Lytchett Minster School

Year 8 Mathematics Knowledge organisers

If you lose your Knowledge organiser you will be asked to replace it at a cost of 50p per copy.

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2025/2026

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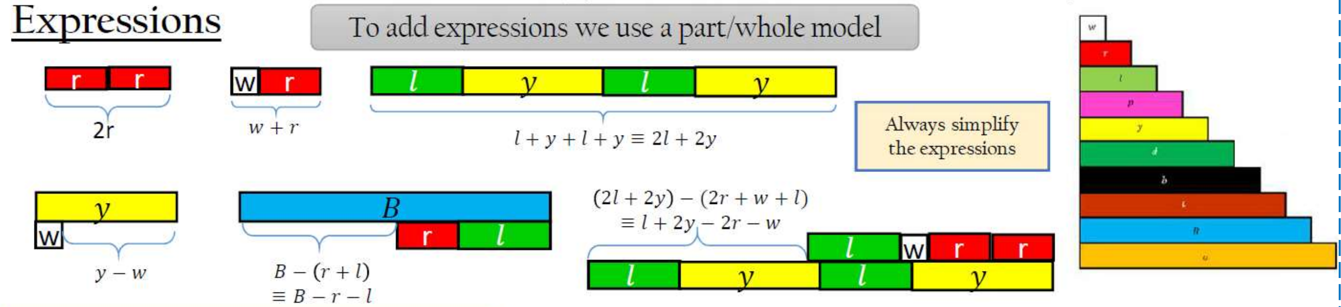
Forming algebraic expressions

Expressions

To add expressions we use a part/whole model



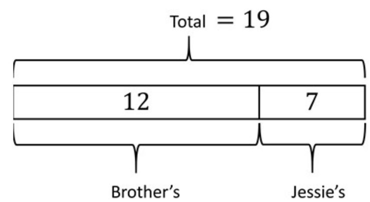
Always simplify the expressions

Brackets allow you to group different variables together

Part-part whole bar model

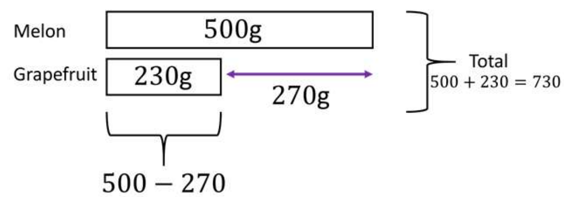
Jessie gives her brother 12 chocolates. She has 7 chocolates left.
Draw a bar model to represent this situation.

How many chocolates did Jessie have to start with?



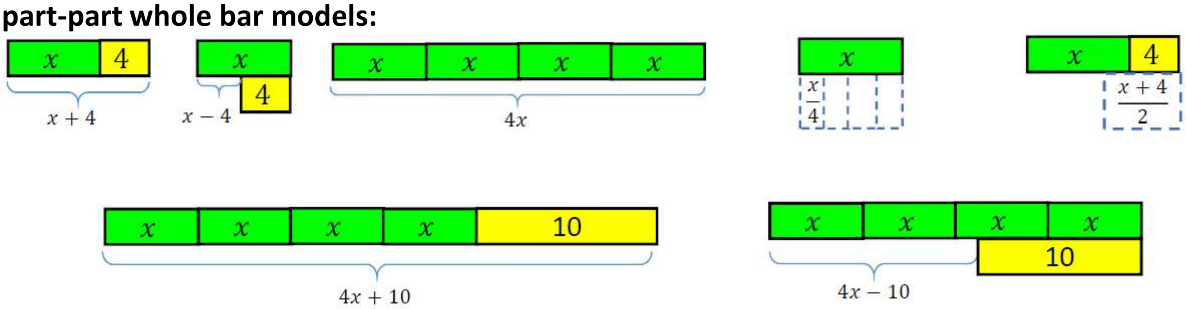
Comparison bar model

A melon weighs 500g and a grapefruit weighs 270g less.
Draw a bar model to represent this.
How much does the grapefruit weigh?
What is the total weight?



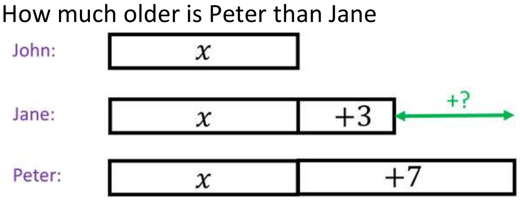
Forming algebraic expressions using bar models:

Using part-part whole bar models:

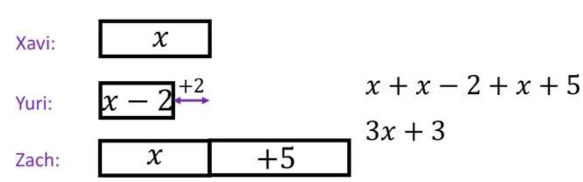


Using Comparison bar models:

John is x years old.
Jane is 3 years older than John.
Peter is seven years older than John.
How much older is Peter than Jane



Xavi has some money.
Yuri has £2 less than Xavi.
Zach has £5 more than Xavi.
Can you find an expression for how much money they have in total?



