

# Algebra 2 – Section 3-4

## Polynomial Functions

What are polynomial functions and how do you graph them?

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## Vocabulary

- Monomial – a number, a variable, or a product of numbers and variables  
Ex)  $4x^1$  or  $-5y^3$
- Degree of the Monomial – the exponent of the variable  
Ex)  $9$   $m^2$
- Polynomial – a monomial or a sum of monomials  
Ex)  $2x - 7$  or  $6x^2 + x + 24$
- Polynomial function – a function of the form  

$$f(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_1 x + a_0$$
 where  $a_n \neq 0$ , the exponents are all whole numbers, and the coefficients are all real numbers  
 Ex)  $f(x) = 5x^2 + x - 9$  or  $y = x^4 - 6x^3 + 5x$

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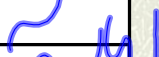

# Terminology of Functions

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

- The function is in standard form since its terms are written in descending order
- The leading coefficient is 5 *Exponents*  
*# in front of the highest exponent*
- The degree of the function is 2
- The constant term is -9

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# Common Polynomial Functions

Degree	Type	Example	General shape of graph
0	constant	$f(x) = -14$	
1	linear	$f(x) = 5x - 7$	
2	quadratic	$f(x) = 2x^2 + x - 9$	
3	cubic	$f(x) = x^3 - x^2 + 3x - 2$	
4	quartic	$f(x) = x^4 + 5x^3 - x^2 + 2x - 1$	

Give the degree, type, leading coefficient and odd/even.

a.  $k(x) = x + 2 - 0.6x^2$

*0.6x<sup>2</sup> + x + 2*

*D: 2*

*Type: Quadratic*

*L.C. -0.6*

*odd/even even*

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**EXAMPLE 1 Identify polynomial**

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

b.  $g(x) = 7x - \sqrt{3} + \pi x^2$  *yes*

*$\pi x^2 + 7x - \sqrt{3}$*   
 D: 2    Type: Quadratic    Lic:  $\pi$

c.  $f(x) = 5x^2 + 3x^{-1} - x$

*Exponent of -1  
 $\therefore$  Not a polynomial*

d.  $k(x) = x + 2^x - 0.6x^5$

*Exponent of  $x$   
 any #  $\therefore$  Not a polynomial*

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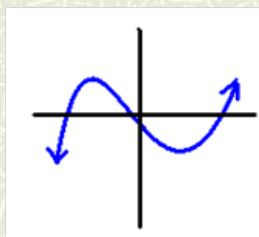
## End Behavior of Polynomial Functions

Degree: odd

Leading Coefficient: positive

$$f(x) \rightarrow -\infty \text{ as } x \rightarrow -\infty$$

$$f(x) \rightarrow +\infty \text{ as } x \rightarrow +\infty$$



Degree: odd

Leading Coefficient: negative

$$f(x) \rightarrow +\infty \text{ as } x \rightarrow -\infty$$

$$f(x) \rightarrow -\infty \text{ as } x \rightarrow +\infty$$



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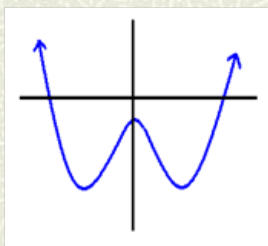
# End Behavior of Polynomial Functions

Degree: even

Leading Coefficient: positive

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

$f(x) \rightarrow +\infty$  as  $x \rightarrow +\infty$

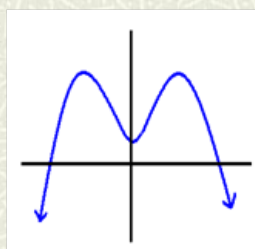


Degree: even

Leading Coefficient: negative

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

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



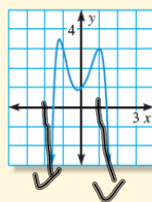
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## EXAMPLE 4

### Standardized Test

1 Answer?  
What is true about the degree and leading coefficient of the polynomial function whose graph is shown?

- A Degree is odd; leading coefficient is positive
- B Degree is odd; leading coefficient is negative
- C Degree is even; leading coefficient is positive
- D Degree is even; leading coefficient is negative



Odd/Even: Even

Degree: 2, 4, 6...

