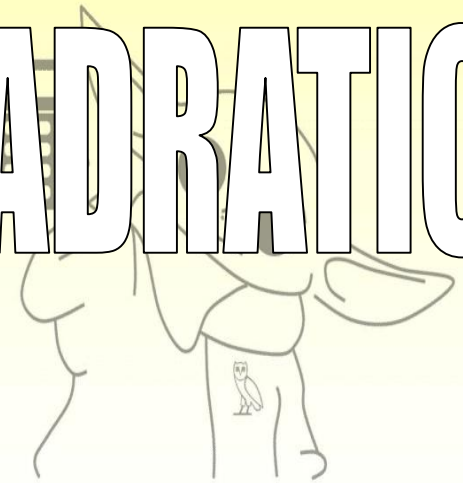
ST. JEAN DE BREBEUF
MATHEMATICS

CHAPTER 4.1

MODELLING WITH QUADRATIC RELATIONS



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CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

KEY CONCEPTS

The graph of a quadratic relation is a *symmetrical* U-shaped curve called a **parabola**.

The parabola has several features:

VERTEX

The **point** of a parabola where the curve changes direction

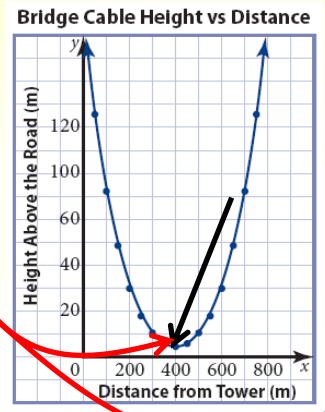
→the **lowest** point on a parabola that opens *upward*

→the **highest** point on a parabola that opens *downward*

MINIMUM

On an *xy*- plane, the ***y*-coordinate** of the **lowest** point on a parabola that opens *upward*

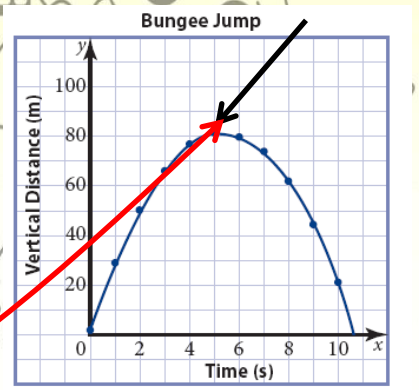
The ***y*-coordinate of the vertex**



MAXIMUM

On an *xy*-plane, the ***y*-coordinate** of the **highest** point on a parabola that opens *downward*

The ***y*-coordinate of the vertex**



CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

KEY CONCEPTS

For any quadratic relation
→First differences are **non-constant**
→Second differences are **constant**.

Every quadratic relation has an x^2-term; the degree of the polynomial is **2**.

CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

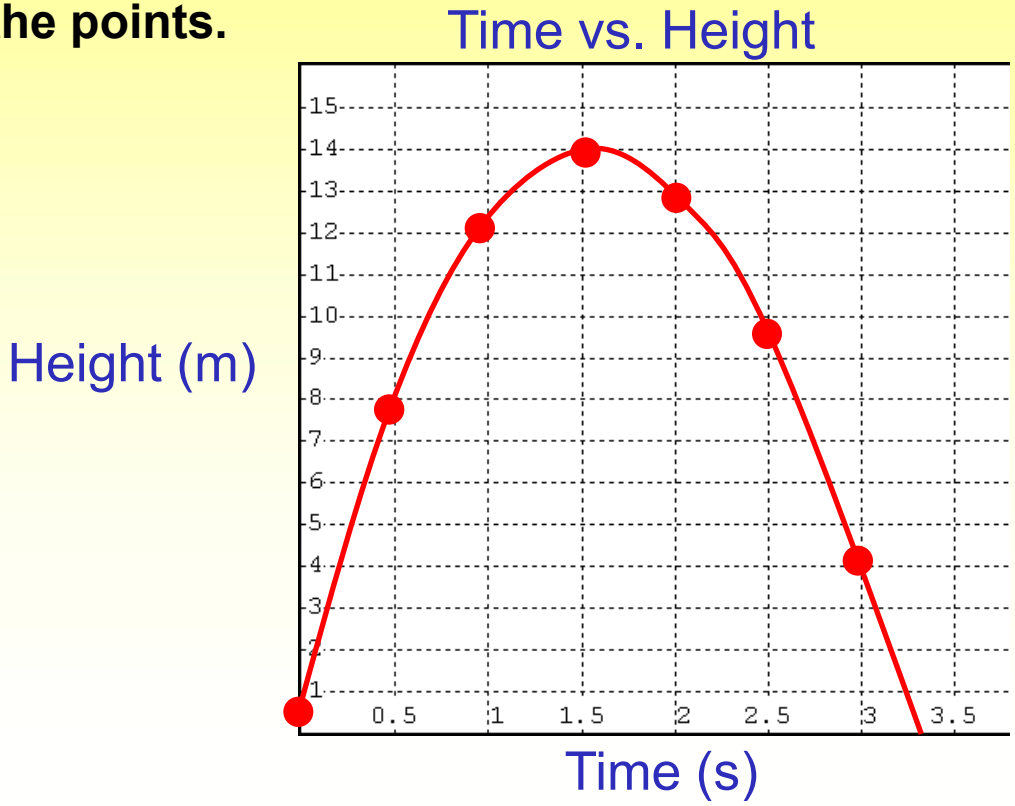
EXAMPLE 1

Using Graphs to Identify a Quadratic Relation

The table shows a soccer ball's height above the ground over time after it was kicked in the air.

Time (s)	Height (m)
0	0.10
0.5	7.80
1.0	12.00
1.5	13.80
2.0	13.00
2.5	9.75
3.0	4.00

a) Graph the data. **Draw a smooth curve through the points.**



CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

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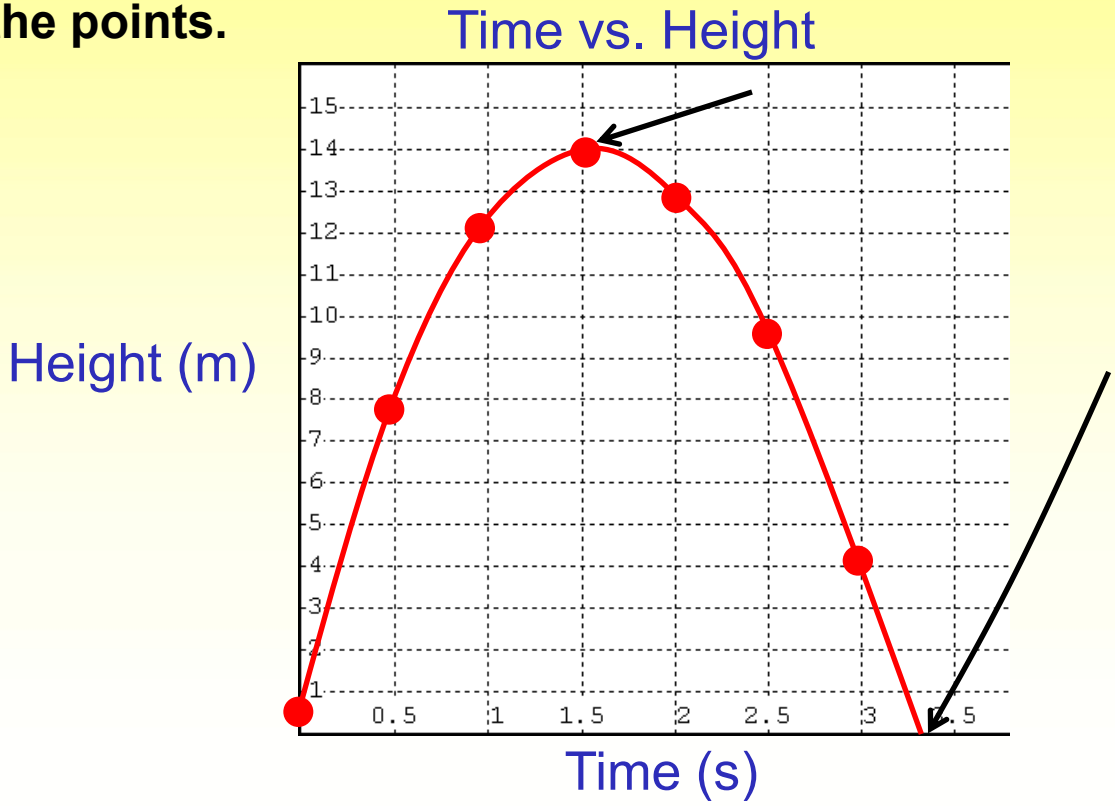
Using Graphs to Identify a Quadratic Relation

