ST. JEAN DE BREBEUF
MATHEMATICS

CHAPTER 5.2

CHANGE QUADRATIC RELATIONS

FROM VERTEX FORM TO STANDARD FORM

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KEY CONCEPTS

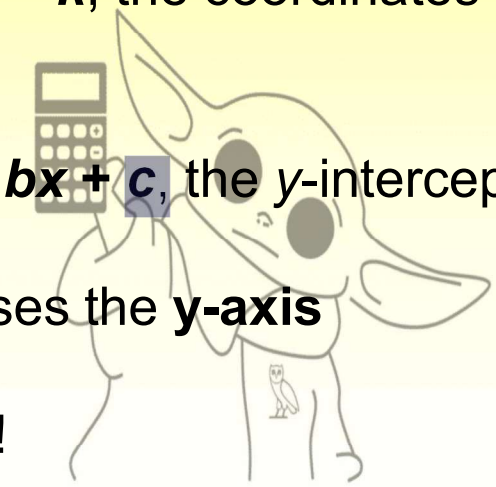
A quadratic relation can be written in **vertex form**, $y = a(x - h)^2 + k$, or in **standard form**, $y = ax^2 + bx + c$.

Expand and **simplify** the *vertex* form to write the quadratic relation in *standard* form.

Given a quadratic relation in *vertex* form, $y = a(x - h)^2 + k$, the coordinates of the vertex are (h, k).

Given a quadratic relation in *standard* form, $y = ax^2 + bx + c$, the *y*-intercept is *c*.
→Recall that the **y-intercept** is where the graph crosses the **y-axis**

*** **Note:** The **"a"** values for both forms are the same!



CHAPTER 5.2 CHANGE QUADRATIC RELATIONS FROM VERTEX FORM TO STANDARD FORM

EXAMPLE 1 *Writing Quadratic Relations in Standard Form*

Expand and simply the following relations in *vertex* form to obtain the relation in *standard* form

(a) $y = (x + 3)^2$

$= (x + 3)(x + 3)$

$= x^2 + 3x + 3x + 9$

$= x^2 + 6x + 9$

- Always expand the terms in the brackets first!
- Gather terms and simplify!

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EXAMPLE 1 *Writing Quadratic Relations in Standard Form*

Expand and simply the following relations in *vertex* form to obtain the relation in *standard* form

(b) $y = -2(x-5)^2$

$= -2(x-5)(x-5)$

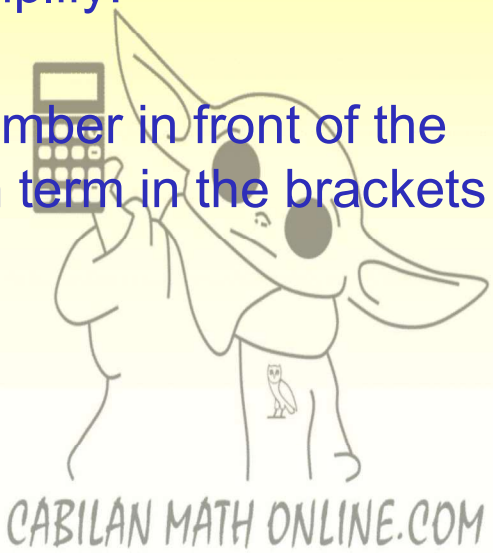
$= -2(x^2 - 5x - 5x + 25)$

$= -2(x^2 - 10x + 25)$

$\boxed{= -2x^2 + 20x - 50}$

- Always expand the terms in the brackets first!
- Gather terms and simplify!

Distribute the number in front of the brackets to each term in the brackets



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EXAMPLE 1 *Writing Quadratic Relations in Standard Form*

Expand and simply the following relations in *vertex* form to obtain the relation in *standard* form

(c) $y = 3(x - 2)^2 - 8$

$= 3(x - 2)(x - 2) - 8$

$= 3(x^2 - 2x - 2x + 4) - 8$

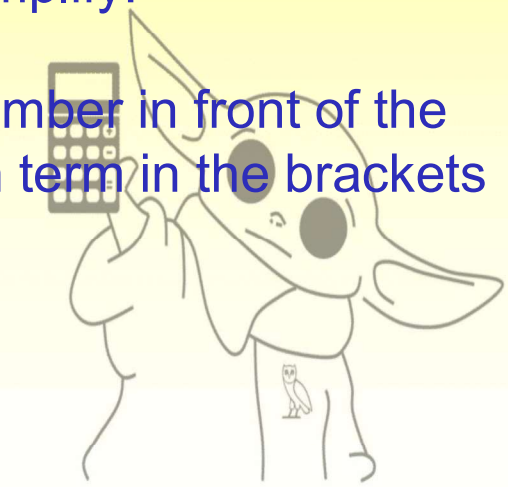
$= 3(x^2 - 4x + 4) - 8$

$= 3x^2 - 12x + 12 - 8$

$= 3x^2 - 12x + 4$

- Always expand the terms in the brackets first!
- Gather terms and simplify!

