...From Linear To Quadratic...

Open: DESMOS Graphing Calculator

Task 1: Let's Review Linear Relationships

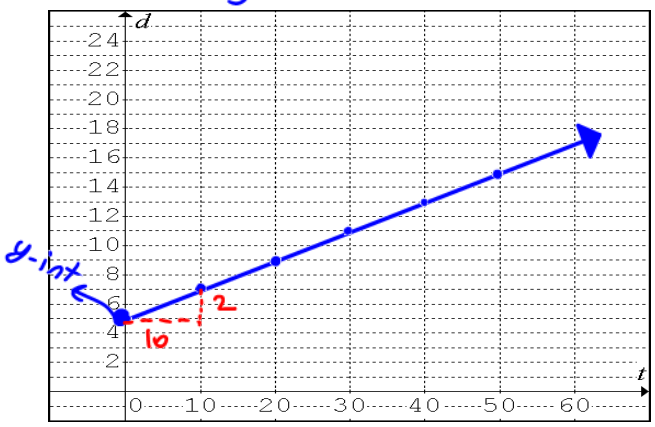
Billy Bob's dog is out for a walk. The equation to model its distance away from the house, d metres, after t seconds is: $d = 0.2t + 5$.

- Enter this equation into in DESMOS.
- Adjust your screen to show the scales like they are shown in the grid below.

1. Complete the Distance column in the table below. To calculate the distances, you can:
   - You can use the equation above and your calculator.
   - You can use the TRACE feature on the online graphing calculator.

Time (sec)	Distance (m)	*Finite Differences* First Differences
0	5	7-5=2
10	7	9-7=2
20	9	11-9=2
30	11	13-11=2
40	13	15-13=2
50	15	

Distance away from home



2. Graph the relation on the grid.

3. a. How far from the house is the dog when he starts his walk? This is the **y-intercept**. 5 m
   Please label this point on the graph.

   b. At what rate does the dog walk? This is the **slope**. 2 m/10sec = 1m/5sec
   Please indicate this on the graph with a rate triangle.

4. Calculate the **first differences**? Do you remember how?

5. The first differences are all equal. What does that tell you about the relationship between d and t?
   LINEAR RELATIONSHIP

Task 2: Quadratic Relations *Now, let's kick it up a notch!!!*

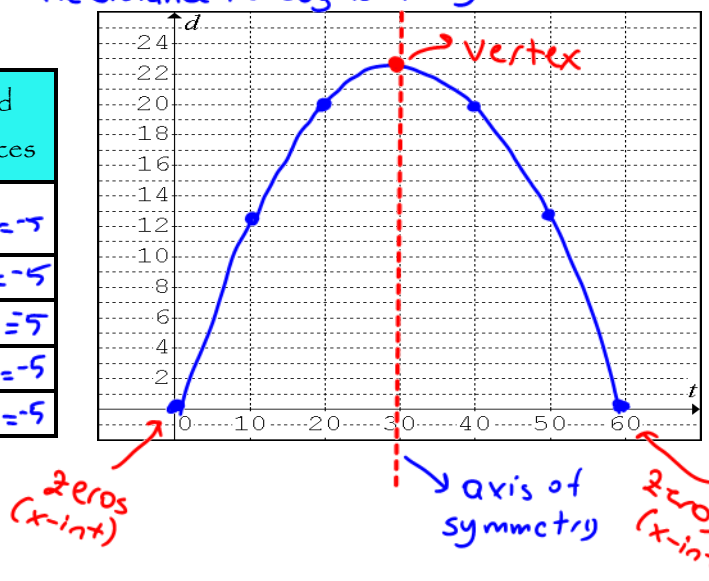
Billy Bob's dog is now going to run, fetch a frisbee, and then run back. The equation to model the distance, d metres, the dog is away from Billy Bob after t seconds is: $d = -0.025t^2 + 1.5t$.

- Enter this equation in the online graphing calculator.

6. Complete the Height column in the table below. To calculate the height, you can:
   - You can use the equation above and your calculator.
   - You can use the TRACE feature on the online graphing calculator.

Time (s)	Height (m)	Finite Differences: First Differences	Finite Differences: Second Differences
0	0		
10	12.5	12.5-0 = 12.5	7.5 - 12.5 = -5
20	20	20-12.5 = 7.5	2.5 - 7.5 = -5
30	22.5	22.5-20 = 2.5	-2.5 - 2.5 = -5
40	20	20-22.5 = -2.5	-7.5 - (-2.5) = -5
50	12.5	12.5-20 = -7.5	-12.5 - (-7.5) = -5
60	0	0 - 12.5 = -12.5	