The table shows a soccer ball's height above the ground over time after it was kicked in the air.

a) Graph the data. **Draw a smooth curve through the points.**



b) Describe the **shape** of the graph.

Parabola
- "U-shaped"

c) What was the ball's **maximum height**? At what **time** was it achieved?

The maximum height was **13.80 metres** after **1.5 seconds**

d) For about **how many seconds** was the ball in the air?

The ball was in the air for about **3.4 seconds**

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CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

EXAMPLE 2

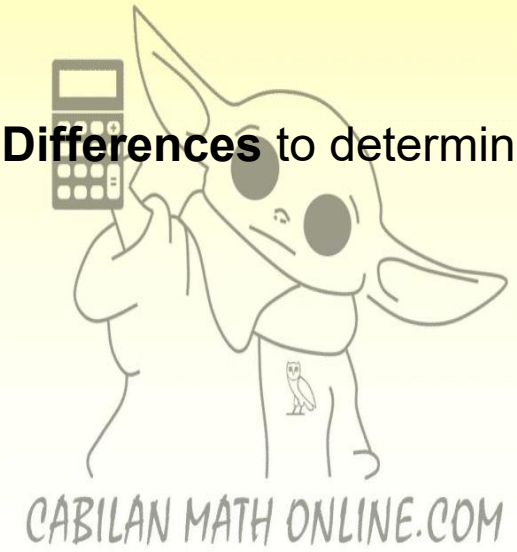
Using Table of Values to Identify Linear and Quadratic Relations

Recall from Grade 9 and 10...

Relations are **LINEAR** when the 1st Differences are all **equal** or **constant**
→1st Differences are calculated by subtracting successive *y*-values

Relations are **QUADRATIC** when
→1st Differences are **non-constant**
→2nd Differences are **constant**

For the tables given, calculate the **1st Differences** and **2nd Differences** to determine if the relation is **linear** or **quadratic**



CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

EXAMPLE 2

Using Table of Values to Identify Linear and Quadratic Relations

For the tables given, calculate the **1st Differences** and **2nd Differences** to determine if the relation is **linear** or **quadratic**

(a)

x	y	1st Diff.	2nd Diff.
– 2	2		
		3	
– 1	5		
		3	
0	8		
		3	
1	11		
		3	
2	14		

5 – 2 = 3

8 – 5 = 3

11 – 8 = 3

14 – 11 = 3

Subtract the successive *y*-values

Relation type: _____

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CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

EXAMPLE 2

Using Table of Values to Identify Linear and Quadratic Relations

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(a)

x	y	1st Diff.	2nd Diff.
– 2	2		
		3	
– 1	5		
		3	
0	8		
		3	
1	11		
		3	
2	14		

Since the 1st Differences are the same, we do not need to calculate 2nd Differences

