

Interweaving

connecting the threads of mathematics

Nathan Day

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interwovenmaths.com

Rory ran to school at 6 mph, and then ran home the same way at 4 mph. What was Rory's average speed?



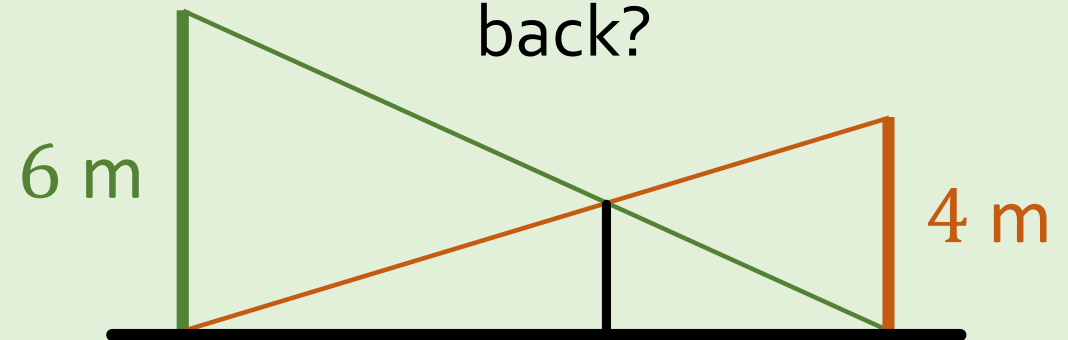
What is the density of an alloy made from equal masses of gallium and barium?

Metal	Density
Gallium	6 g/cm ³
Barium	4 g/cm ³

Anne could paint a room in 6 hours. Bob could paint the room in 4 hours. How long would they take to paint two coats of the room, working together?



An engineer has to fix a fault where these two wires cross. How far does she have to climb to get to the fault and back?



Interweaving

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What is Interweaving?

Using questions and tasks that bring together multiple different topics from across mathematics.

What is Interweaving?

It's not interleaving!

Rory ran to school at 6 mph, and then ran home the same way at 4 mph. What was Rory's average speed?



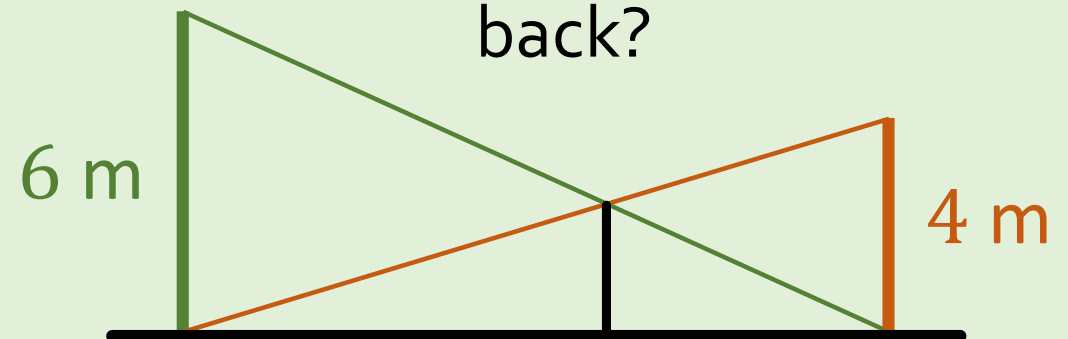
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What is the density of an alloy made from equal masses of gallium and barium?

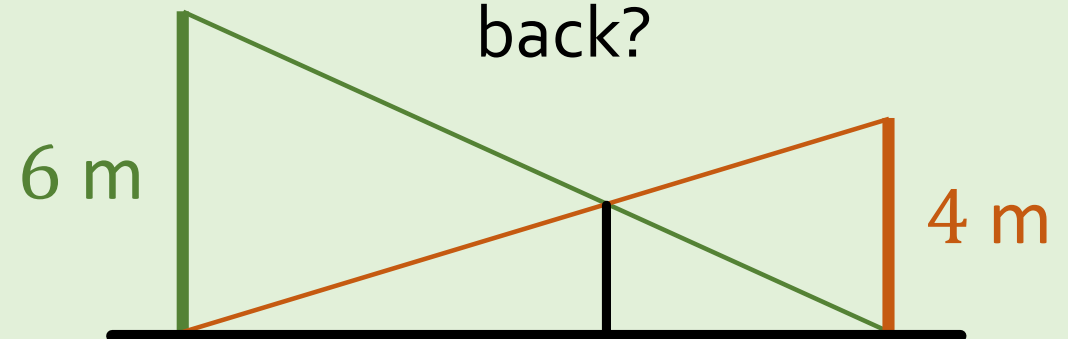
Metal	Density
Gallium	6 g/cm ³
Barium	4 g/cm ³

Why do these questions all have the same answer?

Anne could paint a room in 6 hours. Bob could paint the room in 4 hours. How long would they take to paint two coats of the room, working together?



An engineer has to fix a fault where these two wires cross. How far does she have to climb to get to the fault and back?



Rory ran to school at 6 mph, and then ran home the same way at 4 mph. What was Rory's average speed?



What is the density of an alloy made from equal masses of gallium and barium?

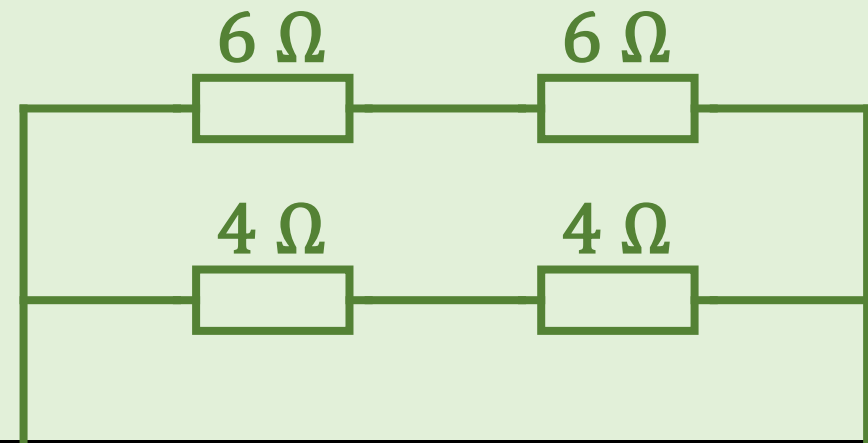
Metal	Density
Gallium	6 g/cm ³
Barium	4 g/cm ³

Why do these questions all have the same answer?

Anne could paint a room in 6 hours. Bob could paint the room in 4 hours. How long would they take to paint two coats of the room, working together?



What is the total resistance of the circuit?



Rory ran to school at 6 mph, and then ran home the same way at 4 mph. What was Rory's average speed?



What is the density of an alloy made from equal masses of gallium and barium?

