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| Real data rarely fits a mathematical model \_\_\_\_\_\_\_\_. We need to find a model that best fits the data collected.  **KEY WORDS**  Perfectly  best  first  second  differences  growth/decay  scatter  regression  statistical  100  To help decide which model might be **\_\_\_\_\_\_\_** to use when modeling data, you can:   1. Examine the \_\_\_\_\_\_ and \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ and the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ factors 2. Create a \_\_\_\_\_\_\_\_ plot of the data 3. Look at the R2 value of a \_\_\_\_\_\_\_\_\_\_ model. R2 is a \_\_\_\_\_\_\_\_\_\_\_\_ measure of how close the data are to the fitted regression line. R2 is always between 0 and \_\_\_\_%. |

**Identifying Relationships in Data**

***EXAMPLE 1*** Electrical appliances such as a VCR or digital clock contain a capacitor for power during brief electrical outages. The table shows how the voltage in a capacitor decreases over time after a power outage.

Which type of relationship seems to exist between voltage and time? Justify your answer.

a) Determine the 1st, 2nd differences and Decay factor since the Voltage levels are decreasing.

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| **Time (s)** | **Voltage (V)**  7 – 9 = -2  **1st Differences**  **2nd Differences**  7 / 9 =  **Decay Factor** |
| 0 | 9.0 |
| 2 | 7.0 |
| 4 | 5.2 |
| 6 | 3.9 |
| 8 | 3.0 |
| 10 | 2.3 |

The 1st differences are \_\_\_ the same; therefore, it is \_\_\_\_\_\_\_ **linear relationship**.

The 2nd differences are \_\_\_ the same; therefore, it is \_\_\_\_\_\_ **quadratic relationship**.

Decay factor is almost the \_\_\_\_\_\_\_\_\_; therefore, it is **exponential relationship**.

**EXAMPLE2:** In a science experiment, students punched a hole near the bottom of a 2-L pop bottle. They filled the bottle with water and measured how the water level changed over time. The results are shown in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **x- axis**  **Time (s)** | 0 | 25 | 50 | 75 | 100 |
| **y-axis**  **Water Level (cm)** | 30.0 | 22.3 | 16.1 | 11.2 | 7.8 |

Using **DESMOS graphing calculator (either download or go to desmos.com)**, find a model for the data:

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| * Click , then choose table. * Using the table above, enter the values for time in the x1 column and values for water level in the y1 column. * To see the scatter plot, zoom out. * Click on the 2nd line below your tableto enter the following: * Type y1~mx1+b. This is how it should look like on your screen * In the table below record r2, this is called regression; calculate the percentage by multiplying r2 by 100. * Record m and b values, finally form your equation by substituting the numerical values for m and b. * We are done with linear model. Now let’s enter the values for quadratic model to see if the data fits the quadratic model more than the linear one. * Type y1~ax12 + bx12 + c. It should look like this: * In the table below, record r2; calculate percentage, and write the equation. * Finally, we will check the exponential modal. * Type y1~abx1. It should look like this: * Write the equation in the table below. |

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|  | **LINEAR** | **QUADRATIC (Polynomial)** | **EXPONENTIAL** |
| **r2** |  |  |  |
| **Percentage r2 x 100** |  |  |  |
| **Equation** | m = b =  y = mx + b | a = b =  c =  y = ax2 + bx + c | a = b =  y = abx |

c) Which model best represents the data? Justify your answer.

d) Examine the graph in desmos. How long does it takes the water to stop flowing? \_\_\_\_\_

e) What was the initial height of the water? \_\_\_\_\_\_

f) What is the height of the hole? \_\_\_\_\_\_

g) Using the formula, calculate the height of the water level when time is 120 seconds.