Relation type: LINEAR

1st Differences are equal

CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

EXAMPLE 2

Using Table of Values to Identify Linear and Quadratic Relations

For the tables given, calculate the **1st Differences** and **2nd Differences** to determine if the relation is **linear** or **quadratic**

(b)

x	y	1st Diff.	2nd Diff.
– 2	5		
		– 3	
– 1	2		
		– 1	
0	1		
		1	
1	2		
		3	
2	5		

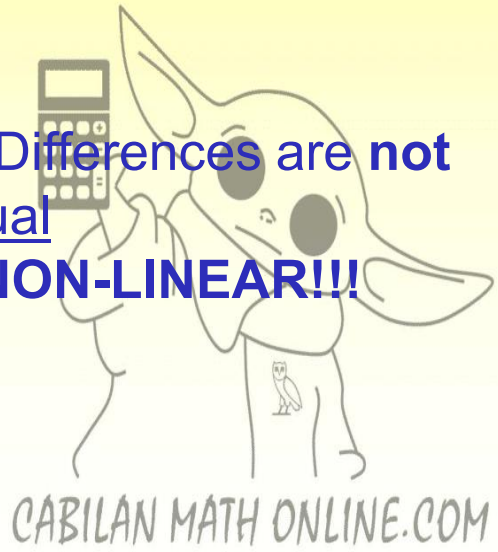
$2 - 5 = -3$

$1 - 2 = -1$

$2 - 1 = 1$

$5 - 2 = 3$

Relation type: _____



CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

EXAMPLE 2

Using Table of Values to Identify Linear and Quadratic Relations

For the tables given, calculate the **1st Differences** and **2nd Differences** to determine if the relation is **linear** or **quadratic**

(b)

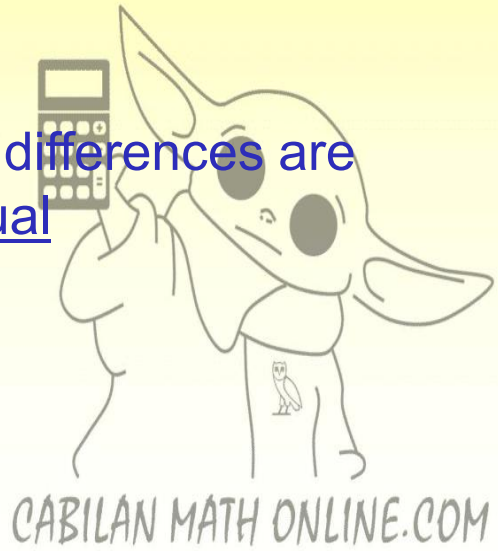
x	y	1st Diff.	2nd Diff.
– 2	5		
		– 3	
– 1	2		2
		– 1	
0	1		2
		1	
1	2		2
		3	
2	5		