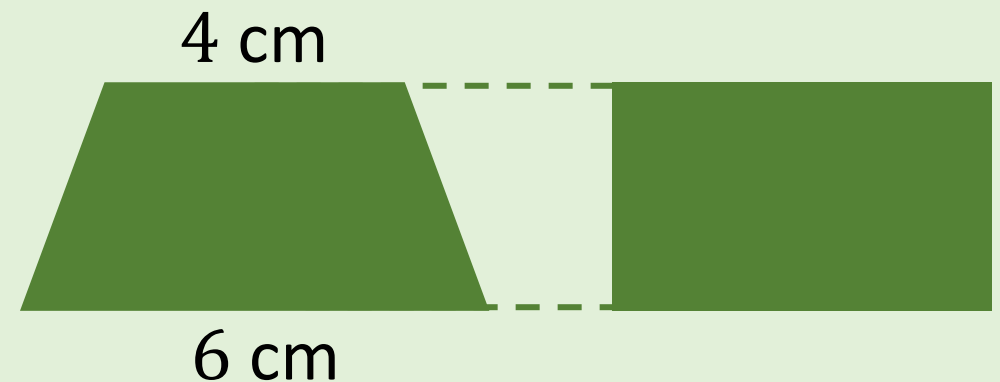
Metal	Density
Gallium	6 g/cm ³
Barium	4 g/cm ³

Which one doesn't belong?

Anne could paint a room in 6 hours. Bob could paint the room in 4 hours. How long would they take to paint two coats of the room, working together?



What width would make the rectangle have the same area as the trapezium?



Bonnyrigg Rose

4

2

East Fife

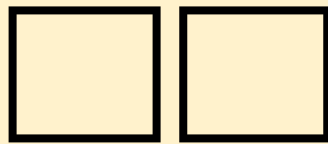
FT

How many different scores could there have been at half time?

400

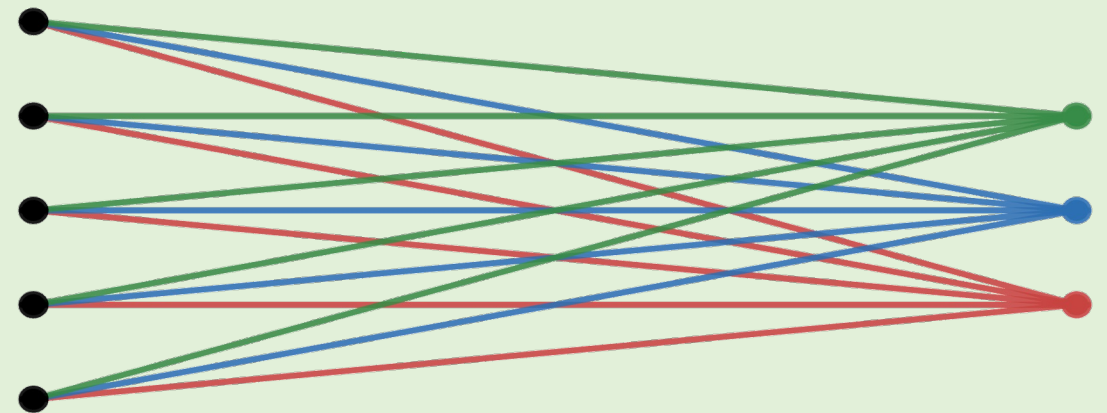
How many different factors does this number have?

Why do these questions all have the same answer?



The first digit is a square number.
The second digit is odd.
How many numbers are possible?

How many lines?



Why do Interweaving?

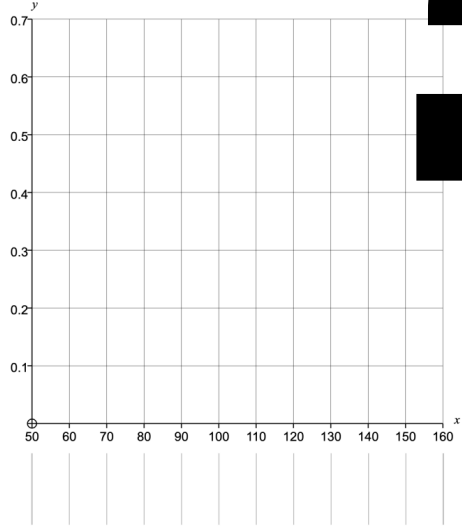
- 1 – Making Connections
- 2 – Retrieval
- 3 – Depth
- 4 – Challenge
- 5 – Purpose
- 6 – Revision

Interior angles of regular polygons from triangles – pentadecagons (15 sides)															
60°															156°

Group	Frequency	Cumulative Frequency	Class Width	Frequency Density	Midpoint	F × M
$50^\circ \leq x < 100^\circ$						
$100^\circ \leq x < 125^\circ$						
$125^\circ \leq x < 145^\circ$						
$145^\circ \leq x < 155^\circ$						
$155^\circ \leq x < 160^\circ$						

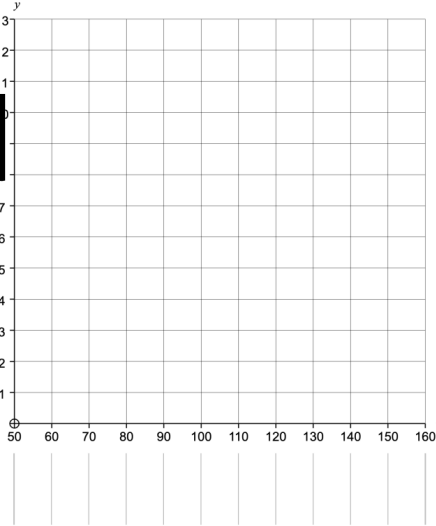
Mean	Lower Quartile	Estimated Mean
Median	Upper Quartile	Modal Class
Range	Interquartile Range	Median Class

Histogram

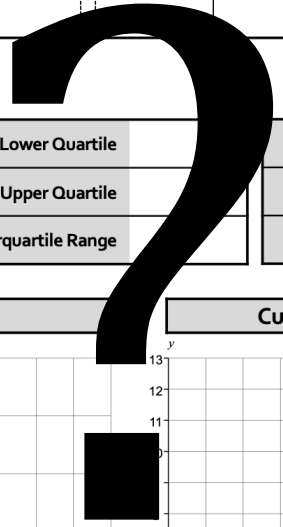


Actual Box Plot

Cumulative Frequency



Estimated Box Plot



1 – Remove Supports

<p>Ratio</p> <p>\widehat{ADB} and \widehat{AEB} are in the ratio 2 : 7.</p> <p>What is \widehat{ADB}?</p>	<p>Equations</p> <p>\widehat{ABC} is 10° greater than \widehat{ADB}.</p> <p>What is \widehat{ABC}?</p>	<p>Percentages</p> <p>\widehat{ABC} is 25% of the size of \widehat{ACB}.</p> <p>What is \widehat{ABC}?</p>
<p>Circle Theorems with...</p> <p><small>C is the centre of the circle, all other points are on the circumference.</small></p>		
<p>Bounds</p> <p>\widehat{ACB} is 30°, to the nearest 10°.</p> <p>What is the error interval for \widehat{ADB}?</p>	<p>Averages</p> <p>The mean of \widehat{ACB} and \widehat{ADB} is 24°.</p> <p>What is \widehat{ADB}?</p>	<p>Sequences</p> <p>The angles of $ABDE$ form an arithmetic sequence.</p> <p>The smallest angle is 45°.</p> <p>What is the second smallest angle?</p>

Ratio

\widehat{ADB} and \widehat{AEB} are in the ratio 2 : 7.

