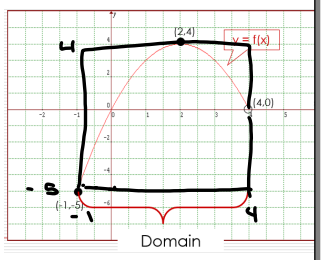
Warm Up: Give the domain and range for the function

Domain:
[-1, 4)
Range
[-5, 4]



What's a zero?

Zeros/Solutions/Roots $x = a$

x-intercepts $(a, 0)$

Where the graph crosses the x-axis

You may have no roots.

You may have many.

y-intercepts

Where the graph crosses the y-axis

Polys have exactly 1 y int.

$(0, b)$ ← constant of the poly in standard form.

Ex $y = 5x^5 + 2x^3 - 4$

y int: $(0, -4)$

Identify:

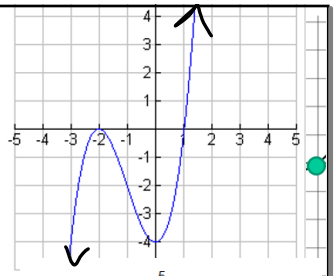
domain $(-\infty, \infty)$

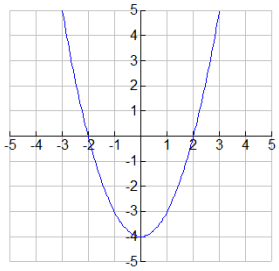
range $(-\infty, \infty)$

x-intercepts $(-2, 0)$ $(1, 0)$

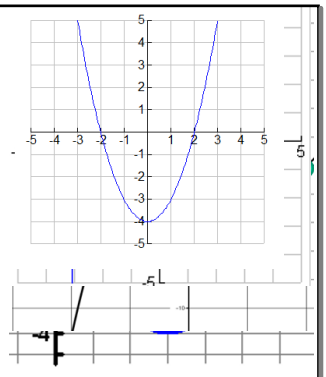
roots $x = -2, 1$

y-intercepts $(0, -4)$





Determine the intervals of increase and decrease for the graph.



Practice Problems for Polynomial Graphs

The number of zeros that a poly can have is equal to the degree.

5) $f(x) = -4x^3 + x + 9$

It will have 3 zeros.

