

# Graphing Calculations

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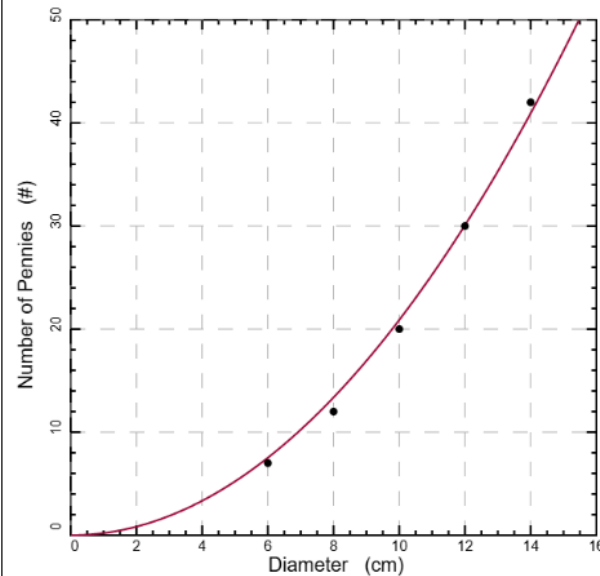
IB PHYSICS | SCIENCE SKILLS

# Using a Mathematical Model | 1

Data Table

x data	y data
Diameter (cm)	# of pennies
6	7
8	12
10	20
12	30
14	42

Graph with Line of Fit



Roughly how many pennies would fit in a 50-cm diameter circle?

$$\begin{aligned}
 p &= 0.209D^2 \\
 &= 0.209 \times 50^2 \\
 &= 522 \text{ pennies}
 \end{aligned}$$

Select a model

- Proportional ( $y = Ax$ )
- Linear ( $y = Ax + B$ )
- Square Law ( $y = Ax^2$ )**
- Inverse ( $y = A/x$ )
- Inverse Square ( $y = A/x^2$ )

A = **0.209**

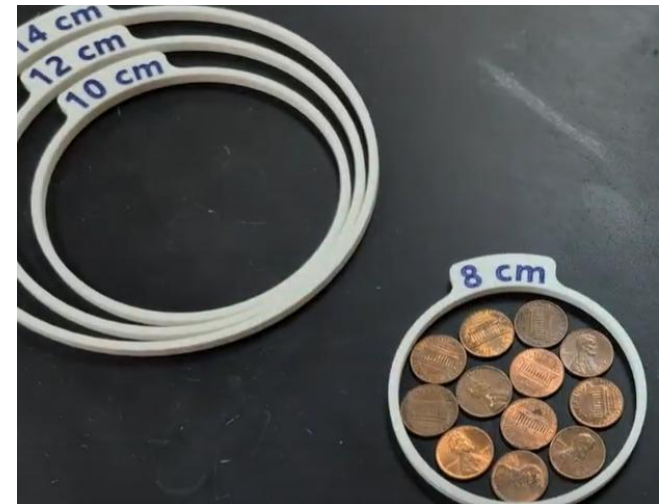
y → p (pennies)

x → D (diameter)

Best fit equation with substitutions

$$y = Ax^2$$

$$p = 0.209D^2$$

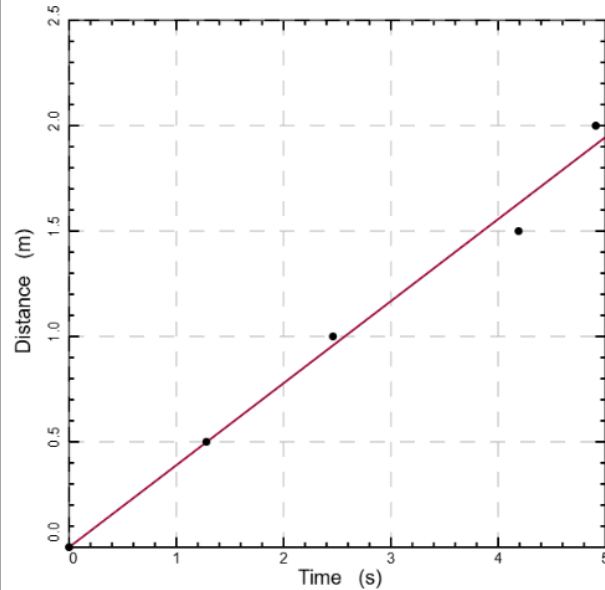


# Using a Mathematical Model | 2

Data Table

x data	y data
Time (s)	Distance (m)
0	0
1.28	0.5
2.46	1.0
4.19	1.5
4.91	2.0

Graph with Line of Fit



How long would it take this toy car to travel 400 m?