What is \widehat{ADB} ?

Equations

\widehat{ABC} is 10° greater than \widehat{ADB} .

What is \widehat{ABC} ?

Percentages

\widehat{ABC} is 25% of the size of \widehat{ACB} .

What is \widehat{ABC} ?

Circle Theorems with...

C is the centre of the circle, all other points are on the circumference.

Bounds

\widehat{ACB} is 30° , to the nearest 10° .

What is the error interval for \widehat{ADB} ?

Averages

The mean of \widehat{ACB} and \widehat{ADB} is 24° .

What is \widehat{ADB} ?

Sequences

The angles of ABDE form an arithmetic sequence.

The smallest angle is 45° .
What is the second smallest angle?

Ratio

\widehat{ADB} and \widehat{AEB} are in the ratio 2:7.

$$40^\circ$$

Equations

\widehat{ABC} is 10° greater than \widehat{ACB} .

$$50^\circ$$

Percentages

\widehat{ABC} is 25% of the size of \widehat{ACB} .

$$30^\circ$$

Circle Theorems with...

C is the centre of the circle, all other points are on the circumference.

Bounds

\widehat{ACB} is 30° , to the nearest degree.

$$12.5^\circ \leq \theta < 17.5^\circ$$

or

$$172.5^\circ < \theta \leq 177.5^\circ$$

Averages

The mean of \widehat{ACB} and \widehat{ADB} is 16° .

$$16^\circ$$

What is \widehat{ADB} ?

Sequences

The angles of $ABDE$ form an arithmetic sequence.

The smallest angle is 45° .

What is the largest angle?

$$75^\circ$$

What is the smallest angle?

Ratio

\widehat{ADB} and \widehat{AEB} are in the ratio 2:5.

$$40^\circ$$

Equations

\widehat{ABC} is 10° greater than \widehat{ACB} .

$$50^\circ$$

Percentages

\widehat{ABC} is 25% of the size of \widehat{ACB} .

$$30^\circ$$

Circle Theorems with...

C is the centre of the circle, all other points are on the circumference.

Bounds

\widehat{ACB} is 30° , to the nearest degree.

$$12.5^\circ \leq \theta < 17.5^\circ$$

or

$$172.5^\circ < \theta \leq 177.5^\circ$$

Averages

The mean of \widehat{ACB} and \widehat{ADB} is 16° .

$$16^\circ$$

What is \widehat{ADB} ?

Sequences

The angles of $ABDE$ form an arithmetic sequence.

The smallest angle is 45° .

What is the second smallest angle?

Ratio

$\hat{A}DB$ and $\hat{A}EB$ are in the ratio 2 : 7.

What is $\hat{A}DB$?

Equations

$\hat{A}BC$ is 10° greater than $\hat{A}DB$.

What is $\hat{A}BC$?

Percentages

$\hat{A}BC$ is 25% of the size of $\hat{A}CB$.

What is $\hat{A}BC$?

Circle Theorems with...

C is the centre of the circle, all other points are on the circumference.

Bounds

$\hat{A}CB$ is 30° , to the nearest 10° .

What is the error interval for $\hat{A}DB$?

Averages

The mean of $\hat{A}CB$ and $\hat{A}DB$ is 24° .

What is $\hat{A}DB$?

Sequences

The angles of a quadrilateral form an arithmetic sequence.

Show that it is a cyclic quadrilateral.

1 – Remove Supports

2 – Require Justifications

<p>Show that...</p> <p>A is 80% of C</p>	Show
<p>Show that...</p> <p>B has more factors than C if and only if $r > q$</p>	
<p>Show that...</p> <p>A, B and C can be the first three terms of an arithmetic sequence</p>	Show

A, B and C can be sides lengths of a right-angled triangle

$$3(C - A) = B$$



Sam Blatherwick
@blatherwick_sam



my new year 10s hate showing their working out

so I have taken away their beloved answers

- Explain** why the lowest common multiple of 75 and 60 is 300
- Explain** why the lowest common multiple of 450 and 288 is 7200
- Explain** why the highest common factor of 2400 and 2850 is 150
- Denise says she has a quick way to work out a lowest common multiple. For example: 12 and 18
 “Write it as a fraction and cancel it down $\frac{12}{18} = \frac{2}{3}$
 I needed to divide them both by 6, so I do $2 \times 3 \times 6 = 36$ which is the lowest common multiple”
 Try this method with **15 and 21** and with **75 and 60**. Why does it work? Can you **explain**?
- The lowest common multiple of 45 and another number is 540. Work out what the other number could be. Are there any other possibilities?

Require Justifications

Show that... A is 80% of C	Show that... A + B is a multiple of 7	Show that... A is both the mean and the median of the three numbers
Show that... B has more factors than C if and only if $r > q$	$\mathbf{A} = 2^{p+2} \times 3^q \times 5^r$ $\mathbf{B} = 2^p \times 3^{q+1} \times 5^r$ $\mathbf{C} = 2^p \times 3^q \times 5^{r+1}$	Show that... The gradient of the line going through (A, C) and (B, B) is 2
Show that... A, B and C can be the first three terms of an arithmetic sequence	Show that... A, B and C can be sides lengths of a right-angled triangle	Show that... $3(\mathbf{C} - \mathbf{A}) = \mathbf{B}$

- 1 – Remove Supports
- 2 – Require Justifications
- 3 –**

What's happening here?

