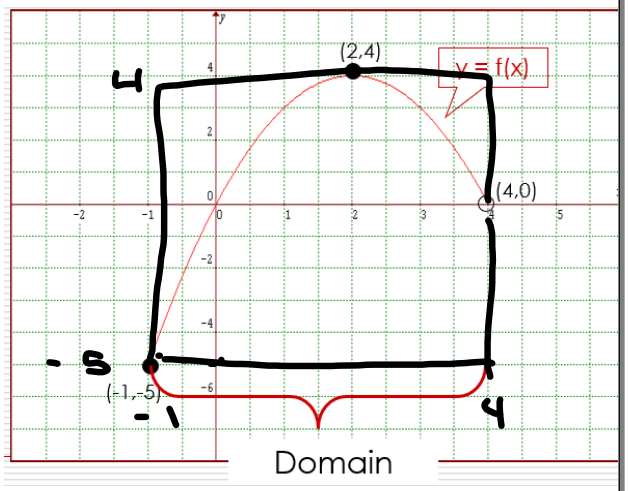
Warm Up: Give the domain and range for the function

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



Identify:

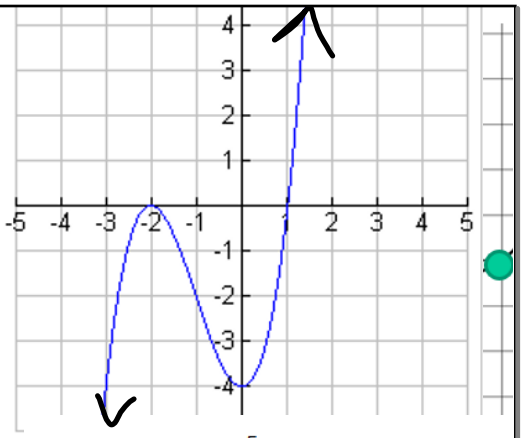
domain $(-\infty, \infty)$

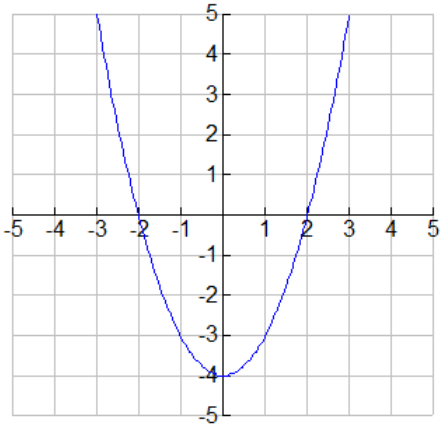
range $(-\infty, \infty)$

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

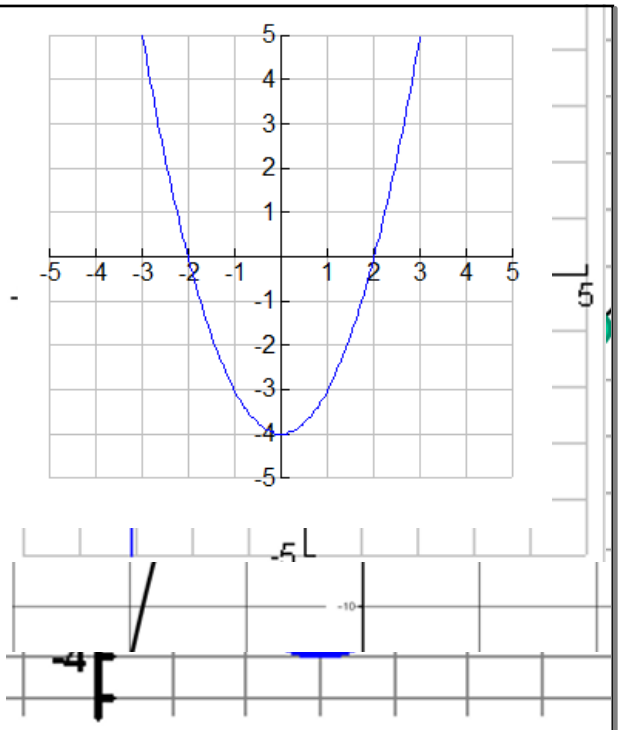
roots $x = -2, 1$

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.

Day 1

Identify the following characteristics of the function:

1) Domain $(-\infty, \infty)$

2) y-intercept $(0,1)$

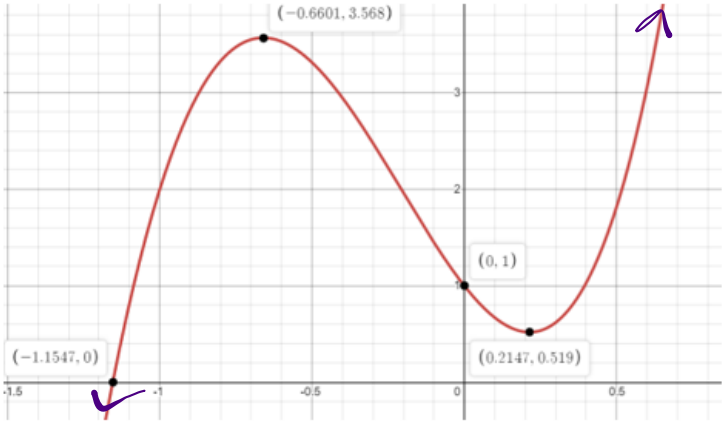
3) Zero(s) -1.1547

4) Extrema

5) EB: $x \to -\infty, f(x) \to -\infty$
$x \to \infty, f(x) \to \infty$

6) Does it have an overall maximum or minimum point?

