Objective: Graph a Quadratic Function Using the Zeros and Vertex from Standard Form.

## Concept

**Zero Product Property**

If the product of two factors is zero, then at least one of the factors must be equal to zero.

If $a \cdot b = 0$

then $a = 0$ *or* $b = 0$

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## Concept

### The Quadratic Function

standard form

$$f(x) = ax^2 + bx + c$$

$$\text{vertex} = (h,k) = \left( -\frac{b}{2a}, f\left( -\frac{b}{2a} \right) \right)$$

Given $f(x) = x^2 - 6x + 8$, the vertex is found by doing the following,

$x = \frac{-1(-6)}{2(1)} = \frac{6}{2} = 3$, and $y = f(3) = (3)^2 - 6(3) + 8 = -1$.

Therefore, the vertex of $f(x)$ is $(3, -1)$.

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Ex) a) State the zeros; b) state the vertex and whether it is a maximum or minimum; c) sketch a graph of the function using the zeros and vertex

$$f(x) = 2x^2 - 4x - 6$$

① find the zeros (x=? when y=0)

ⓐ $f(x) = 2x^2 - 4x - 6$

$0 = 2x^2 - 4x - 6$ (factor)

ⓑ $0 = 2(x^2 - 2x - 3)$

$0 = 2(x-3)(x+1)$

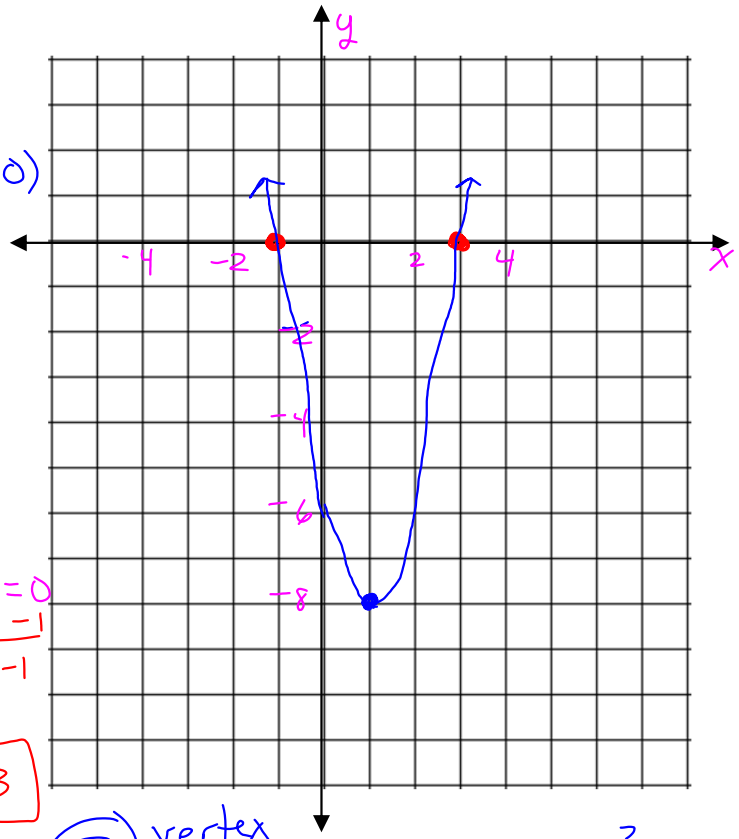
ⓒ zero product property: $2 \neq 0$, $x-3=0$, $x+1=0$

$+3\ +3$, $-1\ -1$

$x = 3$, $x = -1$

2 zeros!

Zeros: $x = -1$ and $x = 3$




Ⓑ vertex

$x = h = \frac{\text{add zeros}}{2} = \frac{-1+3}{2} = 1$ *

$y = k = f(1) = 2(1)^2 - 4(1) - 6$

$= 2 \cdot 1 - 4 - 6$

$= -2 - 6 = -8$ *

vertex (1, -8)

minimum

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$g(x) = -x^2 - 3x$

① find zeros ↳ (x=? when y=0)

