



Sketching a parabola from vertex form ($a=1$)

Mana Maths

Te reo Māori terms



whārite pūrua

quadratic equation

Open in Te Aka

koi

vertex

Open in Te Aka

hangarite

symmetry

Open in Te Aka

pito hurihuri

turning point

Open in Te Aka

Parabola vertex form ($a=1$ only)



Vertex Form ($a = 1$)

Key idea

With $a = 1$: $y = (x - h)^2 + k$. Vertex (h, k) , axis $x = h$. The graph always opens upward, with minimum value k .

Reading the graph

For $y = (x - 2)^2 - 3$: vertex $(2, -3)$, axis $x = 2$, minimum value -3 .

Using symmetry

Still $y = (x - 2)^2 - 3$: $y(1) = -2$ and $y(3) = -2$, since 1 and 3 are both one unit from the axis $x = 2$.

Common mistake

Switch the sign inside the bracket. $y = (x + 4)^2 - 1$ has axis $x = -4$, not $x = 4$.



= copy this into your book. Boxes without a pencil are just to read.



Parabola vertex form (a=1 only)

Solving with Vertex Form



Writing the equation from the vertex

If the turning point is $(4, 1)$, then $h = 4$ and $k = 1$, so $y = (x - 4)^2 + 1$. The axis is $x = 4$.

When roots exist

For $y = (x - 3)^2 - 9$, set $y = 0$:
 $(x - 3)^2 = 9$, so $x - 3 = \pm 3$, giving
 $x = 0$ and $x = 6$.

Common mistake

Not every vertex-form parabola crosses the x -axis. If $k > 0$, the whole graph sits above the x -axis, so there are no real roots.