Your turn to practice:

1) James has 15 sweets. Lucy has 7 fewer sweets than James. Max has twice as many sweets as Lucy. Draw a bar model to represent this.
How many sweets does Lucy have?
How many sweets do they have altogether?

2) A child ticket to the cinema costs £c. An adult ticket is twice as much. Find an expression for the total cost of 3 child and 2 adult tickets

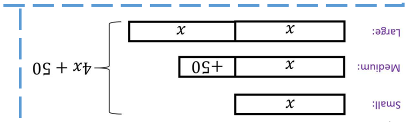
3) A small parcel weighs x grams. A medium parcel weighs 50g more than the small parcel. A large parcel weighs twice as much as the small parcel. Draw a bar model to represent the weights of the 3 parcels. Find an expression for the total weight of the 3 parcels

Answers

1) Lucy has 8 sweets. There are 39 sweets altogether

2) An adult ticket = 2c
$3c + 2(2c) = 3c + 4c = \mathbf{7c}$

3)



Linear equations – Bar Models

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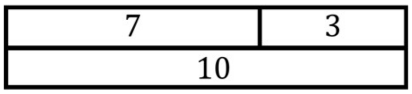
Equivalence bar model



This is an equivalence bar model and represents the calculation:

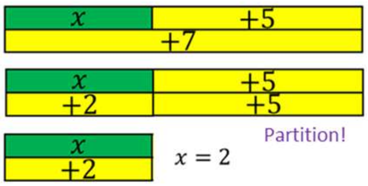
$$7 + 3 = 10$$

It could also represent:

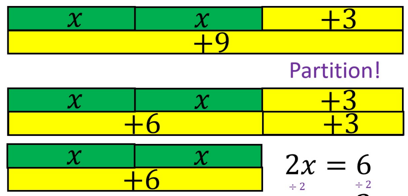
$3 + 7 = 10$ $10 - 3 = 7$ $10 - 7 = 3$

Solving equations - Addition

Solve: $x + 5 = 7$



Solve: $2x + 3 = 9$



$2x = 6$
÷2   ÷2
$x = 3$

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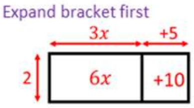
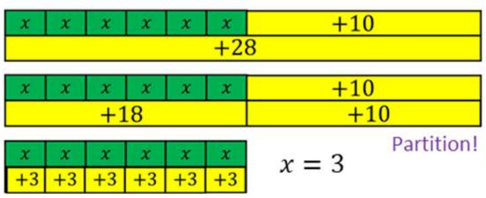
Solve: $2(3x + 5) = 28$

Expand bracket first



$6x + 10 = 28$



$x = 3$

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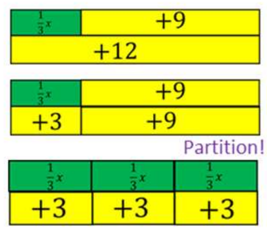
Solve: $\frac{x}{3} + 9 = 12$



$x = 9$

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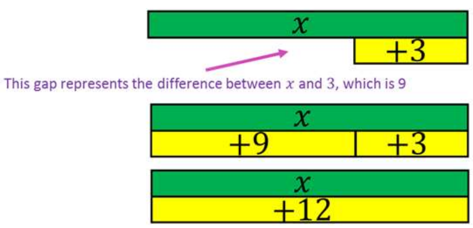
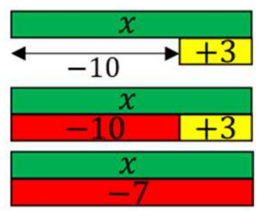
Solving equations - Subtraction

Solve: $x - 3 = 9$



$x = 12$

Solve: $x - 3 = -10$



$x = -7$

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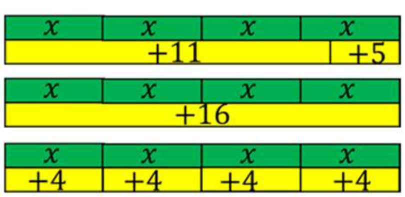
Solve: $4x - 5 = 11$



$x = 4$

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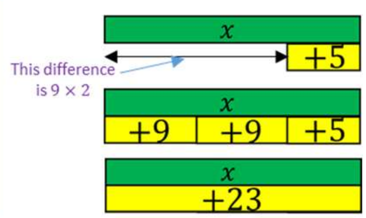
Solve: $\frac{x-5}{2} = 9$



$x = 23$

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Your turn to practice:

Solve

1) $y + 7 = 15$
2) $7 + t = 14$
3) $13 = x + 4$
4) $41 = x + 23$
5) $k + 2 = -4$
6) $7x + 4 = 39$
7) $28 = 8x + 4$
8) $2x + 3 = -29$
9) $3t + 12 = 9$
10) $3x + 41 = 5$
11) $2(x + 1) = 18$
12) $3(2x + 1) = 9$
13) $5(2 + 3x) = 25$
14) $\frac{1}{2}(6x + 8) = 19$
15) $7(3x + 8) = 14$