$$d = 0.389t$$

$$400 = 0.389t$$

$$t = \frac{400}{0.389} = 1028 \text{ s} \\ = 17.1 \text{ min}$$

Select a model

- Proportional ( $y = Ax$ )**
- Linear ( $y = Ax + B$ )
- Square Law ( $y = Ax^2$ )
- Inverse ( $y = A/x$ )
- Inverse Square ( $y = A/x^2$ )

A = **0.389**

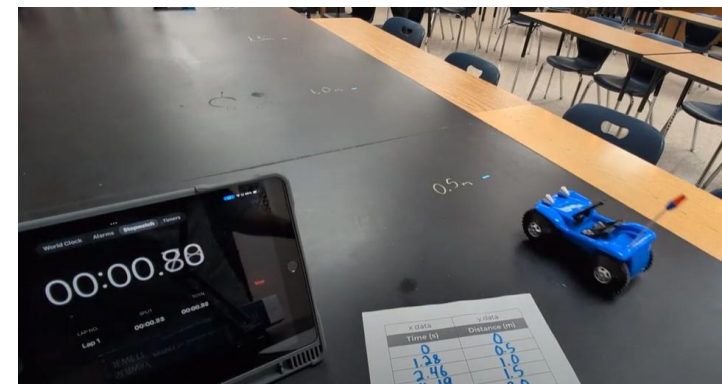
y → d (distance)

x → t (time)

