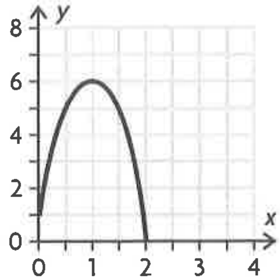
10. a)



b) t represents time, which is never negative and is between 0 and 2.095 s, when the ball hits the ground.
c) The maximum height of the ball is 6 m.
d) The ball reaches its maximum height after 1 s.
e) The ball is in the air for 2.095 s.
f) The maximum height is 6 m so the ball never reaches a height of 10 m.
g) The domain is the possible time so it must start at 0 and end at 2.095 s when the ball hits the ground. The range is height of the ball and is the minimum height of 0 m to the maximum height of 6 m. $D = \{t \in \mathrm{R} \mid 0 \le t \le 2.095\}$, $R = \{h(t) \in \mathbf{R} \mid 0 \le h(t) \le 6\}$.
11. a) $R(n) = -0.003n^2 + 1.167n$
b) See Table 11.b below
c) $D = \{n \in \mathbf{W} \mid 0 \le n \le 350\}$, $R = \{R(n) \in \mathbf{R} \mid 0 \le R(n) \le 100\}$.
12. a) The values of the domain and range must make sense for the situation.
b) Restrictions are necessary in order for the situation to make sense. For example, it doesn't make sense to have a negative value for time or a negative value for height in most situations.
13. a) The radius of one circle cannot be negative so it must start at 0. $D = \{r \in \mathbf{R} \mid r \ge 0\}$
b) The smallest shaded region that can be calculated is 0. $R = \{A(r) \in \mathbf{R} \mid A(r) \ge 0\}$.

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1) a. Domain is the set of all ages shown. So the domain is the numbers 1 to 12.
$D = \{a \in \mathbf{R} \mid 1 \le a \le 12\}$
b) The range is the set of all masses between the least and greatest masses shown.
$R = \{m \in \mathbf{R} \mid 11.5 \le m \le 49.5\}$.
c) The relation is a function because there is only one y-value for each x-value.
2. See Table 2 below
The relation is a quadratic function because the second differences are close to 6.
3. a) The function $f(x) = -8 + 3x$ has a degree of 1 since the highest power of the variable, x, is 1. The function is linear.
b) The function $g(x) = 4x^2 - 3x + 5$ has a degree of 2 since the highest power of the variable, x, is 2. The function is quadratic.
c) The function $g(x) = (x - 4)(4x^2 - 3)$ when expanded is $g(x) = 4x^3 - 16x^2 - 3x + 12$ and has a degree of 3 since the highest power of the variable, x, is 3. The function is neither linear nor quadratic.
4. a) $f(x) = 3x^2 - 3x + 1$
$f(-1) = 3(-1)^2 - 3(-1) + 1$
$f(-1) = 3 + 3 + 1$
$f(-1) = 7$
b) $f(x) = 3x^2 - 3x + 1$
$f(3) = 3(3)^2 - 3(3) + 1$
$f(3) = 27 - 9 + 1$
$f(3) = 19$
c) $f(x) = 3x^2 - 3x + 1$
$f(0.5) = 3(0.5)^2 - 3(0.5) + 1$
$f(0.5) = 0.75 - 1.5 + 1$
$f(0.5) = 0.25$

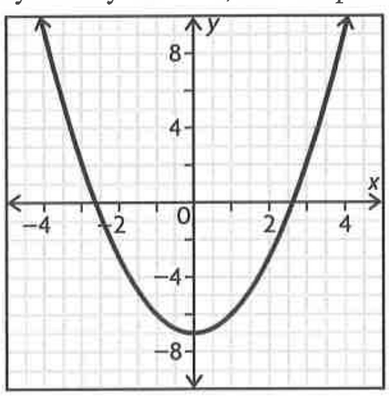
Table 11.b

Price	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.00
Tickets	320	290	260	230	200	170	140	110	80	50
Profit	32	58	78	92	100	102	98	88	72	50