L.C.: Negative

Give the END Behavior with symbols:

$x \rightarrow +\infty f(x) \rightarrow -\infty$

$x \rightarrow -\infty f(x) \rightarrow -\infty$

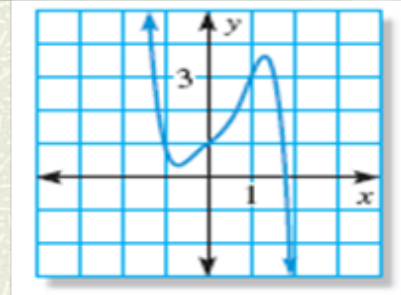
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Describe the degree and leading coefficient of polynomial function whose graph is shown.

Odd/Even: **Odd**

Degree: **1, 3, 5, ...**

L.C.: **Negative**



Give the END Behavior with symbols:

**$x \rightarrow -\infty, f(x) \rightarrow +\infty$**   
 **$x \rightarrow +\infty, f(x) \rightarrow -\infty$**

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**EXAMPLE 5 Graph polynomial**

**Graph  $f(x) = -x^3 + x^2 + 3x - 3$**

To graph the function, connect the points with a smooth curve and check the end behavior.

Odd/Even: **Odd**

Degree: **3**

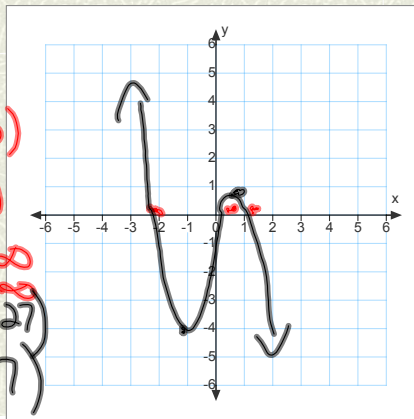
L.C.: **-1**

**Zeros:  $(-1.73, 0), (1, 0)$**

**E.B.:  $x \rightarrow +\infty, f(x) \rightarrow -\infty$**   
 **$x \rightarrow -\infty, f(x) \rightarrow +\infty$**

**Max/Min:  $\text{Min: } (-.72, -4.27)$**

**$x = -1.73$**   
 **$x = 1$**



The degree is odd and leading coefficient is negative. So,  $f(x) \rightarrow +\infty$  as  $x \rightarrow -\infty$  and  $f(x) \rightarrow -\infty$  as  $x \rightarrow +\infty$ .

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**GUIDED PRACTICE**

**Graph the polynomial function.**

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

Odd/Even:

Degree:

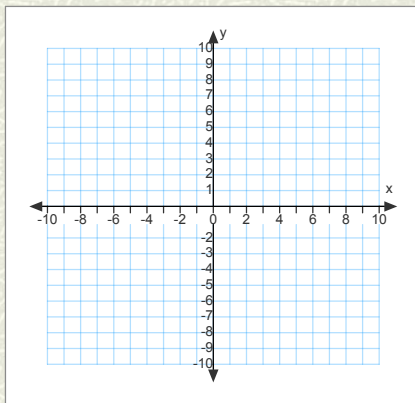
L.C.:

Zeros:

E.B.:

Max/Min: \_\_\_\_\_

Max/Min:



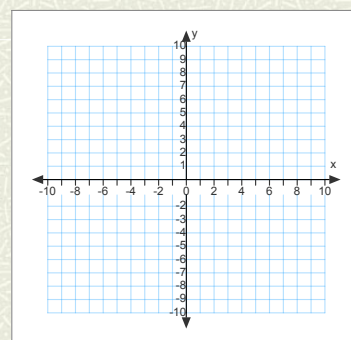
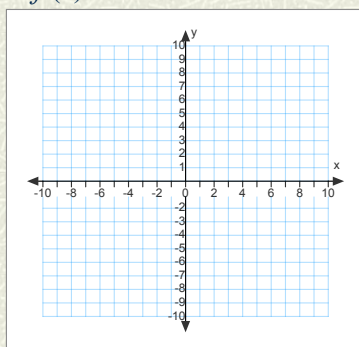
x	y

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**Graph the polynomial function.**

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

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



Odd/Even:

Degree:

L.C.:

Zeros:

E.B.:

Max/Min:

x	y

Odd/Even:

Degree:

L.C.:

Zeros:

E.B.:

Max/Min:

x	y

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