Evaluate the function for the given value of x.

1. $f(x) = 7x - 6$; $x = -2$
2. $g(x) = x^2 + 3$; $x = 6$
3. $f(x) = -3x + 4$; $x = -2$
4. $g(x) = x^2 - 6x$; $x = -4$
5. $f(x) = 1.7x - 73$; $x = 16$
6. $h(x) = 8.49x$; $x = 4$

Warm Up

* review substitution of a constant value

Determine whether the given characteristics describe a parabola that opens up or down.

1. Focus: (0, −5)
   Directrix: $y = 5$
2. Focus: (0, 5)
   Directrix: $y = -5$
3. Focus: (0, −1)
   Directrix: $y = 1$
4. Focus: (0, 1)
   Directrix: $y = -1$

Cumulative Warm Up

* skip *

Essential Question

What are some common characteristics of the graphs of cubic and quartic polynomial functions?

Cubic - raised to 3rd power

quartic - raised to 4th power

Essential Question

What you will learn:

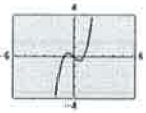
- Identify polynomial Functions
- Graph polynomial functions using tables and end behavior

Work with a partner. Match each polynomial function with its graph. Explain your reasoning. Use a graphing calculator to verify your answers.

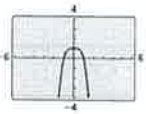
a. $f(x) = x^3 - x$ **b.** $f(x) = -x^3 + x$ **c.** $f(x) = -x^4 + 1$

d. $f(x) = x^4$ **e.** $f(x) = x^3$ **f.** $f(x) = x^4 - x^2$

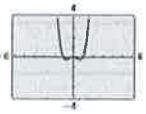
A. a.



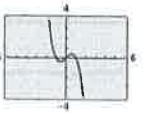
B. c.



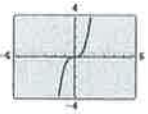
C. f.



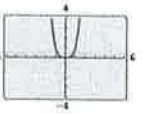
D. b.



E. e.



F. d.



Exploration 1

* use graphing software to look at and match functions to graphs

- talk about x-intercepts
- y-intercepts
- positive / negative a term

Work with a partner. Each of the polynomial graphs in Exploration 1 has x-intercept(s) of -1, 0, or 1. Identify the x-intercept(s) of each graph. Explain how you can verify your answers.

Exploration 2

* skip b/c done during discussion on Exploration 1. *

Decide whether each function is a polynomial function. If so, write it in standard form and state its degree, type, and leading coefficient.

a. $f(x) = -2x^3 + 5x + 8$

Yes - degree 3

LC = -2

b. $g(x) = -0.8x^3 + \sqrt{2}x^4 - 12$

LC = $\sqrt{2}$

yes:

$\sqrt{2}x^4 - .8x^3 - 12$

degree 4

c. $h(x) = -x^2 + 7x^{-1} + 4x$

No

Negative Exponent

d. $k(x) = x^2 + 3x$

Yes: LC 1

Standard Form

degree = 2

Example 1

discuss - Polynomials
- standard form
- degrees of polynomials

- may need to review degrees of monomial terms and how to determine polynomial

Decide whether the function is a polynomial function. If so, write it in standard form and state its degree, type, and leading coefficient.

1. $f(x) = 7 - 1.6x^2 - 5x$

2. $p(x) = x + 2x^{-2} + 9.5$

3. $q(x) = x^3 - 6x + 3x^4$

Monitoring Progress 1-3

additional practice

* have students pair and share thoughts

* then discuss as a class.

Evaluate $f(x) = 2x^4 - 8x^2 + 5x - 7$ when $x = 3$.

$f(3) = 2(3)^4 - 8(3)^2 + 5(3) - 7$

$= 2(81) - 8(9) + 15 - 7$

$= 162 - 72 + 15 - 7$

$= 98$

Example 2

Substitute:

- discuss how substitution works when subbing a negative

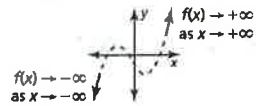
- Review how we always start by simplifying the exponent.

* will want for test / Quizzes *

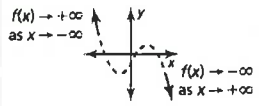
Core Concept

End Behavior of Polynomial Functions

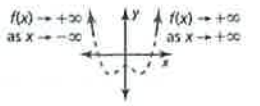
Degree: odd
Leading coefficient: positive



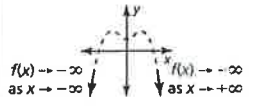
Degree: odd
Leading coefficient: negative



Degree: even
Leading coefficient: positive



Degree: even
Leading coefficient: negative



Core Concept

end behavior: the behavior of the graph as x approaches positive infinity ($+\infty$) or negative infinity ($-\infty$)

- for a polynomial function end behavior is determined by the functions degree and the sign of the leading coefficient

Describe the end behavior of the graph of $f(x) = -0.5x^4 + 2.5x^2 + x - 1$.

degree = 4

leading coeff. = -.5

degree is even and leading coeff. is neg.

