

### Mathematics Objectives

- Students will model exponential growth.
- Students will graph equations of the form  $y = ab^x$ .
- Students will solve problems using exponential equations.
- Students will solve problems using compound interest.
- Students will solve problems involving exponential decay.

### Applications and Skills

#### Graphs

Coordinates and Equations  
Scatter Plot  
Function Graphing  
Intersection Point

#### Lists and Spreadsheets

Formula  
Cell Formula

### Materials

- TI-Nspire handhelds
- *Uncle Buck\$*  
(pages 198–200; page198.pdf)
- *More Buck\$*  
(pages 201–202; page201.pdf)
- *Compound Buck\$*  
(pages 203–205; page203.pdf)

### Starting the Lesson

**Note:** There is no TNS lesson file. (There is a solution file, solution14.tns) The students will be creating a new TNS file during this lesson.

To begin the exercise, instruct students to do the following:

1. Turn on the TI-Nspire by pressing **(on)**.
2. Press **(on)** and choose **New Document**.
4. Remind students how to navigate through the TNS file. To move forward through the pages, press **(ctrl) ▶**. To move backward through the pages, press **(ctrl) ◀**. To choose a particular page, press **(ctrl) ▲**, position the cursor on the desired page and press **(enter)**. To undo previous steps, press **(ctrl) Z** or **(ctrl) (esc)**. Show students that any time they are using a menu that they wish to exit, they should press **(esc)**.



**Note:** Page numbers refer to the TI-Nspire file lesson14 created in this lesson by students.

## Explaining the Concept

### Problem 1—Uncle Buck\$

**Step 1** Distribute copies of *Uncle Buck\$* (pages 198–200) to students so they can record their findings as appropriate during the instructional steps of this problem.

**Step 2** The students are creating an interactive spreadsheet that they will be able to adjust for different initial values and multiplication factors. Have students open a new Lists and Spreadsheet document. Have them name the first column *day* and the second column *dollars*. In the formula cell under *day*, have the students type in  $\text{seq}(n,n,0,10)$ .

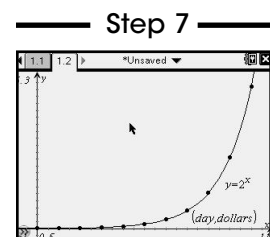
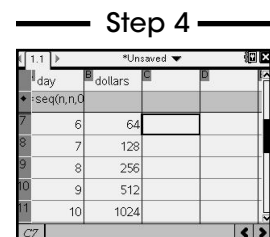
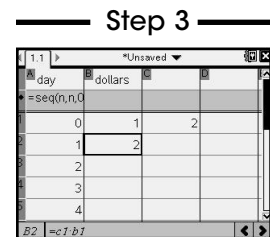
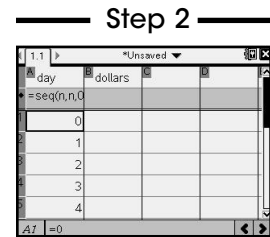
**Step 3** Students enter 1 into cell B1 for the initial value and 2 in cell C1 to serve as the multiplication factor. Type in the formula  $=C1 \cdot B1$  into cell B2. Explain to students that the spreadsheet will multiply the contents of these cells even if they are changed. Ask students to change values for C1 and B1 to see that the formula keeps working. Have them change the values back to 1 and 2.

**Step 4** Help students work out that the formula for each cell in *dollars* is C1 times the B cell above. The number for the B cell is the same as the adjacent number in *day*.

**Step 5** On the chart on question 2a, help students identify the total number of times that 2 has been used as a factor for each value in *dollars*. They should notice that it is the same as the number in *day*. For the powers of two, discuss the meaning of  $2^0$ . To write the formula in 2b, help them see that they are just replacing the number for *day* with  $x$ .

**Step 6** To create the scatter plot in question 2c, have students insert a new Graphs page. Then, press  $\left(\text{menu}\right)$  and choose **Graph Type** and then **Scatter Plot**.

