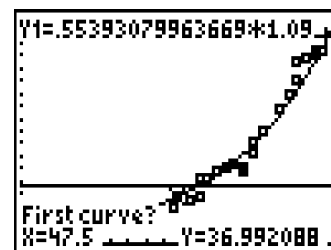
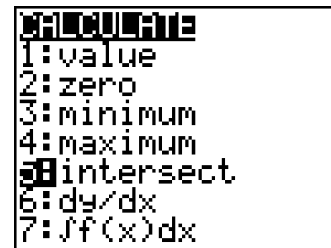


3. Find the coordinates of the point of intersection of the two lines. Press $\boxed{2\text{nd}} \boxed{[CALC]}$.
4. Select **5:intersect** and press $\boxed{[ENTER]}$.



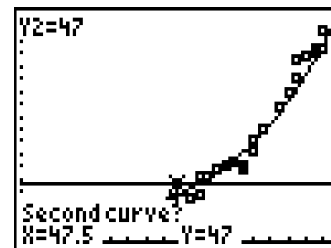
5. The calculator will prompt you for the *First curve*. Make sure the cursor is flashing on the regression line and then press $\boxed{[ENTER]}$.

Note: Use $\boxed{\uparrow}$ and $\boxed{\downarrow}$ to select the function. After selecting the regression line, press $\boxed{[ENTER]}$.

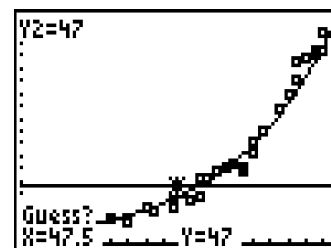


6. The calculator will prompt you for the *Second curve*. Make sure the cursor is flashing on the second line and then press $\boxed{[ENTER]}$.

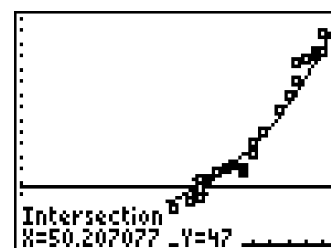
Note: Use $\boxed{\uparrow}$ and $\boxed{\downarrow}$ to select the function. After selecting the regression line, press $\boxed{[ENTER]}$.



7. The calculator will prompt you to *Guess*. Try to estimate the coordinates of the point of intersection.



8. Press $\boxed{[ENTER]}$ to find the exact point of intersection.



Answer question 5 on the **Data Collection and Analysis** page.

Graphing the data: Setting up a box-and-whisker plot

You can use a box-and-whisker plot to analyze the near point accommodation of the different age groups. You have already entered the near point accommodations of 35 - 44 year olds in **L3**, 45 - 54 year olds in **L4**, and 55 - 64 year olds in **L5**.

1. Press **2nd** [STAT PLOT] and select **1:Plot1** by pressing **ENTER**.

```

STAT PLOTS
1:Plot1...Off
  L1 L2
2:Plot2...Off
  L3 L4
3:Plot3...Off
  L5 L6
4↓PlotsOff
  
```

2. Set up the plot as shown by pressing **ENTER** **▾** **▶** **▶** **▶** **▶** **▶** **ENTER** **▾** **2nd** [L3] **ENTER** **ENTER**.

```

Plot1 Plot2 Plot3
Off Off
Type: L1 L2 L3
      L4 L5 L6
Xlist:L3
Freq:1
  
```

3. Press **2nd** [STAT PLOT] and select **2:Plot2** and press **ENTER**.

```

STAT PLOTS
1:Plot1...On
  L3 1
2:Plot2...Off
  L1 L3
3:Plot3...Off
  L1 L4
4↓PlotsOff
  
```

4. Set up the plot as shown by pressing **ENTER** **▾** **▶** **▶** **▶** **▶** **▶** **ENTER** **▾** **2nd** [L4] **ENTER** **ENTER**.

```

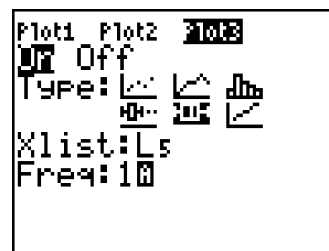
Plot1 Plot2 Plot3
Off Off
Type: L1 L2 L3
      L4 L5 L6
Xlist:L4
Freq:1
  