No



3	4	6	8	9	1	5	7	2
2	9	1	7	3	5	6	8	4
5	7	8	2	6	4	3	9	1
8	5	9	4	7	3	1	2	6
4	6	3	9	1	2	8	5	7
7	1	2	6	5	8	4	3	9
1	3	7	5	4	9	2	6	8
9	2	4	3	8	6	7	1	5
6	8	5	1	2	7	9	4	3

5

r

g

2	4	3	1
3	1	4	2
1	3	2	4
4	2	1	3

4 by 4 Sudoku for Kids

3	4	6	8	9	1	5	7	2
2	9	1	7	3	5	6	8	4
5	7	8	2	6	4	3	9	1
8	5	9	4	7	3	1	2	6
4	6	3	9	1	2	8	5	7
7	1	2	6	5	8	4	3	9
1	3	7	5	4	9	2	6	8
9	2	4	3	8	6	7	1	5
6	8	5	1	2	7	9	4	3

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

$x^2(x+2) + (-1)(x+2) = (x^2-1)(x+2)$

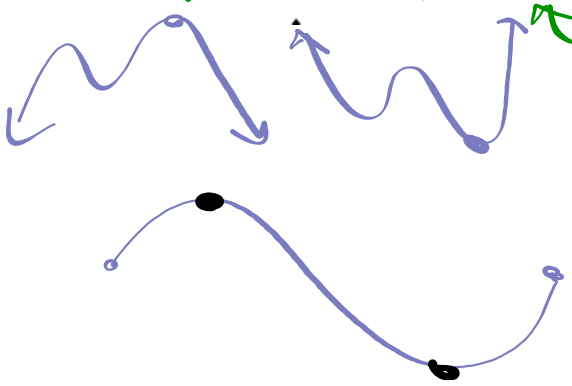
Rel. Max: $(-1.54, .65)$ Rel. Min: $(.21, -2.11)$

peaks valley

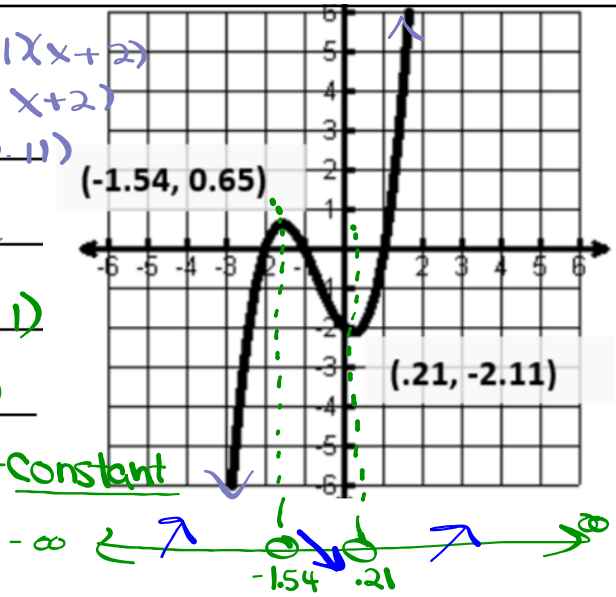
Abs. Max: none Abs. Min: none

Inc: $(-\infty, -1.54) \cup (.21, \infty)$ Dec: $(-1.54, .21)$

Roots: $-2, \pm 1$ y-int: $(0, -2)$



constant



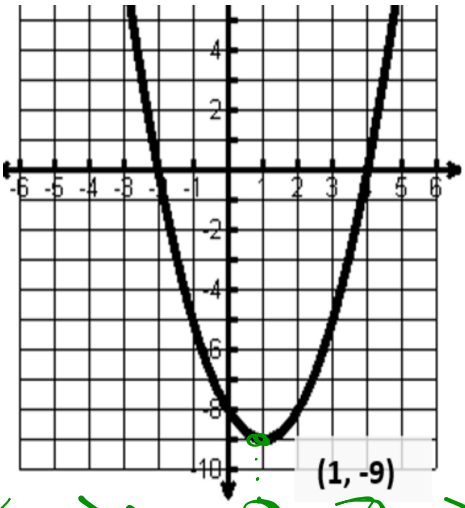
2. $f(x) = x^2 - 2x - 8$ $= (x-4)(x+2)$

Rel. Max: none Rel. Min: $(1, -9)$

Abs. Max: none Abs. Min: $(1, -9)$

Inc: $(1, \infty)$ Dec: $(-\infty, 1)$

Domain: $(-\infty, \infty)$ Range: $[-9, \infty)$



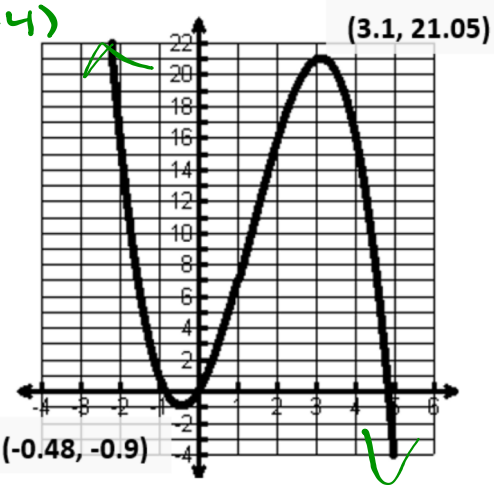
3. $f(x) = -x^3 + 4x^2 + 4x$ $= -x(x^2 - 4x - 4)$