The distance the dog is away from B.B



7. Graph the relation on the grid.

8. a. How far is the dog from Billy Bob when he starts running? This is the **y-intercept**. 0
   b. What is the **maximum** distance between the dog and Billy Bob? This is the **vertex**. 22.5m
   c. This shape is called a **parabola**. Draw a vertical line through the vertex of the parabola. This is the **axis of symmetry**.
   d. Would you say that this parabola '**opens up**' or '**opens down**'? DOWN
   e. When is the dog 0m away from Billy Bob? These are the **zeros**! (aka: x-intercepts). @ 0sec and 60sec

9. On the graph, label and calculate the following:
   a. y-intercept (0,0) b. vertex (30,22.5) c. axis of symmetry x=30 d. zeros (0,0) and (60,0)

10. Calculate the first differences.

11. The first differences are not equal. What does that tell you about the relationship between d and t?
    It's non linear.

12. Calculate the second differences. You do this by calculating the first differences of the first differences.

13. The second differences are equal. This means that the relationship is Quadratic.

14. How does the equation of a Linear Relation compare to the equation of a Quadratic Relation?
    Linear: the exponent of "t" is 1
    Quad: the exponent of t is 2

	Linear	Quadratic
general equation	$y = x$	$y = x^2$
shape	STRAIGHT LINE	CURVE (PARABOLA)
equations	slope/y-intercept: $y = mx + b$ slope/point: $y = m(x-p)+q$ standard: $Ax + By + C = 0$	standard: $Ax^2 + Bx + C = 0$ vertex: $y = a(x-h)^2 + k$
degree	1	2

finite differences

x	$y = x$	finite diff. 1st Diff.
-3	-3	-2-(-3)=1
-2	-2	-1-(-2)=1
-1	-1	0-(-1)=1
0	0	1-0=1
1	1	2-1=1
2	2	3-2=1
3	3	

first differences are EQUAL

x	y	finite differences 1st Diff.	2nd Diff.
-3	$(-3)^2=9$	4-9=-5	-3-(-5)=2
-2	$(-2)^2=4$	1-4=-3	-1-(-3)=2
-1	$(-1)^2=1$	0-1=-1	1-(-1)=2
0	$0^2=0$	1-0=1	3-1=2
1	$1^2=1$	4-1=3	5-3=2
2	$2^2=4$	9-4=5	
3	$3^2=9$		

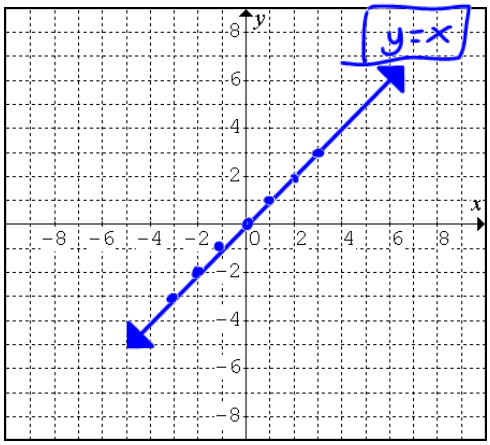
first differences are LINEQUAL
second differences are EQUAL

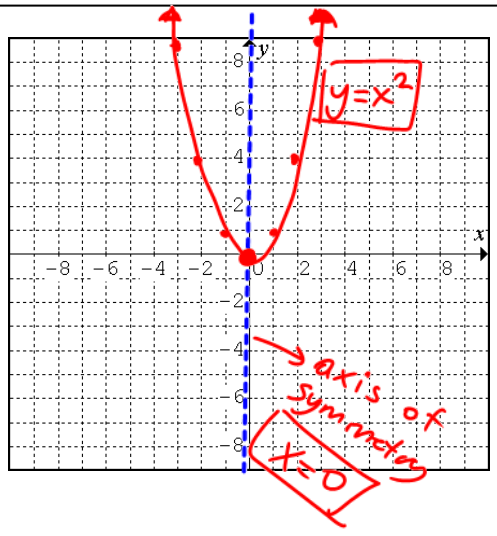
direction

if first differences are + =	UP (↗)
if first differences are - =	DOWN (↘)

if second differences are + =	UP ∪
if second differences are - =	DOWN ∩

graph





key properties

y-intercept: (0, 0)

slope: $\frac{\text{rise}}{\text{run}} = \frac{1}{1} = 1$

y-intercept: (0, 0)

zeros (x-intercepts): (0, 0)

