ST. JEAN DE BREBEUF
MATHEMATICS

CHAPTER 4.5

INTERPRET GRAPHS OF QUADRATIC RELATIONS

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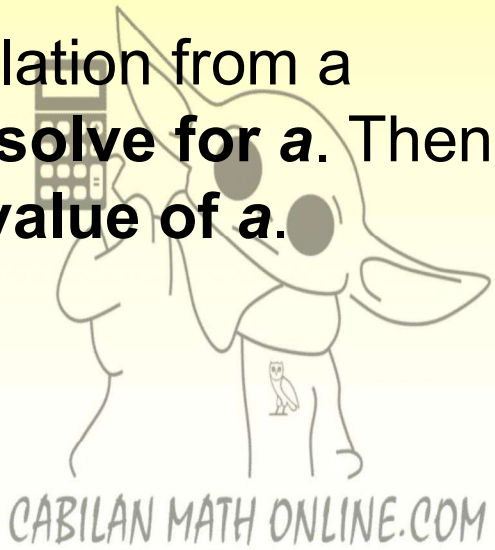
KEY CONCEPTS

When modelling a quadratic relation, choose a convenient location for the **origin**.

A quadratic relation can be represented by a **table**, a **graph**, or an **equation**.

To determine the **equation** for a quadratic relation from a *graph*, use the **vertex** and **another point** to **solve for *a***. Then, *write the equation* using the **vertex** and the **value of *a***.



CHAPTER 4.5 INTERPRET GRAPHS OF QUADRATIC RELATIONS

EXAMPLE 1

Using the Equation and/or Vertex to Interpret a Quadratic Relation

A construction worker drops his wrench. Its fall is modelled by the relation $h = -4.9t^2 + 342$, where ***h* is the height** above the ground, in *metres*, and ***t* is the time** after the wrench was dropped, in *seconds*.

a) How far above the ground was the wrench when it was dropped?

Method 1: Using the equation

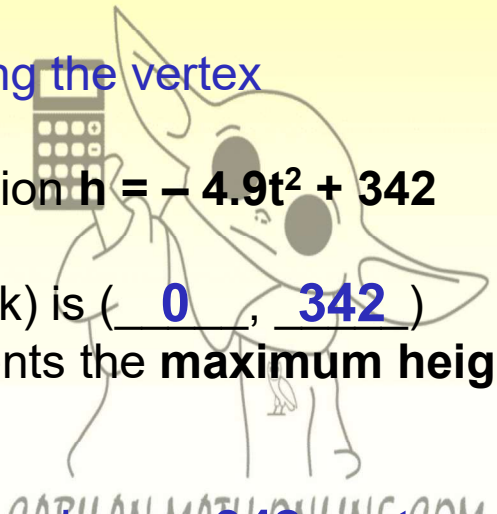
We need to find the height (h) of the wrench *before* it was thrown
→Let **t =** __0__ (the time before the wrench was thrown)

$h = -4.9t^2 + 342$
$= -4.9(0)^2 + 342$
$= \mathbf{342}$

Method 2: Using the vertex

Given the relation $\mathbf{h = -4.9t^2 + 342}$

The vertex (h, k) is (__0__, __342__)
→This represents the **maximum height** of the wrench



Therefore the wrench was **342 metres** above the ground.

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Therefore the wrench was **342 metres** above the ground.

b) How far has the wrench fallen after **5 s**?

