About the Lesson

In this activity, students will investigate the total cost of a private party at each of three restaurants. Each restaurant states its pricing information differently, but all charge a flat room fee, (represented by the *y*-intercept), plus a per guest plate fee (represented by the slope). Students will model the cost of a party at each restaurant with the graph of a linear function. As a result, students will:

- Graph an equation of the form $y = mx + b$ and display a table of values to find its *y*-intercept.
- Estimate and calculate the slope of a line using data in a table.
- Write the equation of a straight line given its slope and its *y*-intercept.
- Given the slope of a line and a point on it, use the point-slope form to write the equation of the line.
- Formulate linear models and use them to draw and report conclusions about the data to solve a problem.

Vocabulary

- linear
- slope-intercept form
- point-slope form

Teacher Preparation and Notes

- This activity is appropriate for students in Algebra 1. It is assumed that students have recently been introduced to the notions of slope, *y*-intercept, $y = mx + b$, and point-slope form.
- This activity is designed to have students explore **individually and in pairs**. However, an alternate approach would be to use the activity in a whole-class format. By using the questions found on the student worksheet, you can lead an interactive class discussion.
- The student worksheet guides students through the main ideas of the activity. You may wish to have the class record their answers on separate sheets of paper, or just use the questions posed to engage a class discussion.
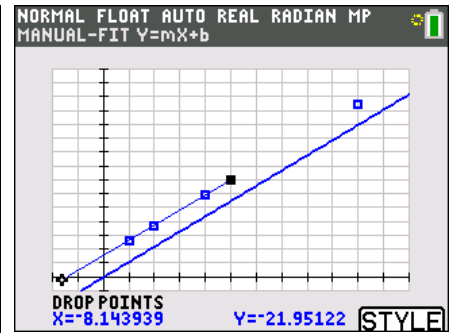
Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus C Silver Edition. It is also appropriate for use with the TI-84 Plus family with the latest TI-84 Plus operating system (2.55MP) featuring MathPrint ™ functionality. Slight variations to these directions given within may be required if using other calculator models.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

Compatible Devices:
- TI-84 Plus Family
- TI-84 Plus C Silver Edition

Associated Materials:
- DinnerParty_Student.doc
- Dinner_Party_Student.pdf

Students are given the following scenario on the student worksheet:

> Your boss asks you to plan a retirement party for one of your co-workers. You are comparing the cost of a dinner party at different restaurants. Each restaurant charges a flat room fee (no matter how many guests attend) and a per plate fee.

Problem 1 – Linear Bistro

The table shows the costs of a party at Linear Bistro for different numbers of guests. Let's investigate this data to determine the room fee and the per plate fee at Linear Bistro.

Guests, *G*	Cost, *C*
5	$ 260
10	$ 370
20	$ 590
25	$ 700
50	$ 1250

 1. In your group, predict what the equation of the line would be. Show your work to find the slope of the line.

Answer: Students should be encouraged to each estimate the relationship, or slope, between the number of guests and the cost of the party in dollars. Then the groups can try to use the points to find the slope.

Teacher Tip: Student should be encouraged to estimate the relationship between the number of guests and the cost of the party in dollars. Then, the groups can use the points to calculate the slope. This question can be helpful for formative assessment to determine what students know. Predicting and estimating a value can be a powerful method to engage students and encourage number sense. The exact answer is not as important at this point as productive conversation.

Tech Tip: On the TI-84 Plus C Silver Edition, turn on the GridLine by pressing 2nd ZOOM to change the [FORMAT] settings. Note that the GridLine feature is unique to the TI-84 Plus C Silver Edition.

Students are to enter the data in the chart in lists L1 and L2. To do this they can ress STAT ENTER to enter the data in lists L_1 and L_2. If necessary, clear any data in L_1 or L_2 . To do this, have students press ▲ to move the cursor onto L_1 and then press CLEAR ENTER.

Then, have students press WINDOW and change the
settings to those shown on their worksheet.

To set up the scatter plot, students should press 2nd
[STAT PLOT] and select **Plot1**. Then students should match
the settings as shown on the right.
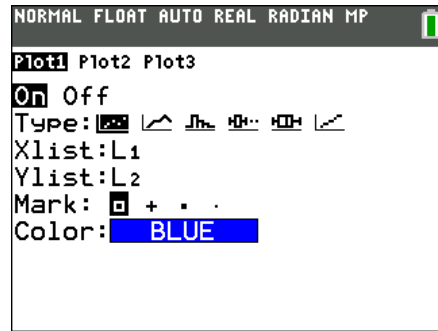
2. Look at the points in the scatter plot. Do you notice a
pattern in the plot?

Answer: The points are increasing a constant rate. It
looks like a linear relationship.