$-1-(-3)$
$-1+3$
$=2$

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

$3-1$
$=2$

2nd differences are equal



Relation type: QUADRATIC

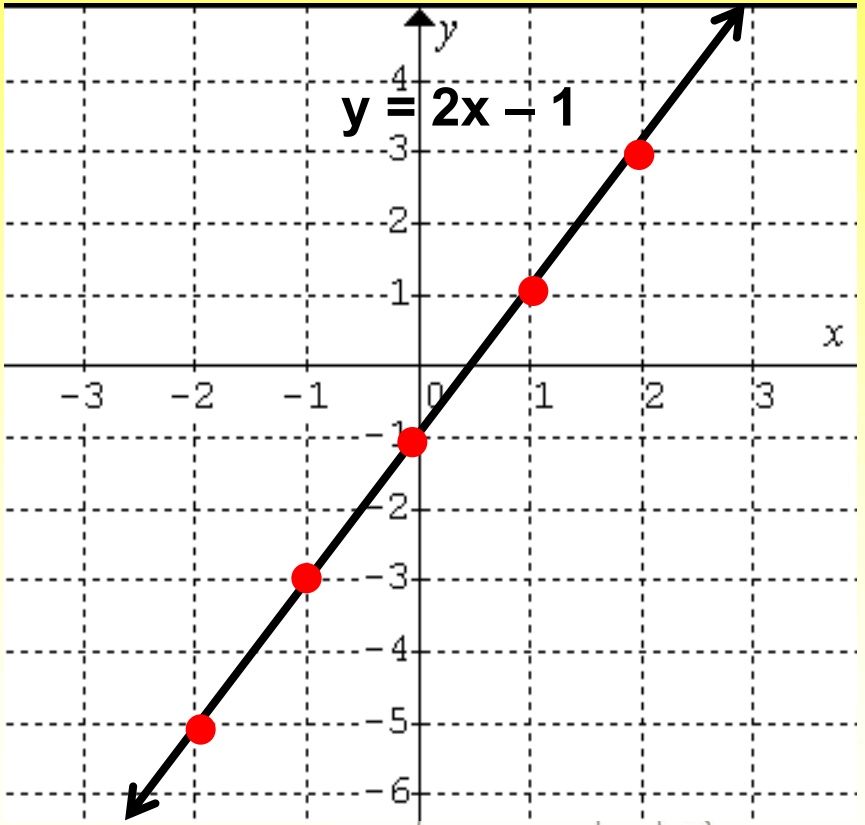
CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

EXAMPLE 3 *Using Algebra to Identify a Quadratic Relation*

For each relation, complete the table of values and graph.

(a) $y = 2x - 1$

x	y	
-2	$y = 2(-2) - 1$ $= -4 - 1$ $= -5$	$(-2, -5)$
-1	$y = 2(-1) - 1$ $= -3$	$(-1, -3)$
0	$y = 2(0) - 1$ $= -1$	$(0, -1)$
1	$y = 2(1) - 1$ $= 1$	$(1, 1)$
2	$y = 2(2) - 1$ $= 3$	$(2, 3)$



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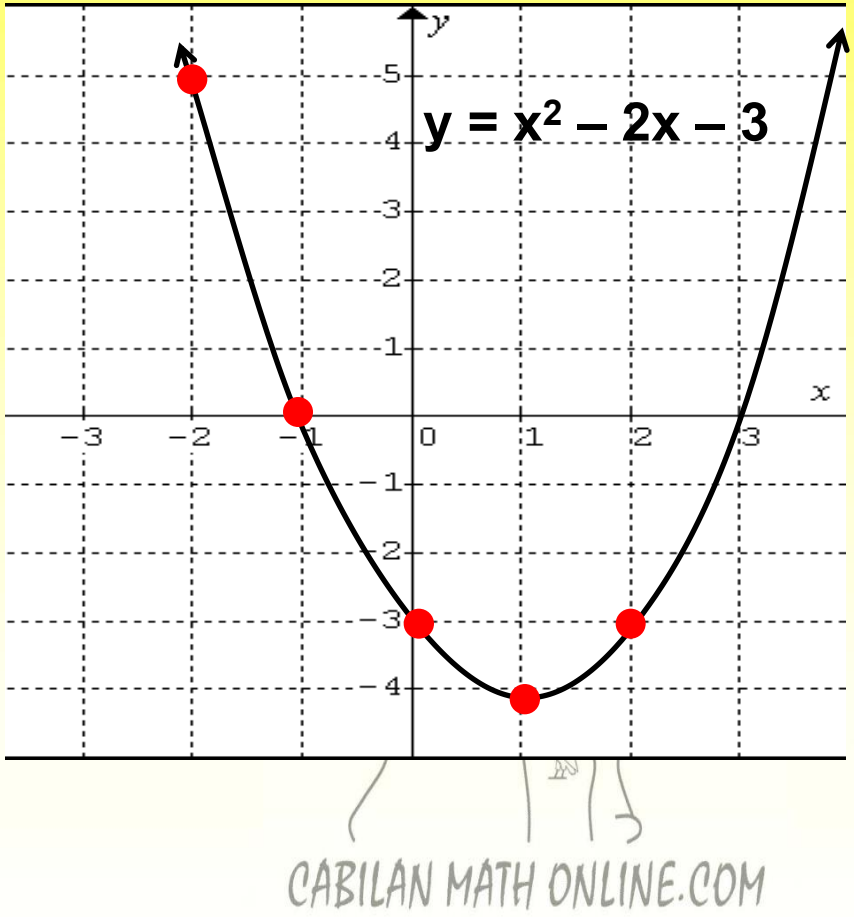
CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