Best fit equation with substitutions

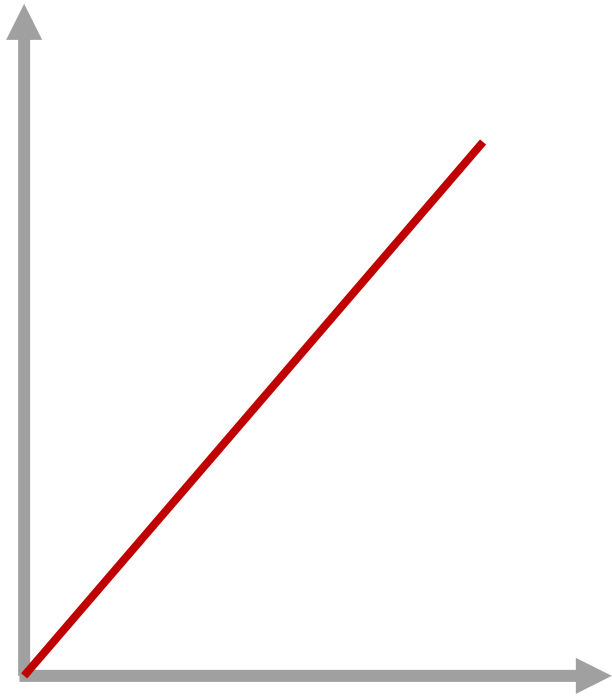
$$y = Ax$$

$$d = 0.389t$$



# Slope

$$\frac{\textit{rise}}{\textit{run}} = \frac{y}{x}$$

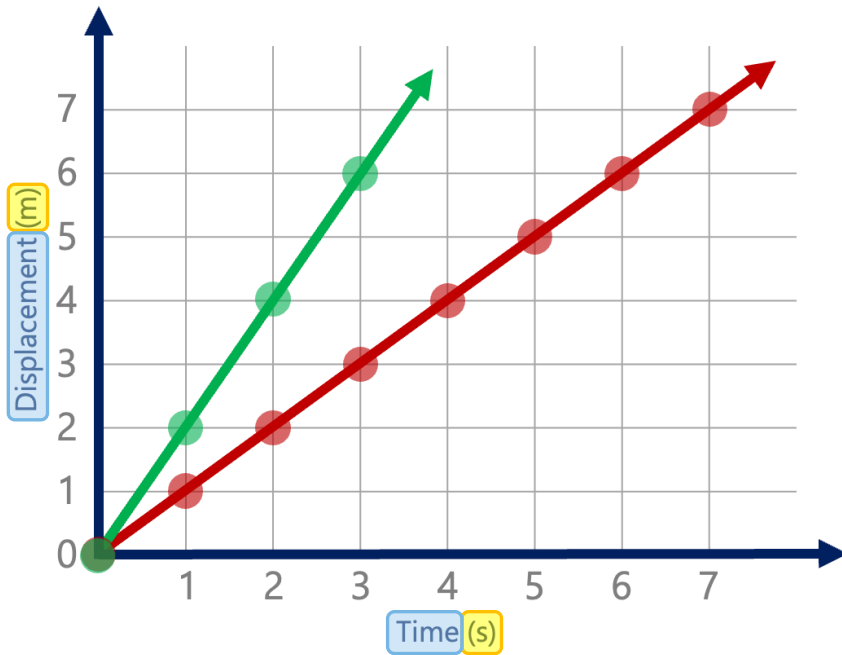


**Equation**

**Value**

**Units**

# Slope as Velocity



**Equation**

$$\frac{\text{displacement}}{\text{time}}$$

**Value**

$$\frac{1}{1} = 1$$

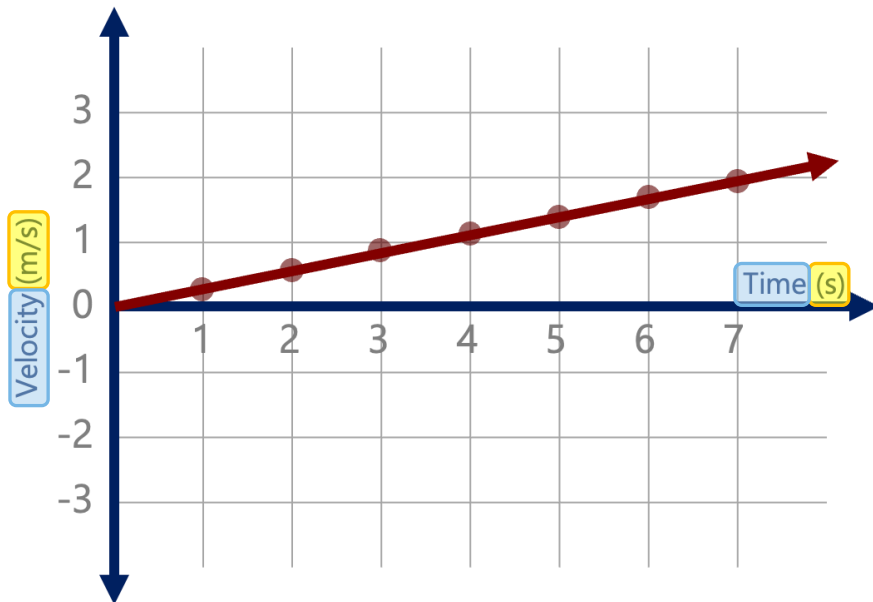
**Value**

$$\frac{2}{1} = 2$$

**Units**

$$\frac{\text{meters}}{\text{second}} = \frac{\text{m}}{\text{s}}$$