**Step 7** The pop-up menu for  $x$  is automatically highlighted. Press  $\left(\text{var}\right)$  and move to *day*, press  $\left(\text{tab}\right)$  to select it. Move to  $y$  by pressing  $\left(\text{tab}\right)$ . Press  $\left(\text{var}\right)$  and move to *dollars*. Press  $\left(\text{tab}\right)$  to select it. Press  $\left(\text{tab}\right)$  until the cursor has moved to the graph. Use the Zoom Data option by pressing  $\left(\text{menu}\right)$  and choosing **Window/Zoom** and then **Zoom–Data**. Press  $\left(\text{ctrl}\right)\left(\text{G}\right)$  to close and open the Function Editor.

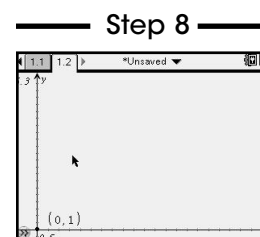


**Note:** Page numbers refer to the TI-Nspire file *lesson14* created in this lesson by students.

### Explaining the Concept

#### Problem 1—Uncle Buck\$ (cont.)

**Step 8** In 2d, have the students find the intersection of the  $y$ -axis. (See page 230 for detailed instructions on finding an intersection point.) The point of intersection is not obvious because it was also a point on the scatter plot. Hide the graph and the scatter plot. (See page 238 for detailed instructions on hiding graphs.) Find the coordinates. (See page 245 for detailed instructions on using the Coordinates and Equations tool.) Emphasize that the  $y$ -coordinate of the ordered pair  $(0, 1)$  is the  $y$ -intercept because the  $x$ -coordinate is 0. Ask the students to explain why this is the initial value, the value on day 0.



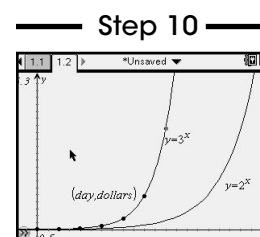
**Step 9** In 3a, explain that when the students change spreadsheet cell C1 to 3 on page 1.1, all of the formulas in *dollars* use 3 for the factor and each value is 3 times the previous value.

**Step 9**

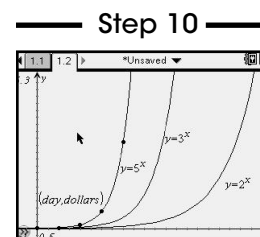
day	dollars	
0	1	3
1	3	
2	9	
3	27	
4	81	

**Step 10** Students should notice that  $y = 3^x$  and  $y = 5^x$  have the same  $y$ -intercept as  $y = 2^x$  but are steeper.

**Step 11** In question 4, students should see that changing cell B1 changes the  $y$ -intercept of the graph and requires an equation of the form  $y = ab^x$ .



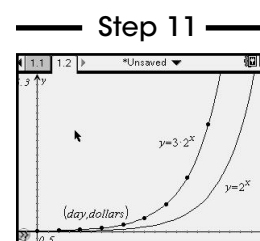
**Step 12** Instruct students to save this work by pressing  $\text{ctrl}$   $\text{S}$  and typing the filename *lesson14*.



#### Problem 2—More Buck\$

**Step 1** Distribute copies of *More Buck\$* (pages 201–202) to students so they can record their findings as appropriate during the instructional steps of this problem.

**Step 2** Column D, *dollar1*, will contain the total amount the student has each day. It is designed to help students get ready for the idea of compound interest. The formula for each cell in *dollar1* will multiply the number above it times the factor in C1. The formula in D2 is  $= c1 \cdot d1 + d1$ .



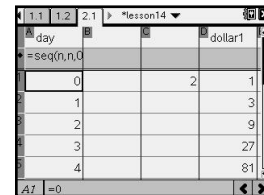
**Note:** Page numbers refer to the TI-Nspire file *lesson14* created in this lesson by students.