Rel. Max: $(3.1, 21.05)$ Rel. Min: $(-.48, -.9)$

Abs. Max: none Abs. Min: none

Inc: $(-.48, 3.1)$ Dec: $(-\infty, -.48) \cup (3.1, \infty)$

Domain: $(-\infty, \infty)$ Range: $(-\infty, \infty)$



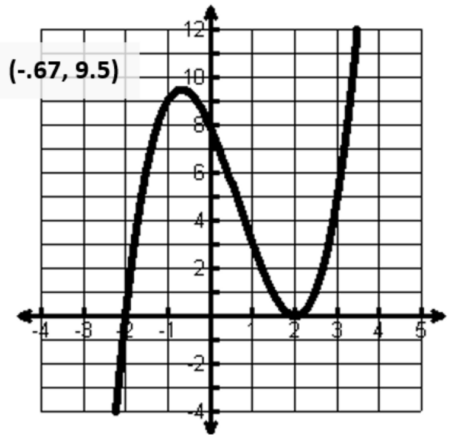
4. $f(x) = x^3 - 2x^2 - 4x + 8$

Rel. Max: _____ Rel. Min: _____

Abs. Max: _____ Abs. Min: _____

Inc: _____ Dec: _____

Roots: _____ y-int: _____



Day 2

Identify the following characteristics of the graph:

1) zeros

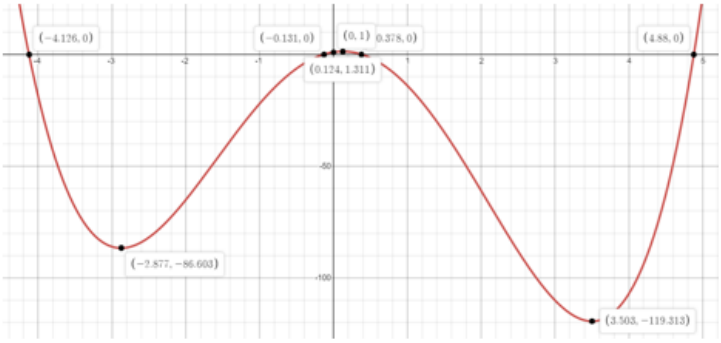
2) y-intercept

3) Range

4) $x \to -\infty, f(x) \to$ ___
$x \to \infty, f(x) \to$ ___

5) Extrema

6) Interval of increase



Day 2

Identify the following characteristics of the graph:

1) zeros $x = -4.126, -.131, .378, 4.88$

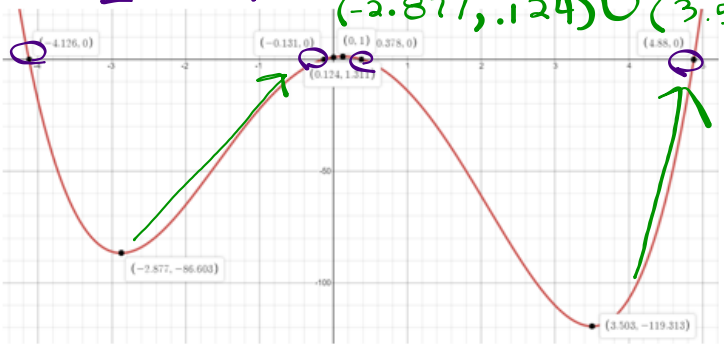
2) y-intercept $(0, 1)$

3) Range $[-119.31, \infty)$

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

5) Extrema $(-2.877, -86.603)$

6) Interval of increase $(.124, 1.311)$ $(3.503, -119.313)$
$(-2.877, .124) \cup (3.503, \infty)$



#7 – 12

y int: plug 0 in for x & solve for y.

★ In standard form, the constant is the y int.

# of zeros = degree of Function

7) $f(x) = x^3 - 16$

# of zeros = 3

→ y int (0, -16)

What's a zero?

Zeros/Solutions/Roots = value of x-coordinate

x-intercepts point

Where the graph crosses the x-axis

y-intercepts

Where the graph crosses the y-axis

written as a point $(0, y)$ – NOT just a value.

# of intercepts

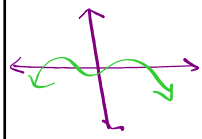
yint: always have exactly one.

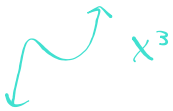
xint: 0 to n xint = to degree

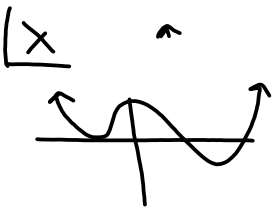
Ex

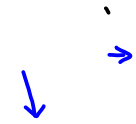
★If n is odd, you will have at least 1 x intercept.

★If n is EVEN it may never cross the x-axis.









