Wednesday, 18 March 2026

We are learning about: Forming and solving quadratic equations

Key terms: Coefficient, constant, simplify, expand, equation, factorise, bracket, multiply, add, subtract, divide, terms

Problem 1

Solve the equation $\frac{5}{2-x}+\frac{x-5}{x+2}+\frac{3x+8}{x^2-4}=0$. In the answer box, write the roots separated by a comma.

$(x-1)(x-8)=0$, so the roots are $x=1$ and $x=8$. The equation is defined for them, so they are both solutions.

- Developing learners will be able to solve a quadratic equation by factorising, completing the square or the quadratic formula.
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- Quadratic equation — 二次方程
- Parabola — 抛物线
- Vertex — 顶点
- Roots — 根
- Discriminant — 判别式

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If $x^2 - 2ax + a^2 = 0$, find the value of $\frac{x}{a}$.

$(\frac{x}{a})^2 - 2.\frac{x}{a} + 1 = 0$, or $(\frac{x}{a} - 1)^2 = 0$, which yields $\frac{x}{a} = 1$.

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$$\frac{x^{2002} + 4x^{2001}}{4x^{2000}} = 2449.25$$

The roots of the equation are -101 and 97.

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Problem 3

Find value of $\sqrt{6+(\sqrt{6+(\sqrt{6...}$

$x = -2$ or $x = 3$

x must be greater than 0, so

$\sqrt{6+(\sqrt{6+(\sqrt{6...} = 3$

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Solve for x :

Example 1 :

$$9^x + 3 = 4(3^x)$$

So, the solution is {0, 1}

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$$4^x - 10(2^x) + 16 = 0$$

$x = 1$ or 3

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$$4^x + 2^x = 20$$

$$x = 2$$

So, the solution is 2.

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Ex1 There are 8 sweets in a jar.
n of the sweets are green.
Katie takes one sweet at random from the jar and does not replace it.
She takes a second sweet at random from the jar. The probability that she takes 2 green sweets is $^5/_{14}$.

[a] Show that $n^2 - n - 20 = 0$.

[b] How many green sweets are there in the jar?

Solution

Write the probabilities of **picking a green sweet** on the **first** and **second throws.**

First pick. $\frac{n}{8}$ — There are n **green sweets.** Out of a **total 8 sweets.**

Second pick. $\frac{n-1}{7}$ — There are $n-1$ **green sweets.** Out of a **total 7 sweets left.**

Write an **expression** for the **probability of GG.**

$$P(GG) = \frac{n}{8} \times \frac{n-1}{7} = \frac{n^2 - n}{56}$$

Simplify.

Form an **equation** using **the expression** and the **information from the question.**

$$\frac{n^2 - n}{56} = \frac{5}{14}$$

$\times 56$ $\quad$ $\times 56$

$$n^2 - n = \frac{280}{14}$$

Simplify the fraction

$$n^2 - n = 20$$

-20 $\quad$ -20

$$n^2 - n - 20 = 0$$

∴ Shown.

Factors of 20

1, 20
2, 10
4, 5

$n^2 - n - 20 = 0$

$(x \quad)(x \quad) = 0$

This **must factorise** as there has to be an **positive integer number of sweets.**

$x = -4$ $\quad$ $x = 5$

There are **5 green sweets in the jar.**

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Ex2 Clark is a javelin thrower.

The formula $h = 10 + 20t - 7t^2$ gives the height, in metres, of the shot above the ground t seconds after Clark releases the throw. How many seconds does it take for the javelin to hit the ground?

Give your answer correct to two significant figures.

Solution

The height is 0 when the javelin hits the ground.

Substitute $h = 0$ into the formula.

$h = 10 + 20t - 7t^2$

$0 = 10 + 20t - 7t^2$ — **Solve.**

This quadratic equation **cannot be factorised.**

We need to use the **quadratic formula.**

$a =$ $b =$ $c =$

$x = \frac{-b}{}$

$x = \frac{-(20)}{}$

$x = \frac{-20 \pm \sqrt{680}}{-14}$

$x_+ =$ $x_- =$

$t = 3.2912$ as time must be positive.

It takes 3.3 (2sf) seconds for the javelin to hit the ground.

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Q1 Tony kicks a football in the air.
The formula $h = 9 + 20t - 4t^2$ gives the height, in feet, of the ball above the ground t seconds after Tony kicks it. How many seconds is the ball in the air for?
Give your answer correct to two significant figures.

Solution

The height is 0 when the ball hits the ground.

Substitute $h = 0$ into the formula.

$h = 9 + 20t - 4t^2$

$0 = 9 + 20t - 4t^2$ — **Solve.**

This quadratic equation **cannot be factorised.**

We need to use the **quadratic formula.**

$a =$ $b =$ $c =$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-20) \pm \sqrt{544}}{-8}$$

$x_+ =$ $x_- =$

$t = 5.4155$ as time must be positive.