# Slope as Acceleration



**Equation**

$$\frac{\text{velocity}}{\text{time}}$$

**Value**

$$\frac{2}{7} = 0.29$$

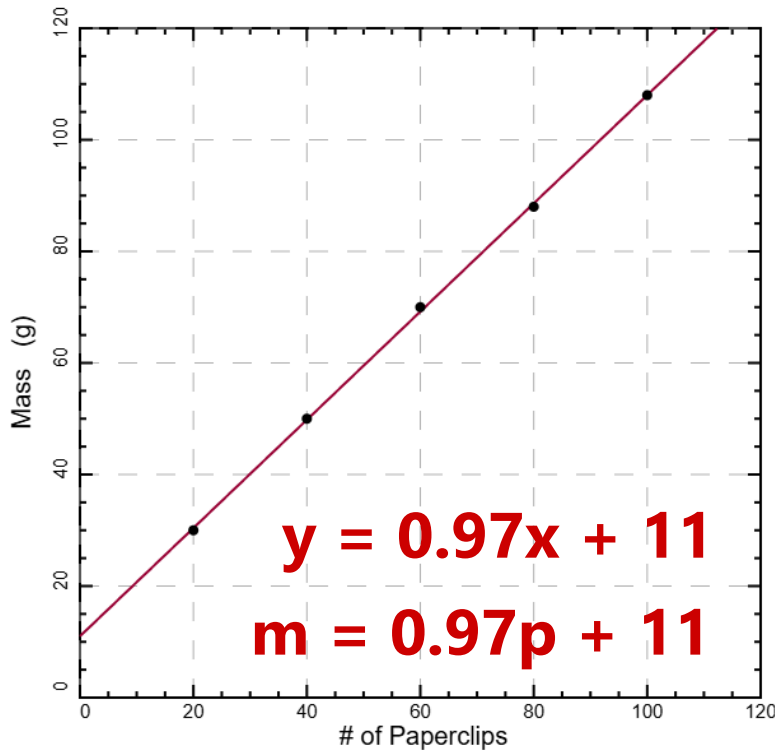
**Units**

$$\frac{m/s}{s} \quad m/s/s$$
$$m/s^2$$

# Y-Intercept has Meaning Too!



Graph of paperclip boxes with different numbers of paperclips



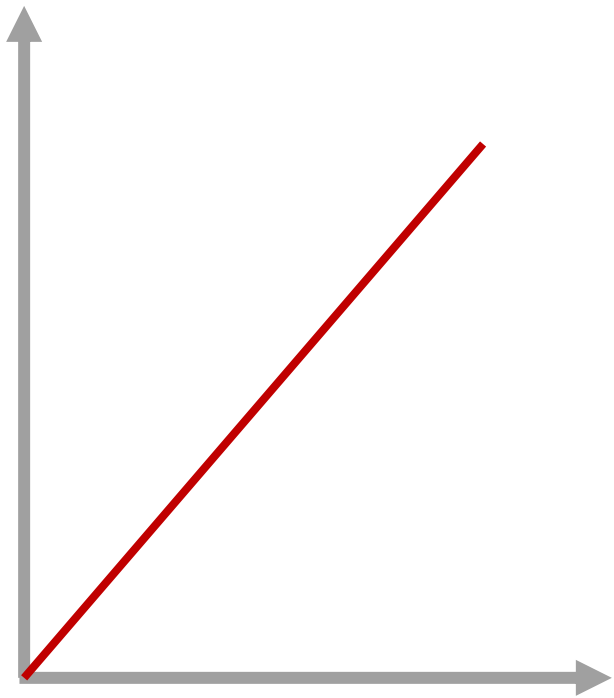
**Slope**

**Y-Intercept**

<b>Value</b> (with units)	0.97 g/paperclip
<b>Meaning</b>	Average mass of a single paperclip
<b>Value</b> (with units)	11 g
<b>Meaning</b>	Mass of the paperclip box

