

## 2.2 day 2 multiplicity and sketching polynomials with graphs.notebook

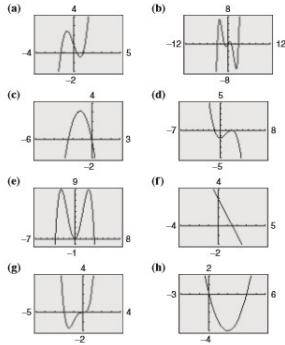
### Warm up

1. Describe the end behavior of  $f(x) = -3x^4 + 2x^2 - 1$ . (Use the limit notation discussed in class.)

2. Simplify  $\frac{2i}{1-i}$

3. Page 112 in your book, 1 - 8 (matching). Do not graph on your calculator. Use your knowledge of end behavior to match the graph with the equation.

In Exercises 1–8, match the polynomial function with its graph. [The graphs are labeled (a) through (h).]



1.  $f(x) = -2x + 3$
2.  $f(x) = x^2 - 4x$
3.  $f(x) = -2x^2 - 5x$
4.  $f(x) = 2x^3 - 3x + 1$
5.  $f(x) = -\frac{1}{4}x^4 + 3x^2$
6.  $f(x) = -\frac{1}{3}x^3 + x^2 - \frac{4}{3}$
7.  $f(x) = x^4 + 2x^3$
8.  $f(x) = \frac{1}{3}x^5 - 2x^3 + \frac{9}{3}x$

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GO COUGARS!



### p 112 Homework Questions

In Exercises 9 and 10, sketch the graph of  $y = x^n$  and each specified transformation.

9.  $y = x^3$
- (a)  $f(x) = (x - 2)^3$       (b)  $f(x) = x^3 - 2$   
 (c)  $f(x) = -\frac{1}{2}x^3$       (d)  $f(x) = (x - 2)^3 - 2$

In Exercises 15–22, use the Leading Coefficient Test to describe the right-hand and left-hand behavior of the graph of the polynomial function. Use a graphing utility to verify your result.

15.  $f(x) = 2x^4 - 3x + 1$       16.  $h(x) = 1 - x^6$   
 17.  $g(x) = 5 - \frac{1}{2}x - 3x^2$       18.  $f(x) = \frac{1}{3}x^3 + 5x$   
 19.  $f(x) = \frac{6x^3 - 2x^4 + 4x^2 - 5x}{3}$   
 20.  $f(x) = \frac{3x^7 - 2x^5 + 5x^3 + 6x^2}{4}$   
 21.  $h(t) = -\frac{7}{2}(t^2 - 5t + 3)$   
 22.  $f(s) = -\frac{1}{2}(s^3 + 5s^2 - 7s + 1)$

**Graphical Analysis** In Exercises 33–44, (a) find the zeros algebraically, (b) use a graphing utility to graph the function, and (c) use the graph to approximate any zeros and compare them with those from part (a).

33.  $f(x) = 3x^2 - 12x + 3$   
 34.  $g(x) = 5x^2 - 10x - 5$   
 35.  $g(t) = \frac{1}{2}t^4 - \frac{1}{2}$   
 41.  $f(x) = x^3 - 4x^2 - 25x + 100$   
 42.  $y = 4x^3 + 4x^2 - 7x + 2$   
 43.  $y = 4x^3 - 20x^2 + 25x$   
 44.  $y = x^5 - 5x^3 + 4x$

In Exercises 45–48, use a graphing utility to graph the function and approximate (accurate to three decimal places) any real zeros and relative extrema.

45.  $f(x) = 2x^4 - 6x^2 + 1$   
 46.  $f(x) = -\frac{3}{8}x^4 - x^3 + 2x^2 + 5$   
 47.  $f(x) = x^5 + 3x^3 - x + 6$   
 48.  $h(x) = \frac{1}{2}x^3 - 3x^2 + 4x - 6$

Feb 2-9:51 PM

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### 2.2 Polynomial Functions of Higher Degree, Day 2

zeros

end behavior

multiplicity

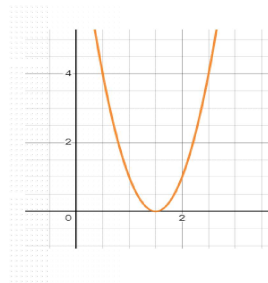
sketch a graph

Sep 20-7:12 AM

Find the zeros of

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

$x = \frac{3}{2} \quad | \quad x = \frac{3}{2}$



How many zeros did we expect? 0  
How many did we get? 1 distinct zero  
What does the graph look like?

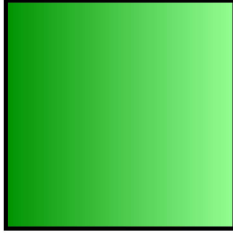
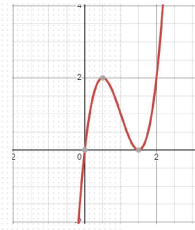
Sep 27-8:44 AM

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Now find the zeros of



$$x=0 \quad x=-\frac{3}{2}$$



What are the zeros of



How does it compare to the one above?

