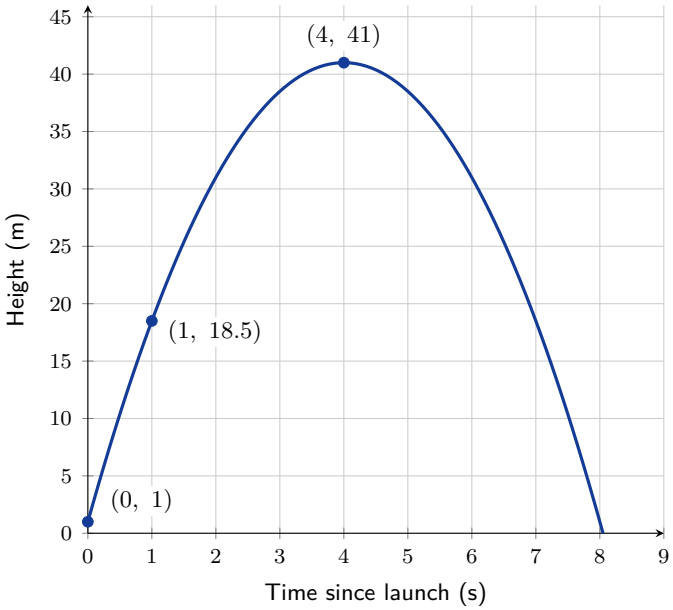
Task Cards

Print double-sided (flip on the long edge: Long-Edge binding): three sheets. Cards 1 to 6 are the sequence; Extensions A and B are for groups that finish early. Cut along the frames.

Card 1



A firework is launched from a platform 1 m above the ground. It reaches its greatest height, 41 m, 4 s after launch. The graph shows its height over time, with three points marked.

Write an equation for the firework's height.

Use the symmetry of the parabola to name one more point on the curve.

The point (1, 18.5) is also on the curve. Check your equation with it.

Card 2

Look at your equation for the firework from Card 1.

What do h and k tell you about the firework?

What does the sign of a tell you?

Card 3

The firework from Card 1 is 31 m high 2 s after launch.

At what other time is it 31 m high?

Find the time without substituting. Then substitute to check.

Task Cards — Backs

Answers for the cards on the other side of this sheet.

Card 1 — answer

The greatest height is the vertex: $(4,\ 41)$.

$y = a(x-4)^2 + 41$

The launch point $(0,\ 1)$ is on the curve:
$1 = a(0-4)^2 + 41$
$1 = 16a + 41$
$-40 = 16a$, so $a = -2.5$

$\boldsymbol{y = -2.5(x-4)^2 + 41}$, where x is the time since launch in seconds and y is the height in metres.

Symmetry: the launch point $(0,\ 1)$ is 4 s before the highest point, so the firework is at the same height 4 s after it: $(8,\ 1)$. (Another correct answer: $(7,\ 18.5)$, the mirror image of $(1,\ 18.5)$.)

Check $(1,\ 18.5)$: $-2.5(1-4)^2 + 41 = -22.5 + 41 = 18.5$.

Card 3 — answer

The axis of symmetry is $x = 4$, the time of the greatest height.

2 s is 2 s *before* the peak, so the matching time is 2 s *after* it: **6 s** after launch.

Check: $-2.5(6-4)^2 + 41 = -10 + 41 = 31$.

Card 2 — answer

$h = 4$: the firework is highest 4 s after launch.

$k = 41$: its greatest height is 41 m.

$a = -2.5$ is negative: the parabola opens downward, so the firework rises, reaches a top, and then falls.

Task Cards

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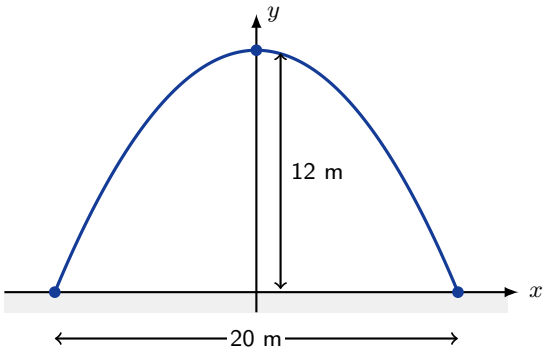
Card 4

Use your equation from Card 1.

Find the firework's height 5 s after launch and 10 s after launch.

Which prediction makes sense? Why does the other one not?