# Area

$$y \times x$$

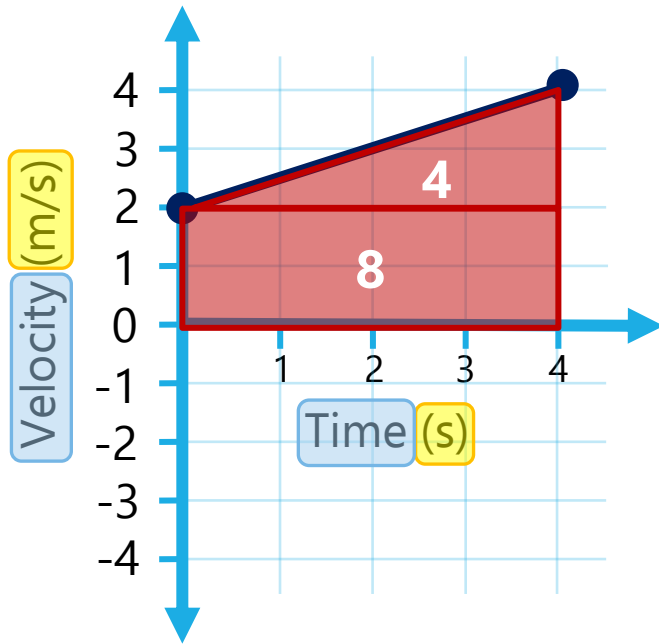


**Equation**

**Value**

**Units**

# Area as Displacement

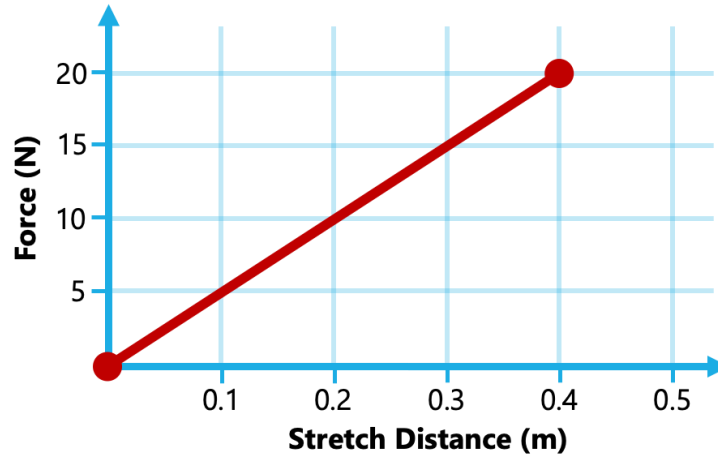


**Equation**  $velocity \times time$

**Value**  $8 + 4 = 12$

**Units**  $\left(\frac{m}{s}\right) \times s = m$

# Try it...



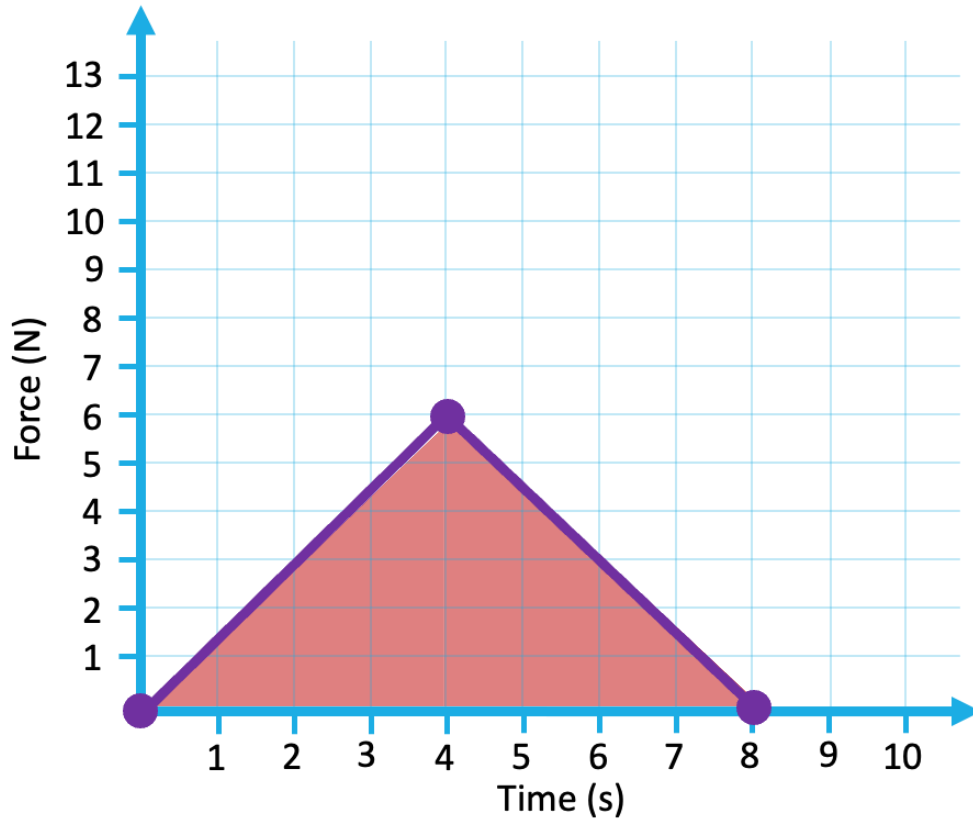
## Slope

## Area

<b>Equation</b>	$\frac{\text{Force}}{\text{Stretch}}$
<b>Value</b>	$\frac{20}{0.4} = 50$
<b>Units</b>	$N/m$

<b>Equation</b>	$\text{Force} \times \text{Stretch}$
<b>Value</b>	$\frac{1}{2}(0.4)(20) = 4$
<b>Units</b>	$N \times m$

# Try it...



You have been asked to calculate something called **impulse** with units of "N x s". What is this value?

$$\frac{1}{2} (8)(6)$$

$$= 24 \text{ N} \times \text{s}$$

# Lesson Takeaways

- I can use a mathematical model to make a prediction
- I can determine the equation, values, and units for the slope of a graph
- I can determine the equation, values, and units for the area of a graph
- I can identify strategies to calculate displacement, velocity, and acceleration from a graph