vertex: (0, 0) max/min

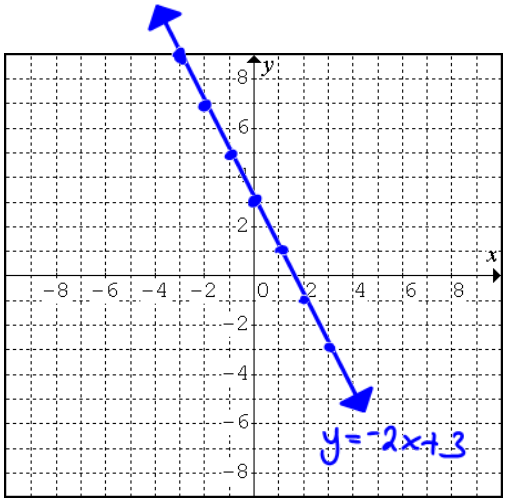
direction of opening: UP

axis of symmetry: $x = 0$

example

$y = -2x + 3$

x	y	finite diff. 1st Diff.
-3	9	7 - 9 = -2
-2	7	5 - 7 = -2
-1	5	3 - 5 = -2
0	3	1 - 3 = -2
1	1	-1 - 1 = -2
2	-1	-3 - (-1) = -2
3	-3	

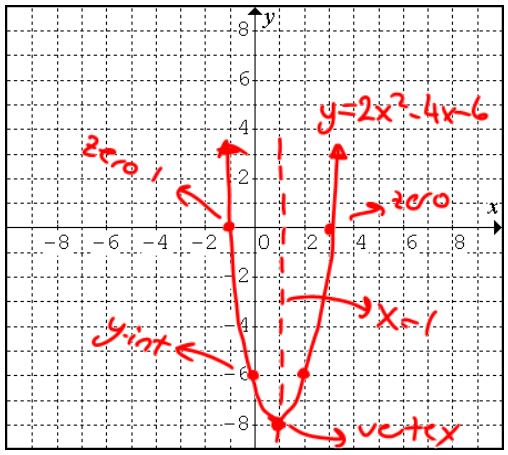


slope = -2

y-intercept = 3

$y = 2x^2 - 4x - 6$

x	y	finite differences 1st Diff.	2nd Diff.
-3	24	10 - 24 = -14	-10 - (-14) = 4
-2	10	0 - 10 = -10	-6 - (-10) = 4
-1	0	-6 - 0 = -6	-2 - (-6) = 4
0	-6	-8 - (-6) = -2	2 - (-2) = 4
1	-8	-6 - (-8) = 2	6 - 2 = 4
2	-6	0 - (-6) = 6	
3	0		



y-intercept = (0, -6)

zeros (x-intercepts) = (-2, 0) and (3, 0)

vertex = (1, -8)

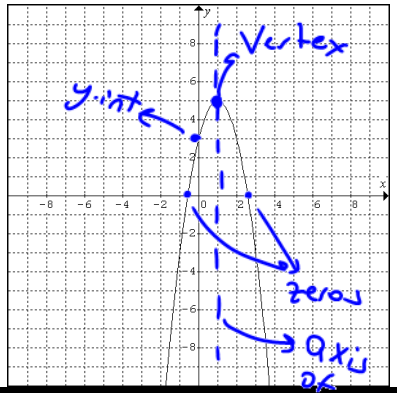
max/min = (1, -8)

direction of opening = UP

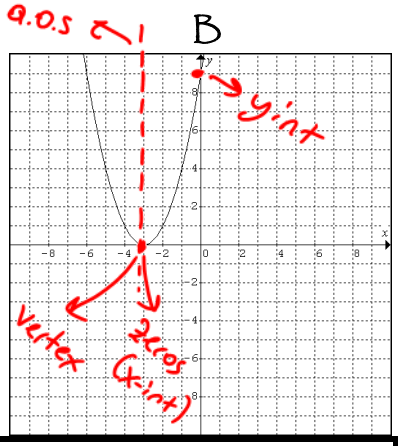
axis of symmetry = $x = 1$

Examples:

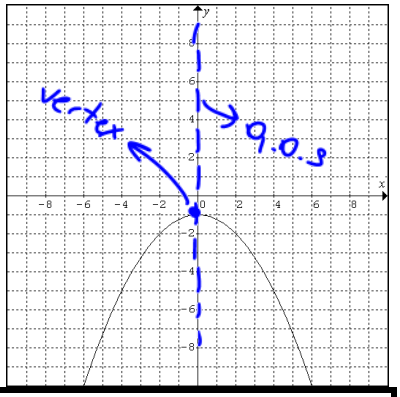
A



B



C



	A	B	C
state & label the vertex	(1,5)	(-3,0)	(0,-1)
state & label the y-intercept	(0,3)	(0,9)	(0,-1)
state & label the zeros	app. (-0.7, 0) (2.7, 0)	(-3,0)	NONE
state the equation & draw in the axis of symmetry	x=1	x=-3	x=0
does the parabola open up or down?	Down	UP	Down
is the vertex a max or a min?	max	Min	MAX
finite differences	first differences are unequal second differences are equal and negative (positive or negative?)	first differences are unequal second differences are equal and POSITIVE (positive or negative?)	first differences are unequal second differences are equal and NEGATIVE (positive or negative?)