Card 5



A greenhouse is a glass building where plants grow. The front wall of this greenhouse is a parabolic arch. It is 20 m wide at the ground and 12 m tall at its centre.

The origin is at the centre of the base. Write an equation for the arch in intercepts form.

The arch is 9 m tall 5 m from its centre. Check your equation with that point.

Card 6

Look at your equation for the arch from Card 5.

What do the two zeros tell you about the arch?

What does the sign of a tell you about the arch?

Put $x = 0$ into your equation to find the height at the centre. What does the size of a do to that height?

Extension A

In the last class, a gate 12 m wide had its left end at the origin. Its equation was

$$y = -\tfrac{1}{4}x(x - 12)$$

Put the left end of the greenhouse arch at the origin.

Write its equation. What changed in the equation? What stayed the same?

Task Cards — Backs

Answers for the cards on the other side of this sheet.

Card 5 — answer

The arch meets the ground at $x = -10$ and $x = 10$, so $y = a(x + 10)(x - 10)$.

The top is $(0,\ 12)$:
$12 = a(0 + 10)(0 - 10) = -100a$, so
$a = -0.12$.

$$\boldsymbol{y = -0.12(x + 10)(x - 10)}$$

Check $(5,\ 9)$:
$-0.12(5 + 10)(5 - 10) = -0.12(15)(-5) = 9$.

Card 4 — answer

$x = 5$:
$-2.5(5 - 4)^2 + 41 = -2.5 + 41 = 38.5\,\text{m}$.
$x = 10$:
$-2.5(10 - 4)^2 + 41 = -90 + 41 = -49\,\text{m}$.

38.5 m at 5 s makes sense: 5 s is inside the time the graph shows (**interpolation**).

−49 m does not: a height below the ground is impossible. The firework comes down at about 8 s, so 10 s is outside the model (**extrapolation**).

Extension A — answer

The arch now meets the ground at $x = 0$ and $x = 20$, and the top is midway, at $(10,\ 12)$.
$y = ax(x - 20)$, and
$12 = a(10)(10 - 20) = -100a$, so $a = -0.12$.

$$\boldsymbol{y = -0.12x(x - 20)}$$

Changed: the zeros, so the brackets: x and $(x - 20)$ instead of $(x + 10)$ and $(x - 10)$.
Same: $a = -0.12$, and the arch itself: 20 m wide and 12 m tall. Only the axes moved.

Card 6 — answer

The zeros, −10 and 10, are the x-values of the two points where the arch meets the ground, 10 m each side of the centre. Those points are 20 m apart, so the arch is 20 m wide.

The sign of a: -0.12 is negative, so the parabola opens downward and has a highest point, the top of the arch.

The size of a: At the centre, $x = 0$, the brackets give $(10)(-10) = -100$. The a value multiplies that: $-0.12 \times (-100) = 12$, the height of the arch. So the size of a sets how tall the arch is. With the same zeros, $a = -0.24$ would make the arch 24 m tall.

Task Cards

Print double-sided (flip on the long edge: Long-Edge binding): three sheets. Cards 1 to 6 are the sequence; Extensions A and B are for groups that finish early. Cut along the frames.

Extension B

Year	x	Total mass (1000s of tonnes)
2010	0	150
2011	1	322
2012	2	518
2013	3	737
2014	4	978
2015	5	1243
2016	6	1531
2017	7	1841

A landfill is a place where garbage is buried. This landfill opened in 2010. The table gives the total mass of garbage in it at the end of each year. A model for the totals is

$$y = 11.5(x + 7)^2 - 413$$

where x is the number of years after 2010 and y is the total mass, in thousands of tonnes.

Check the model against two rows of the table. Then predict the total at the end of 2022. How far would you trust that prediction?

Task Cards — Backs

Answers for the cards on the other side of this sheet.

Extension B — answer

Checks: 2013, $x = 3$: $11.5(10)^2 - 413 = 1150 - 413 = 737$ (table: 737). 2017, $x = 7$: $11.5(14)^2 - 413 = 2254 - 413 = 1841$ (table: 1841).

2022, $x = 12$: $11.5(19)^2 - 413 = 4151.5 - 413 = 3738.5$, about 3700 thousand tonnes (3.7 million tonnes).

Trust: it is extrapolation, 5 years past the data, so less certain. It holds only if garbage keeps arriving the way it has. A new recycling program, or the landfill filling up, would break it.