Review Exercise 1

1 a $8^{\frac{1}{3}}$

Use $a^{\frac{1}{m}} = \sqrt[m]{a}$, so $a^{\frac{1}{3}} = \sqrt[3]{a}$

$= \sqrt[3]{8}$

$= 2$

b $8^{-\frac{2}{3}} = \dfrac{1}{8^{\frac{2}{3}}}$ $\left(\text{Use } a^{-m} = \dfrac{1}{a^m}\right)$

First find $8^{\frac{2}{3}}$ $a^{\frac{n}{m}} = \sqrt[m]{(a^n)}$ or $\left(\sqrt[m]{a}\right)^n$

$8^{\frac{2}{3}} = \left(\sqrt[3]{8}\right)^2$

$8^{\frac{2}{3}} = 2^2 = 4$

$8^{-\frac{2}{3}} = \dfrac{1}{8^{\frac{2}{3}}}$

$= \frac{1}{4}$

2 a $125^{\frac{4}{3}}$

$a^{\frac{n}{m}} = \sqrt[m]{(a^n)}$ or $\left(\sqrt[m]{a}\right)^n$

$= \left(\sqrt[3]{125}\right)^4$

$= 5^4$

$= 625$

b $24x^2 \div 18x^{\frac{4}{3}}$

(Use $a^m \div a^n = a^{m-n}$)

$= \dfrac{24x^2}{18x^{\frac{4}{3}}} = \dfrac{4x^2}{3x^{\frac{4}{3}}}$ cancelling by 6

$= \dfrac{4x^{\frac{2}{3}}}{3}$ because $2 - \dfrac{4}{3} = \dfrac{2}{3}$

3 a $\sqrt{80}$

Use $\sqrt{(bc)} = \sqrt{b}\sqrt{c}$

$= \sqrt{16} \times \sqrt{5}$

$= 4\sqrt{5}\ (a = 4)$

b $\left(4-\sqrt{5}\right)^2 = \left(4-\sqrt{5}\right)\left(4-\sqrt{5}\right)$

$= 4\left(4-\sqrt{5}\right) - \sqrt{5}\left(4-\sqrt{5}\right)$

$= 16 - 4\sqrt{5} - 4\sqrt{5} + 5$

$= 21 - 8\sqrt{5}$

$(b = 21 \text{ and } c = -8)$

4 a $\left(4+\sqrt{3}\right)\left(4-\sqrt{3}\right)$

$= 4\left(4-\sqrt{3}\right) + \sqrt{3}\left(4-\sqrt{3}\right)$

$= 16 - 4\sqrt{3} + 4\sqrt{3} - 3$

$= 13$

b $\dfrac{26}{4+\sqrt{3}} \times \dfrac{4-\sqrt{3}}{4-\sqrt{3}} = \dfrac{26\left(4-\sqrt{3}\right)}{\left(4+\sqrt{3}\right)\left(4-\sqrt{3}\right)}$

$= \dfrac{26\left(4-\sqrt{3}\right)}{13}$

$= 2\left(4-\sqrt{3}\right)$

$= 8 - 2\sqrt{3}$

$(a = 8 \text{ and } b = -2)$

5 a mean $= \dfrac{1-\sqrt{k}+2+5\sqrt{k}+2\sqrt{k}}{3}$

$= \dfrac{3+6\sqrt{k}}{3}$

$= 1 + 2\sqrt{k}$

5 b range = $2+5\sqrt{k}-(1-\sqrt{k})$

$= 1+6\sqrt{k}$

6 a $y^{-1}=\left(\frac{1}{25}x^4\right)^{-1}$

$=\dfrac{1}{\frac{1}{25}x^4}$

$=\dfrac{25}{x^4}$

$=25x^{-4}$

b $5y^{\frac{1}{2}}=5\left(\frac{1}{25}x^4\right)^{\frac{1}{2}}$

$= 5\left(\frac{1}{5}x^2\right)$

$= x^2$

7 Area = $\frac{1}{2}h(a+b)$

$=\frac{1}{2}\left(2\sqrt{2}\right)\left(3+\sqrt{2}+5+3\sqrt{2}\right)$

$=\sqrt{2}\left(8+4\sqrt{2}\right)$

$=8\sqrt{2}+8$

The area of the trapezium is $8+8\sqrt{2}$ cm^2.