The ball is in the air for 4.2 (2sf) seconds.

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Q2 There are 10 marbles in a bag.
n of the marbles are blue.
Jim takes one marble at random from the bag and does not replace it.
He takes a second marble at random from the bag. The probability that he takes 2 blue marbles is $^1/_{15}$.

[a] Show that $n^2 - n - 6 = 0$.

[b] How many blue marbles are there in the bag?

Solution

Write the probabilities of **picking a green sweet** on the **first** and **second throws.**

First pick. $\frac{n}{10}$ — There are n **blue marbles.** Out of a **total 10 in the bag.**

Second pick. $\frac{n-1}{9}$ — There are $n-1$ **blue marbles.** Out of a **total 9 marbles left.**

Write an **expression** for the **probability of BB.**

$$P(BB) = \frac{n}{10} \times \frac{n-1}{9} = \frac{n^2 - n}{90}$$

Simplify.

Form an **equation** using **the expression** and the **information from** the **question.**

$$\frac{n^2 - n}{90} = \frac{1}{15}$$

$\times 90$ $\times 90$

$$n^2 - n = \frac{90}{15}$$

Simplify the fraction

$$n^2 - n = 6$$

-6 -6

$$n^2 - n = 0$$

∴ Shown.

$n^2 - n - 6 = 0$

$(x \quad)(x \quad) = 0$

Factors of 6

1, 6

2, 3

This **must factorise** as there has to be an **positive integer number of marbles.**

$x = -2$ $x = 3$

There are **3 blue marbles in the bag.**

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Q3 Elizabeth is x years old.
Ruby is 6 years older than Elizabeth.
The product of their ages is 40.

Solution

[a] Show that $x^2 + 6x - 40 = 0$.

Elizbeth x
Ruby $x + 6$

$x(x + 6) = 40$
$x^2 + 6x = 40$
$-40 \quad -40$
$x^2 + 6x - 40 = 0$

∴ Shown.

[b] How old are Elizabeth and Ruby?

$x^2 + 6x - 40 = 0$
$(x \quad)(x \quad) = 0$
$x = -10 \quad x = 4$

Factors of 40: 1, 40, 5, 8

This **must factorise** as **age** must be **positive integer.**

Age must be positive.

Elizabeth is 4 years old.
Ruby is 10 years old.

Q4 Harriet is x years old.
Martha is 5 years younger than Harriet.
The product of their ages is 84.

Solution

[a] Show that $x^2 - 5x - 84 = 0$.

Harriet x
Martha $x - 5$

$x(x - 5) = 84$
$x^2 - 5x = 84$
$-84 \quad -84$
$x^2 - 5x - 84 = 0$

∴ Shown.

[b] How old are Harriet and Martha?

$x^2 - 5x - 84 = 0$
$(x \quad)(x \quad) = 0$
$x = -7 \quad x = 12$

Factors of 84: 1, 84, 2, 42, 3, 28, 4, 21, 6, 14, 7, 12

This **must factorise** as **age** must be **positive integer.**

Age must be positive.

Harriet is 12 years old.
Martha is 7 years old.

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Q5 Jimmy is x years old.
Sarah is 11 years older than Jimmy.
The product of their ages is 80.

Solution

[a] Show that $x^2 + 11x - 80 = 0$.

Jimmy x
Sarah $x + 6$

$x(x + 11) = 80$
$x^2 = 80$
$-80 \quad -80$
$x^2 + 11x = 0$ **∴ Shown.**

[b] How old are Jimmy and Sarah?

$x^2 + 11x - 80 = 0$
$(x \quad)(x \quad) = 0$
Factors of 84
This **must factorise** as **age** must be **positive integer.**
$x = -16$ $x = 5$
Age must be positive.
Jimmy is **years old.**
Sarah is **years old.**

Q6 Kerry is x years old.
Craig is 9 years younger than Kerry.
The product of their ages is 136.

Solution

[a] Show that $x^2 - 9x - 136 = 0$.

Kerry x
Craig $x - 9$

$x(x - 9) = 136$
$x^2 = 136$
$-136 \quad -136$
$x^2 - 9x = 0$ **∴ Shown.**

[b] How old are Kerry and Craig?

$x^2 - 9x - 136 = 0$
$(x \quad)(x \quad) = 0$
Factors of 136
This **must factorise** as **age** must be **positive integer.**
$x = -8$ $x = 17$
Age must be positive.
Kerry is **years old.**
Craig is **years old.**

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Q7 Callum buys a pair of trainers for £$25x$.
He later sells the trainers for £$(200 + 2x)$.
He makes a profit of x%.
Calculate the percentage profit x%.

Solution

Recall **percentage profit** $= \frac{\text{Change}}{\text{Original}} \times 100$

The profit was 8%.