$$3x + \frac{4}{11} = 6.\dot{0}\dot{3}$$

$$3x + \frac{4}{11} = 6.\dot{0}\dot{3}x$$

$$\frac{3}{x + \frac{4}{11}} = \frac{6.\dot{0}\dot{3}}{x}$$

$$0.3x + \frac{1}{4} = 5.35$$

$$0.3x + \frac{1}{4} = 5.35x$$

$$\frac{0.3}{x + \frac{1}{4}} = \frac{5.35}{x}$$

$$3x + 14 = 5$$

$$3x + 14 = 5x$$

$$\frac{3}{x + 14} = \frac{5}{x}$$

Numbers

Hard

$$3x + \frac{4}{11} = 6.\dot{0}\dot{3}$$

$$3x + \frac{4}{11} = 6.\dot{0}\dot{3}x$$

$$\frac{3}{x + \frac{4}{11}} = \frac{6.\dot{0}\dot{3}}{x}$$

Medium

$$0.3x + \frac{1}{4} = 5.35$$

$$0.3x + \frac{1}{4} = 5.35x$$

$$\frac{0.3}{x + \frac{1}{4}} = \frac{5.35}{x}$$

Easy

$$3x + 14 = 5$$

$$3x + 14 = 5x$$

$$\frac{3}{x + 14} = \frac{5}{x}$$

Easy

Medium

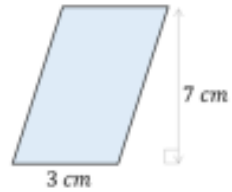
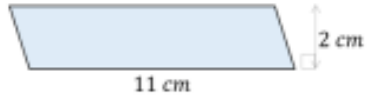
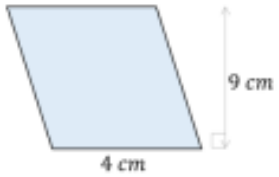
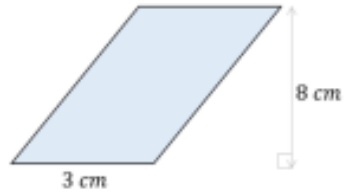
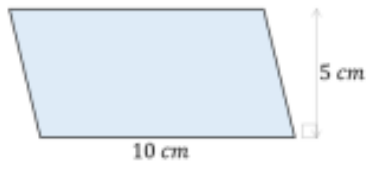
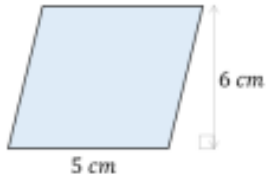
Hard

Equation

- 1 – Remove Supports
- 2 – Require Justifications
- 3 – Vary on Multiple Axes
- 4 – Force an Understanding**

<https://ponderingplanning.wordpress.com/2019/09/01/thinking-about-areas-of-parallelograms/>

Calculate the area of each parallelogram.



Force an Understanding

Find the upper and lower bounds of each of the following expressions, where:

$x = 3.5$ (1 decimal place), $y = 27$ (2 significant figures), $z = 30$ (nearest ten).

Give your answers to 4 significant figures.

Expression	Lower Bound	Upper Bound	Expression	Lower Bound	Upper Bound
$x + y$			15% of x		
$y - x$			$\frac{2}{7}$ of x		
$\frac{y}{x}$			The range of x , y and z		
$\frac{1}{x} + y$			The median of x , y and z		
xy			The mean of x , y and z		
$\frac{y-x}{z}$				51.50	62.50

Find the upper and lower bounds of each of the following expressions, where:

$x = 3.5$ (1 decimal place), $y = 27$ (2 significant figures), $z = 30$ (nearest ten).

Give your answers to 4 significant figures.

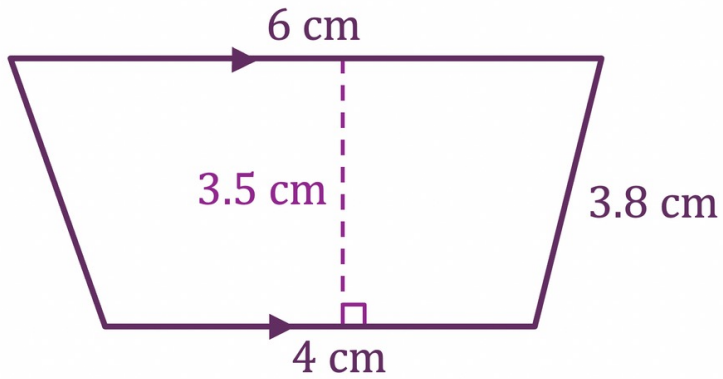
Expression	Lower Bound	Upper Bound	Expression	Lower Bound	Upper Bound
$x + y$	29.95	31.05	15% of x	0.5175	0.5325
$y - x$	22.95	24.05	$\frac{2}{7}$ of x	0.9857	1.014
$\frac{y}{x}$	7.465	7.971	The range of x , y and z	22.95	31.55
$\frac{1}{x} + y$	26.78	27.79	The median of x , y and z	25.00	27.50
xy	91.43	97.63	The mean of x , y and z	18.32	22.02
$\frac{y-x}{z}$	0.6557	0.9620	$y + z$	51.50	62.50

- 1 – Remove Supports
- 2 – Require Justifications
- 3 – Vary on Multiple Axes
- 4 – Force an Understanding
- 5 – Make them Messy**

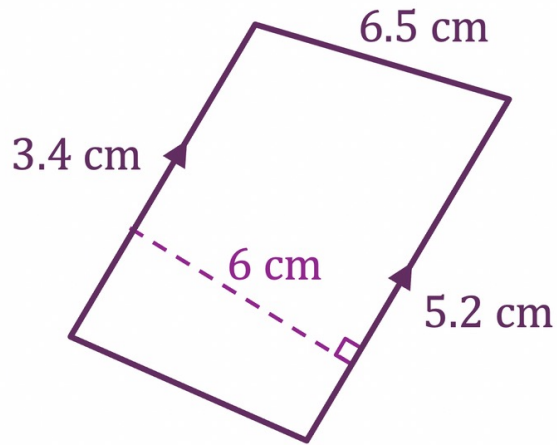
Make them Messy

Find the area of each trapezium.

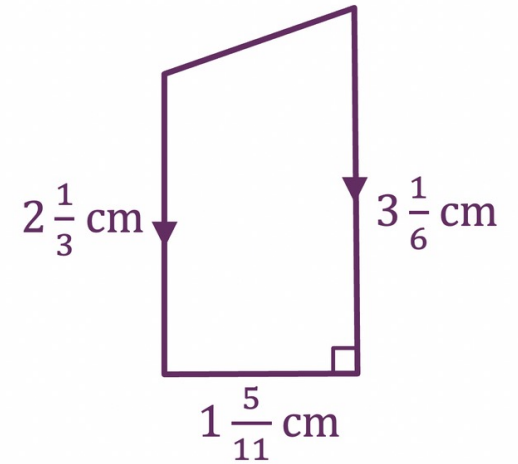
a)



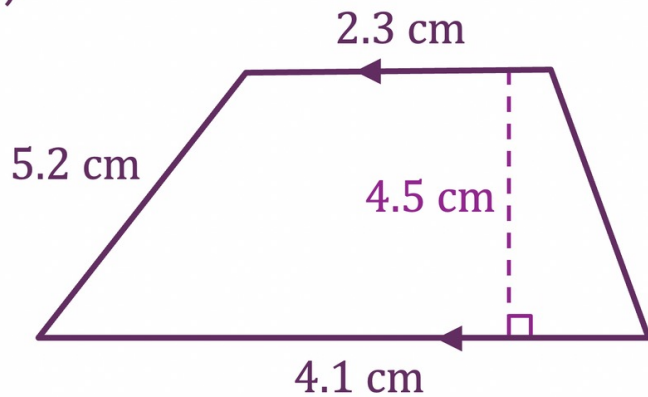
b)



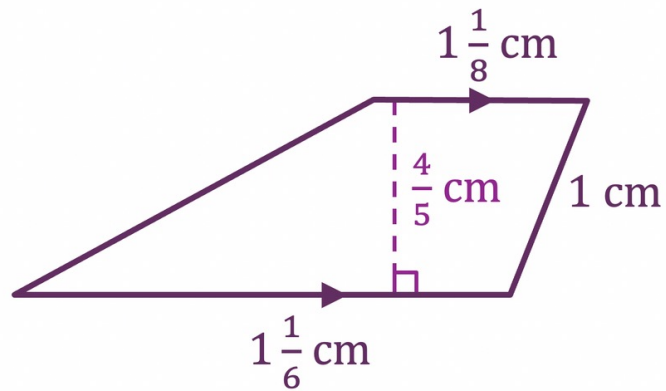
c)