8 $\dfrac{p+q}{p-q} = \dfrac{(3-2\sqrt{2})+(2-\sqrt{2})}{(3-2\sqrt{2})-(2-\sqrt{2})}$

$=\dfrac{5-3\sqrt{2}}{1-\sqrt{2}}$

$=\dfrac{(5-3\sqrt{2})}{(1-\sqrt{2})}\times\dfrac{(1+\sqrt{2})}{(1+\sqrt{2})}$

$=\dfrac{5+5\sqrt{2}-3\sqrt{2}-6}{1+\sqrt{2}-\sqrt{2}-2}$

$=\dfrac{-1+2\sqrt{2}}{-1}$

$=1-2\sqrt{2}$ $(m=1, n=-2)$

9 a $x^2 - 10x + 16 = (x-8)(x-2)$

b Let $x = 8^y$

$8^{2y} - 10(8^y) + 16 = (8^y - 8)(8^y - 2) = 0$

So $8^y = 8$ or $8^y = 2$

$y = 1$ or $y = \frac{1}{3}$

10 a $x^2-8x=(x-4)^2-16$

Complete the square for $x^2-8x-29$

$x^2-8x-29=(x-4)^2-16-29$

$=(x-4)^2-45$

$(a=-4$ and $b=-45)$

b $x^2-8x-29=0$

$(x-4)^2-45=0$

Use the result from part **a**:

$(x-4)^2=45$

Take the square root of both sides:

$x-4=\pm\sqrt{45}$

$x=4\pm\sqrt{45}$

$\sqrt{45}=\sqrt{9}\times\sqrt{5}=3\sqrt{5}$

since $\sqrt{(ab)}=\sqrt{a}\sqrt{b}$

Roots are $4\pm3\sqrt{5}$

$(c=4$ and $d=\pm3)$

11 $f(a) = a(a-2)$ and $g(a) = a + 5$

$a(a-2) = a + 5$

$a^2 - 2a - a - 5 = 0$

$a^2 - 3a - 5 = 0$

Using the quadratic formula:

$a = \dfrac{3\pm\sqrt{(-3)^2-4(1)(-5)}}{2(1)}$

$= \dfrac{3\pm\sqrt{29}}{2}$

$= 4.19$ or -1.19

As $a > 0$, $a = 4.19$ (3 s.f.)

12 a The height of the athlete's shoulder above the ground is 1.7 m

b $1.7 + 10t - 5t^2 = 0$
Using the quadratic formula when $a = -5$, $b = 10$ and $c = 1.7$

$$t = \frac{-10 \pm \sqrt{(10)^2 - 4(-5)(1.7)}}{2(-5)}$$
$$= \frac{-10 \pm \sqrt{134}}{-10}$$
$$= -0.16 \text{ or } 2.16$$
As $t > 0$, $t = 2.16$ s (3 s.f.)

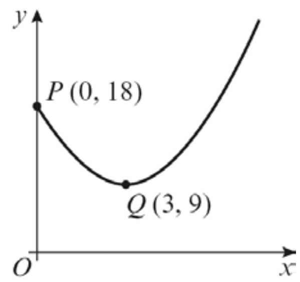
c $1.7 + 10t - 5t^2 = 1.7 - 5(t^2 - 2t)$
$= 1.7 - 5((t - 1)^2 - 1)$
$= 1.7 - 5(t - 1)^2 + 5$
$= 6.7 - 5(t - 1)^2$
$A = 6.7$, $B = 5$ and $C = 1$