EXAMPLE 3 *Using Algebra to Identify a Quadratic Relation*

For each relation, complete the table of values and graph.

(b) $y = x^2 - 2x - 3$

x	y	
-2	$y = (-2)^2 - 2(-2) - 3$ $= 4 + 4 - 3$ $= 5$	$(-2, 5)$
-1	$y = (-1)^2 - 2(-1) - 3$ $= 0$	$(-1, 0)$
0	$y = (0)^2 - 2(0) - 3$ $= -3$	$(0, -3)$
1	$y = (1)^2 - 2(1) - 3$ $= -4$	$(1, -4)$
2	$y = (2)^2 - 2(2) - 3$ $= -3$	$(2, -3)$



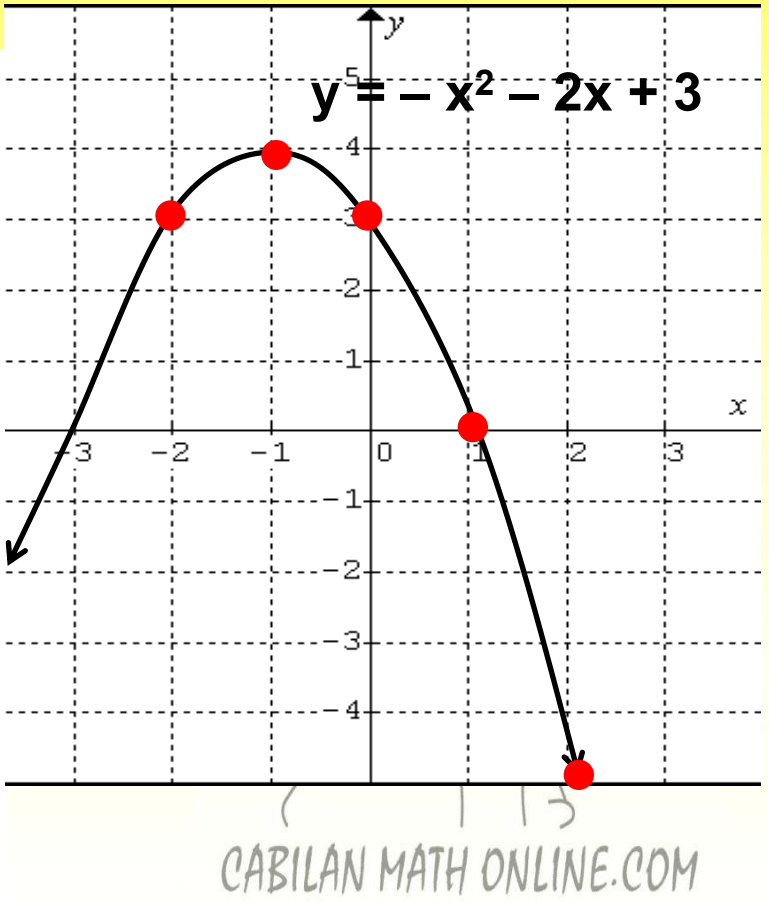
CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

EXAMPLE 3 *Using Algebra to Identify a Quadratic Relation*

For each relation, complete the table of values and graph.