3. In list **L$_3$** calculate the change in *x*-values using
DeltaList(L$_1$). Find this operation by pressing 2nd STAT for
[LIST], select OPS, 7: ΔList(. Press 2nd 1 for **L$_1$**. In **L$_4$**
calculate the change in *y*-values using DeltaList(**L$_2$**). In **L$_5$**
calculate the ratio **L$_4$/L$_3$**. What do you notice?

Answer: The average rate of change is constant, and
in fact, the value is 22. This indicates the function is
linear.
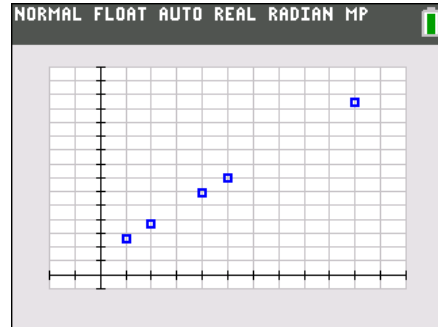
> **Teacher Tip:** Students can use the fraction template to calculate the slope.
> To do this, press ALPHA [F1] and select **n/d**. Then enter the numerator,
> press ▾, enter the denominator, and press ENTER. Note that when using
> the fraction template, students do not need to use parentheses in the
> numerator or denominator.

4. What are the units of the values in L5? (circle one)

    A. dollars   B. number of guests

    C. dollars per guest   D. number of guests per dollar

Answer: Choice C, dollars per guest

5. What does your answer to the previous question tell you
about the formula for the line?

Answer: Because the slope is 22, the Bistro charges 22
dollars per guest, or 22 dollars per plate.

6. **a.** How do the data points and the line shown to the right compare?

    Answer: The line shown in the figure has the same slope as a line that passes though the data points, but it passes through the origin.

b. What is the equation of this line? Enter the equation in **Y₁**.

    Answer: $y = 22x$

c. Use the **Manual-Fit Y=mX+b** command to draw a line through these data points. Press STAT CALC, **Manual-Fit Y=mX+b** and store your equation in **Y₁**. Use ALPHA [F4] to insert **Y₁**. Use the arrow keys to position a point on the screen, press ENTER and repeat. Type in values for m and b, using your value for the slope in Question 3 and the scale on the y-axis to estimate the y-intercept.

    Answer: The value of m is 22. Answers will vary, but the value of b should be close to 150.
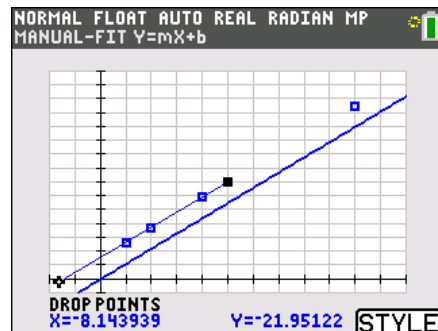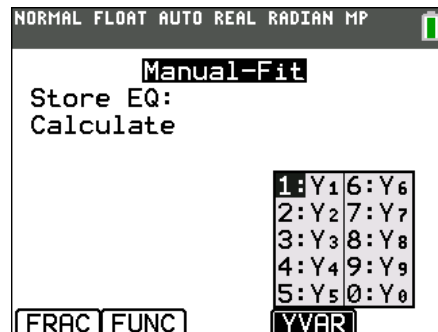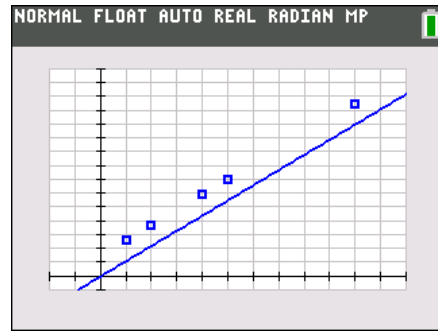
7. You have found that the formula for Linear Bistro can be written in the form $y = mx + b$.
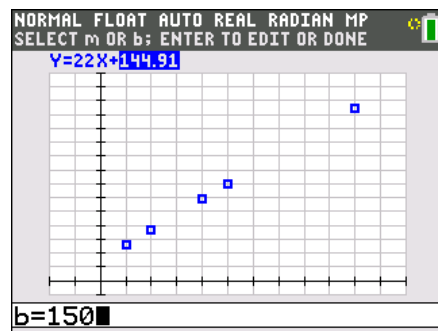
a. What is the value of m?

Answer: 22

b. Substitute a point (x, y) from the table to solve for b.

Answer: $370 = 22(10) + b$

              $370 = 220 + b$

              $150 = b$

c. What is the formula for the linear model which gives the cost *C* for a dinner with *G* guests? Graph your equation in Y1 to check your answer.

Answer: *C* = 150 + 22*G*

d. What is the room fee at Linear Bistro?