d Maximum when $(t - 1) = 0$, $t = 1$s and maximum height = 6.7 m

13 a $\text{f}(x) = x^2 - 6x + 18$
$x^2 - 6x = (x-3)^2 - 9$
Complete the square for $x^2 - 6x + 18$
$x^2 - 6x + 18 = (x-3)^2 - 9 + 18$
$= (x-3)^2 + 9$
$a = 3$ and $b = 9$

b $y = x^2 - 6x + 18$
$y = (x-3)^2 + 9$
$(x-3)^2 \geq 0$
Squaring a number cannot give a negative result.
The minimum value of $(x - 3)^2$ is 0, when $x = 3$.
So the minimum value of y is $0 + 9 = 0$, when $x = 3$.
Q is the point (3, 9).
The curve crosses the y-axis where $x = 0$.

13 b For $x = 0$, $y = 18$
P is the point (0, 18).
The graph of $y = x^2 - 6x + 18$ is a ⋃ shape.
For $y = ax^2 + bx + c$, if $a > 0$, the shape is ⋃.



Use the information about P and Q to sketch the curve $x \geq 0$, so the part where $x < 0$ is not needed.

c $y = (x-3)^2 + 9$
Put $y = 41$ into the equation of C.
$41 = (x-3)^2 + 9$
Subtract 9 from both sides.
$32 = (x-3)^2$
$(x-3)^2 = 32$
Take the square root of both sides.
$x - 3 = \pm\sqrt{32}$
$x = 3 \pm \sqrt{32}$
$\sqrt{32} = \sqrt{16} \times \sqrt{2} = 4\sqrt{2}$
using $\sqrt{(ab)} = \sqrt{a}\sqrt{b}$
$x = 3 \pm 4\sqrt{2}$
x-coordinate of R is $3 + 4\sqrt{2}$
The other value is $3 - 4\sqrt{2}$ which is less than 0, so is not needed.

14 a Using the discriminant
$b^2 - 4ac = 0$ for equal roots
$(2\sqrt{2})^2 - 4(1)(k) = 0$
$8 - 4k = 0$
$k = 2$

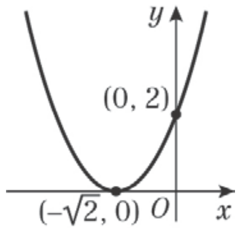
14 b $y = x^2 + 2\sqrt{2}x + 2$

$= (x+\sqrt{2})^2$

When $y = 0$, $(x+\sqrt{2})^2 = 0$

$x = -\sqrt{2}$

When $x = 0$, $y = 2$



15 a $g(x) = x^9 - 7x^6 - 8x^3$

$= x^3(x^6 - 7x^3 - 8)$

To factorise $x^6 - 7x^3 - 8$, let $y = x^3$

$y^2 - 7y - 8 = (y + 1)(y - 8)$

So $g(x) = x^3(x^3 + 1)(x^3 - 8)$

$a = 1$, $b = -8$

b $g(x) = x^3(x^3 + 1)(x^3 - 8) = 0$

$x^3 = 0$, $x^3 = -1$ or $x^3 = 8$

$x = -1$, $x = 0$ or $x = 2$

16 a $x^2 + 10x + 36$

$x^2 + 10x = (x+5)^2 - 25$

Complete the square for $x^2 + 10x + 36$

$x^2 + 10x + 36 = (x-5)^2 - 25 + 36$

$= (x+5)^2 + 11$

$a = 5$ and $b = 11$

b $x^2 + 10x + 36 = 0$

$(x+5)^2 + 11 = 0$

'Hence' implied in part **a** must be used

$(x+5)^2 = -11$

A real number squared cannot be negative. There are no real roots.

c $x^2 + 10x + k = 0$

$a = 1$, $b = 10$, $c = k$

16 c For equal roots, $b^2 = 4ac$

$10^2 = 4 \times 1 \times k$

$4k = 100$

$k = 25$

d The graph of $x^2 + 10x + 25$ is a ∪ shape.