## Explaining the Concept (cont.)

### Problem 2—More Buck\$ (cont.)

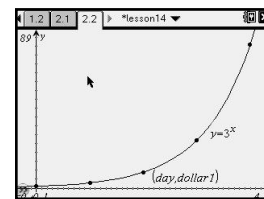
- Step 3** In the table on question 3, help students with the *Sum* column. They should see that each term is  $2 \cdot (\text{above}) + 1 \cdot (\text{above})$  and, using the distributive property, this is  $3 \cdot (\text{above})$ . This is a very important step before students consider compound interest in *Compound Buck\$*.
- Step 4** Students will need to resize column D to see the values in the lower cells. To resize the column, move the cursor to the top of the column until the column is highlighted. Press **menu** and choose **Actions**, then **Resize**, and finally **Resize Column Width**. Move the cursor to the right until there is enough room to see the lower values and then press **enter**.
- Step 5** Have students insert a Graphs page for the scatter plot of *day* vs. *dollar1*.
- Step 6** Help students see that these equations are of the form  $y = a(b + 1)^x$ . The  $+ 1$  comes from the adding in of the previous sum. On question 5, ask the students another way to write  $y = 4(4)^x$ .
- Step 7** Remind students to save their work by pressing **ctrl** **S**.

#### Step 3

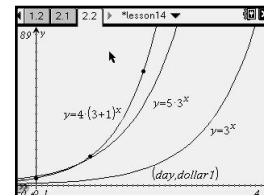


day	dollar1
0	1
1	3
2	9
3	27
4	81

#### Step 5



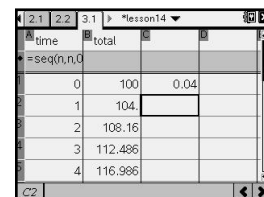
#### Step 6



### Problem 3—Compound Buck\$

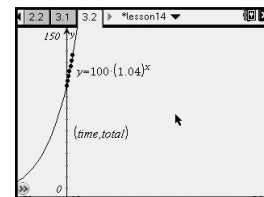
- Step 1** Distribute copies of *Compound Buck\$* (pages 203–205) to students so they can record their findings.
- Step 2** This investigation uses the TI-Nspire skills and the mathematics from *Uncle Buck\$* and *More Buck\$*. Since students are using the same document, have them insert a new problem. Students will name lists and create formulas as they did in previous exercises. The formula in cell B2 should be  $=B1 + C1 \cdot B1$ .
- Step 3** In question 1d, the scatter plot looks almost linear when the Zoom-Data option is used. Have students change the window settings so that the Ymin is 0, the Ymax is 150, the Xmin is -50, and the Xmax is 200.

#### Step 2



time	total
0	100
1	104
2	108.16
3	112.486
4	116.986

#### Step 3



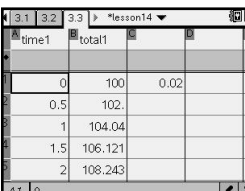
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### Applying the Concept

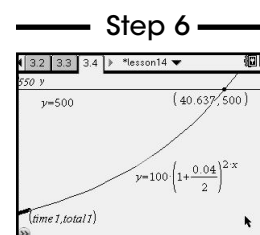
#### Problem 3—Compound Buck\$ (cont.)

- Step 4** In question 2, help students see the factoring as  $.04(\text{above}) + \text{above} = 1.04(\text{above})$ , and then write the exponential expression. Show them that the equation is  $y = 100(1.04)^x$  where  $x$  is the number of years that have elapsed. Discuss the use of compound interest in banking.
- Step 5** In question 3, point out that interest rates are always expressed in terms of annual rates. If the interest is compounded twice a year, then the customer will receive that rate every six months. In the formula  $A = P(1 + \frac{r}{n})^n$ , point out that the rate is divided by  $n$  just as the 4% was divided by 2 for semi-annual, and the number of years is multiplied by  $n$  because it represents the number of compounding periods that have elapsed.
- Step 6** In question 3e, remind students that they can find out when the account will exceed \$500 by graphing  $y = 500$  on the same graph and finding the point of intersection. (See page 230 for detailed instructions on finding an intersection point.) Note: The window settings will need to be adjusted.

**Step 5**



time1	total1	
0	100	0.02
0.5	102	
1	104.04	
1.5	106.121	
2	108.243	



#### Differentiation

- **Below Grade Level**—Have students work in small groups to complete *Compound Buck\$* (pages 203–205). Observe groups closely providing instruction as needed.
- **Above Grade Level**—After completing *Compound Buck\$* (pages 203–205) have students write a paragraph explaining in detail how they answered question 3. Then, have students exchange paragraphs with partners. They should use one another's paragraphs to check their own work and see if they answered the question correctly.

### Extending the Concept

- Have students find examples of graphs showing exponential growth in newspapers and magazines.