(c) $y = -x^2 - 2x + 3$

x	y
-2	$y = -(-2)^2 - 2(-2) + 3$ $= -4 + 4 + 3$ $= 3$ $(-2, 3)$
-1	$y = -(-1)^2 - 2(-1) + 3$ $= 4$ $(-1, 4)$
0	$y = -(0)^2 - 2(0) + 3$ $= 3$ $(0, 3)$
1	$y = -(1)^2 - 2(1) + 3$ $= 0$ $(1, 0)$
2	$y = -(2)^2 - 2(2) + 3$ $= -5$ $(2, -5)$



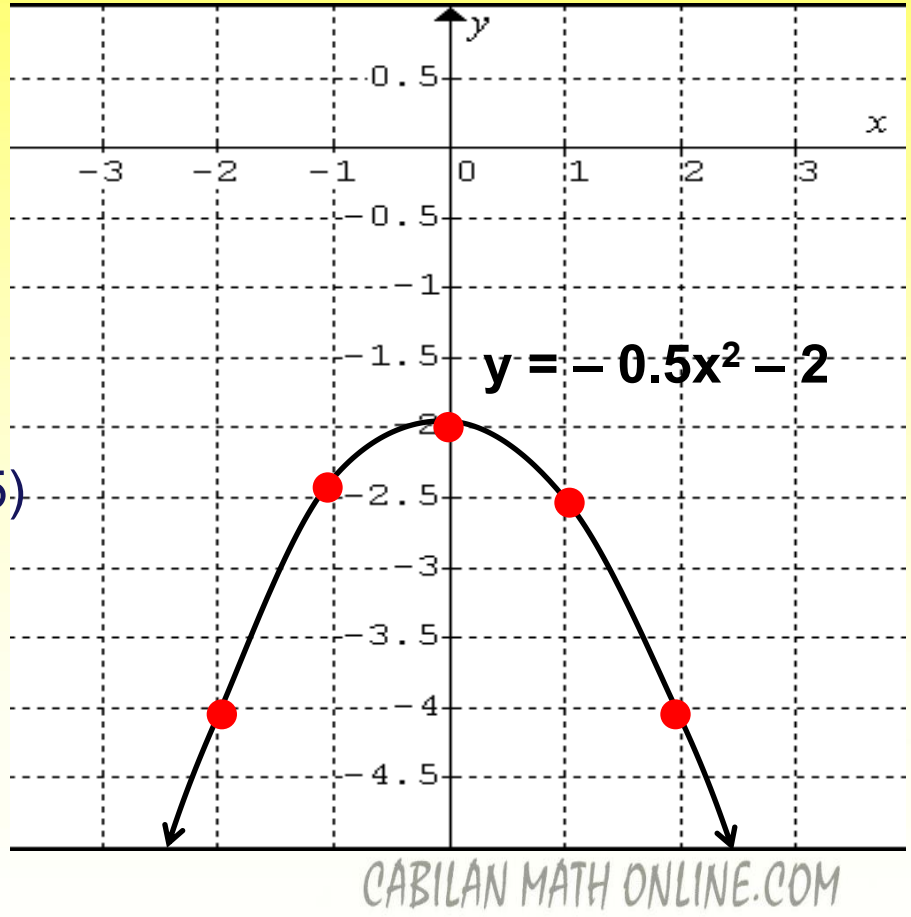
CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

EXAMPLE 3 *Using Algebra to Identify a Quadratic Relation*

For each relation, complete the table of values and graph.