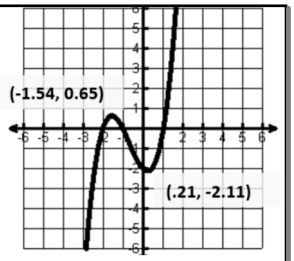
1. $f(x) = x^3 + 2x^2 - x - 2$

Rel. Max: _____ Rel. Min: _____

Abs. Max: _____ Abs. Min: _____

Inc: _____ Dec: _____

Roots: _____ y-int: _____



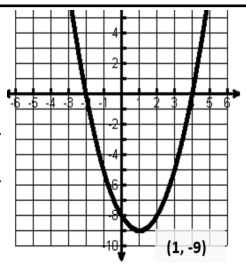
2. $f(x) = x^2 - 2x - 8$

Rel. Max: _____ Rel. Min: _____

Abs. Max: _____ Abs. Min: _____

Inc: _____ Dec: _____

Domain: _____ Range: _____



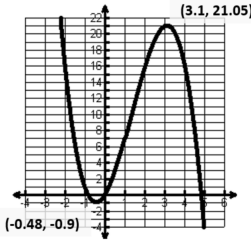
3. $f(x) = -x^3 + 4x^2 + 4x$

Rel. Max: _____ Rel. Min: _____

Abs. Max: _____ Abs. Min: _____

Inc: _____ Dec: _____

Domain: _____ Range: _____



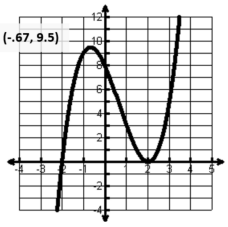
4. $f(x) = x^3 - 2x^2 - 4x + 8$

Rel. Max: _____ Rel. Min: _____

Abs. Max: _____ Abs. Min: _____

Inc: _____ Dec: _____

Roots: _____ y-int: _____



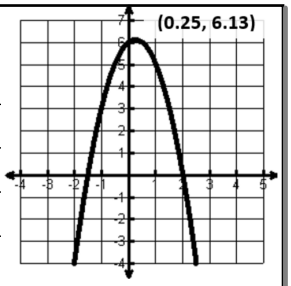
5. $f(x) = -2x^2 + x + 6$

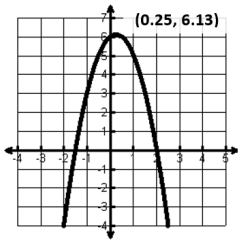
Rel. Max: _____ Rel. Min: _____

Abs. Max: _____ Abs. Min: _____

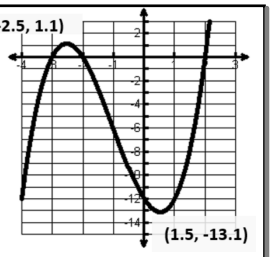
Inc: _____ Dec: _____

Domain: _____ Range: _____





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



Rel. Max: _____ Rel. Min: _____

Abs. Max: _____ Abs. Min: _____

Inc: _____ Dec: _____

Roots: _____ y-int: _____

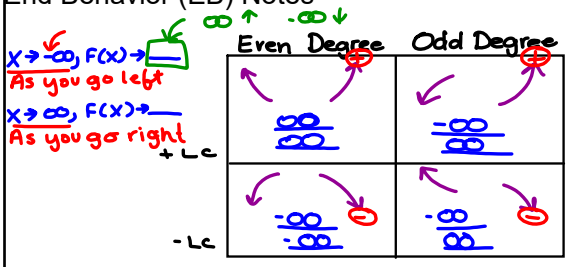
12. $f(x) = -2x^3 + 7$

Y-Int: _____ # of Zeros: _____

Notes on EB and Extrema

Let's play around with Desmos and draw some conclusions.

End Behavior (EB) Notes

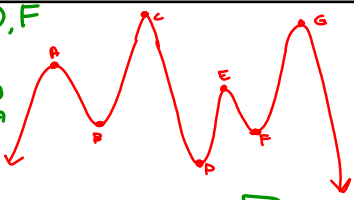


Extrema

- Turning **points** $E = D - 1 \rightarrow D = E + 1$
- MAX Number of extrema = degree - 1
- Includes all maximum and minimum points
  - Relative max- all the peaks
  - Relative min - all the valleys
  - Absolute max - above the whole graph
  - Absolute min - below the whole graph

Relative Mins B, D, F

Relative Maxs A, C, E, G



Abs. Min none

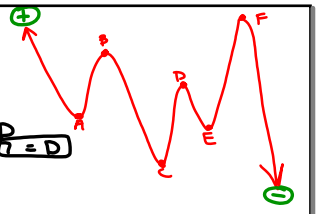
Abs. Max C

Least Degree: Extrema + 1 ⇒ 7 + 1 = 8

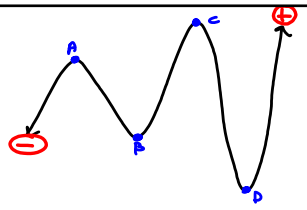
EB: $x \rightarrow -\infty, F(x) \rightarrow -\infty$
$x \rightarrow \infty, F(x) \rightarrow -\infty$

Ext. + 1 = Degree
Ext = D - 1

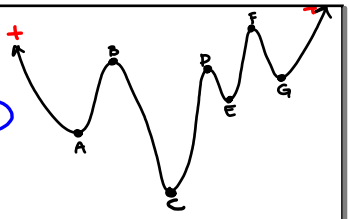
Rel. Min A, C, E
Rel Max B, D, F
Abs. Min none
Abs Max none
Least Degree E + 1 = D
6 + 1 = 7 = D
EB: ← →
$x \to -\infty, f(x) \to \infty$
$x \to \infty, f(x) \to -\infty$
Degree Even or Odd?
LC positive or Negative?



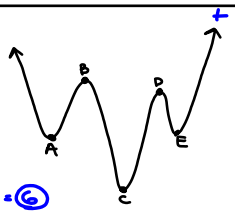
Relative Min B, D
Relative Max A, C
Absolute Min none
Absolute Max none
EB
$x \to -\infty, f(x) \to -\infty$
$x \to \infty, f(x) \to \infty$
Least Degree? D = E + 1 → D = 4 + 1 = 5
Degree: Even or Odd?
LC: positive or neg? R Hand arrow



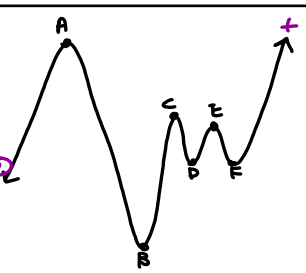
Rel. Min A, C, E, G
Rel. Max B, D, F
Abs. Min C
Abs Max None
Least Degree: 7 + 1 = 8
EB:
$x \to -\infty, f(x) \to \infty$
$x \to \infty, f(x) \to \infty$
Degree: Even or Odd
LC: positive or neg



Rel. Min A, C, E
Rel Max B, D
Absol. Min C
Absol. Max None
Deg is Even or Odd?
LC positive or neg?
Least Degree: D = E + 1 = 5 + 1 = 6
EB
$x \to -\infty, f(x) \to \infty$
$x \to \infty, f(x) \to \infty$

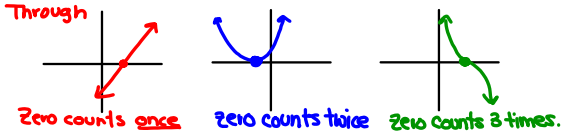


Rel. Min B, D, F
Rel. Max A, C, E
Absol. Min none
Absol Max none
Degree: Even or Odd?
LC: pos or neg?
Least degree: 6 + 1 = 7
EB:
$x \to -\infty, f(x) \to -\infty$
$x \to \infty, f(x) \to \infty$



Bounces, Through, and Snakes

The way a function crosses or touches the x-axis reveals how many zeros it has at that location. Let's go to desmos to investigate.