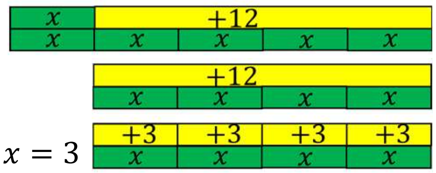
Answers

1) $y = 8$
2) $t = 7$
3) $x = 9$
4) $x = 18$
5) $k = -6$
6) $x = 5$
7) $x = 3$
8) $x = -16$
9) $t = -1$
10) $x = -12$
11) $x = 8$
12) $x = 1$
13) $x = 1$
14) $x = 5$
15) $x = -2$

Linear equations – Bar Models 2

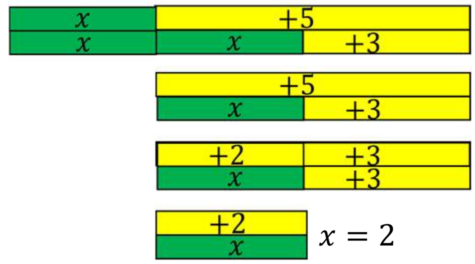
Solving equations, unknowns both sides - Addition

Solve: $x + 12 = 5x$



$x = 3$

Solve: $x + 5 = 2x + 3$

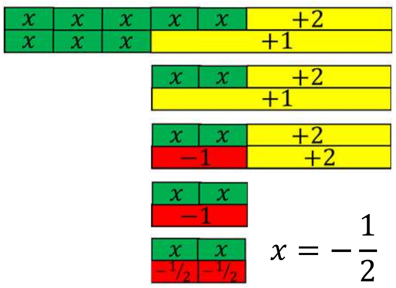


$x = 2$

Solve: $5x + 2 = 1 + 3x$

$5x + 2 = 3x + 1$

We have used the commutative law as we want the unknowns to line up in our bar model.



The magnitude of +2 is greater than +1, so there will be negatives to consider here.

Partition!

$x = -\frac{1}{2}$

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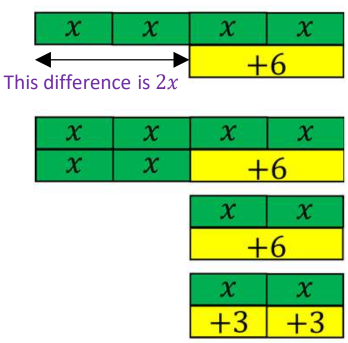
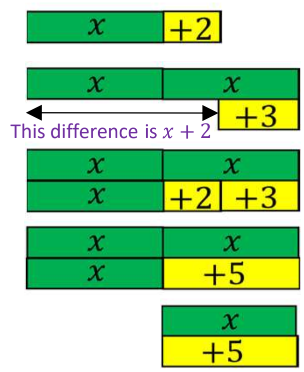
Solving equations, unknowns both sides - Subtraction

Solve: $4x - 6 = 2x$



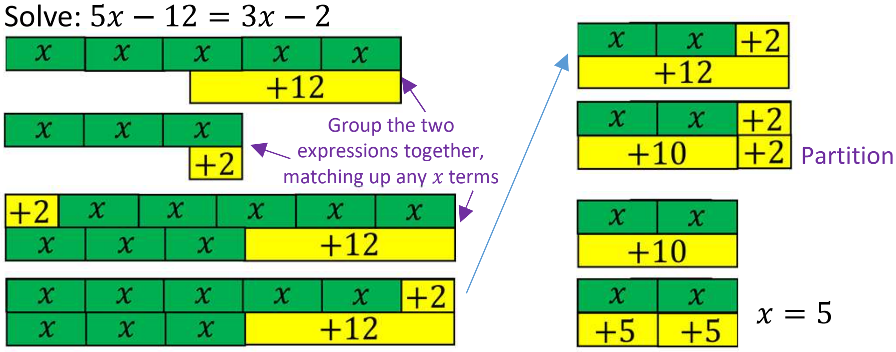
$x = 3$

Solve: $x + 2 = 2x - 3$



$x = 5$

Solve: $5x - 12 = 3x - 2$



$x = 5$

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Your turn to practice: Solve, using bar models

1) $5a = 21 + 2a$
2) $b + 15 = 6b$
3) $2c + 20 = 4c$
4) $4d + 3 = 2d + 11$
5) $5e + 7 = 3e + 11$
6) $2f + 21 = 8f + 3$
7) $4g - 5 = 3g$
8) $7h + 7 = 9h - 1$
9) $6j - 2 = 5j + 4$
10) $12k - 4 = 7k - 29$
11) $4m - 7 = m - 1$
12) $8n - 7 = 6n - 4$

Answers

1) $a = 7$
2) $b = 3$
3) $c = 10$
4) $d = 4$
5) $e = 2$
6) $f = 3$
7) $g = 5$
8) $h = 4$
9) $j = 6$
10) $k = -5$
11) $m = 2$
12) $n = 1.5$

Adding and Subtracting fractions

Keywords and Phrases:

Unit fraction - One equal part of a whole is called a unit fraction

Common multiples – Multiples of 2 are 2, 4, 6, 8, 10, 12, 14, 16, 18,
Multiples of 3 are 3, 6, 9, 12, 15, 18

There are infinite common multiples of numbers but only one lowest common multiple.