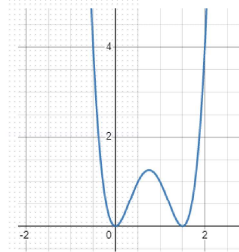
flipped over x axis

And the zeros of



How is this one different from the others?

opens up - u shaped



Sep 27-8:55 AM

Multiplicity is the number of times a zero is used towards the total number of zeros. (look at the exponent of the factor)

$$f(x) = x(4x^2 - 12x + 9)$$

$$\frac{x(2x-3)^2}{x=0 \quad x=\frac{3}{2}}$$

zeros	multiplicity
0	1
$\frac{3}{2}$	2

C  
B

$$f(x) = x^2(4x^2 - 12x + 9)$$

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

zeros	multiplicity
0	2
$\frac{3}{2}$	2

B  
B

How does multiplicity affect the graph?

- \* If the exponent of the factor is **odd**, the graph **crosses** through the x-axis at that zero.
- \* If the exponent of the factor is **even**, the graph **bounces** off the x-axis at that zero.

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To sketch a graph of a polynomial function:

- \* Determine the end behavior
- \* Find the zeros (factor, quadratic formula, complete the square)
- \* Determine the multiplicity of each zero
- \* Sketch

Example  $y = x^3 + x^2 - 20x$

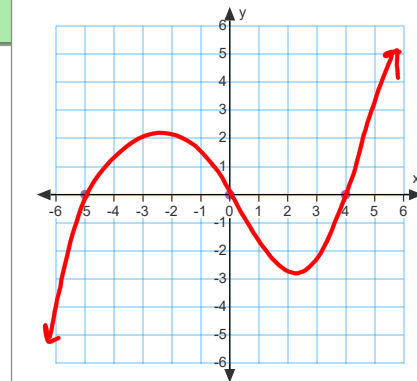
$$x(x^2 + x - 20)$$

$$0 = x(x+5)(x-4)$$

$$x=0 \quad x=-5 \quad x=4$$

degree: 3

end behavior:  $\lim_{x \rightarrow \infty} f(x) = \infty$   $\lim_{x \rightarrow -\infty} f(x) = -\infty$



zeros	multiplicity
0	1
-5	1
4	1

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More Examples

$$f(x) = x^6 + x^4 - 20x^2$$

$$= x^2(x^4 + x^2 - 20)$$

$$= x^2(x^2 - 4)(x^2 + 5)$$

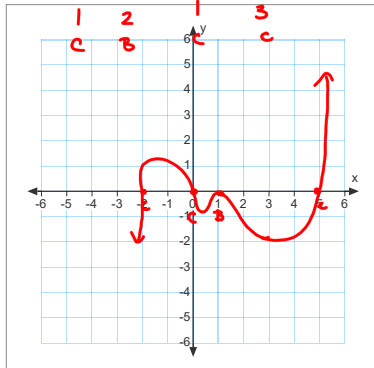
$$= x^2(x-2)(x+2)(x^2 + 5)$$

$$x=0 \quad x=2 \quad x=-2 \quad x=\pm\sqrt{5}i$$

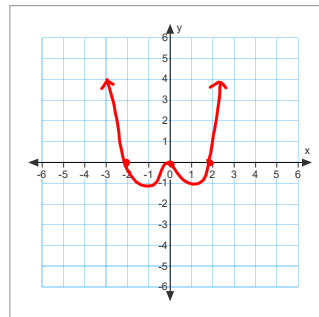
$$f(x) = -x^4 + 12x^3 - 36x^2$$

$$f(x) = x(x-1)^2(x+2)(x-5)^3 = x^7$$

$$x=0 \quad x=1 \quad x=-2 \quad x=5$$



zeros	multiplicity
0	2
2	1
-2	1



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# HOMWORK



P 113

23-29 odd Sketch by hand  
65-75 odd (omit part c)  
83-89 odd Sketch by hand  
107

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## Warm up

Page 112 #1-8

Use your knowledge of end behavior to match the graphs with the equations.

Answers to factoring worksheet

Diff of squares

1.  $(x - 6)(x + 6)$
3.  $(4y - 3)(4y + 3)$
5.  $(4x - 1/3)(4x + 1/3)$
7.  $(x - 3)(x + 1)$
9.  $(3u - 2v)(3u + 2v)$

Sum/Diff of cubes

1.  $(x - 2)(x^2 + 2x + 4)$
3.  $(y + 4)(y^2 - 4y + 16)$
5.  $(2t - 1)(4t^2 + 2t + 1)$
7.  $(u + 3v)(u^2 - 3uv + 9v^2)$

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