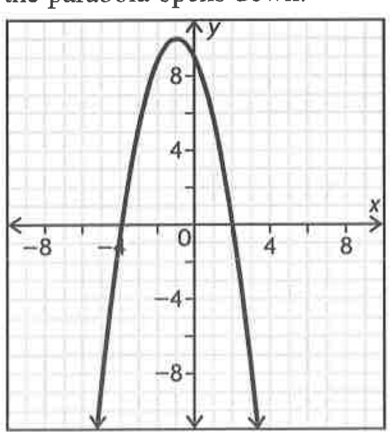
Table 2

x	−1	0	1	2	3
y	1	2	−3	−14	−31
First Differences	1	5	11	17	
Second Differences	4	6	6		

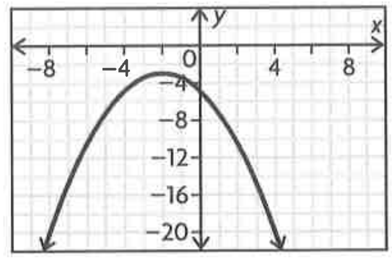
5. a) When the x-value is 3 the y-value is 5 because that is the y-coordinate of the ordered pair $(3, 5)$. So $f(3) = 5$.
b) When the x-value is 3 the y-value is 4. So, $f(3) = 4$.
c) $f(x) = 4x^2 - 2x + 1$
$f(4) = 4(3)^2 - 2(3) + 1$
$f(4) = 36 - 6 + 1$
$f(4) = 31$
d) When the x-value is 3 the y-value is 4 because that is the y-coordinate of the graph at $x = 3$. So $f(3) = 4$.
6. a) In the function $y = x^2 - 7$, $a = 1$, $h = 0$, and $k = -7$. The vertex is $(0, -7)$, the axis of symmetry is $x = 0$, and the parabola opens up.



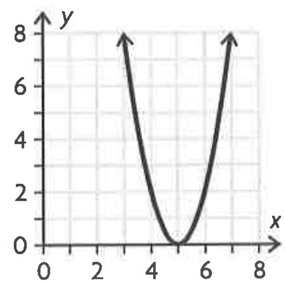
b) In the function $y = -(x + 1)^2 + 10$, $a = -1$, $h = -1$, and $k = 10$. The vertex is $(-1, 10)$, the axis of symmetry is $x = -1$, and the parabola opens down.



c) In the function $y = -\frac{1}{2}(x + 2)^2 - 3$, $a = -1$, $h = -2$, and $k = -3$. The vertex is $(-2, -3)$, the axis of symmetry is $x = -2$, and the parabola opens down.



d) In the function $y = 2(x - 5)^2$, $a = 2$, $h = 5$, and $k = 0$. The vertex is $(5, 0)$, the axis of symmetry is $x = 5$, and the parabola opens up.