So, the lowest common multiple of 2 and 3 is 6. **LCM (2,3) = 6**

Adding and subtracting same denominator:

When adding or subtracting fractions with the same denominator we ONLY add or subtract the numerators.

$$\frac{a}{m}+\frac{b}{m}=a\times\frac{1}{m}+b\times\frac{1}{m}$$

$$=(a+b)\times\frac{1}{m}$$

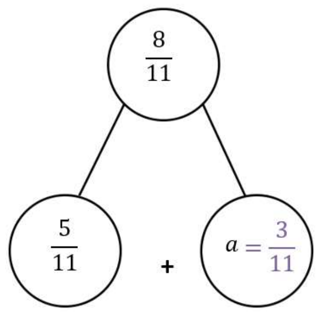
$$\frac{a}{m}-\frac{b}{m}=a\times\frac{1}{m}-b\times\frac{1}{m}$$

$$=(a-b)\times\frac{1}{m}$$

Multiple of a Unit fraction

Example: $\frac{5}{11}+a=\frac{8}{11}$

Pictorial Representation



Formal Working

$$a=\frac{8}{11}-\frac{5}{11}$$

$$a=8\times\frac{1}{11}-5\times\frac{1}{11}$$

$$a=(8-5)\times\frac{1}{11}$$

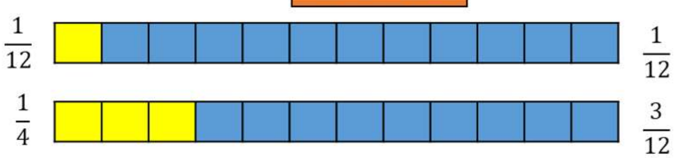
$$a=3\times\frac{1}{11}$$

Adding and subtracting different denominators:

To add or subtract fractions we need to be adding multiples of the same unit.
This means that we need fractions with the same denominator.

$\frac{1}{12}+\frac{1}{4}$

Pictorial Method



$$\frac{1}{12}+\frac{3}{12}=\frac{4}{12}$$

Lowest Common Multiple

Formal Method

$$\frac{1}{12}+\frac{1}{4} \quad \times 3$$

$$\frac{1}{12}+\frac{3}{12}=\frac{4}{12}$$

Multiples of 4 - 4, 8, 12
Multiples of 12 - 12, 24, 36

Lowest Common Multiple

Your turn to practice:

1) $\frac{1}{3}+\frac{2}{3}=$
2) $\frac{2}{5}+\frac{1}{5}=$
3) $\frac{7}{6}+\frac{3}{6}=$
4) $\frac{3}{15}-\frac{1}{15}=$
5) $\frac{5}{13}-\frac{2}{13}=$
6) $\frac{1}{3}+\frac{1}{6}=$
7) $\frac{2}{10}+\frac{3}{5}=$
8) $\frac{1}{6}+\frac{3}{18}=$
9) $\frac{7}{15}-\frac{1}{5}=$
10) $\frac{9}{14}-\frac{2}{7}=$
11) $\frac{1}{5}+\frac{1}{6}=$
12) $\frac{2}{4}+\frac{3}{5}=$
13) $\frac{1}{6}+\frac{3}{7}=$
14) $\frac{6}{7}-\frac{1}{5}=$
15) $\frac{9}{12}-\frac{2}{7}=$

Answers
1) $\frac{3}{3}=1$
2) $\frac{3}{5}$
3) $\frac{10}{6}$
4) $\frac{2}{15}$
5) $\frac{3}{13}$
6) $\frac{1}{2}$
7) $\frac{4}{5}$
8) $\frac{1}{3}$
9) $\frac{4}{15}$
10) $\frac{5}{14}$
11) $\frac{11}{30}$
12) $\frac{11}{10}$
13) $\frac{25}{42}$
14) $\frac{23}{35}$
15) $\frac{13}{28}$

+ or − Mixed number fractions

Keywords and Phrases:

Mixed number – A mixed number is a whole number and a proper fraction combined

Proper fraction - A fraction where the numerator is less than the denominator.

Improper fraction – An Improper Fraction has a numerator larger than (or equal to) the denominator.