Answer: $150

8. How can you find the *y*-intercept in a function table?

Answer: Students can press [GRAPH] [TABLE] to view the function table and find the exact value of the *y*-intercept. They should remember that the value of *x* always equals 0 for the *y*-intercept.

9. Determine the cost for 30 guests.

Answer: $810. Students can use a table or evaluate the function *C* = 22(30) + 150.

Problem 2 – Straight Eight's Restaurant

Students are given the room fee and per plate fee for another restaurant. Students are to write an equation in *y*-intercept form and enter it into **Y₂**. Then they can view the graph.

Straight Eight's Restaurant charges a $100 room fee and $32 per plate.

10. How much would a dinner party for 10 people cost at Straight Eight's Restaurant?

Answer: $420

> **Tech Tip:** Remind students to turn off the scatter plot. To do this, they can press [2nd] [STAT PLOT], select **Plot1**, and press [ENTER], select Off and press [ENTER], or they can press [ENTER] on **Plot1** while on the [Y=] screen.

11. Write an equation in the form *y* = *mx* + *b* that models the cost of a dinner party at Straight Eight's Restaurant for *x* guests. Enter it as **Y₂** and view its graph. (Remember to turn off your scatter plot and equation in **Y₁** from Problem 1.)

Answer: *y* = 32*x* + 100

View the function table and use it to check your equation. Is the *y*-intercept correct? Does the value at *x* = 10 match your answer to Question 11?

```
NORMAL FLOAT AUTO REAL RADIAN MP
PRESS + FOR △Tbl
   X      Y2
  0      100
  1      132
  2      164
  3      196
  4      228
  5      260
  6      292
  7      324
  8      356
  9      388
 10      420

X=0
```

Problem 3 – First Degree Café

Students are given a price a restaurant charges for a party of 5 people and the per plate fee.

Students are to write an equation in point-slope form. Then they will simplify it to *y*-intercept form and enter it into **Y₃**. Then they can view the graph.

Once again students will use the function table to check the information given with their equation.

First Degree Café charges a whopping $800 for a party of 5 people. However, the cost per plate is only $10.

```
NORMAL FLOAT AUTO REAL RADIAN MP
PRESS + FOR △Tbl
   X      Y3
  0      750
  1      760
  2      770
  3      780
  4      790
  5      800
  6      810
  7      820
  8      830
  9      840
 10      850

X=0
```

12. Write an equation in point-slope form, $(y - y_1) = m(x - x_1)$, that models the cost of a dinner party at First Degree Café.

  Answer: $(y - 800) = 10(x - 5)$

13. Write the equation in the form $y = mx + b$. Graph it as **Y₃**.

 **Answer:** $y = 10x + 750$.

14. View the function table. Explain how to use it to check your equation.

  Answer: Students should look for the value of the function when *x* = 5. It should be 800.

15. Your boss plans to pay for all of the expenses and asks you which of these three restaurants is the least expensive. At present, the number of guests is unknown. What should you tell your boss? Be as specific as possible.

Answer: The restaurant with the lowest cost is modeled by the line in the graph that is below the other two. Students should find the intersection point of the red and blue lines and the blue and black lines. The red line (Straight Eight's Restaurant) in Y_2 is least expensive if only 5 or less guests attend. The blue graph (Linear Bistro) in Y_1 is best if between 5 and 50 guests attend. Notice the intersection point between the red Y_2 line and the black Y_3 line is not needed.
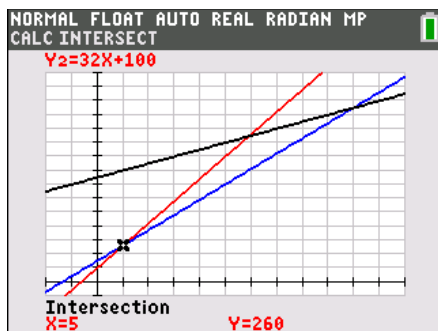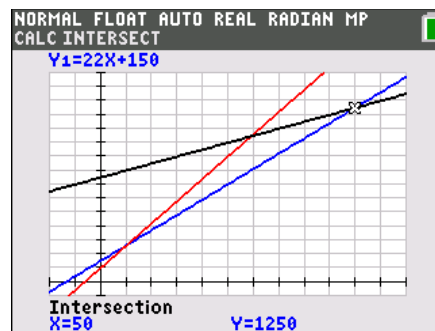
Solve $Y_1 = Y_2$	Solve $\quad\quad Y_1 = Y_3$
$22x + 150 = 32x + 100$	$22x + 150 = 10x + 750$
$10x = 50$	$12x = 600$
$x = 5$	$x = 50$

> **Teacher Tip:** Watch if students also find the intersection point of Y_2 and Y_3. To help students develop procedural fluency, discuss if this intersection point is meaningful to the solution of the problem. Representing the functions graphically enables students to decide which pairs of equations are needed.