$f(x) \to -\infty$ as $x \to -\infty$

and

$f(x) \to -\infty$ as $x \to +\infty$

* Check by graphing w/ calculator

Example 3

Evaluate the function for the given value of x.

4. $f(x) = -x^3 + 3x^2 + 9$; $x = 4$

$f(4) = -7$

5. $f(x) = 3x^5 - x^4 - 6x + 10$; $x = -2$

$f(-2) = -90$

6. Describe the end behavior of the graph of $f(x) = 0.25x^3 - x^2 - 1$.

$f(x) \to -\infty$ as $x \to -\infty$

and $f(x) \to \infty$ as $x \to \infty$

* do these together make sure we are using the chart given in Core Concepts

Monitoring Progress 4-6

Graph (a) $f(x) = -x^3 + x^2 + 3x - 3$ and (b) $f(x) = x^4 - x^3 - 4x^2 + 4$.

* use graphing calculators to graph

* discuss end behavior

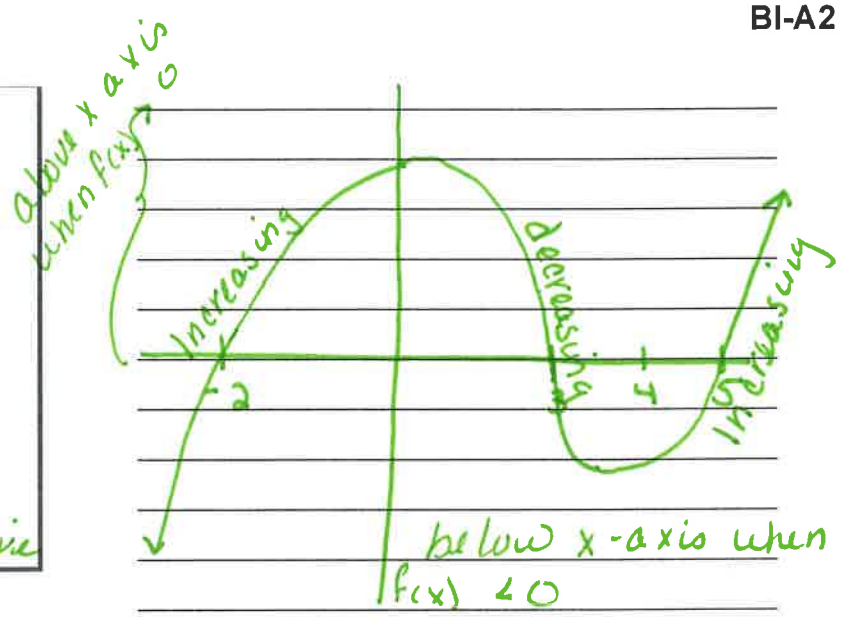
* use chart from Core Concepts.

Example 4

Sketch a graph of the polynomial function f having these characteristics.

- f is increasing when $x < 0$ and $x > 4$.
- f is decreasing when $0 < x < 4$.
- $f(x) > 0$ when $-2 < x < 3$ and $x > 5$.
- $f(x) < 0$ when $x < -2$ and $3 < x < 5$.

Use the graph to describe the degree and leading coefficient of f.



- $f(x) \to -\infty$ as $x \to -\infty$ and $f(x) \to +\infty$ as $x \to +\infty$
  degree is odd LC = positive

Example 5

The estimated number V (in thousands) of electric vehicles in use in the United States can be modeled by the polynomial function

$$V(t) = 0.151280t^3 - 3.28234t^2 + 23.7565t - 2.041$$

where t represents the year, with $t = 1$ corresponding to 2001.

a. Use a graphing calculator to graph the function for the interval $1 \le t \le 10$. Describe the behavior of the graph on this interval.

b. What was the average rate of change in the number of electric vehicles in use from 2001 to 2010?

c. Do you think this model can be used for years before 2001 or after 2010? Explain your reasoning.

c) end behavior indicates model has unlimited growth as t increases.

- Unlimited growth is not reasonable

Example 6

b.) $t = 1$ $t = 10$

AROC $1 \le t \le 10$

$$\frac{V(10) - V(1)}{10 - 1} = \frac{58.57 - 18.5844444}{9}$$

$$\approx 4.443$$

average rate of change about 4.4 thousand electric vehicles per year

Graph the polynomial function.

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

8. $f(x) = 4 - x^3$

9. $f(x) = x^3 - x^2 + x - 1$

Monitoring Progress 7-9

* Student practice.

10. Sketch a graph of the polynomial function f having these characteristics.

- f is decreasing when $x < -1.5$ and $x > 2.5$; f is increasing when $-1.5 < x < 2.5$.
- $f(x) > 0$ when $x < -3$ and $1 < x < 4$; $f(x) < 0$ when $-3 < x < 1$ and $x > 4$.

Use the graph to describe the degree and leading coefficient of f.

11. WHAT IF? Repeat Example 6 using the alternative model for electric vehicles of

$V(t) = -0.0290900t^4 + 0.791260t^3 - 7.96583t^2 + 36.5561t - 12.025.$

Monitoring Progress 10-11

Exit Ticket: "What do you know about the graph of $f(x) = 3.5x^4 + 4x^2 - 7x + 2$ without actually graphing the function?"

Closure