Writing improper fractions as mixed numbers

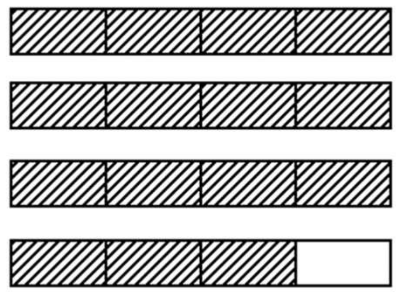
$$\frac{15}{4} = 15 \times \frac{1}{4}$$

$$= \frac{4}{4} + \frac{4}{4} + \frac{4}{4} + \frac{3}{4}$$

$$= 1 + 1 + 1 + \frac{3}{4}$$

$$= 3\frac{3}{4}$$

Pictorial representation of 15 lots of $\frac{1}{4}$



$4 \times \frac{1}{4}$

$4 \times \frac{1}{4}$

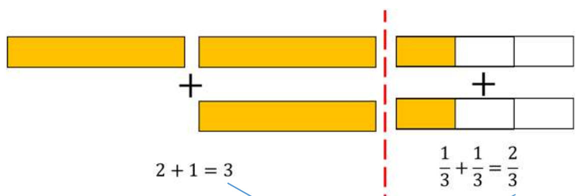
$4 \times \frac{1}{4}$

$3 \times \frac{1}{4}$

Adding and subtracting mixed numbers same denominator

Using **partitioning** to add mixed numbers:

$$2\frac{1}{3} + 1\frac{1}{3}$$



$2 + 1 = 3$

$\frac{1}{3} + \frac{1}{3} = \frac{2}{3}$

$3\frac{2}{3}$

Or….. Convert into improper fractions to add

$2\frac{1}{3} = \frac{7}{3}$ $\quad 1\frac{1}{3} = \frac{4}{3}$

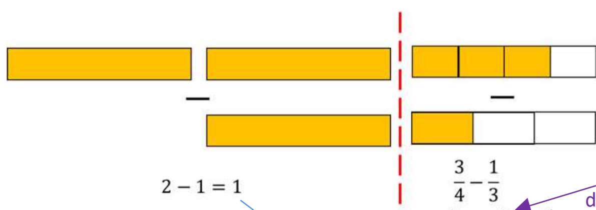
$\frac{7}{3} + \frac{4}{3} = \frac{11}{3}$

Convert back into a mixed number $\frac{11}{3} = 3\frac{2}{3}$

Adding and subtracting mixed numbers different denominator

Using **partitioning** to subtract mixed numbers:

$$2\frac{3}{4} - 1\frac{1}{3}$$



$2 - 1 = 1$

$\frac{3}{4} - \frac{1}{3}$

Common denominator

$\frac{9}{12} - \frac{4}{12} = \frac{5}{12}$

$1\frac{5}{12}$

Or….. Convert into improper fractions to subtract

$2\frac{3}{4} = \frac{11}{4}$ $\quad 1\frac{1}{3} = \frac{4}{3}$

Common denominator

$\frac{11}{4} - \frac{4}{3} = \frac{33}{12} - \frac{16}{12} = \frac{17}{12}$

Convert back into a mixed number $\frac{17}{12} = 1\frac{5}{12}$

Your turn to practice:

Convert into mixed numbers

1) $\frac{11}{4} =$

2) $\frac{27}{7} =$

Convert into Improper fractions

3) $3\frac{4}{5} =$

4) $4\frac{5}{7} =$

5) $5\frac{7}{8}$

Calculate, partitioning method is easier and simplify:

6) $1\frac{1}{4} + 2\frac{1}{4} =$

7) $1\frac{1}{5} + 3\frac{2}{5} =$

8) $1\frac{4}{5} + 2\frac{3}{5} =$

9) $4\frac{3}{7} - 1\frac{2}{7} =$

10) $5\frac{5}{8} - 2\frac{3}{8} =$

11) $1\frac{1}{3} + 2\frac{3}{4} =$

12) $1\frac{1}{5} + 3\frac{2}{7} =$

13) $1\frac{4}{5} + 2\frac{3}{8} =$

14) $4\frac{1}{5} - 1\frac{2}{7} =$

15) $5\frac{1}{5} - 2\frac{3}{8} =$

Answers

1) $2\frac{3}{4}$ 2) $3\frac{6}{7}$ 3) $\frac{19}{5}$ 4) $\frac{33}{7}$ 5) $\frac{47}{8}$ 6) $3\frac{1}{2}$ 7) $4\frac{3}{5}$

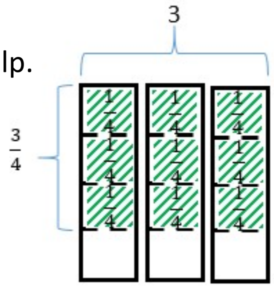
8) $4\frac{2}{5}$ 9) $3\frac{1}{7}$ 10) $3\frac{1}{4}$ 11) $4\frac{1}{12}$ 12) $4\frac{17}{35}$ 13) $4\frac{7}{40}$ 14) $2\frac{32}{35}$ 15) $2\frac{33}{40}$

Multiply and Simplify Fractions

Multiply an integer by a fraction:

To multiply a fraction by an integer, draw an array to help.