Distribute the number in front of the brackets to each term in the brackets



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EXAMPLE 2 *Writing Equations in Standard Form using the Vertex Form*

Write an equation in **standard form** for the following:

(a) **a = 3**, vertex at **(h, k) = (1, 7)**

$y = a(x - h)^2 + k$

$y = \mathbf{3}(x - \mathbf{1})^2 + \mathbf{7}$

$y = \mathbf{3}(x - 1)(x - 1) + 7$

$y = \mathbf{3}(x^2 - 1x - 1x + 1) + 7$

$y = \mathbf{3}(x^2 - 2x + 1) + 7$

$y = 3x^2 - 6x + 3 + 7$

$\boxed{y = 3x^2 - 6x + 10}$

STEPS

1. Write down the equation in vertex form, **$y = a(x - h)^2 + k$**
2. Substitute the known values for **a, h** and **k**
3. Expand and simplify

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EXAMPLE 2 *Writing Equations in Standard Form using the Vertex Form*

Write an equation in **standard form** for the following:

(b) **a = – 4**, maximum of **17** when **x = 3**

This tells us the **vertex**

→(**3** (**h**) , **17** (**k**))

$y = a(x - h)^2 + k$

$y = -4(x - 3)^2 + 17$

$y = -4(x - 3)(x - 3) + 17$

$y = -4(x^2 - 3x - 3x + 9) + 17$

$y = -4(x^2 - 6x + 9) + 17$

$y = -4x^2 + 24x - 36 + 17$

$y = -4x^2 + 24x - 19$

STEPS

1. Write down the equation in vertex form, $y = a(x - h)^2 + k$
2. Substitute the known values for **a, h** and **k**
3. Expand and simplify

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EXAMPLE 3

Application: Projectile Motion

The path of a projectile can be modelled by the relation $y = -4.9t^2 + vt + h$, where ***t* is the time**, in *seconds*, since launching; ***y* is the projectile's height**, in *metres*; ***h* is the projectile's initial height**, in *metres*; and ***v* is the projectile's initial velocity**, in *metres per second*.

Find the initial velocity and the initial height of a projectile that reaches a **maximum height of 50 m** after **3 s** (use steps from previous example)

Vertex = (h: 3 , k: 50)

- Write down the equation in vertex form, $y = a(x - h)^2 + k$
- Substitute the known values for **a, h** and **k**
- Expand and simplify

$y = a(x - h)^2 + k$

$y = -4.9(x - 3)^2 + 50$

$y = -4.9(x - 3)(x - 3) + 50$

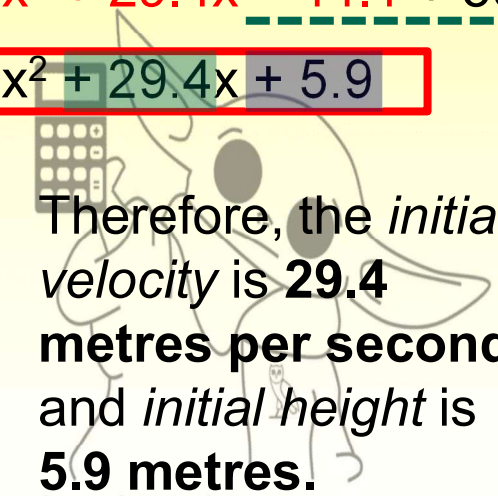
$y = -4.9(x^2 - 3x - 3x + 9) + 50$

$y = -4.9(x^2 - 6x + 9) + 50$

$y = -4.9x^2 + 29.4x - 44.1 + 50$

$y = -4.9x^2 + 29.4x + 5.9$

Therefore, the *initial velocity* is **29.4 metres per second** and *initial height* is **5.9 metres.**



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Homework:

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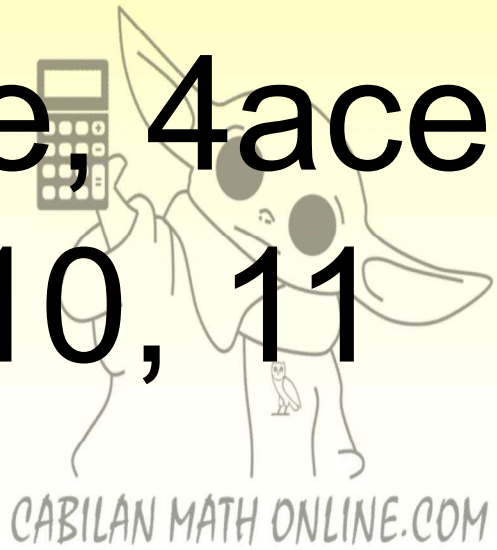
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