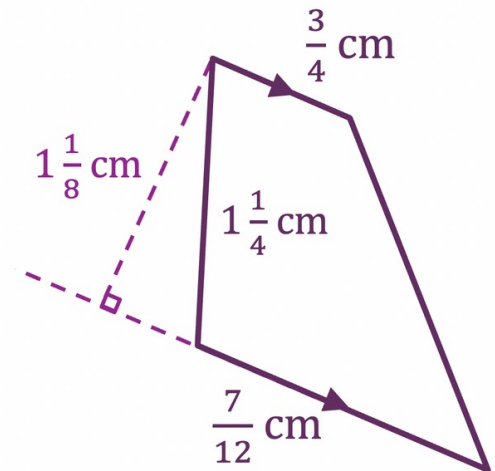
d)



e)



f)

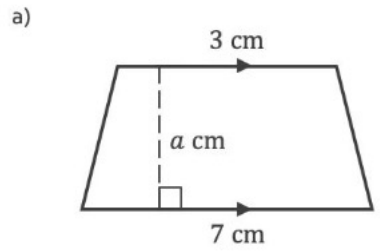
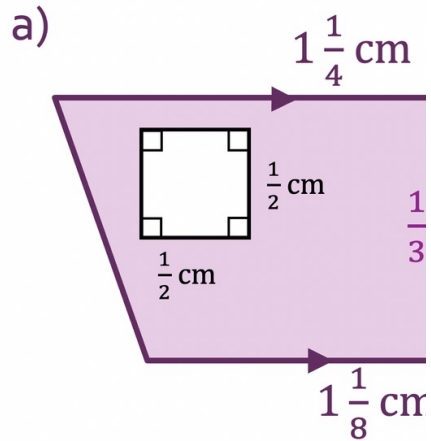


From Karen Hancock

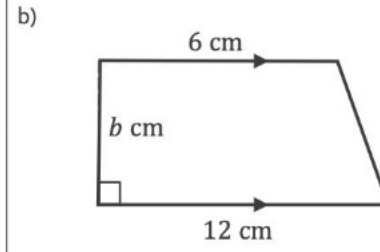
<https://interwovenmaths.com/areas-of-trapeziums>

Make them Messy

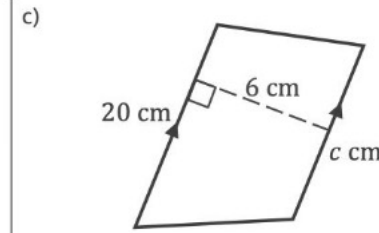
Find each shaded



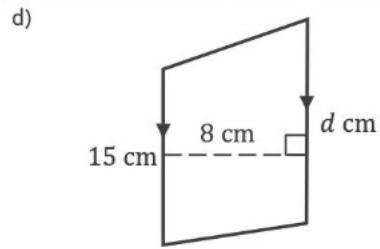
Area = 55 cm^2 $a = \square \text{ cm}$



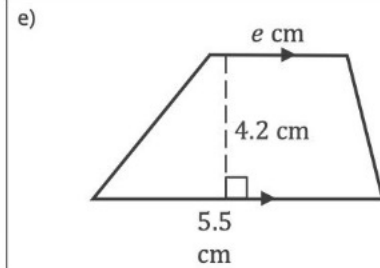
Area = 27 cm^2 $b = \square \text{ cm}$



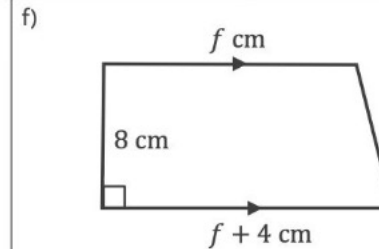
Area = 90 cm^2 $c = \square \text{ cm}$



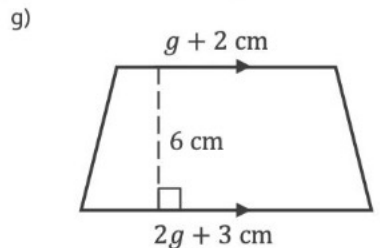
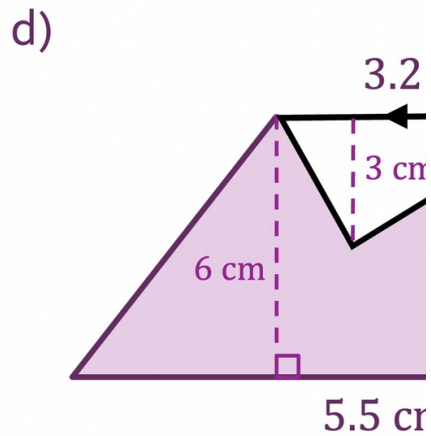
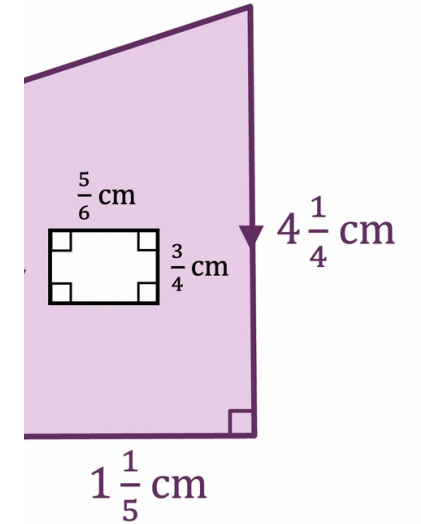
Area = 160 cm^2 $d = \square \text{ cm}$



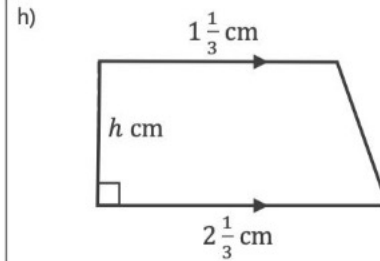
Area = 21 cm^2 $e = \square \text{ cm}$



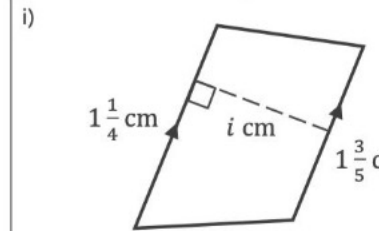
Area = 40 cm^2 $f = \square \text{ cm}$



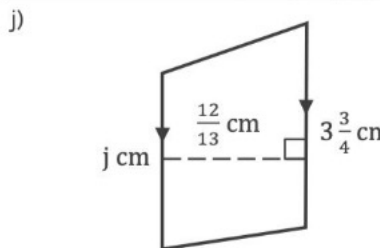
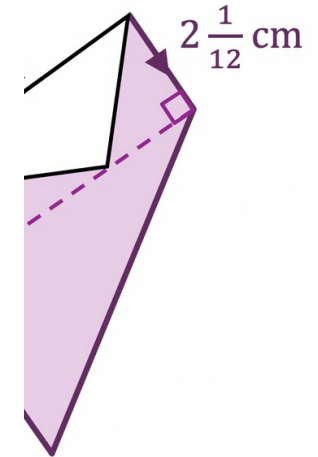
Area = 28.5 cm^2 $g = \square \text{ cm}$



