Student: ______________________ Class: ______________________ Date: ______________________

Using Functions in Models and Decision Making: Step and Piecewise Functions

V.C Student Activity Sheet 10: Concentrations of Medicine

Part A

Have you ever taken a medication that your doctor warned you would not take effect for a few days? In this activity, you will investigate why that is the case.

Consider the allergy medicine Sneeze-B-Gone. The regular adult dose is 20 milligrams. As with all medicines, the body gradually filters Sneeze-B-Gone out of the bloodstream. The rate at which the medicine is filtered out is called the *flush rate*. For Sneeze-B-Gone, the flush rate is 30%. In other words, 24 hours after the pill is taken, 30% of Sneeze-B-Gone has flushed out of the body.

1. If 30% of Sneeze-B-Gone has flushed out of the body after 24 hours, what percent of Sneeze-B-Gone remains?

2. Use your calculator's recursion feature to fill in the table below, assuming that an adult is taking one 20-milligram dose per day.

3. At what value does the amount of Sneeze-B-Gone in the bloodstream level off? How many days does it take for that to happen?

4. What type of function could model the amount of Sneeze-B-Gone in the bloodstream as a function of time? Explain your choice.

5. What would you expect a graph of the amount of Sneeze-B-Gone in the bloodstream as a function of time to look like? Explain your prediction.

Day	**Sneeze-B-Gone in Bloodstream (in mg)**
1	20
2	34
3	43.8
4	
5	
6	
7	
8	
9	
10	

Day	**Sneeze-B-Gone in Bloodstream (in mg)**
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

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6. Recall that the general form for exponential decay functions is $y = a(b)^x$, where a represents the starting amount of the substance and b represents the rate of decay. For a 20-milligram dose and a 30% flush rate, what exponential function could describe the amount of Sneeze-B-Gone in the bloodstream (y) as a function of time (x)? (Do not forget that b represents the percent of Sneeze-B-Gone that remains in the bloodstream.)

7. Since the patient did not begin taking the medicine until Day 1, adjust your function rule by subtracting 1 from the exponent. Graph the function on your graphing calculator. Sketch your graph and describe your viewing window.

8. If time (x) is given in terms of the number of days, what happens to the amount of Sneeze-B-Gone in the patient's bloodstream at the start of Day 2 when the patient takes a second pill? How does this affect the graph?

9. Use what you learned about step and piecewise functions in previous activities to restrict the domain of the graph. Sketch your new graph.

10. For Day 2, enter the function $y = 34 \bullet 0.7^{x-1}$ into your calculator. What do the constants 34, 0.7, and 2 represent? Sketch the new graph.

11. Based on the functions for Day 1 and Day 2, write a function from the data in your table for Day 3 and a function for Day 4.

12. Graph both of these new functions. What patterns do you notice? What do you expect the graph for Day 5 to look like?

13. Test your prediction by writing a function for Day 5.

14. **REFLECTION:** Assume the patient takes 20 milligrams of Sneeze-B-Gone every day. If you extend the graph to Day 20 or beyond, what would the minimum amount of Sneeze-B-Gone in the bloodstream be? The maximum amount?

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Part B

1. Suppose a patient requires a 30-milligram dose of Sneeze-B-Gone. Use home screen recursion on your calculator to fill in the table.

Day	Sneeze-B-Gone in Bloodstream (in mg)	Day	Sneeze-B-Gone in Bloodstream (in mg)
1	30	11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9		19	
10		20	

2. At what value does the amount of Sneeze-B-Gone in the bloodstream level off? How many days does it take for that to happen?

3. How does the function rule for the 20-milligram dose change for a 30-milligram dose? Write the new function rule for the portion of the graph between Day 1 and Day 2.

4. How do you think those changes would affect the graph of the new function rule?

5. Use your graphing calculator to test your prediction. Sketch your graph.

6. When the amount of Sneeze-B-Gone in the bloodstream levels off for a patient taking a 30-milligram daily dose, what are the minimum and maximum amounts of Sneeze-B-Gone in the bloodstream within a given day?

7. Suppose a patient requires a 40-milligram dose of Sneeze-B-Gone. Based on what you have observed so far, what would you expect the function rule and graph to look like?

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8. Use recursion on your calculator to fill in the table.

9. At what value does the amount of Sneeze-B-Gone in the bloodstream level off? How many days does it take for that to happen? You may need to extend the values in the table.

10. How does the function rule for the 30-milligram dose change with a 40-milligram dose? Write the new function rule for the portion of the graph between Day 1 and Day 2.

11. How do you think those changes would affect the graph of the new function rule?

12. Use your graphing calculator to test your prediction. Sketch your graph.

Day	**Sneeze-B-Gone in Bloodstream (in mg)**	**Day**	**Sneeze-B-Gone in Bloodstream (in mg)**
1	40	11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9		19	
10		20	

13. When the amount of Sneeze-B-Gone in the bloodstream levels off for a patient taking a 40-milligram dose, what are the minimum and maximum amounts of Sneeze-B-Gone in the bloodstream within a given day?

14. **REFLECTION:** How does an increase in dose affect the amount of Sneeze-B-Gone in the bloodstream when the amount levels off?

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15. Fill in the table below. What relationships do you notice?

Dose	**Flush Rate**	**Leveled-off Amount**	$\frac{\textbf{Dose}}{\textbf{Flush Rate}}$
20			
30			
40			

16. REFLECTION: If you were a doctor or nurse and you knew that a patient needed to have about 100 milligrams of Sneeze-B-Gone in his bloodstream for the medicine to be effective, what dose would you prescribe? Explain your decision.

17. EXTENSION: A new cholesterol-lowering medicine has a flush rate of 50%. For a 20-milligram dose of this medicine, how do the function rules and graph compare to those for the 20-milligram dose of Sneeze-B-Gone with a flush rate of 30%? Use your graphing calculator to investigate. Present your work to the class.