**Percent Change and Exponential Functions**

**Growth of Cell Phones**

1. Cell phones were introduced in the United States in the mid-1980s. In 1985 (time 0), there were 300,000 cell phones in use. The number of cell phones then increased by about 50% each year for the next several years.
2. Fill in the table to show approximately how many cell phones were in use in the U.S. in the years following 1985.



|  |  |
| --- | --- |
| **Years after 1985** | **Number of cell phones in the U.S.** |
| 0 |  |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |

1. What is the growth factor you can use to calculate

the number of cell phones in the U.S. the

next year?

1. Make a graph of your data on the grid.

Scale and label the axes appropriately.

1. What is the *y*-intercept of your graph? What does it mean in this situation?
2. Describe the function pattern you see in the table and the graph.
3. Use what you know about this kind of function to write an equation that models this situation. Be sure to identify the variables you use.
4. Use your equation to predict how many cell phones there would have been in the year 1995.
5. Do you think that your estimate in (g) is accurate? Why or why not? (Think: How many people lived in the United States in 1995?)
6. Use your equation to predict how many cell phones there will be in the year 2015.
7. Do you think that your estimate in (i) is accurate? Why or why not?

**Efficacy of Organic Pesticide**

1. An agricultural student is testing a new organic pesticide. The manufacturer of the pesticide claims the pesticide reduces the number of crop eating insects by 90% at each application without causing harm to the environment. The student estimates the number of insects in a test plot and then sprays the test plot once a day. She does this for three days. The results are found in the table below.

|  |  |
| --- | --- |
| **Number of Days** | **Number of Insects Remaining** |
| 0 | 200 |
| 1 | 20 |
| 2 | 2 |
| 3 | 0 |

1. Do these results confirm the claim? Explain how you know.
2. What is the equation that models this relationship between number of insects and time?
3. Suppose the student tries this pesticide on a plot with 1,000,000 insects. Assume the claim is true and the pesticide reduces the number of insects by 90% each day. How many insects will be left after 3 days?
4. If the pesticide reduces the number of insects by 90% each day, how many days will it take for there to be no insects left on this plot? Justify your answer.

**Summary**. When amounts change by the same percent after a given unit of time, we can use the percentage rate, *r*, to find a single growth factor or decay factor to get the new amount. If we want to know the new amount after *x* units of time, we just use the growth factor (or decay factor) on the original amount *x* times. Instead or writing out the multiplication over and over again, we use the fact that an exponent indicates repeated multiplication. Let’s look more closely at our two examples.

**Cell Phones:** Cell phones were introduced in the United States in the mid-1980s. In 1985

(time 0), there were 300,000 cell phones in use. The number of cell phones then increased by about 50% each year for the next several years. (**Growth factor = 1 + 0.50 = 1.50**)

After 1 year 300,000(1.5) = 300,000(1.5)1 = 450,000

After 2 years (300,000(1.5))∙(1.5) = 300,000(1.5)2 = 675,000

After 3 years (300,000(1.5)(1.5))∙(1.5) = 300,000(1.5)3 = 1,012,500

After 4 years (300,000(1.5)(1.5)(1.5))∙(1.5) = 300,000(1.5)4 = 1,518,750

After ***x* years** **300,000 ∙ (1.5)(1.5)(1.5)∙ ∙ ∙ (1.5) = 300,000(1 + 0.5)x = 300,000(1.5)x**

*x* times

**Organic Pesticide**: An agricultural student is testing a new organic pesticide. It is claimed that the new organic pesticide reduces the number of crop eating insects by 90% each day when applied daily without causing harm to the environment. Suppose there are 1,000,000 insects on a certain plot to start. (**Decay factor = 1 – 0.90 = 0.10**)

After 1 day 1,000,000(0.1) = 1,000,000(0.1)1 = 100,000

After 2 days (1,000,000(0.1))∙(0.1) = 1,000,000(0.1)2 = 10,000

After 3 days (1,000,000(0.1)(0.1))∙(0.1) = 1,000,000(0.1)3 = 1,000

After 4 days (1,000,000(0.1)(0.1)(0.1))∙(0.1) = 1,000,000(0.1)4 = 100

After ***x* days** **1,000,000 ∙ (0.1)(0.1)(0.1)∙ ∙ ∙ (0.1) = 1,000,000(1 – 0.9)x = 1,000,000(0.1)x**

*x* times

1. Suppose cell phone usage increased by 40% each year instead of 50%. Write an expression for the number of cell phones after *x* years.
2. Suppose the organic pesticide reduced the number of crop-eating insects by 85% each day instead of 90%. Write an expression for the number of insects left after *x* days.