$\frac{\text{Change}}{\text{Original}} = \frac{200}{25x} \times 400$

Simplify the numerator. **Convert to percentage and cancel.**

$x^2 + 92x - 80$

$(x \quad)(x \quad)$

Simplify the numerator. **This can be factorised!**

$800 = x$

$x = -100$ $x = 8$

Percentage profit must be positive.

Set equal to the profit, x.

$\times$

$800 -$

$-800 + 92x$

Q8 $20x$ red squirrels are delivered to a forest as part of a re-introduction program.
The population increases $220 + 8x$ in the first year. Calculate the percentage increase of the population.

Solution

Convert to percentage and cancel.

$\frac{\text{Change}}{\text{Original}} = \frac{220}{20x} \times 100$

Simplify the numerator

$= \frac{1100}{x} = x$

$\times$

$1100 -$

Set equal to the profit, x.

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Q7 Callum buys a pair of trainers for £$25x$.
He later sells the trainers for £$(200 + 2x)$.
He makes a profit of x%.
Calculate the percentage profit x%.

Solution

Recall **percentage profit** $= \frac{\textbf{Change}}{\textbf{Original}} \times 100$

The profit was 8%.

Change $200 + 2x - 25x$
Original $25x$

$$\frac{200 + 2x - 25x}{25x} = \frac{200 - 23x}{x} \times 4$$

$$800 - 92x = x \quad \times x \quad \times x$$

$$800 - 92x = x^2$$

$$-800 + 92x$$

$$x^2 + 92x - 800 = 0$$

This can be factorised!

$$(x + 100)(x - 8) = 0$$

$x = -100$ $x = 8$

Percentage profit must be **positive.**

Q8 $20x$ red squirrels are delivered to a forest as part of a re-introduction program.
The population increases $220 + 8x$ in the first year. Calculate the percentage increase of the population.

Solution

$$1100 - 85x = x^2$$

$a =$ $b =$ $c =$

$$-1100 + 85x \qquad -1100 + 85x$$

$$0 =$$

x

The percentage increase of the population was 11.41%.

$$x = \frac{\pm\sqrt{\quad}}{}$$

$x_+ =$ $x_- =$

Percentage increase must be **positive.**

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Q9 A coin is biased so that the probability that it shows tails on any throw is p.
The coin is thrown twice. The probability that the coin shows tails exactly once is $^4/_9$.
Show that $9p^2 - 9p = 2$

Solution

P(T) = p

P(H) = $1 - p$

P(TH) = $p(1-p)$

= P(T) × P(H)

= p

P(T once) = $2p(1-p)$

Write the probabilities of tails and heads

Set up and rearrange.

The probability of HT is equal to TH.

There are two possible events, so multiply by 2.

$2p(1-p) = \frac{4}{9}$

Expand

$2p - 2p^2 = \frac{4}{9}$

× 9 × 9

$18p - 18p^2 = 8$

$9p^2 - 9p = -8$

$\therefore$ Shown

Q10 The length of a rectangle is the same as the length of each side of a square. The length of the rectangle is 5cm more than twice the width of the rectangle. The area of the square is 63cm^2 greater than the area of the rectangle.
Find the length of the square.

Solution

Width

Length

Write the width and length of the rectangle.

Area of square. ( )^2 $4x^2$

Area of rectangle. ( ) $2x^2 - 2x^2 - 5x - 63$

$4x^2 - 2x^2 - 5x - 63 = 2x^2$

$2x^2 - 5x - 63 = 0$

Set = 0 and solve.

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The coin is thrown twice. The probability that the coin shows tails exactly once is $^4/_9$.
Show that $9p^2 - 9p = 2$

Solution

$P(T) = p$

$P(H) = 1 - p$

Set up and rearrange.

$P(TH) = P(HT)$

$= P(T) \times P(H)$

$= p(1 - p)$

$P(T \text{ once}) = 2p(1 - p)$

$2p(1 - p) = \frac{4}{9}$

Expand

$2p - 2p^2 = \frac{4}{9}$

$\times 9 \quad \times 9$

$\frac{18p - 18p^2}{2} = \frac{4}{2}$

$9p - 9p^2 = 2$

∴ Shown.

Q10 The length of a rectangle is the same as the length of each side of a square. The length of the rectangle is 5cm more than twice the width of the rectangle. The area of the square is 63cm^2 greater than the area of the rectangle.
Find the length of the square.

Solution

$2x^2 + 15x - 38 = 0$ **$2 \times 38 =$**

Factors of 76
1, 76
2, 38
4, 19

$(2x \quad)(2x \quad) = 0$

2

$(\quad)(\quad) = 0$

Length must be positive.

$x = -9.5$ $x = 2$

Substitute $x = 2$ for the length of the square.

$2x + 5 =$

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