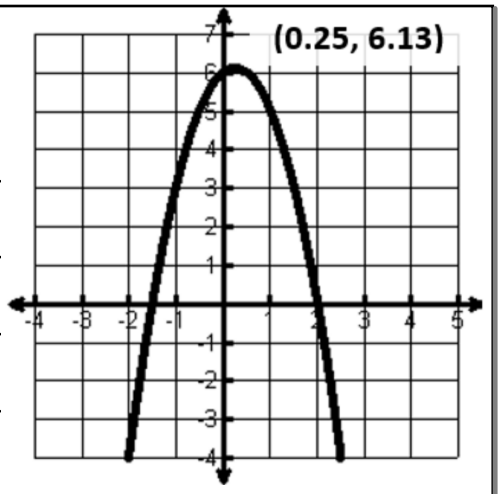
5. $f(x) = -2x^2 + x + 6$

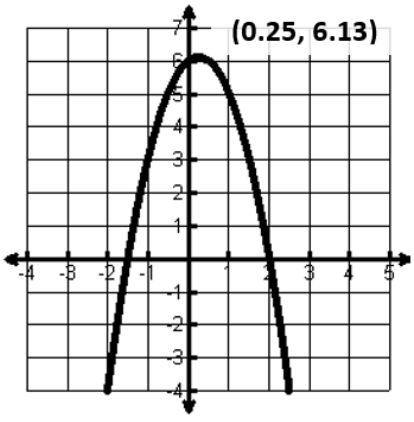
Rel. Max: _____ Rel. Min: _____

Abs. Max: _____ Abs. Min: _____

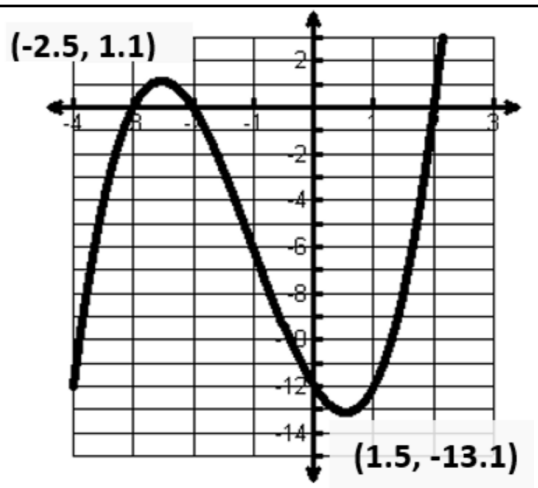
Inc: _____ Dec: _____

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

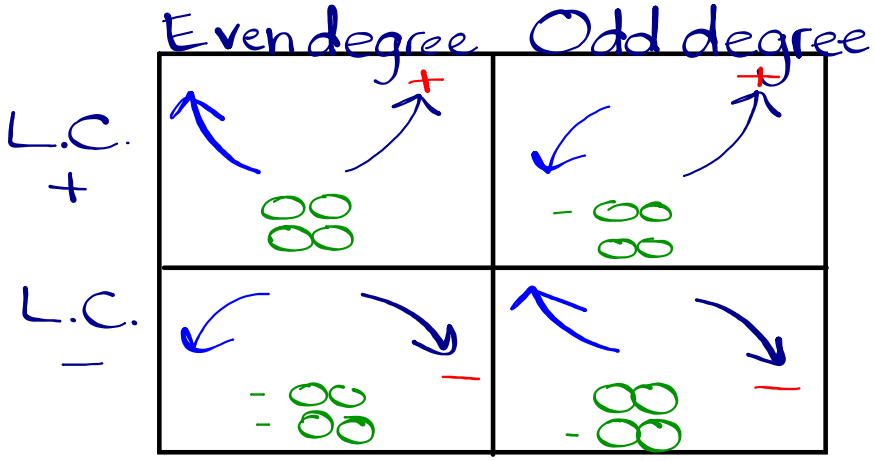
Y-Int: _____ # of Zeros: _____

Notes on EB and Extrema

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

End Behavior (EB) Notes

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



Extrema

Max extrema = Degree − 1
Least Degree = Extrema + 1

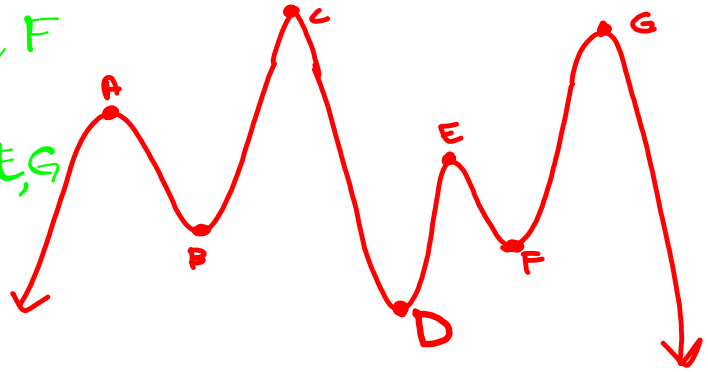
- Turning **points**
- MAX Number of extrema = degree - 1
- Includes all maximum and minimum points
  - Relative max- all the peaks
  - Relative min - all the valleys
  - Absolute max - above the whole graph
  - Absolute min - below the whole graph

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

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

Rel. Min A, C, E

Rel Max B, D, F

Abs. Min None

Abs Max None

Least Degree $6+1=7$

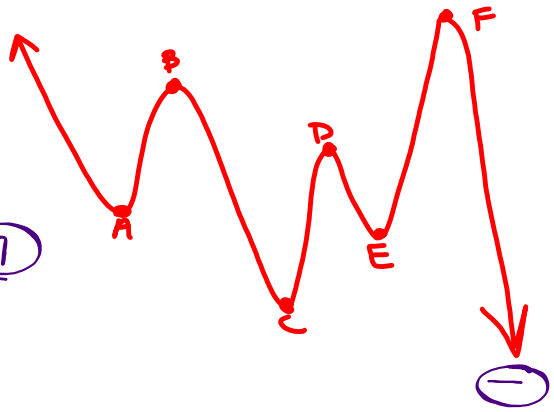
EB:

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

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

Degree Even or Odd?