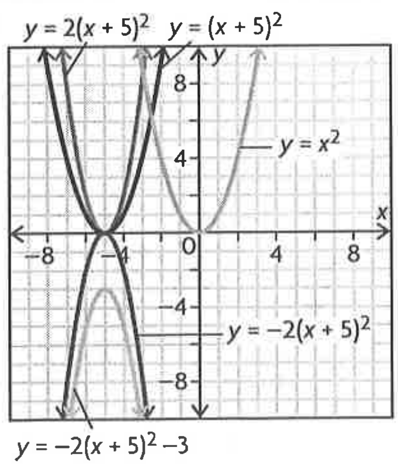


7. a) $y = x^2 - 7$ has a vertical translation 7 units down.
b) $y = -(x + 1)^2 + 10$ has a horizontal translation 1 unit left, vertical reflection in the x-axis, and vertical translation 10 units up.
c) $y = -\frac{1}{2}(x + 2)^2 - 3$ has a horizontal translation 2 units left, vertical compression by a factor of $\frac{1}{2}$, vertical reflection in the x-axis, and a vertical translation 3 units down.
d) $y = 2(x - 5)^2$ has a horizontal translation 4 units right and a vertical stretch by a factor of 2.
8. a) i) $y = 5x^2 - 4$ has a vertical translation 4 units down and a vertical stretch by a factor of 5.
ii) $y = \frac{1}{4}(x - 5)^2$ has a horizontal translation 5 units to the left and a vertical compression by a factor of $\frac{1}{2}$.
iii) $y = -3(x + 5)^2 - 7$ has a horizontal translation 5 units left, vertical stretch by a factor of 3, vertical reflection in the x-axis, and a vertical translation 7 units down.
b) i) This is a quadratic function that opens up and the vertex is at $(0, -4)$, which is a minimum. The y-coordinate of the vertex is -4 so

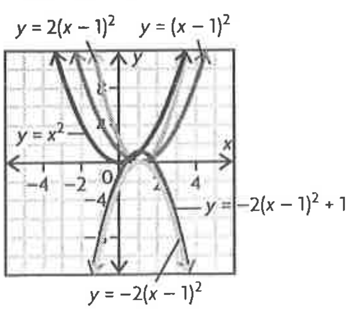
the range is all values of y greater than or equal to -4. Since the function is a parabola the domain is defined for all values of x.
$D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} \mid y \geq -4\}$
ii) This is a quadratic function that opens up and the vertex is at $(-5, 0)$, which is a minimum. The y-coordinate of the vertex is 0 so the range is all values of y greater than or equal to 0. Since the function is a parabola the domain is defined for all values of x. $D = \{x \in \mathbf{R}\}$,
$R = \{y \in \mathbf{R} \mid y \geq 0\}$
iii) This is a quadratic function that opens up and the vertex is at $(-5, -7)$, which is a maximum. The y-coordinate of the vertex is -7 so the range is all values of y less than or equal to -7. Since the function is a parabola the domain is defined for all values of x. $D = \{x \in \mathbf{R}\}$,
$R = \{y \in \mathbf{R} \mid y \leq -7\}$

9. a) $y = -2(x + 5)^2 - 3$ has a horizontal translation of 5 units left, vertical stretch by a factor of 2, vertical reflection in the x-axis, and a vertical translation 3 units down.

b)



10. a)



b) The graph has a horizontal translation 1 unit right, vertical stretch by a factor of 2, vertical reflection in the x-axis, and vertical translation 1 unit up.

11. a) $y = 2(x^2 - 4)$ or $y = 2x^2 - 8$
b) $y = 2x^2 - 4$; The vertex is at $(0, -4)$.
c) The graphs are different because the operations of multiplying by 2 and subtracting 4 are done in different orders for a) and b).
d) Vertical stretch by a factor of 2, vertical translation 4 units down.

12. a) The ball was 1.34 m off the ground when it was thrown.
b) The maximum height of the ball is 9 m.
c) The ball is 1.343 75 m high at 2.5 s.
d) The ball is not in the air after 6 s.
e) The ball will hit the ground after 2.0625 s.

13. a) The maximum height of the disks is 57 m.
b) The disks hit the ground at 6.4 s.
c) The domain is the possible time so it must start at 0 and end at 6.4 s when the disks hit the ground. The range is height of the disks and is the minimum height of 0 m to the maximum height of 57 m. $D = \{t \in \mathbf{R} \mid 0 \leq t \leq 6.4\}$,
$R = \{h(t) \in \mathbf{R} \mid 0 \leq h(t) \leq 6.4\}$.

14.
$$\begin{aligned}
\text{Earth height} &= -0.5(9.8)t^2 + 400\\
75 &= -4.9t^2 + 400\\
-325 &= -4.9t^2\\
66.33 &= t^2\\
8.14 &= t\\
\text{Moon height} &= -0.5(1.6)t^2 + 400\\
75 &= -0.8t^2 + 400\\
-325 &= -0.8t^2\\
406.25 &= t^2\\
20.16 &= t
\end{aligned}$$
Difference: $20.16 - 8.14 = 12.01$ s.