Example: $\frac{3}{4} \times 3 = \frac{9}{4}$

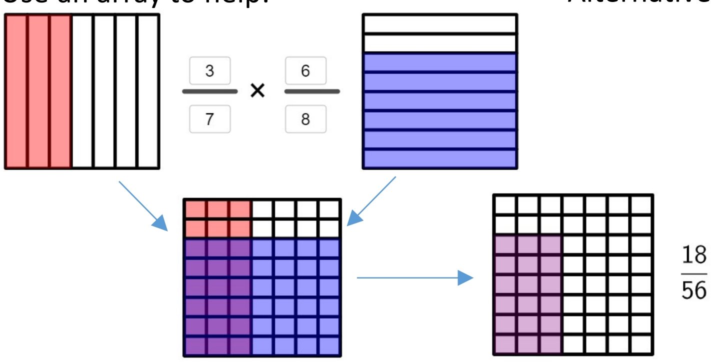


$$c \times \frac{a}{b} = \frac{a \times c}{b}$$

$$\frac{a}{b} \times c = \frac{a \times c}{b}$$

Multiply a fraction by a fraction:

Use an array to help:



Alternatively you could calculate like this:

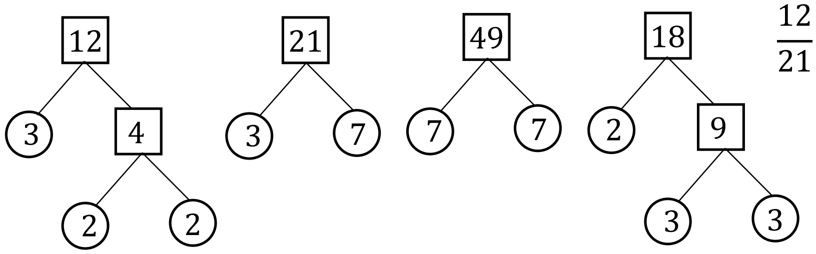
$$\frac{3}{7} \times \frac{6}{8} = \frac{3 \times 6}{7 \times 8}$$

$$= \frac{18}{56}$$

$$\frac{a}{b} \times \frac{c}{d} = \frac{a \times c}{b \times d}$$

Sometimes it is best to simplify using product of primes before you multiply, e.g:

$$\frac{12}{21} \times \frac{49}{18}$$



$12 = 3 \times 2 \times 2$ $\quad 21 = 3 \times 7$ $\quad 49 = 7 \times 7$ $\quad 18 = 2 \times 3 \times 3$

$$\frac{12}{21} \times \frac{49}{18} = \frac{3 \times 2 \times 2 \times 7 \times 7}{3 \times 7 \times 2 \times 3 \times 3}$$

$$= \frac{2 \times 2 \times 3 \times 7 \times 7}{2 \times 3 \times 3 \times 3 \times 7}$$

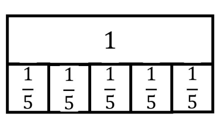
$$= \frac{2}{2} \times \frac{3}{3} \times \frac{7}{7} \times \frac{2 \times 7}{3 \times 3}$$

$$= 1 \times 1 \times 1 \times \frac{14}{9} = 1\frac{5}{9}$$

Reciprocals:

The reciprocal is the number that we have to multiply by to make one.

$5 \times \frac{1}{5} = 1$ Five lots of one fifth.



The reciprocal of 5 is $\frac{1}{5}$

$\frac{1}{5} \times 5 = 1$ ← The commutative law for multiplication!

The reciprocal of $\frac{1}{5}$ is 5

$$\frac{2}{3} \times \frac{3}{2} = \frac{2 \times 3}{3 \times 2} = \frac{2}{2} \times \frac{3}{3} = 1 \times 1 = 1$$

The reciprocal of $\frac{2}{3}$ is $\frac{3}{2}$

Your turn to practice:

Calculate and simplify:

1) $\frac{1}{3} \times 5 =$
2) $3 \times \frac{1}{7} =$
3) $\frac{2}{5} \times 4 =$
4) $4 \times \frac{3}{16} =$
5) $-\frac{6}{3} \times -4 =$
6) $\frac{1}{3} \times \frac{1}{5} =$
7) $\frac{3}{5} \times \frac{1}{7} =$
8) $\frac{2}{5} \times \frac{3}{2} =$
9) $\frac{4}{15} \times \frac{3}{16} =$
10) $-\frac{16}{13} \times -\frac{13}{4} =$
11) What is the reciprocal of 7
12) What is the reciprocal of $\frac{1}{6}$
13) What is the reciprocal of $\frac{5}{9}$

Answers:
1) $\frac{5}{3}$ 2) $\frac{3}{7}$ 3) $\frac{8}{5} = 1\frac{3}{5}$ 4) $\frac{3}{4}$ 5) 8 6) $\frac{1}{15}$ 7) $\frac{3}{35}$
8) $\frac{3}{5}$ 9) $\frac{1}{20}$ 10) 4 11) $\frac{1}{7}$ 12) 6 13) $\frac{9}{5}$

Fractions Division

Keywords and Phrases:

$5 \times \frac{1}{5} = 1$ The reciprocal of 5 is $\frac{1}{5}$

Reciprocal - The reciprocal is the number that we have to multiply by to make one.