LC positive or Negative?



Relative Min: B, D

Relative Max A, C

Absolute Min
Absolute Max: } None

EB

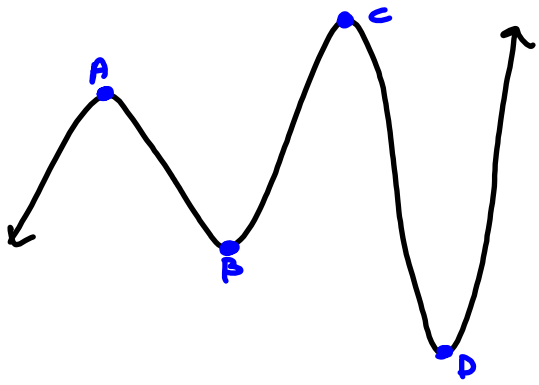
$x \to -\infty, f(x) \to -\infty$

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

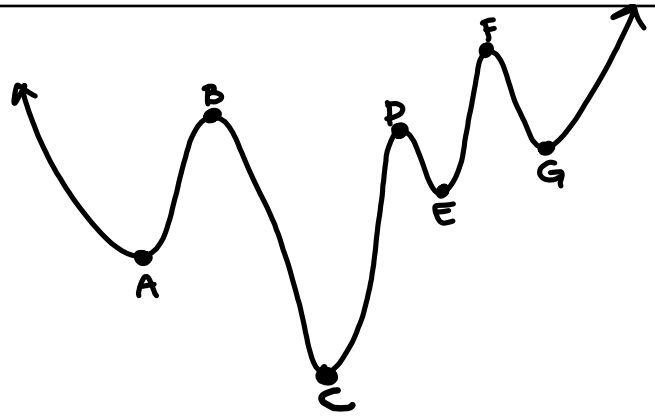
Least Degree? $4+1=5$

Degree: Even or Odd?

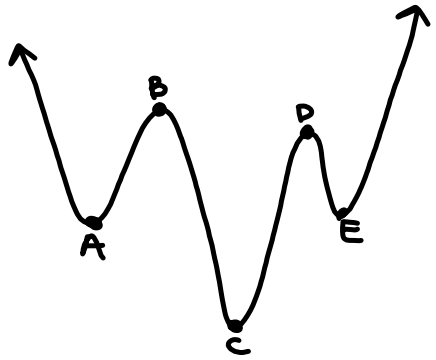
LC: positive or neg?



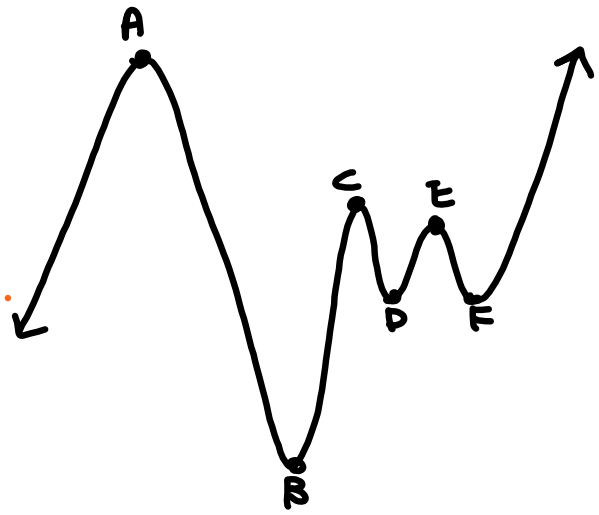
Rel. Min
Rel. Max
Abs. Min
Abs Max
Least Degree:
EB:
$x \to -\infty$, $f(x) \to$ ___
$x \to \infty$, $f(x) \to$ ___
Degree: Even or Odd
LC: positive or neg



Rel. Min
Rel Max
Absol. Min
Absol. Max
Deg is Even or Odd?
LC positive or neg?
Least Degree:
EB
$x \to -\infty$, $f(x) \to$ ___
$x \to \infty$, $f(x) \to$ ___

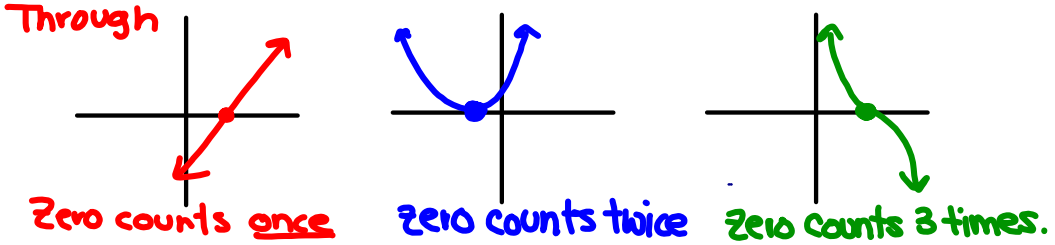


Rel. Min
Rel. Max
Absol. Min
Absol Max
Degree: Even or Odd?
LC : pos or neg?
Least degree:
EB:
$x \to -\infty$, $f(x) \to$ ___
$x \to \infty$, $f(x) \to$ ___



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.



