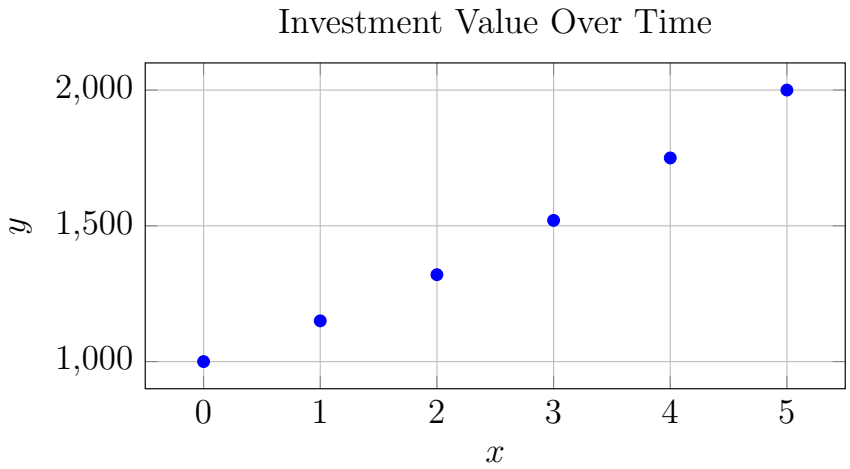
MA103: Mathematical Modeling
Model Assessment II **08 October 2025**

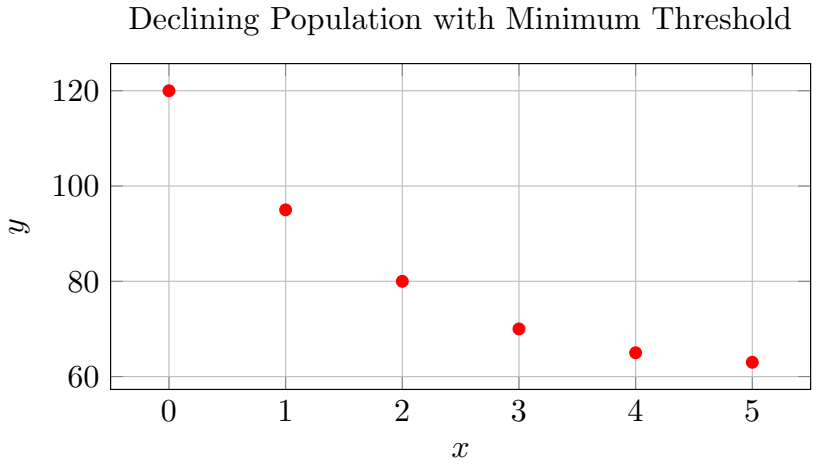
Warm-Up:



The value of an investment compounding over several years.

Write the functional form: $y =$ _____

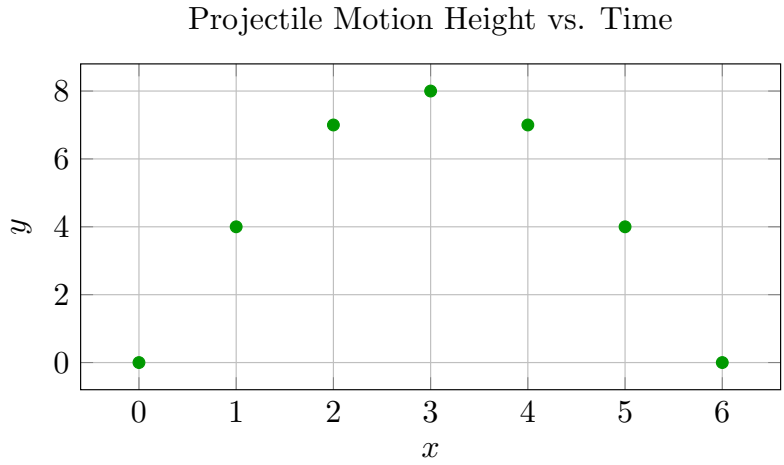
Determine parameters: _____



A shrinking population that approaches a minimum sustainable level.

Write the functional form: $y =$ _____

Determine parameters: _____



The height of a projectile at different times after launch.

Write the functional form: $y =$ _____

Determine parameters: _____

Example Problem:

An logistics officer is studying how the weight of supplies loaded onto a truck (x, in tons) affects the truck's fuel efficiency (y, in miles per gallon). The officer develops a linear model to predict fuel efficiency based on load weight:

$$\hat{y} = 10 - 0.6x$$

To test this model, the officer collects data from several trial runs:

x (tons of load)	y (observed MPG)	Error $(y - \hat{y})$
2	9.0	
4	7.3	
6	5.9	
8	4.5	

1. Use the model $\hat{y} = 10 - 0.6x$ to calculate the predicted fuel efficiency $\hat{y}$ for each load.
2. Compute the error $(y - \hat{y})$ for each trial and fill in the table.
3. Finally, calculate the **Sum of Squared Errors (SSE)** using:

$$\text{SSE} = \sum (y - \hat{y})^2$$

Interpretation: A smaller SSE means the model predicts the truck's fuel efficiency more accurately under different load conditions.

Practice Problem:

1. A team is testing how quickly a cup of hot coffee cools in a standard office environment. They want to model the temperature drop and use it to decide how long coffee remains at a "drinkable" temperature (above 55°C). Based on first principles, cooling is often modeled with a logarithmic or exponential decay. Use the data to:

- Plot the data on the board. What type of model do you suggest using?
- Use the visual to estimate the parameters of your model.
- Justify your model selection based on physics and fit.
- Estimate when the coffee falls below 55°C and if that prediction is reliable.

Time (min)	Coffee Temp (°C)
1	89.4
2	74.5
3	62.5
4	54.3
5	50.6
6	45.3
7	42.2
8	39.7
9	38.2
10	36.4