For $y = ax^2 + bx + c$, if $a > 0$, the shape is ∪.

$x = 0$: $y = 0 + 0 + 25 = 25$

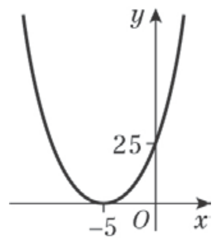
Meets y-axis at (0, 25).

$y = 0: x^2 + 10x + 25 = 0$

$(x+5)(x+5) = 0$

$x = -5$

Meets x-axis at (−5, 0).



The graph meets the x-axis at just one point, so it 'touches' the x-axis.

17 a $x^2 + 2x + 3$

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

Complete the square for $x^2 + 2x + 3$

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

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

$a = 1$ and $b = 2$

b The graph of $y = x^2 + 2x + 3$ is a ∪ shape.

For $y = ax^2 + bx + c$, if $a > 0$, the shape is ∪.

$x = 0 : y = 0 + 0 + 3$

Put $x = 0$ to find the intersection with the y-axis:

Meets y-axis at (0, 3).

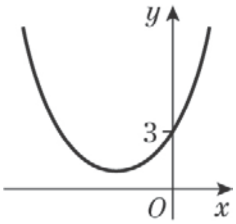
17 b Put $y = 0$ to find the intersection with the x-axis:

$y = 0 : x^2 + 2x + 3 = 0$

$(x + 1)^2 + 2 = 0$

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

A real number squared cannot be negative, therefore, no real roots, so not intersection with the x-axis.



c $x^2 + 2x + 3$

$a = 1, b = 2, c = 3$

$b^2 - 4ac = 2^2 - 4 \times 1 \times 3$

$= -8$

Since the discriminant is negative, the equation has no real roots, so the graph does not cross the x-axis.

d $x^2 + kx + 3 = 0$

$a = 1, b = k, c = 3$

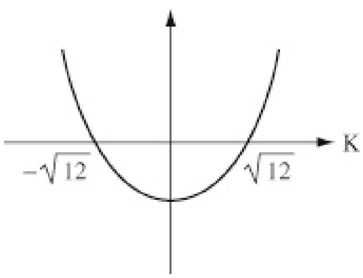
For no real roots, $b^2 < 4ac$

$k^2 < 12$

$k^2 - 12 < 0$

$\left(k+\sqrt{12}\right)\left(k-\sqrt{12}\right) < 0$

This is a quadratic inequality with critical values $-\sqrt{12}$ and $\sqrt{12}$.



Critical values:

$k = -\sqrt{12}$, $k = \sqrt{12}$

$-\sqrt{12} < k < \sqrt{12}$

17 d The surds can be simplified using $\sqrt{(ab)} = \sqrt{a}\sqrt{b}$

$\sqrt{12} = \sqrt{4} \times \sqrt{3} = 2\sqrt{3}$

$\left(-2\sqrt{3} < k < 2\sqrt{3}\right)$

18 a $2x^2 - x(x-4) = 8$

$2x^2 - x^2 + 4x = 8$

$x^2 + 4x - 8 = 0$

b $x^2 + 4x - 8 = 0$

$x^2 + 4x = (x+2)^2 - 4$

$(x+2)^2 - 4 - 8 = 0$

$(x+2)^2 = 12$

$x + 2 = \pm\sqrt{12}$

$x = -2 \pm \sqrt{12}$

$\sqrt{12} = \sqrt{4} \times \sqrt{3} = 2\sqrt{3}$

$x = -2 \pm 2\sqrt{3}$

$a = -2$ and $b = 2$

Using $y = x - 4$:

$y = \left(-2 \pm 2\sqrt{3}\right) - 4$

$= -6 \pm 2\sqrt{3}$

Solution: $x = -2 \pm 2\sqrt{3}$

$y = -6 \pm 2\sqrt{3}$

19 a $3(2x+1) > 5 - 2x$

$6x + 3 > 5 - 2x$

$6x + 2x + 3 > 5$

$8x > 2$

$x > \frac{1}{4}$

b $2x^2 - 7x + 3 = 0$

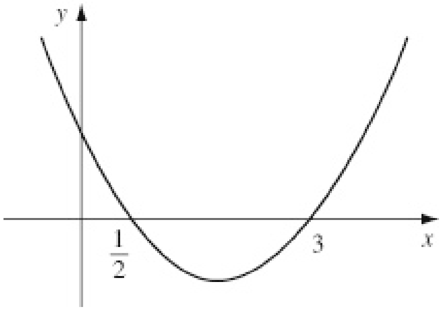
$(2x - 1)(x - 3) = 0$

$(2x - 1) = 0$

$(x - 3) = 0$

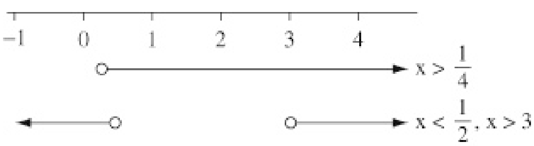
$x = \frac{1}{2}$ or $x = 3$

19 b



$2x^2 - 7x + 3 > 0$ where
$x < \frac{1}{2}$ or $x > 3$

c



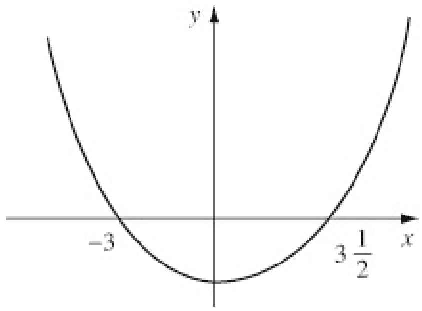
$\frac{1}{4} < x < \frac{1}{2}$ or $x > 3$

20
$-2(x + 1) = x^2 - 5x + 2$
$-2x - 2 = x^2 - 5x + 2$
$x^2 - 3x + 4 = 0$
Using the discriminant
$b^2 - 4ac = (-3)^2 - 4(1)(4) = -7$
As $b^2 - 4ac < 0$, there are no real roots.
Hence there is no value of x for which p(x) = q(x).

21 a $y = 5 - 2x$
$2x^2 - 3x - (5 - 2x) = 16$
$2x^2 - 3x - 5 + 2x = 16$
$2x^2 - x - 21 = 0$
$(2x - 7)(x + 3) = 0$
$x = 3\frac{1}{2}, \quad x = -3$
$x = 3\frac{1}{2}: \; y = 5 - 7 = -2$
$x = -3: y = 5 + 6 = 11$

Solution $x = 3\frac{1}{2}, \; y = -2$
and $x = -3, \; y = 11$

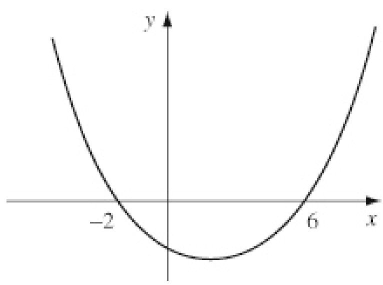
21 b The equation in part **a** could be written as $y = 5 - 2x$ and $y = 2x^2 - 3x - 16$.
Therefore, the solution to
$2x^2 - 3x - 16 = 5 - 2x$ are the same as for part **a**.
These are the critical values for
$2x^2 - 3x - 16 > 5 - 2x$:
$x = 3\frac{1}{2}$ and $x = -3$.
$2x^2 - 3x - 16 > 5 - 2x$
$(2x^2 - 3x - 16 - 5 + 2x > 0)$
$2x^2 - x - 21 > 0$