Unitisation - a mathematical term used to describe counting groups of the same number of things as single units. E.g $\frac{4}{5}$ is $4\ lots\ of\ \frac{1}{5}$ or $4 \times \frac{1}{5}$

Dividing a fraction by an integer:

Dividing by an integer is equivalent to multiplying by its reciprocal.

Example:

$$\frac{1}{5} \div 2 = \frac{1}{5} \times \frac{1}{2} = \frac{1}{10}$$

Example:

$$\frac{2}{3} \div 6 = \frac{2}{3} \times \frac{1}{6} = \frac{2 \times 1}{3 \times 2 \times 3} = \frac{2}{2} \times \frac{1}{3 \times 3} = 1 \times \frac{1}{9} = \frac{1}{9}$$

Don't forget to simplify before you multiply

$$\frac{1}{a} \div b = \frac{1}{a} \times \frac{1}{b}$$

Dividing an integer by a fraction:

Dividing an integer by a fraction is equivalent to multiplying by its reciprocal.

Example:

$$4 \div \frac{3}{5} = 4 \times \frac{5}{3} = \frac{4 \times 5}{3} = \frac{20}{3} = 6\frac{2}{3}$$

$$a \div \frac{b}{c} \equiv a \times \frac{c}{b}$$

Dividing fractions with the same denominator:

Using unitisation method works really well here.

Example:

$$\frac{4}{5} \div \frac{2}{5} = 4 \times \frac{1}{5} \div 2 \times \frac{1}{5}$$

$$4 \div 2 = 2$$

Dividing fractions with different denominator:

Dividing a fraction by a fraction is equivalent to multiplying by its reciprocal.

What is the reciprocal of $\frac{2}{3}$?

$$\frac{4}{5} \div \frac{2}{3} = \frac{4}{5} \times \frac{3}{2} = \frac{12}{10} = 1\frac{1}{5}$$

Your turn to practice:

Calculate and simplify:

1) $\frac{1}{3} \div 5 =$
2) $3 \div \frac{1}{7} =$
3) $\frac{2}{5} \div 4 =$
4) $16 \div \frac{4}{3} =$
5) $-\frac{6}{3} \div -4 =$
6) $\frac{1}{5} \div \frac{2}{5} =$
7) $\frac{6}{7} \div \frac{3}{7} =$
8) $\frac{4}{15} \div \frac{2}{15} =$
9) $\frac{16}{15} \div \frac{4}{15} =$
10) $-\frac{18}{13} \div -\frac{9}{13} =$
11) $\frac{1}{5} \div \frac{1}{6} =$
12) $\frac{6}{5} \div \frac{3}{7} =$
13) $\frac{4}{15} \div \frac{7}{3} =$
14) $\frac{16}{8} \div \frac{4}{24} =$
15) $-\frac{6x}{5} \div -\frac{x}{20} =$

Answers:
1) $\frac{1}{15}$
2) 21
3) $\frac{1}{10}$
4) 12
5) $\frac{1}{2}$
6) $\frac{1}{2}$
7) 2
8) 2
9) 4
10) 2
11) $\frac{6}{5} = 1\frac{1}{6}$
12) $\frac{14}{5} = 2\frac{4}{5}$
13) $\frac{4}{35}$
14) 12
15) 24

× or ÷ Mixed number fractions

Multiplying mixed number fractions:

To multiply mixed number fractions, convert to improper fractions first then multiply numerators and multiply denominators.

Example: $2\frac{3}{4} \times 1\frac{2}{3}$

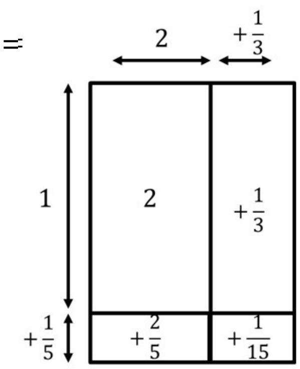
Convert each number to improper fraction first

$2\frac{3}{4} = \frac{11}{4}$ $\quad 1\frac{2}{3} = \frac{5}{3}$ $\quad \rightarrow \quad \frac{11}{4} \times \frac{5}{3} = \frac{11 \times 5}{4 \times 3} = \frac{55}{12} = 4\frac{7}{12}$

Alternatively, use an **area model** to calculate

This method is very similar to how you would calculator 42×65

Example: $1\frac{1}{5} \times 2\frac{1}{3} =$



$= 2 + \frac{1}{3} + \frac{2}{5} + \frac{1}{15}$ — Add up all of the areas

$= 2 + \frac{5}{15} + \frac{6}{15} + \frac{1}{15}$ — Common denominator to add

$= 2 + \frac{12}{15}$

$= 2 + \frac{4}{5} \quad = 2\frac{4}{5}$ — Simplify, and your answers is given as a mixed number

Dividing mixed number fractions:

To divide mixed number fractions, convert to improper fractions first then divide using either "multiplying by the reciprocal" or "unitisation" method.