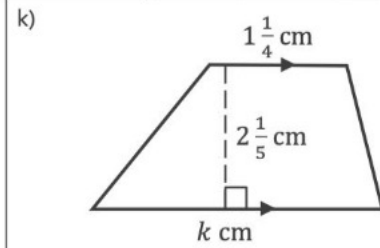
Area = $2 \frac{1}{6} \text{ cm}^2$ $h = \square \text{ cm}$



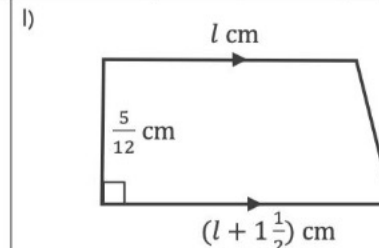
Area = $2 \frac{1}{4} \text{ cm}^2$ $i = \square \text{ cm}$



Area = $2 \frac{1}{2} \text{ cm}^2$ $j = \square \text{ cm}$



Area = $4 \frac{1}{8} \text{ cm}^2$ $k = \square \text{ cm}$



Area = $\frac{5}{6} \text{ cm}^2$ $l = \square \text{ cm}$

From Karen Hancock
<https://interwovenmat>

- 1 – Remove Supports
- 2 – Require Justifications
- 3 – Vary on Multiple Axes
- 4 – Force an Understanding
- 5 – Make them Messy
- 6 – Make them Non-Obvious**

20 sides

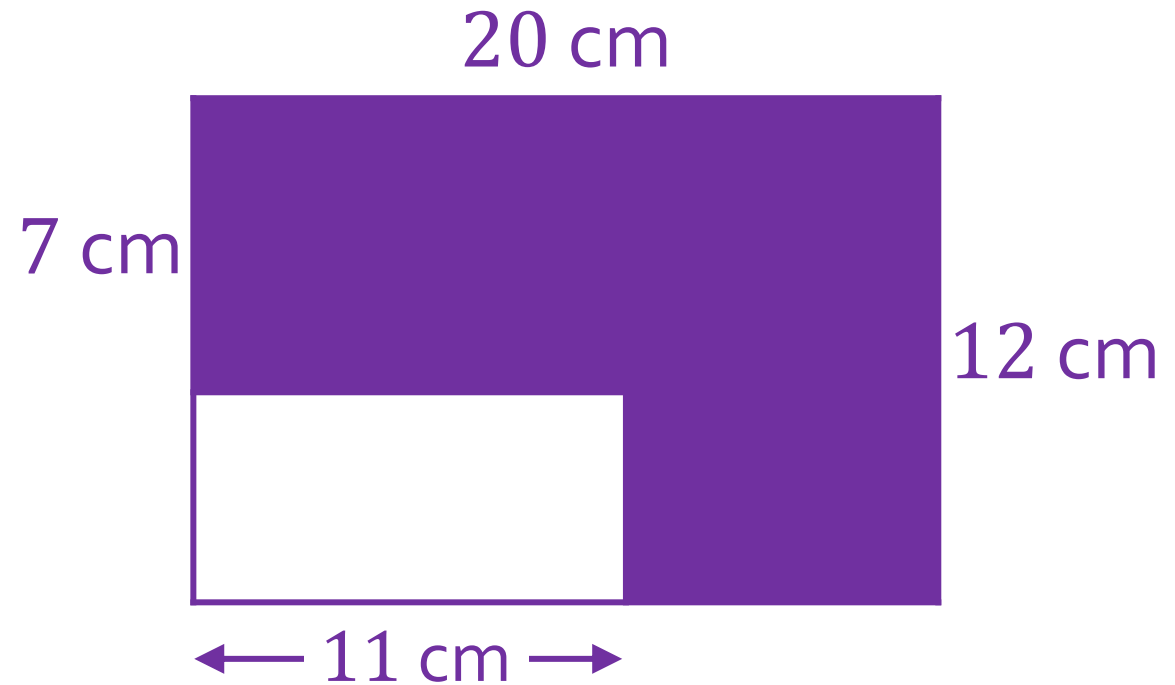


12 sides



I roll both dice.
Find the probability that either
Red is greater than 11,
or **Blue** is at most 7,
or **both**.

What fraction of the rectangle
is shaded?



20 sides



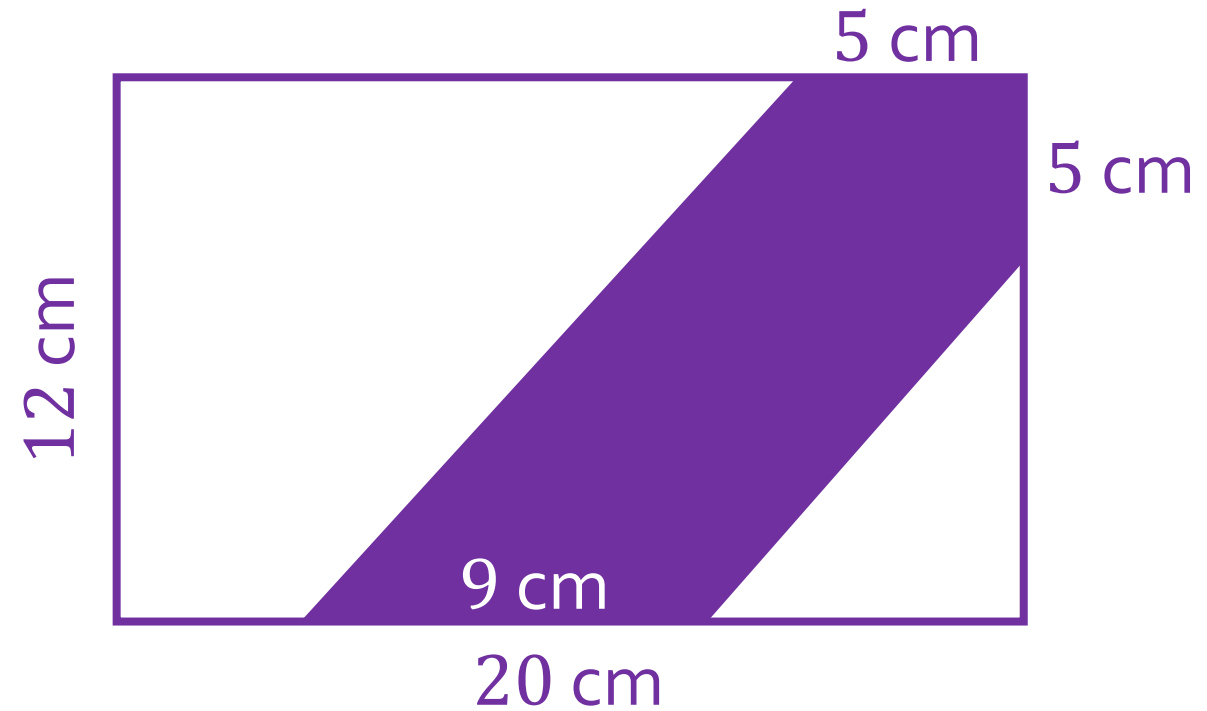
12 sides



I roll both dice.