Let **t = 5** and solve for h

$h = -4.9t^2 + 342$

$= -4.9(5)^2 + 342$

$= \mathbf{219.5}$

This represents the height of the wrench *above* the ground

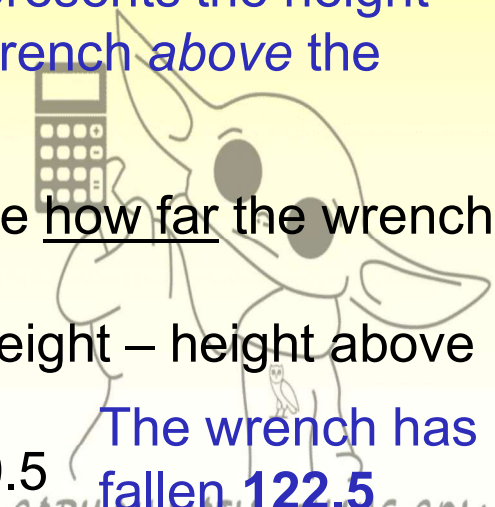
To determine how far the wrench has fallen

= Original height – height above the ground

$= 342 - 219.5$

$= \mathbf{122.5}$

The wrench has fallen **122.5 metres**



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EXAMPLE 1

Using the Equation and/or Vertex to Interpret a Quadratic Relation

A construction worker drops his wrench. Its fall is modelled by the relation $h = -4.9t^2 + 342$, where ***h* is the height** above the ground, in *metres*, and ***t* is the time** after the wrench was dropped, in *seconds*.

c) How far has the wrench fallen after **10 s**? How can you interpret the answer realistically?

Let **t = 10** and solve for h

$h = -4.9t^2 + 342$

$= -4.9(10)^2 + 342$

$= -148$

The *negative* answer is unrealistic for this question... Unless

→The wrench was dropped into a hole in the ground

→The wrench *created* a hole in the ground and the negative height represents the distance below the ground

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EXAMPLE 1

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A construction worker drops his wrench. Its fall is modelled by the relation $h = -4.9t^2 + 342$, where ***h* is the height** above the ground, in *metres*, and ***t* is the time** after the wrench was dropped, in *seconds*.

d) When will the wrench **hit the ground**?

When the wrench hits the ground, the height (h) will be **h = 0**

→ Substitute and solve for ***t***

$$h = -4.9t^2 + 342$$

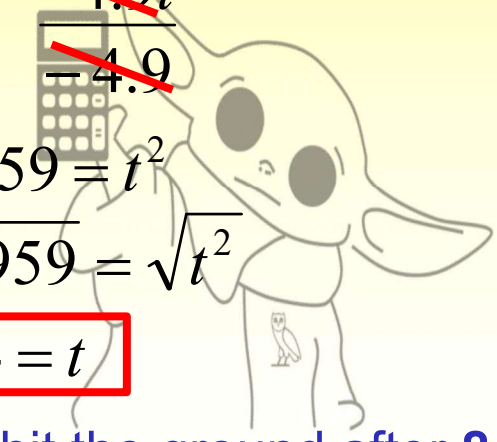
$$0 = -4.9t^2 + 342$$

$$\frac{-342}{-4.9} = \frac{-4.9t^2}{-4.9}$$

$$69.7959 = t^2$$

$$\sqrt{69.7959} = \sqrt{t^2}$$

$$8.4 = t$$



The wrench will hit the ground after **8.4 seconds**.

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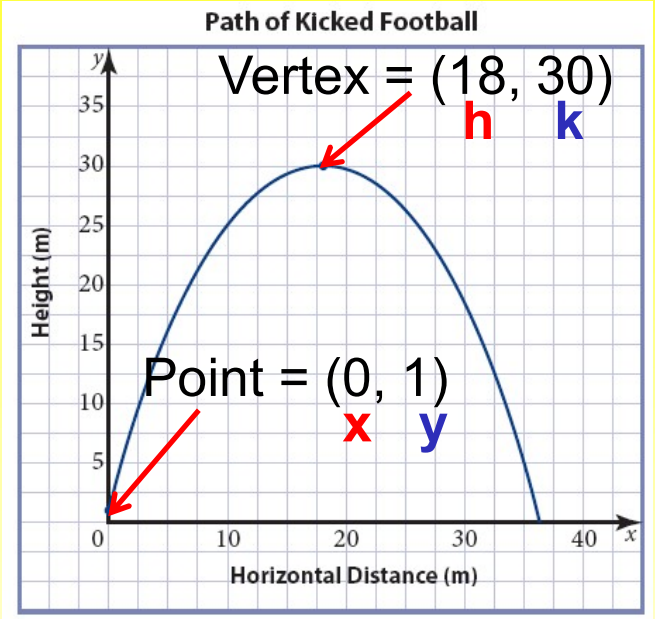
EXAMPLE 2