ⓐ $g(x) = -x^2 - 3x$

$0 = -1x^2 - 3x$

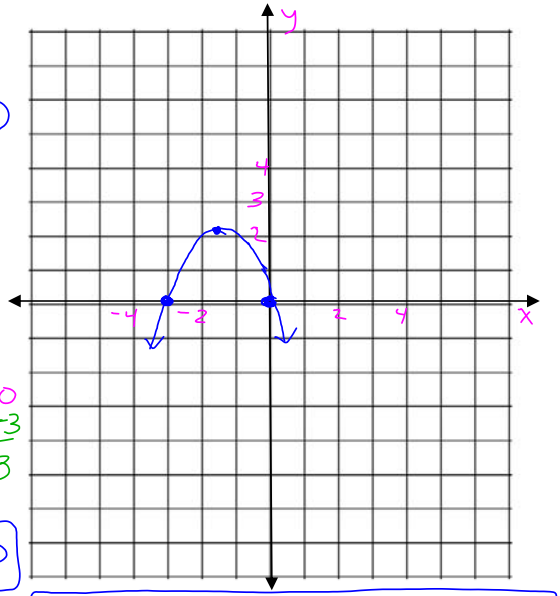
ⓑ factor $0 = -1x(x+3)$

ⓒ use zero product property

$\frac{-1x}{-1} = \frac{0}{-1}$ or $x+3=0$

$x = 0$ $\quad x = -3$

Zeros: $x=-3$ and $x=0$




Ⓑ vertex

$x = h = \frac{\text{add zeros}}{2} = \frac{-3+0}{2} = \frac{-3}{2} = -1\frac{1}{2}$

$y = k = g\left(-\frac{3}{2}\right) = -1\left(\frac{-3}{2}\right)^2 - 3\left(-\frac{3}{2}\right)$

$\frac{-3}{2}\cdot\frac{-3}{2}$

$= \frac{-1}{1}\cdot\frac{9}{4} - \frac{3}{1}\cdot\frac{-3}{2} = \frac{-9}{4} - \frac{-9}{2}\cdot\frac{2}{2}$

$= \frac{-9}{4} + \frac{+18}{4}$

$= \frac{9}{4} = 2\frac{1}{4}$

vertex $\left(-1\frac{1}{2}, 2\frac{1}{4}\right)$; maximum

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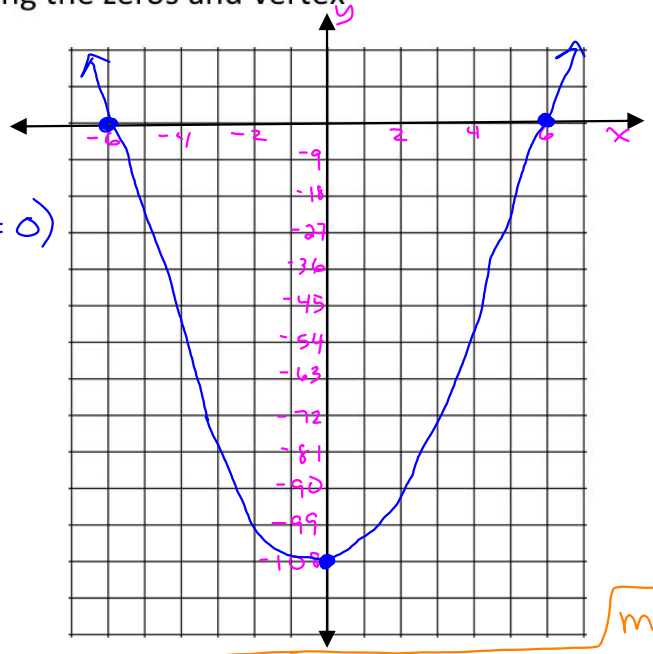
$$h(x) = 3x^2 - 108$$




① find the zeros (x = ? when y = 0)

ⓐ $h(x) = 3x^2 - 108$

$0 = 3x^2 - 108$

ⓑ factor

$0 = 3(x^2 - 36)$

$(x)^2 - (6)^2$

$0 = 3(x+6)(x-6)$

ⓒ use zero product property

$3 \neq 0$ $\quad x+6=0$ or $x-6=0$

$-6 \quad -6 \qquad +6 \quad +6$

$x = -6 \qquad x = 6$

ⓑ vertex (0, −108) minimum

$x = h = \frac{\text{add zeros}}{2}$

$= \frac{-6+6}{2} = \frac{0}{2} = 0$

$y = k = 3(0)^2 - 108$

$= 0 - 108 = -108$

zeros are $x = -6$ and $x = 6$

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## Closure

If the zeros of a quadratic function are $-4$ and $10$, what is the $x$ coordinate of the vertex? Explain how you know.

The $x$ coordinate of the vertex is $3$ because this is the $x$ value halfway between the zeros of $-4$ and $10$.