Find the probability that the two dice are less than 5 apart.

What fraction of the rectangle is shaded?



20 sides



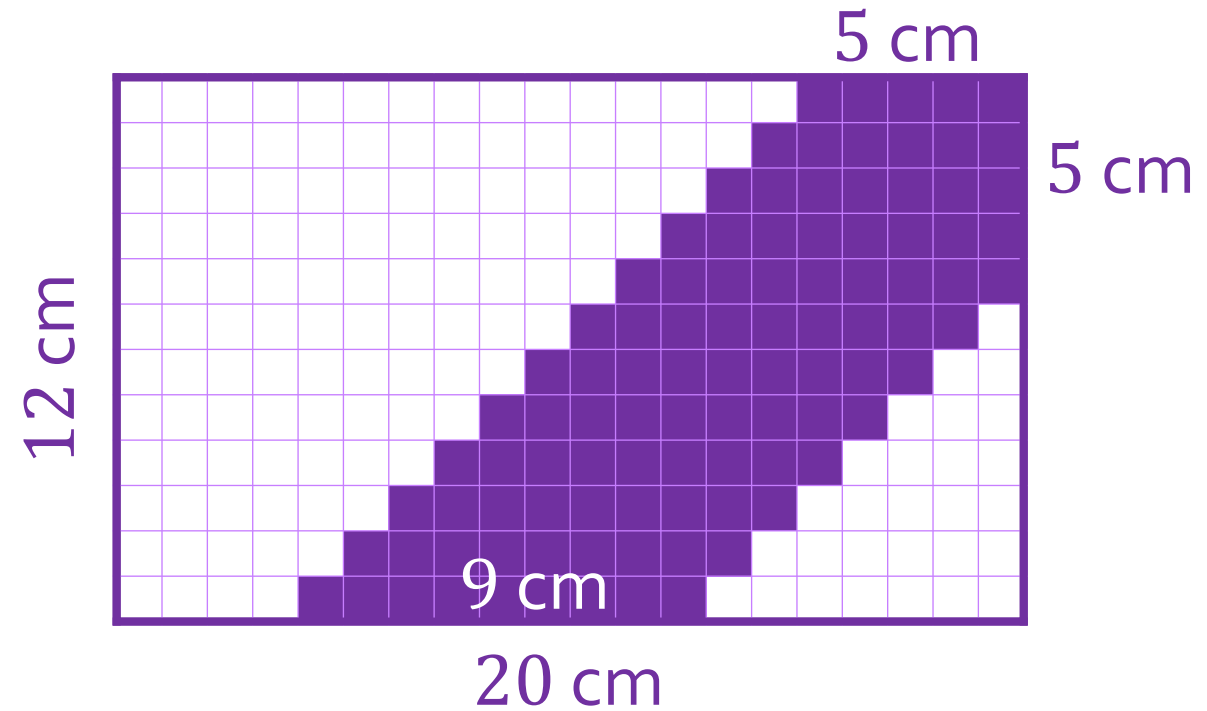
12 sides



I roll both dice.

Find the probability that the two dice are less than 5 apart.

What fraction of the rectangle is shaded?

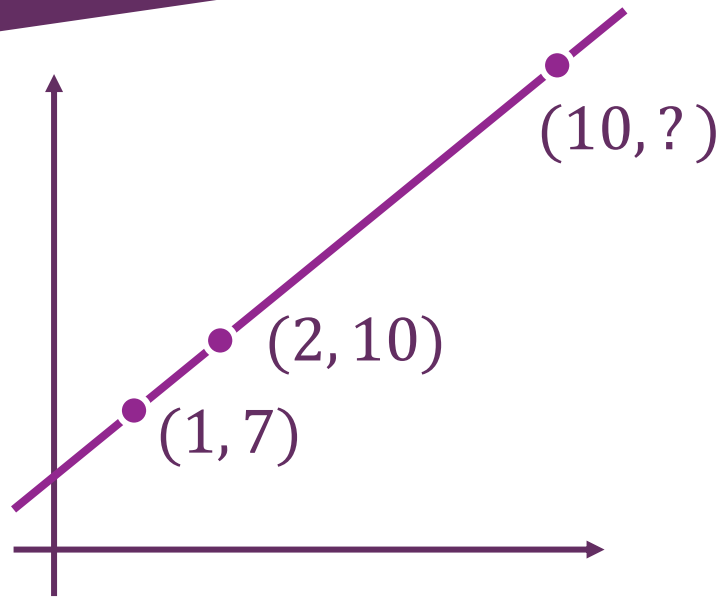


- 1 – Remove Supports
- 2 – Require Justifications
- 3 – Vary on Multiple Axes
- 4 – Force an Understanding
- 5 – Make them Messy
- 6 – Make them Non-Obvious
- 7 – Make them make them**

Make them make them

Find the 10th term of the sequence

7, 10, ...



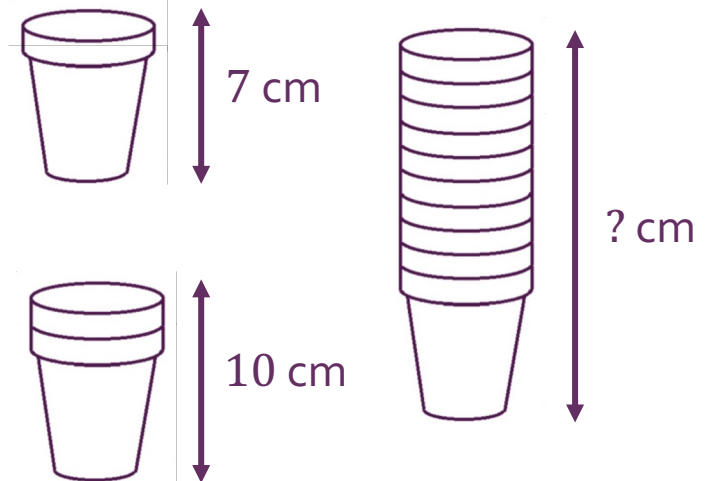
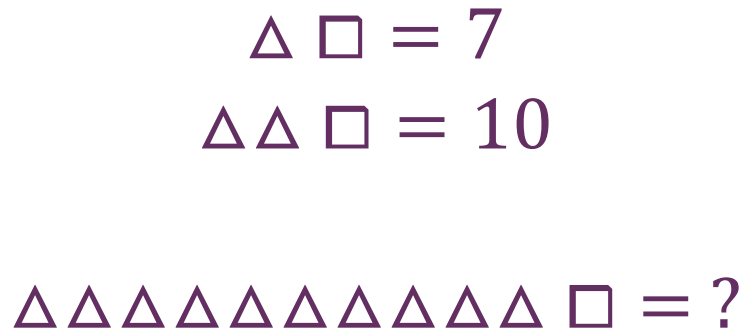
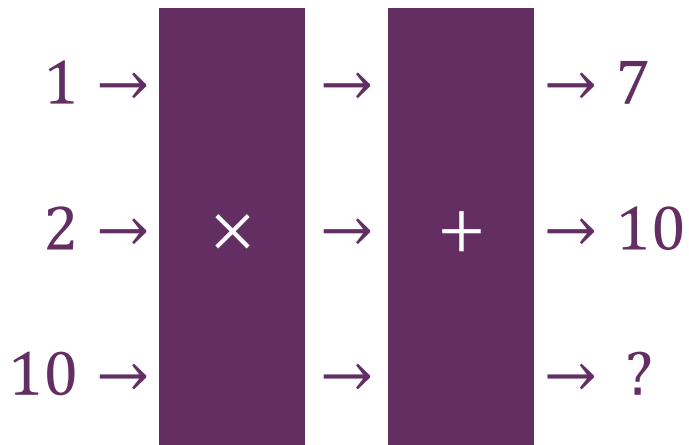
A taxi fare includes a call-out fee and a price per mile driven.