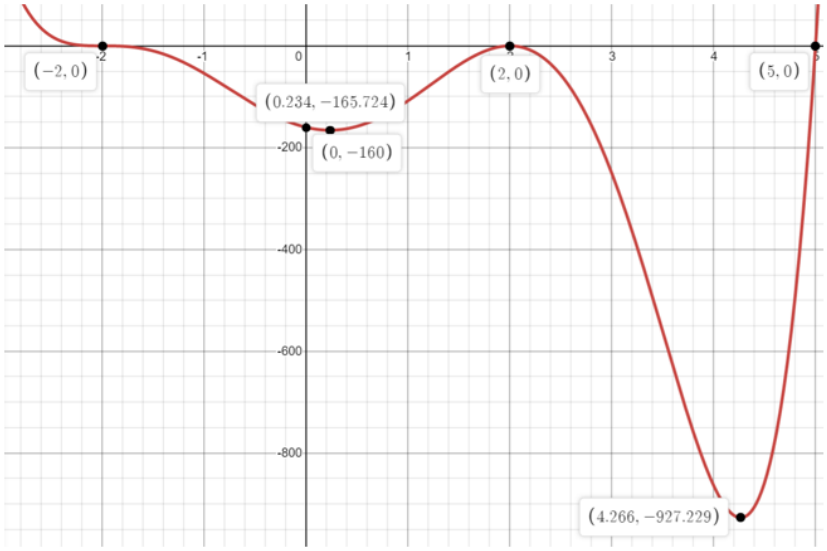
$f(x) = (x-3)^2(x+4)^3(x-1)^1$

① Degree = $2+3+1 = 6$
★ Leading term: $x^2 \cdot x^3 \cdot x^1 = x^6$
② y int: $f(0) = (-3)^2(4)^3(-1)^1 = -576$ $(0, -576)$
③ Zeros: $x-3=0 \Rightarrow x=3$ Bounce | $x+4=0 \Rightarrow x=-4$ Snake | $x-1=0 \Rightarrow x=1$ through

Day 3

Identify the following characteristics of the graph

1) x-intercepts
2) Domain
3) Range
4) Extrema
5) Max point
6) Min point
7) $x \to -\infty, f(x) \to \_\_\_$ $x \to \infty, f(x) \to \_\_\_$
8) y-intercept
9) Interval of increase
10) Interval of decrease



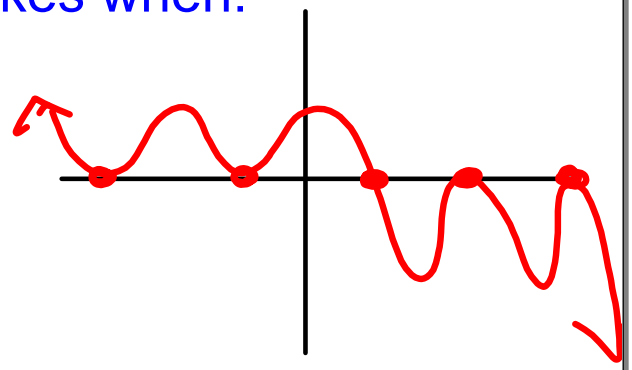
When determining the least degree based on the graph:

bounces + straight + snakes when:

bounces =

straight =

snakes =



Sketch

$(x-4)^3(x+3)^2(x+5)^1 = f(x)$

$f(0) = (-4)^3(3)^2(5)^1 = -2880$

$(0,-2880)$ y int

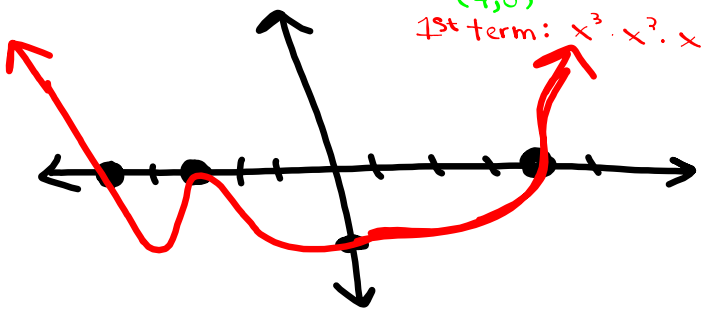
$x-4=0$ $x=4$ $(4,0)$ Bounce $(-3,0)$ through $(-5,0)$ x int.