When determining the least degree based on the graph:

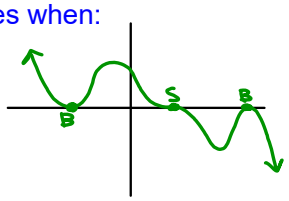
bounces + straight + snakes when:

bounces = 2 x 2 = 4

straight = 0 x 1 = 0

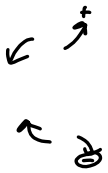
snakes = 1 x 3 = 3

D = 7



Complete the following table using each polynomial function:

Function	Leading Coeff (+ or -)	Degree	End Behavior
1. $f(x) = x^2 - 8x + 12$	+	3	As $x \to +\infty$ $f(x) \to \infty$; As $x \to -\infty$ $f(x) \to -\infty$
2. $f(x) = 3x^3 - 12x + 4$	+	3	As $x \to +\infty$ $f(x) \to \infty$; As $x \to -\infty$ $f(x) \to -\infty$
3. $f(x) = -2x^3 + 4x^2 + x - 2$	−	3	As $x \to +\infty$ $f(x) \to -\infty$; As $x \to -\infty$ $f(x) \to \infty$
4. $f(x) = x^4 - 5x^3 + 5x^2 - x - 6$	-	4	As $x \to +\infty$ $f(x) \to -\infty$; As $x \to -\infty$ $f(x) \to -\infty$
5. $f(x) = x^4 - 2x^3 - 5x^2 - 6x$	−	4	As $x \to +\infty$ $f(x) \to -\infty$; As $x \to -\infty$ $f(x) \to -\infty$



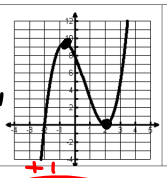
Use the equations to answer the following:

Function	Degree	Max # of Extrema
6. $f(x) = x^2 - 8x + 12$	3	2
7. $f(x) = -12x^2 + 4$	2	1
8. $f(x) = x^4 - 2x^3 - 5x^2 - 6x$	4	3

Degree − 1

Given the graphs, state the Max # of Extrema and the Least Possible Degree

9.

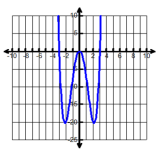


# of Extrema 2

Least possible degree 3

+1

10.



# of Extrema 3

Least possible degree 4

+1

Degree Extrema

−1

Determine the end behavior and maximum number of extrema (u-turns) w/o calculator:

11. $f(x) = -8x^2 - 7x^3 + 3x - 7$

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

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

extrema 4

12. $f(x) = 12 - 3x^3 + 5x^2 - 7x^4$

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

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

extrema 3

13. $f(x) = 1 - 3x - 2x^2 - 5x^3 + 7x - 12x^5$

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

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

extrema 4

14. $f(x) = -7x^5 + 343$

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

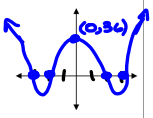
$x \to +\infty$ $f(x) \to -\infty$

extrema 2

Find the number of zeros, y-int, & end behavior. Sketch the graph:

15. $x^4 - 13x^2 + 36 = 0$

given zeros: −3, −2, 2, 3



# of Zeros: 4 Y-Int: (0,36)

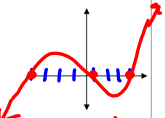
$x \to +\infty$ $f(x) \to \infty$

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

max # of extrema 3

16. $x^4 - x^2 - 16x + 16 = 0$

given zeros: −4, 1, 1



# of Zeros: 3 Y-Int: (0,16)

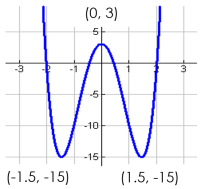
$x \to +\infty$ $f(x) \to \infty$

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

max # of extrema 2

Answer all of the following questions for the following graph:

17.



Domain: $(-\infty,\infty)$	Range: $[-15,\infty)$
Increasing: $(-1.5,0)\cup(1.5,\infty)$	Decreasing: $(-\infty,-1.5)\cup(0,1.5)$
x-intercepts: $(-3,0),(-1.5,0),(3,0)$	y-intercept: $(0,3)$
Abs. Max: None	Abs. Min: $(\pm1.5,-15)$
Rel. Max: $(0,3)$	Rel. Min: $(\pm1.5,-15)$
Min. degree 4	Sign of leading Coeff. +