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Problems Involving Quadratic Relations in Factored Form

Example 1

The profit of a chocolate bar can be modeled by the equation $P = -0.3(n-7)^2 + 10.8$, where P is the profit in Thousands of dollars and n is the number of chocolates sold in thousands.

a) What is the coordinates of the vertex? Explain what it represents

Vertex $= (7, 10.8)$
n P

for 7 thousand chocolate bars the profit is $10.8 thousand

b) What is the P y-intercept? Explain what it represents

in standard form

$P = -0.3(n-7)(n-7) + 10.8$

$P = -0.3(n^2 - 7n - 7n + 49) + 10.8$

$P = -0.3n^2 + 2.1n + 2.1n - 14.7 + 10.8$

(OR sub n=0)

$P = -0.3n^2 + 4.2n - 3.9$

∴ y-int or P-int is −3.9 it represents initial profit is a loss of $3.9 thousand (when sell ∅ bars)

c) What are the zeros? Explain what they represent.

in factored form

$P = -0.3\left(\frac{-0.3n^2}{-0.3} + \frac{4.2n}{-0.3} - \frac{3.9}{-0.3}\right)$

$P = -0.3(n^2 - 14n + 13)$

$P = -0.3(n-13)(n-1)$

$n - 13 = 0$ or $n - 1 = 0$

$n = 13$ $n = 1$

∴ zeros are 13 and 1 they represent Break even points ie. at 1 thousand and 13 thousand bars sold Profit is zero (not loss or gain)

Understanding Problems Related to Factored Form

- draw sketches to help visualize the situation
- consider how key features relate to the context of the problem:
  - initial point = y-int
  - break-even points/distance/time/etc. = zeros
  - max/min profit/distance/height/etc. = optimal value } vertex

point at which max/min occurs = axis of symm

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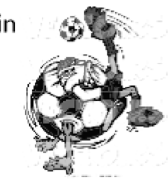
Example 2

The path of a soccer ball can be modelled by the relation $h = -0.1d^2 + 0.5d + 0.6$, where h is the ball's height and d is the horizontal distance from the ~~kicker.~~ Both measured in meters.



a. Find the zeros of the relation.

$h = -0.1(d^2 - 5d - 6)$

sum prod

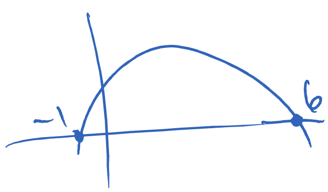
$h = -0.1(d-6)(d+1)$

$d-6=0$ or $d+1=0$

$d=6$ $\quad d=-1$

$\therefore$ zeros $(6,0)$ and $(-1,0)$

b. What do the zeros mean in the context of the question?



The negative zero $d=-1$ is discarded since distance can't be negative.

$d=6$ represents where the ball lands on the ground.

Example 3

The arch of a small suspension bridge over a gorge can be modelled by the equation $y = -2x^2 + 4x + 6$ where x is the distance in meters from the edge of the gorge and y is the height above the ground, also in meters.

a. What are the zeros? What do they represent?

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

sum prod

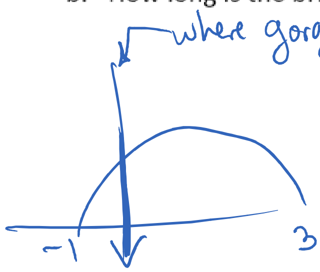
$y = -2(x-3)(x+1)$

$x-3=0$ $\quad x+1=0$

$x=3$ $\quad x=-1$

zeros $(3,0)$ and $(-1,0)$ represent the base edges of the bridge

b. How long is the bridge? Justify your answer.



The bridge is 4 m

(one edge is 1 m left of gorge the other is 3m right of gorge)

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Example 3

A rider on a mountain bike jumps off a ledge. Her path is modelled by the relation $h = -0.3d^2 + 1.2d + 1.5$, where h is her height above the ground and d is her horizontal distance from the ledge, both in metres.

a. What is the height of the ledge?

riders initial height at $d=0$
or y-intercept $\therefore$ height is 1.5 m

b. How far was the rider from the ledge when she landed?

height is zero
look for zeros

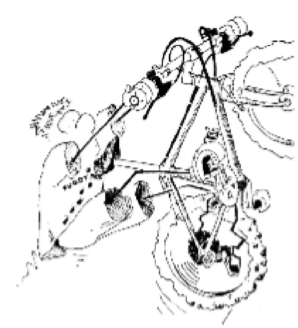
$$h = -0.3\left(\frac{-0.3d^2}{-0.3} + \frac{1.2d}{-0.3} + \frac{1.5}{-0.3}\right)$$

$$h = -0.3(d^2 - 4d - 5)$$

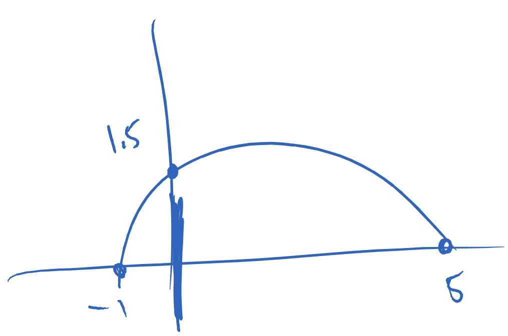
$$h = -0.3(d-5)(d+1)$$

$d - 5 = 0$ $d + 1 = 0$

$d = 5$ $d = -1$



$\therefore$ she landed 5 m away from the ledge.



where ledge is.