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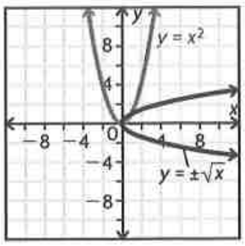
1. a) i) Domain is the set of all x-values $\{1, 3, 4, 7\}$ and the Range is the set of all y-values $\{1, 2\}$.
ii) The relation is a function since there is only one y-value for each x-value.
b) i) Domain is the set of all x-values $\{1, 3, 4, 6\}$ and the Range is the set of all the values in $g(x)$ $\{1, 2, 5\}$.
ii) The relation is a function since there is only value in $g(x)$ for each x-value.
c) i) Domain is the set of all x-values and the Range is the set of all y-values $\{2, 3, 4, 5\}$.

ii) The relation is not a function since it fails the vertical line test.

2. A function is a relation in which there is only one y-value for each x-value. For example, $y = x^2$ is a function but $y = \sqrt{x}$ is not a function.



3.

Time (s)	0	1	2	3	4	5
Height (m)	0	30	40	40	30	0
First Differences	30	10	0	−10	−30	
Second Differences	−20	−10	−10	−20		

Since the first differences and the second differences are not constant, the data does not represent a linear or quadratic function.

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

$f(2) = 3(2)^2 - 2(2) + 6$

$f(2) = 12 - 4 + 6$

$f(2) = 14$

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

$f(x - 1) = 3(x - 1)^2 - 2(x - 1) + 6$

$f(x - 1) = 3x^2 - 6x + 3 - 2x + 2 + 6$

$f(x - 1) = 3x^2 - 8x + 11$

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

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

$f(-1) = 27 + 1$

$f(-1) = 28$

b) $f(1)$ represents the y-coordinate when the x-coordinate is 1.

c) This is a quadratic function that opens up and the vertex is at $(2, 1)$, which is a minimum. The y-coordinate of the vertex is 1 so the range is all values of y greater than or equal to 1. Since the function is a parabola, the domain is defined for all values of x. $D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} \mid y \geq 1\}$

d) It passes the vertical line test.

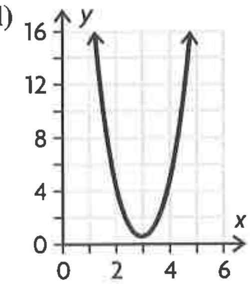
e) It is a quadratic of the form $f(x) = a(x - h)^2 + k$.

6. a) Horizontal translation 3 units left, vertical stretch by a factor of 5, and vertical shift 1 unit up.

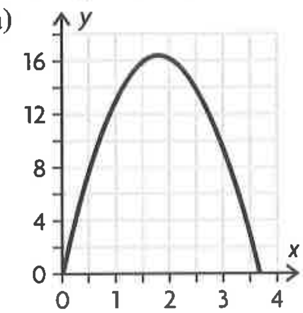
b) This is a quadratic function that opens up and the vertex is at $(3, 1)$, which is a minimum. The minimum value is 1 when $x = 3$. There is no maximum.

c) The y-coordinate of the vertex is 1 so the range is all values of y greater than or equal to 1. Since the function is a parabola the domain is defined for all values of x. $D = \{x \in \mathbf{R}\}$, $R = \{y \in \mathbf{R} \mid y \geq 1\}$

d)



7. a)



b) Time is never negative so $t \geq 0$.

c) The maximum height of the football is 16.7 m.

d) The football reaches the maximum height at 1.8 s.

e) The football is in the air for 3.6 s.

f) The domain is the possible time so it must start at 0 and end at 3.6 s when the football hits the ground. The range is height of the football, which is the minimum height of 0 m to the maximum height of 16.7 m.

$D = \{t \in \mathbf{R} \mid 0 \leq t \leq 3.6\}$,

$R = \{h(t) \in \mathbf{R} \mid 0 \leq h(t) \leq 16.7\}$.