1st term: $x^3 \cdot x^2 \cdot x = 1x^6$ ↑ ↑

x int

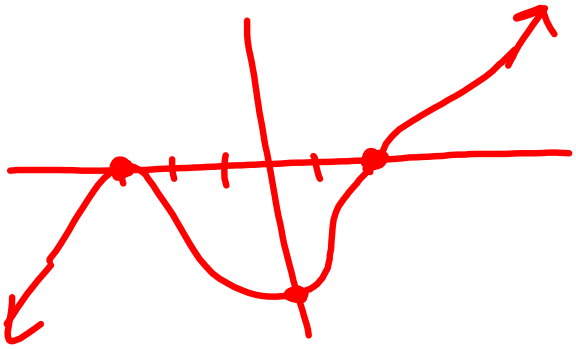
EB

Bounce/Snake Through



Sketch

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



x int

y int

EB

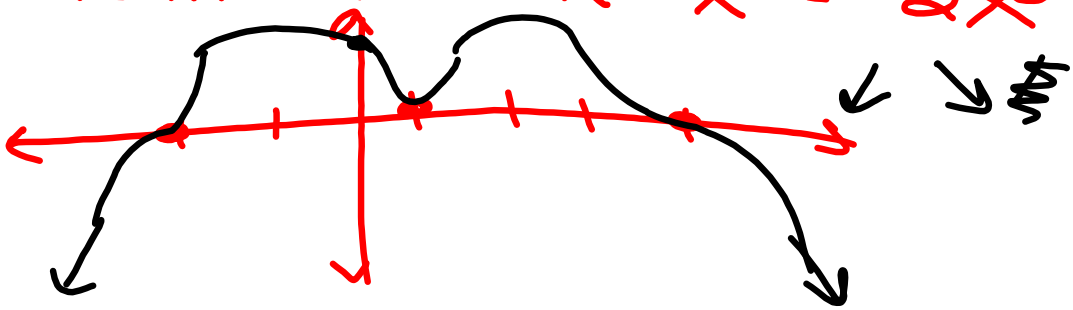
Bounce/Snake through

Sketch

$f(x) = -2(x-4)^3(x-1)^2(x+2)^3$

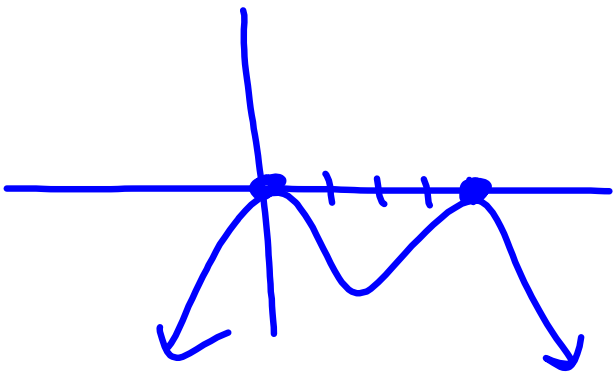
$f(0) = -2(-4)^3(-1)^2(2)^3 = 1024$

1st term: $-2 \cdot x^3 \cdot x^2 \cdot x^3 = -2x^8$



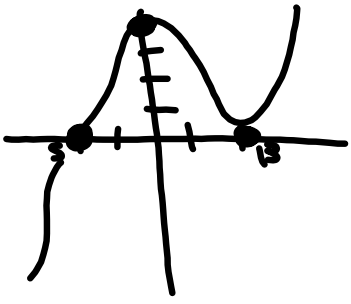
Z: 0, 0, 4, 4

LC : –



Z: -2, -2, -2, 2, 2

y int: (0, 4)



Rel max @ (0,3)
Z: -2, -2, 2, 2

Z: -2, 0, 0
Rel. Max @ (-1,2)

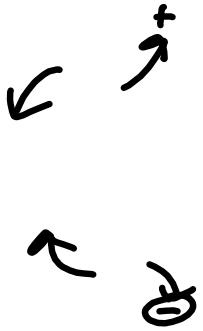
Z: -4, -1, -1, 1, 1, 4
yint: (0,-1)
min @ (2,-5)
D: 6

Complete the following table using each polynomial function:

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

Complete the following table using each polynomial function:

Function	Leading Coeff (+ or -)	Degree	End Behavior
1. $f(x)=x^3-x^2-8x+12$	+	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. $f(x)=x^3-x^2-8x+12$		
7. $f(x)=-12x^2+4$		
8. $f(x)=x^4+2x^3-5x^2-6x$		

Use the equations to answer the following:

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

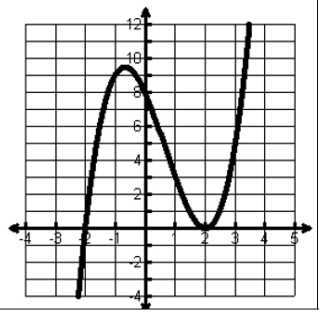
9.

# of Extrema

_____

Least possible degree

_____

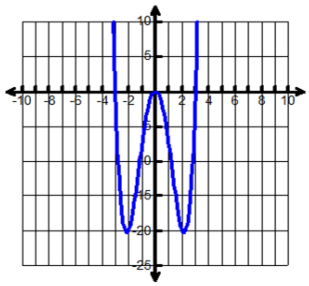


10.

# of Extrema

_____

Least possible degree _____



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

9.

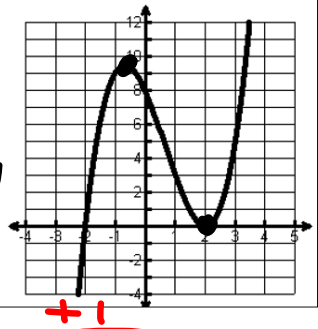
# of Extrema

2

Least possible degree

3

+1

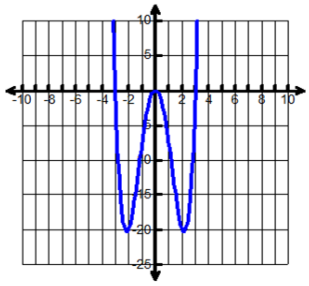


10.