Quadratic Model for the Path of a Football



A football player kicks a football held **1 m** above the ground. The football reaches a **maximum height of 30 m** at a **horizontal distance of 18 m** from the player.

a) Use the graph and determine a **quadratic relation** that models the path of the football.

Step 1: Find the **vertex** and **another point**

Step 2: Write down the relation in *vertex form*, **$y = a(x - h)^2 + k$**

Step 3: Substitute the co-ordinates of the **vertex** into the relation

Step 4: Substitute the co-ordinates of the **other point** into the relation and solve for **a**

Step 5: Substitute **a** into the relation. This is the final answer.

$$y = a(x-h)^2 + k$$
$$y = a(x-18)^2 + 30$$
$$1 = a(0-18)^2 + 30$$
$$1 = a(-18)^2 + 30$$
$$1 = 324a + 30$$
$$1 - 30 = 324a$$
$$\frac{-29}{324} = \frac{324a}{324}$$
$$-0.0895 = a$$

The relation is

$$y = -0.0895(x-18)^2 + 30$$

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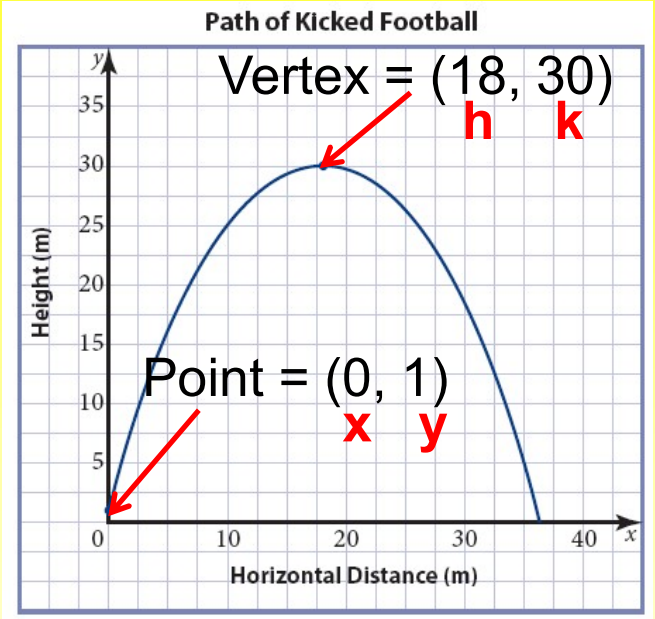
EXAMPLE 2

Quadratic Model for the Path of a Football

A football player kicks a football held **1 m** above the ground. The football reaches a **maximum height of 30 m** at a **horizontal distance of 18 m** from the player.

b) Use an *algebraic method* to determine the horizontal distance the player is when the ball **hits the ground**.



When the ball hits the ground, **y = 0**

→Substitute into equation and solve for ***x***

$$y = -0.0895(x-18)^2 + 30$$

$$0 = -0.0895(x-18)^2 + 30$$

$$\frac{-30}{-0.0895} = \frac{-0.0895(x-18)^2}{-0.0895}$$

$$335.1955 = (x-18)^2$$

$$\sqrt{335.1955} = \sqrt{(x-18)^2}$$

$$18.3083 = x - 18$$

$$18.3083 + 18 = x$$

$$36.3083 = x$$

The relation is $y = -0.0895(x-18)^2 + 30$

Height

Horizontal distance

The player's horizontal distance will be **36.3083 metres** when the ball hits the ground.

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Homework

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