```

5. Press **2nd** [STAT PLOT] and select **3:Plot3** and press **ENTER**.

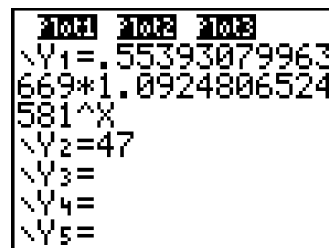
```

STAT PLOTS
1:Plot1...On
  L3 1
2:Plot2...On
  L4 1
3:Plot3...Off
  L1 L4
4↓PlotsOff
  
```

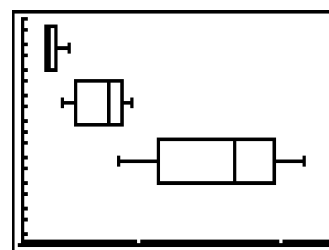
6. Set up the plot as shown by pressing $\boxed{\text{ENTER}}$
 $\boxed{\downarrow} \boxed{\rightarrow} \boxed{\rightarrow} \boxed{\rightarrow} \boxed{\rightarrow} \boxed{\text{ENTER}} \boxed{\downarrow} \boxed{2\text{nd}} \boxed{[L5]} \boxed{\text{ENTER}} \boxed{\text{ENTER}}$.



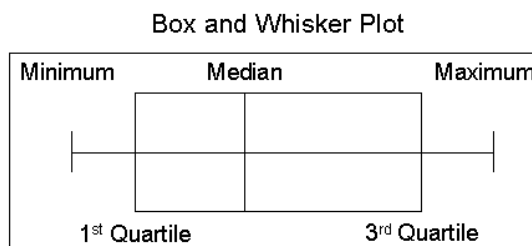
7. Turn OFF the equation in **Y1** and **Y2**. Press $\boxed{Y=}$ $\boxed{\leftarrow}$ $\boxed{\text{ENTER}}$. The equal sign should look like that for **Y3**.



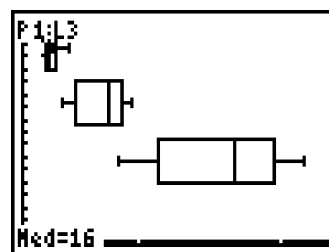
8. Press $\boxed{\text{ZOOM}}$.
 9. Press the up arrow $\boxed{\uparrow}$ or the down arrow $\boxed{\downarrow}$ to select **9:ZoomStat** and press $\boxed{\text{ENTER}}$ to observe the three box-and-whisker plots.



The box-and-whisker plots allow you to visualize the minimum, 1st quartile, median, 3rd quartile, and maximum values of a data list. (See the diagram of a box-and-whisker plot shown here.) You can easily make comparisons by viewing the plots of the three data sets.



10. Press $\boxed{\text{TRACE}}$. The cursor will be on Plot 1. By moving the cursor up and down, you can move from one plot to another. By moving the cursor left and right, you can move to different parts of the box-and-whisker plots. Examine these plots and provide the values for each plot on the **Data Collection and Analysis** page.



Answer questions 6 through 8 on the **Data Collection and Analysis** page.

Data Collection and Analysis

Name _____

Date _____

Activity 7: Now You See It, Now You Don't

Near Point Accommodation Data: Home Survey

Collecting the data

Age	Near Point Accommodation

Age Group	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
35 - 44 (L3)					
45 - 54 (L4)					
55 - 64 (L5)					

Analyzing the data

1. Describe the shape of the age versus near point accommodation plot. Is there a correlation between age and near point accommodation? Explain.

2. In which age group is the near point accommodation rising fastest: 35 - 44, 45 - 54, or 55 - 64? How can you tell by looking at the plot?

3. Write the exponential regression equation.

4. Does the exponential regression seem to fit your data? Explain. (Does it seem to fit some age groups better than others?)

5. A person with a near point accommodation of 47 cm is likely to be _____ years old according to the exponential regression.

6. What is the *median* near point accommodation of the three age groups analyzed?

7. Observe the width of the three box-and-whisker plots. Which plot has the largest width? Which plot has the smallest width? How do these widths relate to the exponential regression analyzed earlier? (**Hint:** Each box-and-whisker plot represents the same number of years – 10.)