1 mile → £7 total

2 miles → £10 total

10 miles → ?

Change each question to make the answer 43



Inputs

Fractions

Surds

Standard Form

Processes

Equations

Ratios

Sequences

Contexts

Geometry

Averages

Rounding

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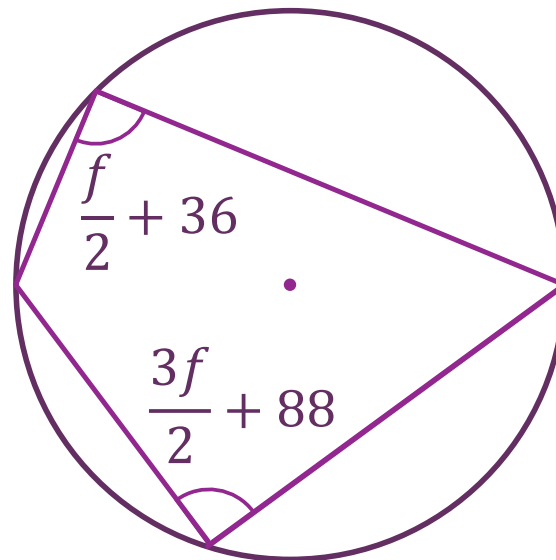
Sequences

Contexts

Geometry

Averages

Rounding



Inputs

Fractions

Surds

Standard Form

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Equations

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Rounding

An irrational amount of money is shared in the ratio 2 : 3 : 7.

The mean amount shared is £ $\sqrt{128}$.

What is the size of the smallest share?

Inputs

Fractions

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Rounding

The first two terms of an arithmetic sequence are 4×10^{-3} and 4.4×10^{-3} .
Find the position of the first term in the sequence that rounds to 3 to the nearest whole number.

Investigate?

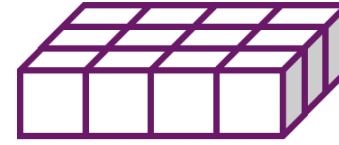
With 12 cubes, you can make 4 different cuboids:



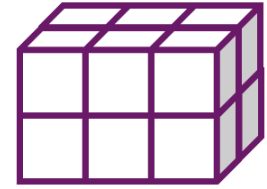
$1 \times 1 \times 12$



$1 \times 2 \times 6$



$1 \times 3 \times 4$



$2 \times 2 \times 3$

12 has 4 non-prime factors: 1, 4, 6, and 12.

12 has the same number of non-prime factors as there are cuboids made from 12 cubes.

Interwoven Maths



- Home
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- Booklets
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Product Rule for Counting Counting Factors

e.g. How many factors does 180 000 have?

$$180\,000 = 10\,000 \times 18$$

$$= 2^4 \times 5^4 \times 2 \times 3^2$$

$$= 2^5 \times 3^2 \times 5^4$$

Number of factors = $(5+1)(2+1)(4+1) = 6 \times 3 \times 5 = 90$

- a) How many factors does 245 000 have?
- b) How many odd factors does 245 000?
- c) How many square numbers are factors of 245 000?
- d) How many factors of 245 000 are also factors of 180 000?
- e) How many factors of 180 000 are **not** also factors of 245 000?
- f) Find three other numbers that would each have the same number of factors as 245 000.

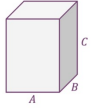
(IW) Product Rule for Counting Factors

Introducing Sequences And Series
an interwoven approach

(IW) Introducing Geometric Series

Volume and Surface Area of a Cuboid

A	B	C	Volume	Surface Area
1 cm	2 cm	10 cm		
1 cm	2 cm		10 cm ³	
1 cm	2 cm			10 cm ²
2 cm	5 cm	90 cm ³		
2 cm	5 cm		90 cm ³	
2 cm	5 cm			90 cm ²
4 cm			400 cm ³	400 cm ²
4 cm			288 cm ³	288 cm ²
5 cm			250 cm ³	250 cm ²



(IW) Interwoven Volume and Surface Area Completion Tables

Prime numbers less than 100

2	3	5	7	11	13	17	19	23	29	31	37	41	43	47	53	59	61	67	71	73	79	83	89	97
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(IW) Histograms and Cumulative Frequency

Fractions

Find the mean, median, and range of: $3\frac{1}{2}$, $6\frac{1}{6}$, and $2\frac{1}{2}$

(IW) Interwoven Revision Questions to Project

Area and Perimeter

A rectangle has a width of 3 cm and a height of 2 cm.

Draw a second rectangle so that the two rectangles have a mean area of 13 cm² and four perimeters with a range of 8 cm.

(IW) Angles in Polygons with... (Mixed Questions)

Standard Form

Find the median of the following:

3×10^{-4} , 4×10^{-3} , 5×10^{-6} , 6×10^{-5}

(IW) Circle Theorems with... (no diagrams!)

Angles in polygons with...

Hexagon

A regular polygon has interior angles that are 2/3 of the size of the angle of its exterior angles.

How many sides does it have?

(IW) Circle Theorems with... (no diagrams!)

Circle Theorems

What is $\angle ACB$?

What is $\angle ABC$?

What is $\angle ADB$?

What is $\angle ABC$?

What is $\angle AEB$?

(IW) Circle Theorems with... (no diagrams!)

Circle Theorems

What is $\angle ACB$?

What is $\angle ABC$?

What is $\angle ADB$?

What is $\angle ABC$?

What is $\angle AEB$?

Trigonometry with...

Area

Find the area of the triangle.

Pythagoras with...

Right-angled triangle

Find the length of the hypotenuse.

Averages with...

Mean

Find the mean of the following numbers.

Which question is the odd one out? Why?

Myrae walked 4 miles in 2.2 hours. How many miles would she walk in 28 hours?

How could the graph be used to represent each of the other questions?

Areas of Trapeziums with... Fractions and Decimals

Find the area of each trapezium.



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