$x < -3$ or $x > 3\frac{1}{2}$

22 a $x^2 + kx + (k + 3) = 0$
$a = 1, \; b = k, \; c = k + 3$
$b^2 > 4ac$
$k^2 > 4(k + 3)$
$k^2 > 4k + 12$
$k^2 - 4k - 12 > 0$

b $k^2 - 4k - 12 = 0$
$(k + 2)(k - 6) = 0$
$k = -2, \; k = 6$

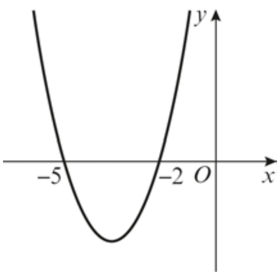


$k^2 - 4k - 12 > 0$ where $k < -2$ or $k > 6$

23 $\frac{6}{x+5} < 2$

Multiply both sides by $(x + 5)^2$
$6(x + 5) < 2(x + 5)^2$
$6x + 30 < 2x^2 + 20x + 50$
$2x^2 + 14x + 20 > 0$

Solve the quadratic to find the critical values.
$2x^2 + 14x + 20 = 0$
$2(x^2 + 7x + 10) = 0$
$2(x + 5)(x + 2) = 0$
$x = -5$ or $x = -2$



The solution is $x < -5$ or $x > -2$.

24 a $9 - x^2 = 0$
$(3 + x)(3 - x) = 0$
$x = -3$ or $x = 3$
When $x = 0$, $y = 9$

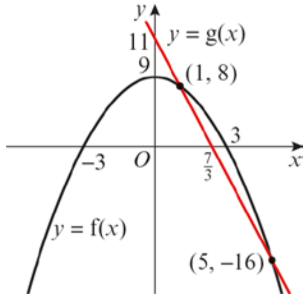
To work out the points of intersection, solve the equations simultaneously.
$9 - x^2 = 14 - 6x$
$x^2 - 6x + 5 = 0$
$(x - 5)(x - 1) = 0$
$x = 1$ or $x = 5$

When $x = 1$, $y = 8$
When $x = 5$, $y = -16$

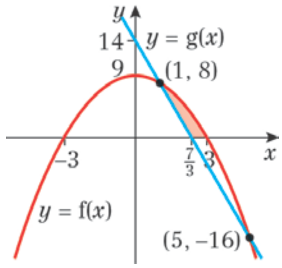
Let $14 - 6x = 0$
$x = \frac{14}{6} = \frac{7}{3}$

The line crosses the x-axis at $\left(\frac{7}{3}, 0\right)$.

24 a

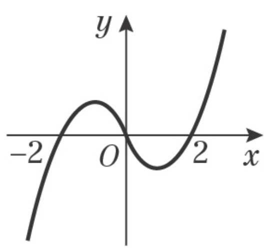


b



25 a $x^3 - 4x = x(x^2 - 4)$
$= x(x+2)(x-2)$

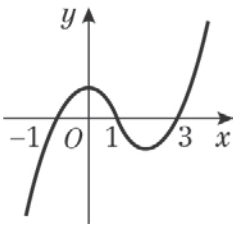
b Curve crosses the x-axis where $y = 0$
$x(x+2)(x-2) = 0$
$x = 0,\ x = -2,\ x = 2$
When $x = 0,\ y = 0$
When $x \to \infty,\ y \to \infty$
When $x \to -\infty,\ y \to -\infty$



Crosses the y-axis at (0, 0).
Crosses the x-axis at (−2, 0), (2, 0).

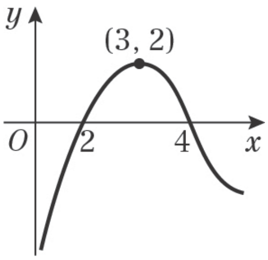
c $y = x^3 - 4x$
$y = (x-1)^3 - 4(x-1)$
This is a translation of +1 in the x-direction.