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Start Tasks



1. For $y = (x - 3)^2 + 1$, write the vertex.

2. For $y = (x + 2)^2 - 4$, write the vertex.

3. For $y = (x - 5)^2$, write the vertex.

4. For $y = (x - 1)^2 + 6$, what is the axis of symmetry?

5. For $y = (x + 4)^2 - 2$, what is the axis of symmetry?

6. In $y = (x - h)^2 + k$, what does h tell you?

7. In $y = (x - h)^2 + k$, what does k tell you?

8. Does $y = (x - 2)^2 + 3$ open up or down?

9. Does $y = (x + 1)^2 - 7$ have a minimum or a maximum?

Start Tasks – Answers



1. $(3, 1)$

4. $x = 1$

7. The minimum
 y -value / vertex
 y -value

2. $(-2, -4)$

5. $x = -4$

8. Upward

3. $(5, 0)$

6. The axis / vertex
 x -value

9. Minimum

Start Tasks



10. Write the equation with vertex $(4, 1)$.

11. Write the equation with vertex $(-3, 2)$.

12. Write the equation with vertex $(0, -5)$.

13. Write the equation if the axis is $x = 6$ and the minimum is -2 .

14. Write the equation if the axis is $x = -1$ and the minimum is 4 .

15. Write the equation if the graph just touches the x -axis at $(3, 0)$.

16. For $y = (x - 2)^2 - 3$, what is the minimum y -value?

17. For $y = (x + 5)^2 + 1$, what is the minimum y -value?

18. For $y = (x - 4)^2$, what is the turning point?

Start Tasks – Answers



10. $y = (x - 4)^2 + 1$

13. $y = (x - 6)^2 - 2$

16. -3

11. $y = (x + 3)^2 + 2$

14. $y = (x + 1)^2 + 4$

17. 1

12. $y = x^2 - 5$

15. $y = (x - 3)^2$

18. $(4, 0)$

Start Tasks



19. For $y = (x - 3)^2 + 2$,
find y when $x = 3$.

20. For $y = (x - 3)^2 + 2$,
find y when $x = 4$.

21. For $y = (x - 3)^2 + 2$,
find y when $x = 2$.

22. For $y = (x + 1)^2 - 5$,
find y when $x = -1$.

23. For $y = (x + 1)^2 - 5$,
find y when $x = 0$.

24. For $y = (x + 1)^2 - 5$,
find y when $x = -2$.

25. Which is the vertex
of $y = (x + 4)^2 - 6$:
 $(-4, -6)$ or $(4, -6)$?

26. Which is the axis of
 $y = (x - 7)^2 + 1$: $x = 7$
or $y = 7$?

27. Why do $x = 1$ and
 $x = 5$ give the same
 y -value for
 $y = (x - 3)^2 - 2$?

Start Tasks – Answers



19. 2

22. -5

25. $(-4, -6)$

20. 3

23. -4

26. $x = 7$

21. 3

24. -4

27. They are both 2
units from the axis
 $x = 3$

Build Tasks



1. For $y = (x - 4)^2 - 3$, write the vertex and axis of symmetry.

2. For $y = (x + 2)^2 + 5$, write the vertex and axis of symmetry.

3. For $y = (x - 1)^2$, write the vertex and axis of symmetry.

4. Find the y-intercept of $y = (x - 3)^2 - 4$.

5. Find the y-intercept of $y = (x + 1)^2 + 2$.

6. Find the y-intercept of $y = (x - 5)^2$.

7. Find y when $x = 0$ for $y = (x + 2)^2 - 1$.

8. Find y when $x = 6$ for $y = (x - 4)^2 + 3$.

9. Find y when $x = -5$ for $y = (x + 3)^2 - 2$.

Build Tasks – Answers



1. Vertex $(4, -3)$, axis
 $x = 4$

4. 5

7. 3

2. Vertex $(-2, 5)$, axis
 $x = -2$

5. 3

8. 7

3. Vertex $(1, 0)$, axis
 $x = 1$

6. 25

9. 2

Build Tasks



10. A parabola has vertex $(2, -6)$ and passes through $(0, -2)$. Write the equation.

11. A parabola has vertex $(-1, 3)$ and passes through $(1, 7)$. Write the equation.

12. A parabola has vertex $(4, 1)$ and passes through $(5, 2)$. Write the equation.

13. Write the equation if the axis is $x = 3$ and the minimum is -5 .

14. Write the equation if the axis is $x = -2$ and the minimum is 0 .

15. Write the equation if the axis is $x = 0$ and the minimum is 4 .

16. Does $y = (x - 2)^2 + 1$ cross the x -axis? Explain.

17. Does $y = (x + 3)^2$ touch the x -axis? If so, where?

18. Solve $(x - 1)^2 - 4 = 0$ to find the x -intercepts.

Build Tasks – Answers



10. $y = (x - 2)^2 - 6$

13. $y = (x - 3)^2 - 5$

16. **No; minimum is 1**

11. $y = (x + 1)^2 + 3$

14. $y = (x + 2)^2$

17. **Yes, at $(-3, 0)$**

12. $y = (x - 4)^2 + 1$

15. $y = x^2 + 4$

18. $x = -1, 3$

Build Tasks



19. Solve

$(x + 2)^2 - 9 = 0$ to find the x -intercepts.

20. Solve

$(x - 4)^2 + 2 = 0$. What does this mean for the graph?

21. Expand

$y = (x - 3)^2 - 4$.

22. Expand

$y = (x + 1)^2 + 5$.

23. Expand

$y = (x - 2)^2$.

