Activity

3-5 Zeros of Polynomial Functions

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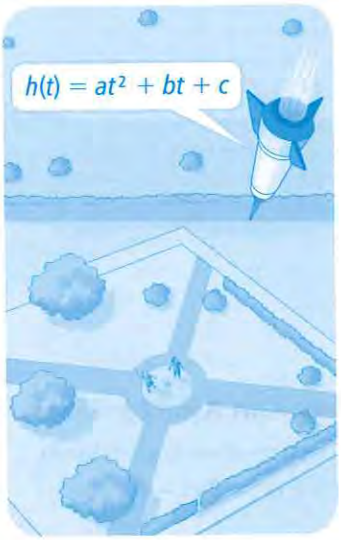
MODEL & DISCUSS

Charlie and Aisha built a small rocket and launched it from their backyard. The rocket fell to the ground 10 s after it launched. The height h, in feet, of the rocket relative to the ground at time t seconds can be modeled by the function shown.



A. How are the launch and landing times related to the modeling function?

B. What additional information about the rocket launch could you use to construct an accurate model for the rocket's height relative to the ground?

C. **Construct Arguments** Charlie believes that the function $h(t) = -16t^2 + 160t$ models the height of the rocket with respect to time. Do you agree? Explain your reasoning and indicate the domain of this function. © MP.3

HABITS OF MIND

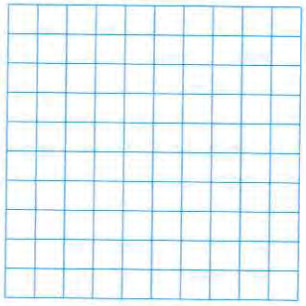
Reason In Charlie's function, what is the value of c? Why is this the correct value? © MP.2

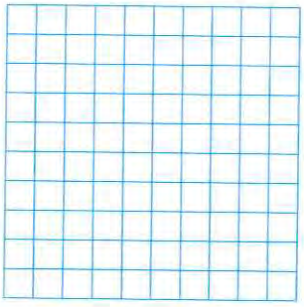
EXAMPLE 1 **Try It! Use Zeros to Graph a Polynomial Function**

1. Factor each function. Then use the zeros to sketch its graph.

   a. $f(x) = 4x^3 + 4x^2 - 24x$

   b. $g(x) = x^4 - 81$





EXAMPLE 2 **Try It! Understand How a Multiple Zero Can Affect a Graph**

2. Describe the behavior of the graph of the function at each of its zeros.

   a. $f(x) = x(x + 4)(x - 1)^4$

   b. $f(x) = (x^2 + 9)(x - 1)^5(x + 2)^2$

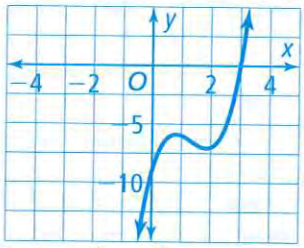
HABITS OF MIND

Reason Do the values of a function always change from positive to negative or negative to positive on either side of a zero? Explain. MP.2

EXAMPLE 3 **Try It! Find Real and Complex Zeros**

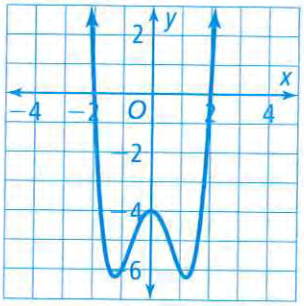
3. What are all the real and complex zeros of the polynomial function shown in the graph?

   a.



$f(x) = 2x^3 - 8x^2 + 9x - 9$

   b.



$f(x) = x^4 - 3x^2 - 4$

Assess

EXAMPLE 4 **Try It! Interpret the Key Features of a Graph in Context**

4. Due to a decrease in the cost of materials, the profit function for Acme Innovations has changed to $Q(x) = -x^3 + 10x^2 + 13x - 22$. How many lamps should they make in order to make a profit?

HABITS OF MIND

Make Sense and Persevere On a graph, how do complex roots differ from real roots? MP.1

EXAMPLE 5 **Try It! Solve Polynomial Equations**

5. What is the solution of the equation?

   a. $x^3 - 7x + 6 = x^3 + 5x^2 - 2x - 24$ b. $x^4 + 2x^2 = -x^3 - 2x$

EXAMPLE 6 **Try It! Solve a Polynomial Inequality by Graphing**

6. What are the solutions of the inequality?

   a. $2x^3 + 12x^2 + 12x < 0$ b. $(x^2 - 1)(x^2 - x - 6) > 0$

HABITS OF MIND

Use Structure How does solving $2x^3 + 12x^2 + 12x = 0$ help you to solve the inequality $2x^3 + 12x^2 + 12x < 0$? MP.7

Do You UNDERSTAND?

1. **ESSENTIAL QUESTION** How are the zeros of a polynomial function related to a function's equation and graph?

2. **Error Analysis** In order to identify the zeros of the function, a student factored the cubic function $f(x) = x^3 - 3x^2 - 10x$ as follows:

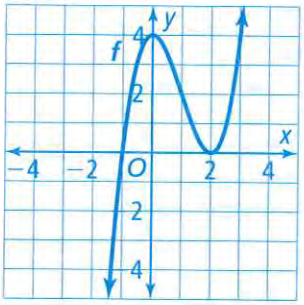
$$\begin{aligned} f(x) &= x^3 - 3x^2 - 10x \\ &= x(x^2 - 3x - 10) \\ &= x(x - 5)(x + 2) \\ x &= 0, x = -5, x = 2 \end{aligned}$$

Describe and correct the error the student made. MP.3

3. **Make Sense and Persevere** Explain how you can determine that the function $f(x) = x^3 + 3x^2 + 4x + 2$ has both real and complex zeros. MP.1

Do You KNOW HOW?

4. If the graph of the function f has a multiple zero at $x = 2$, what is a possible exponent of the factor $x - 2$? Justify your reasoning.



5. Energy Solutions manufactures LED light bulbs. The profit p, in thousands of dollars earned, is a function of the number of bulbs sold, x, in ten thousands. Profit is modeled by the function $-x^3 + 9x^2 - 11x - 21$. For what number of bulbs manufactured is the company profitable?