25 c



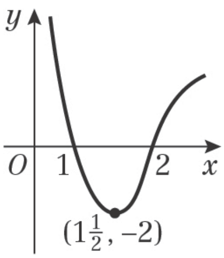
Crosses the x-axis at (−1, 0), (1, 0) and (3, 0).

26 a



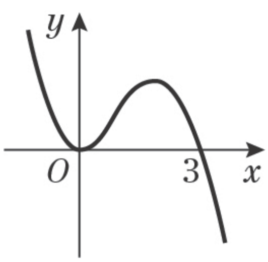
Crosses the x-axis at (2, 0), (4, 0).
Image of P is (3, 2).

26 b



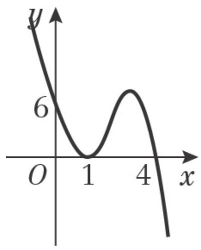
Crosses the x-axis at (1, 0), (2, 0).
Image of P is $\left(1\frac{1}{2}, -2\right)$.

27 a



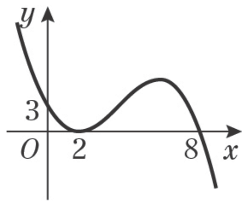
Meets the y-axis at (0, 0).
Meets the x-axis at (0, 0), (3, 0).

27 b



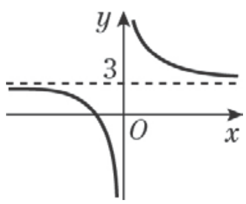
Meets the y-axis at (0, 6).
Meets the x-axis at (1, 0), (4, 0).

c



Meets the y-axis at (0, 3).
Meets the x-axis at (2, 0), (8, 0).

28 a



$y = 3$ is an asymptote.
$x = 0$ is an asymptote.

b The graph does not cross the y-axis (see sketch in part **a**).
Crosses the x-axis where $y = 0$:

$$\frac{1}{x} + 3 = 0$$

$$\frac{1}{x} = -3$$

$$x = -\tfrac{1}{3}, \left(-\tfrac{1}{3}, 0\right)$$

29 a $(x^2 - 5x + 2)(x^2 - 5x + 4) = 0$
For $x^2 - 5x + 2 = 0$

Using the quadratic formula:

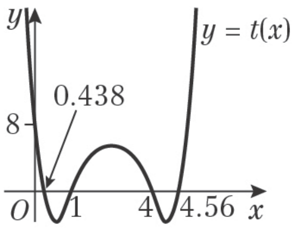
$$x = \frac{5 \pm \sqrt{(-5)^2 - 4(1)(2)}}{2(1)}$$

$$= \frac{5 \pm \sqrt{17}}{2}$$

$x = 4.56$ or $x = 0.438$

For $x^2 - 5x + 4 = 0$
$(x - 1)(x - 4) = 0$
$x = 1$ or $x = 4$
$x = 0.438, 1, 4$ or 4.56

b When $x = 0$, $y = 8$



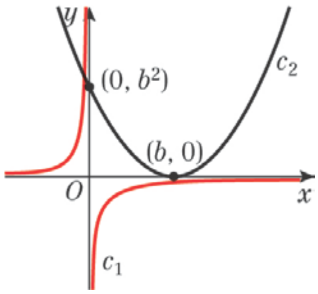
30 a $y = -\text{f}(x)$ is a reflection in the x-axis of $y = \text{f}(x)$, so P is transformed to (6, 8).

b $y = \text{f}(x - 3)$ is a translation 3 units to the right of $y = \text{f}(x)$, so P is transformed to (9, −8).

c $2y = \text{f}(x)$ is $y = \frac{1}{2}\text{f}(x)$ which is a vertical stretch scale factor $\frac{1}{2}$ of $y = \text{f}(x)$, so P is transformed to (6, −4).