# 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:

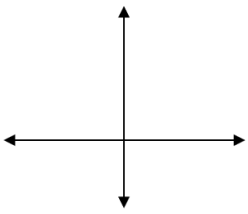
$f(x) = -8x^5 - 7x^3 + 3x - 7$ 11. $x \to -\infty$ $f(x) \to$ _____ extrema _____ $x \to +\infty$ $f(x) \to$ _____	$f(x) = 12 - 3x^3 + 5x^3 - 7x^4$ 12. $x \to -\infty$ $f(x) \to$ _____ extrema _____ $x \to +\infty$ $f(x) \to$ _____
$f(x) = 1 - 3x - 2x^2 - 5x^3 + 7x^4 - 12x^5$ 13. $x \to -\infty$ $f(x) \to$ _____ extrema _____ $x \to +\infty$ $f(x) \to$ _____	$f(x) = -7x^3 + 343$ 14. $x \to -\infty$ $f(x) \to$ _____ extrema _____ $x \to +\infty$ $f(x) \to$ _____

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

$f(x) = -8x^5 - 7x^3 + 3x - 7$ 11. $x \to -\infty$ $f(x) \to$ ∞ extrema 4 $x \to +\infty$ $f(x) \to$ -∞	$f(x) = 12 - 3x^3 + 5x^3 - 7x^4$ 12. $x \to -\infty$ $f(x) \to$ -∞ extrema 3 $x \to +\infty$ $f(x) \to$ -∞
$f(x) = 1 - 3x - 2x^2 - 5x^3 + 7x - 12x^5$ 13. $x \to -\infty$ $f(x) \to$ ∞ extrema 4 $x \to +\infty$ $f(x) \to$ -∞	$f(x) = -7x^3 + 343$ 14. $x \to -\infty$ $f(x) \to$ ∞ extrema 2 $x \to +\infty$ $f(x) \to$ -∞

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

15. $x^4 - 13x^2 + 36 = 0$
given zeros : $-3, -2, 2, 3$

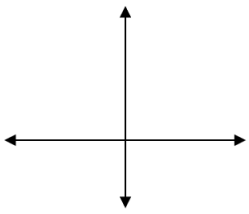


# of Zeros: _____ Y-Int: _____

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

$x \to +\infty$ $f(x) \to$ _____ max # of *extrema* ___

16. $x^3 - x^2 - 16x + 16 = 0$
given zeros : $-4, 1, 4$



# of Zeros: _____ Y-Int: _____

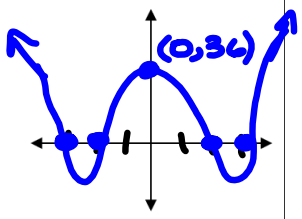
$x \to -\infty$ $f(x) \to$ _____

$x \to +\infty$ $f(x) \to$ _____ max # of *extrema* ___

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

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

given zeros : $-3, -2, 2, 3$



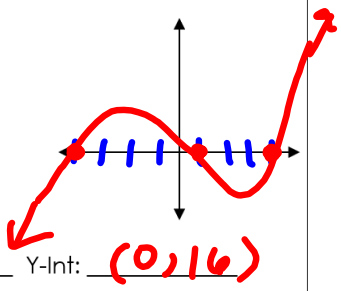
# of Zeros: 4 Y-Int: (0,36)

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

$x \to -\infty$ $f(x) \to \infty$ max # of *extrema* 3

16. $x^3 - x^2 - 16x + 16 = 0$

given zeros : $-4, 1, 4$



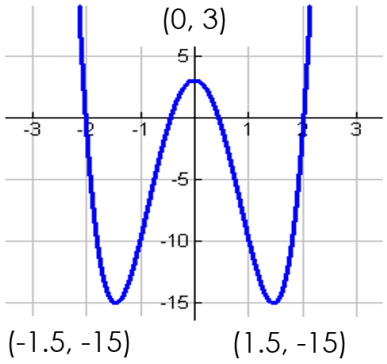
# of Zeros: 3 Y-Int: (0,16)

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

$x \to -\infty$ $f(x) \to -\infty$ max # of *extrema* 2

Answer all of the following questions for the following graph:

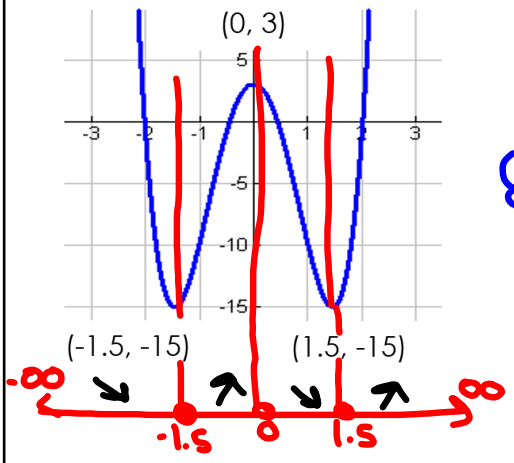
17.



Domain:	Range:
Increasing:	Decreasing:
x-intercepts:	y-intercept:
Abs. Max:	Abs. Min:
Rel. Max:	Rel. Min:
Min. degree	Sign of leading Coeff.

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: $(-2,0),(-1.5,0)$ $(1.5,0),(2,0)$	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. +

Draw the poly:

1) Rel. max @ (0,3)

2: $x=-2,-2,2,2$

2) Z: x = -2, 0, 0
Rel. max @ (-1, 2)

3) Z: x = 0, 0, 4, 4
LC is –

Ex 3
Z: x = -2, -2, -2, 2, 2
y int: (0, 4)

Ex 4
Z: x = -4, -1, -1, 1, 1, 4
y int: (0, -1)
min: (2, -5)

Draw the poly:

1) Rel. max @ (0, 3)
Z: x = -2, -2, 2, 2

2) Z: x = -2, 0, 0
Rel. max @ (-1, 2)

3)
Z: $x = 0, 0, 4, 4$
LC is negative

4) Z: $x = -2, -2, -2, 2, 2$
y int: $(0, 4)$

5) Z: $x = -4, -1, -1, 1, 1, 4$
y int: $(0, -1)$
min @ $(2, -5)$