24. For $y = (x - 5)^2 - 1$, write two x -values with $y = 3$.

25. For $y = (x + 1)^2 + 2$, write two x -values with $y = 11$.

26. A parabola has vertex $(3, -1)$. One point is $(5, 3)$. Write the equation and

27. A parabola has axis $x = -2$ and passes through $(0, 5)$. Find the minimum y -value.

Build Tasks – Answers



19. $x = -5, 1$

22. $y = x^2 + 2x + 6$

25. $x = -4, 2$

20. **No real solution;
no x -intercepts**

23. $y = x^2 - 4x + 4$

26. $y = (x - 3)^2 - 1$; **by
symmetry about $x = 3$**

21. $y = x^2 - 6x + 5$

24. $x = 3, 7$

27. **1**

Push Tasks



1. For $y = (x - 3)^2 - 9$, find the vertex and the x-intercepts.

2. For $y = (x + 1)^2 - 4$, find the vertex and the x-intercepts.

3. For $y = (x - 5)^2 - 1$, find the vertex and the x-intercepts.

4. Which graph has exactly one x-intercept:
 $y = (x - 2)^2$,
 $y = (x - 2)^2 + 3$, or

5. Which graph has no x-intercepts:
 $y = (x + 4)^2 + 1$ or
 $y = (x + 4)^2 - 1$?

6. Which graph has two x-intercepts:
 $y = (x - 1)^2 + 4$ or
 $y = (x - 1)^2 - 4$?

7. For $y = (x - 3)^2 - 16$, find the intercepts and the axis of symmetry.

8. For $y = (x + 2)^2 - 25$, find the intercepts and the axis of symmetry.

9. For $y = (x - 4)^2 + 6$, write the vertex and state whether the roots are real.

Push Tasks – Answers



1. Vertex $(3, -9)$, **roots** $0, 6$

2. Vertex $(-1, -4)$,
roots $-3, 1$

3. Vertex $(5, -1)$, **roots** $4, 6$

4. $y = (x - 2)^2$; the vertex is on the axis

5. $y = (x + 4)^2 + 1$

6. $y = (x - 1)^2 - 4$

7. x-ints $(-1, 0), (7, 0)$;
y-int $(0, -7)$; **axis** $x = 3$

8. x-ints $(-7, 0), (3, 0)$;
y-int $(0, -21)$; **axis** $x = -2$

9. Vertex $(4, 6)$; **no real roots**

Push Tasks



10. A parabola has vertex $(2, -9)$ and roots -1 and 5 . Write the equation.

11. A parabola has vertex $(-3, -4)$ and roots -5 and -1 . Write the equation.

12. A parabola has vertex $(0, -16)$ and roots -4 and 4 . Write the equation.

13. A parabola has roots 1 and 7 . Write it in vertex form.

14. A parabola has roots -2 and 6 . Write it in vertex form.

15. A parabola has roots -5 and -1 . Write it in vertex form.

16. Write $y = (x - 6)^2 - 9$ in factorised form.

17. Write $y = (x + 2)^2 - 1$ in factorised form.

18. Write $y = (x - 1)^2 - 16$ in factorised form.

Push Tasks – Answers



10. $y = (x - 2)^2 - 9$

13. $y = (x - 4)^2 - 9$

16. $y = (x - 3)(x - 9)$

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

14. $y = (x - 2)^2 - 16$

17. $y = (x + 1)(x + 3)$

12. $y = x^2 - 16$

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

18. $y = (x + 3)(x - 5)$

Push Tasks



19. Find k if $y = (x - 3)^2 + k$ passes through $(0, 2)$.

20. Find k if $y = (x + 1)^2 + k$ passes through $(2, 5)$.

21. Find h if $y = (x - h)^2 - 4$ has roots 1 and 5.

22. Find h if $y = (x - h)^2 - 9$ has roots -1 and 5 .

23. Compare $y = (x - 2)^2 - 3$ and $y = (x - 2)^2 + 1$. What stays the same and what changes?

24. Explain why every graph $y = (x - h)^2 + k$ with $k > 0$ has no x -intercepts.

25. Explain why every graph $y = (x - h)^2$ has exactly one x -intercept.

26. A parabola has vertex $(4, -4)$ and y -intercept 12. Write the equation and give

27. A parabola has axis $x = -1$ and goes through $(-4, 5)$ and $(2, 5)$. Write the vertex

Push Tasks – Answers



19. $k = -7$

22. $h = 2$

25. The minimum is 0
at $x = h$, so it touches
once at $(h, 0)$

20. $k = -4$

23. Same axis $x = 2$;
second graph is 4 units
higher

26. $y = (x - 4)^2 - 4$;
roots 2, 6

21. $h = 3$

24. $(x - h)^2 \geq 0$, so
adding $k > 0$ keeps
 $y > 0$

27. $y = (x + 1)^2 - 4$;
turning point $(-1, -4)$