(d) $y = -0.5x^2 - 2$

x	y	
-2	$y = -0.5(-2)^2 - 2$ $= -0.5(4) - 2$ $= -2 - 2$ $= -4$	$(-2, -4)$
-1	$y = -0.5(-1)^2 - 2$ $= -2.5$	$(-1, -2.5)$
0	$y = -0.5(0)^2 - 2$ $= -2$	$(0, -2)$
1	$y = -0.5(1)^2 - 2$ $= -2.5$	$(1, -2.5)$
2	$y = -0.5(2)^2 - 2$ $= -4$	$(2, -4)$

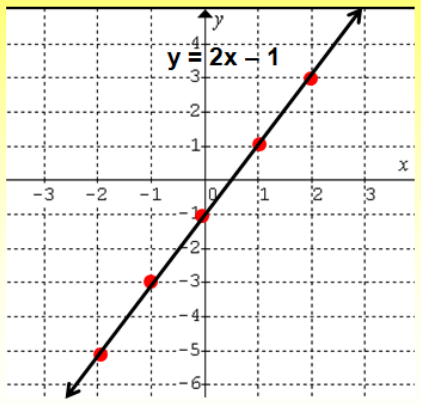


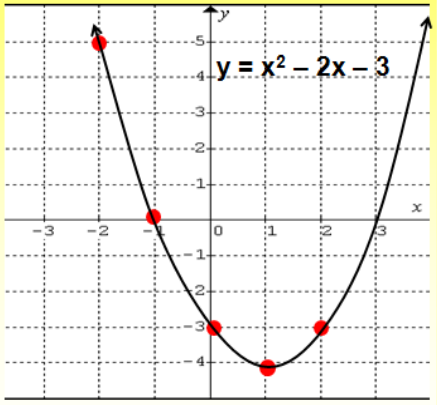
CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

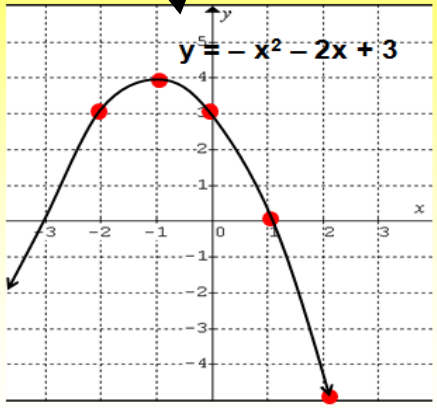
EXAMPLE 3 *Using Algebra to Identify a Quadratic Relation*

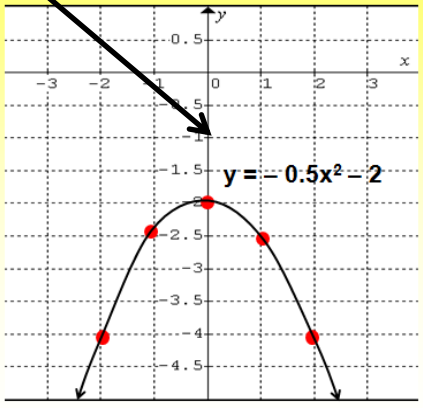
(e) Which relations are **quadratic**? (b), (c) and (d)

(f) Look at the **equations** for the graphs with a *parabola*. What do they all have in common?

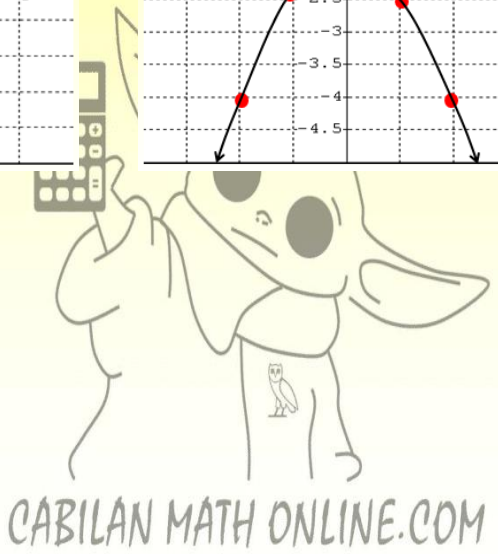








- All have the *x* raised to the exponent **2**
  → The polynomials are of degree **2**



CHAPTER 4.1 MODELLING WITH QUADRATIC RELATIONS

Homework

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