31 a $y = -\frac{a}{x}$ is the curve $y = \frac{k}{x}$, $k < 0$
$y = (x - b)^2$ is a translation, b units to the right of the curve $y = x^2$
When $x = 0$, $y = b^2$
When $y = 0$, $x = b$

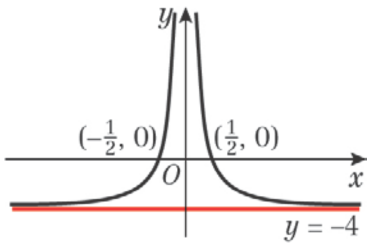
31 a



b The graphs intersect at 1 point, so have 1 point of intersection.

32 a $y = \frac{1}{x^2} - 4$ is a translation $\begin{pmatrix} 0 \\ -4 \end{pmatrix}$ of

$y = \frac{1}{x^2}$



b When $y = \frac{1}{(x+k)^2} - 4$ passes through the origin, $x = 0$ and y = 0.

So $\frac{1}{k^2} - 4 = 0$

$$\frac{1}{k^2} = 4$$

$$k = \pm\frac{1}{2}$$

Challenge

1 a $x^2 - 10x + 9 = 0$
$(x - 1)(x - 9) = 0$
$x = 1$ or $x = 9$

b $3^{x-2}(3^x - 10) = -1$
$3^{2x-2} - 10 \times 3^{x-2} + 1 = 0$
Multiply by 3^2
$3^{2x} - 10 \times 3^x + 9 = 0$
Let $y = 3^x$
$y^2 - 10y + 9 = 0$
Using your answers from part **a**
$y = 1$ or 9
$3^x = 1$ or $3^x = 9$
$x = 0$ or 2

2 Let x and y be the length and width of the rectangle.
Area = $xy = 6$
Perimeter = $2x + 2y = 8\sqrt{2}$
$2y = 8\sqrt{2} - 2x$
$y = 4\sqrt{2} - x$
Solving simultaneously
$x\left(4\sqrt{2} - x\right) = 6$
$x^2 - 4\sqrt{2}x + 6 = 0$

Using the quadratic formula

$$x = \frac{4\sqrt{2} \pm \sqrt{(4\sqrt{2})^2 - 4(1)(6)}}{2(1)}$$

$$= \frac{4\sqrt{2} \pm \sqrt{8}}{2}$$

$$= \frac{4\sqrt{2} \pm 2\sqrt{2}}{2}$$

$x = \sqrt{2}$ or $x = 3\sqrt{2}$

When $x = \sqrt{2}$, $y = 3\sqrt{2}$
When $x = 3\sqrt{2}$, $y = \sqrt{2}$

The dimensions of the rectangle are $\sqrt{2}$ cm and $3\sqrt{2}$ cm.

3 Solving simultaneously
$3x^3 + x^2 - x = 2x(x - 1)(x + 1)$
$3x^3 + x^2 - x = 2x(x^2 - 1)$
$3x^3 + x^2 - x = 2x^3 - 2x$
$x^3 + x^2 + x = 0$
$x(x^2 + x + 1) = 0$

The discriminant of $x^2 + x + 1$
$b^2 - 4ac = 1^2 - 4(1)(1) = -3$
$-3 < 0$ so there are no real solutions for $x^2 + x + 1$

The only solution is when $x = 0$ at $(0, 0)$.

4 $f(x) = (x^2 + x - 20)(x^2 + x - 2)$
$= (x + 5)(x - 4)(x + 2)(x - 1)$
when $f(x) = 0$
$x = -5, -2, 1$ or 4

$g(x - k) = (x - k + 5)(x - k - 4)$
$(x - k + 2)(x - k - 1)$
When $k = 3$,
$g(x - 3) = (x + 2)(x - 7)(x - 1)(x - 4)$

$(x + 2)$, $(x - 1)$ and $(x - 4)$ match
When $k = -3$, $g(x + 3)$
$= (x + 8)(x - 1)(x + 5)(x + 2)$

$(x - 1)$, $(x + 5)$ and $(x + 2)$ match
So $k = -3$ or 3.