8. Do the box-and-whisker plots overlap? If they do, what does this tell you about the near point accommodations of the three age groups that were analyzed?

Extensions

- ◆ Use a histogram to analyze the extent to which near point accommodation varies within your age group. The following table shows some sample data (nearest 0.1 cm).

7.1	6.5	9.3	6.2	8.7	9.0	7.7	8.1	8.3	7.8	8.9	8.8	6.9	9.1	7.5	8.3
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Examine the distribution of near point accommodations in your class.

Which near point accommodations are least common in your age group? Most common?

How could you adjust the window to study different distribution ranges within your age group?

Teacher Notes



Activity 7

Now You See It, Now You Don't

Objectives

- ◆ To study the relationship between age and near point accommodation
- ◆ To predict a person's age based on near point accommodation
- ◆ To use technology to study an exponential regression
- ◆ To use technology to create a box-and-whisker plot
- ◆ To use technology to create a histogram

Materials

- ◆ TI-83 Plus
- ◆ Metric ruler or meter stick
- ◆ String length: 1.5 meters

Preparation

- ◆ You may choose to use the near point accommodation data provided in the manual. If you decide to have your class collect the data, there are several ways to collate it. One option is to type the near point accommodation data directly into the TI-83 Plus in **L1** and **L2** and then share the data with the students by linking calculators. You may want to create a **GROUP** and store the data for easy recall. You may also want to print the data on a handout or put it on the chalkboard and have the students copy it onto their lists.
- ◆ Real studies relating age and near point accommodation (presbyopia) show a general increase with age, but the relationship is not neatly modeled mathematically. From ages 35 - 64, it is close to an exponential model.

Answers to Data Collection and Analysis questions

Collecting the data

- ◆ Sample data:

Age (years) – L1	Near point (cm) – L2	Age (years) – L1	Near point (cm) – L2
35	14	54	65
35	16	55	58
36	15	55	61
38	16	56	80
40	20	56	72
42	18	57	91
44	28	59	108
45	25	60	120
47	29	61	146
49	34	61	132
50	52	62	147
50	38	63	150
51	53	63	155
52	57	64	167
53	62	64	153

Analyzing the data

- Describe the shape of the age versus near point accommodation plot. Is there a correlation between age and near point accommodation? Explain.

The data will vary, but generally, one finds that it rises slowly at first and then more steeply in the upper age groups. As one's age rises, the near point accommodation rises, somewhat exponentially.

- In which age group is the near point accommodation rising fastest: 35 - 44, 45 - 54, or 55 - 64? How can you tell by looking at the plot?

One would expect the steepest rise to be in the 55 - 64 age group.

- Write the exponential regression equation.

Answers will vary depending on what data is used. For the data given in the manual, the regression is:

$$Y = (0.56) (1.1)^X$$

4. Does the exponential regression seem to fit your data? Explain. (Does it seem to fit some age groups better than others?)

Answers will vary depending on what data is used. Based on the data provided, the regression appears to fit the data, but clearly there are individuals that are off the regression line.

5. A person with a near point accommodation of 47 cm is likely to be ____ years old according to the exponential regression.

Answers will vary depending on the data used. According to the data provided, the age of the individual is approximately 50. However, if one examines the actual data, it is obvious that there is a fair amount of variation in near point accommodations at any given age.

6. What is the *median* near point accommodation of the three age groups analyzed?

Ages 35 - 44: Median is 16 cm.

Ages 45 - 54: Median is 52 cm.

Ages 55 - 64: Median is 126 cm.

7. Observe the width of the three *box-and-whisker* plots. Which plot has the largest width? Which plot has the smallest width? How do these widths relate to the exponential regression analyzed earlier? (**Hint:** Each box-and-whisker plot represents the same number of years – 10.)

The box-and-whisker plot is for a 10-year range. The higher the age, the wider the plot because in an exponential regression of age versus near point accommodation, as the age increases, the near point accommodation values increase at a faster rate.

8. Do the box-and-whisker plots overlap? If they do, what does this tell you about the near point accommodations of the three age groups that were analyzed?

The box-and-whisker plots will probably overlap, showing that there are subjects with the highest near point accommodation in one age group. They have higher near point accommodations than the youngest people in the next older age group.