Example: $6\frac{3}{8} \div 2\frac{1}{2} =$

Convert each number to improper fraction first

$6\frac{3}{8} = \frac{51}{8}$ $\quad 2\frac{1}{2} = \frac{5}{2}$ $\quad \rightarrow \quad 6\frac{3}{8} \div 2\frac{1}{2} = \frac{51}{8} \div \frac{5}{2} \quad \rightarrow \quad \frac{51}{8} \times \frac{2}{5}$

Write this as an equivalent calculation using multiplication

What is the reciprocal of $\frac{5}{2}$?

$= \frac{51}{2 \times 4} \times \frac{2}{5}$

$= \frac{2}{2} \times \frac{51}{4 \times 5}$

$= 1 \times \frac{51}{20}$

$= 2\frac{11}{20}$ — Convert back into a mixed number

Your turn to practice:

Calculate and simplify:

1) $2\frac{1}{2} \times 1\frac{1}{2}$
2) $1\frac{1}{4} \times 3\frac{1}{2}$
3) $2\frac{1}{3} \times 3\frac{1}{6}$
4) $2\frac{5}{6} \times 2\frac{2}{3}$
5) $2\frac{3}{7} \times 1\frac{2}{5}$
6) $\frac{2}{3} \div 2\frac{1}{5}$
7) $1\frac{2}{3} \div 2\frac{1}{5}$
8) $2\frac{2}{3} \div 2\frac{1}{5}$
9) $2\frac{2}{3} \div 1\frac{1}{5}$
10) $1\frac{2}{5} \div 2\frac{1}{3}$

Answers

1) $3\frac{3}{4}$ 6) $\frac{10}{33}$
2) $4\frac{3}{8}$ 7) $\frac{25}{33}$
3) $7\frac{7}{18}$ 8) $1\frac{7}{33}$
4) $7\frac{5}{9}$ 9) $2\frac{2}{9}$
5) $3\frac{2}{5}$ 10) $\frac{3}{5}$

Multiply and divide decimals

Keywords and phrases:

Decimal - A number that includes a decimal point to represent values less than one (e.g., 0.75)
Product - The result of multiplication
Quotient - The result of division
Convert - To change from one form to another (e.g., decimal to fraction)

Convert Decimals to fractions:

Use the place value grid to help:

Example: convert 4.3 into a fraction.

	Decimals		
Ones	Tenths	Hundredths	Thousandths
10^0	10^{-1}	10^{-2}	10^{-3}
1	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$
4	3		

$= \frac{43}{10}$

Example: convert 3.45 into a fraction.

	Decimals		
Ones	Tenths	Hundredths	Thousandths
10^0	10^{-1}	10^{-2}	10^{-3}
1	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$
3	4	5	

$= \frac{345}{100}$

Multiply decimals:

Example: 1.3×6.2

Step 1: Convert each decimal into a fraction.

$1.3 \rightarrow \frac{13}{10}$ $\quad 6.2 \rightarrow \frac{62}{10}$

Step 2: Multiply the fractions.

$$\frac{13}{10} \times \frac{62}{10} = \frac{806}{100}$$

Hint: use area model calculate 13×62

	10	3
60	600	180
2	20	6

600 + 180 + 20 + 6 = 806

Step 3: Convert the result back into a decimal.

$\frac{806}{100} = 8.06$

Dividing decimals:

Example: $1.3 \div 0.2$

Step 1: Write the division as a fraction.

$$1.3 \div 0.2 = \frac{1.3}{0.2} \xrightarrow{\times 10} \frac{13}{2}$$

Step 2: Multiply numerator and denominator by a multiple of 10 or 100.

Step 3: Now you have a number you can easily divide using bus stop or alternative method.

$$2 \overline{)\,13.^{1}0} = 6.5$$

Your turn to practice: Calculate the following:

1) 5.6×8.4
2) 4.6×9.02
3) 3.2×7.5
4) 0.06×0.9
5) 12.4×0.25
6) 0.8×0.125
7) 6.03×3.1
8) 0.45×0.2
9) 10.5×0.6
10) 2.75×4
11) $5.6 \div 0.8$
12) $4.6 \div 0.2$
13) $9.02 \div 4.6$
14) $0.9 \div 0.06$
15) $12.4 \div 0.4$
16) $0.18 \div 0.4$
17) $6.03 \div 0.3$
18) $0.45 \div 0.2$
19) $10.5 \div 0.6$
20) $2.75 \div 0.4$

Answers

1) 47.04 11) 7
2) 41.492 12) 23
3) 24.0 13) 1.96
4) 0.054 14) 15
5) 3.1 15) 31
6) 0.1 16) 0.45
7) 18.693 17) 20.1
8) 0.09 18) 2.25
9) 6.3 19) 17.5
10) 11.0 20) 6.875

Linear equations – Formal Working

Solving equations formal working – Addition

You must **always partition** then use **zero pairs**.

Solve: $x + 5 = 7$ (Partition 7 into $2 + 5$)

$$x + 5 = 7$$
$$x + 5 = 2 + 5$$
$$-5 \quad | \quad -5$$
$$x = 2$$

Solve: $2x + 3 = 9$ (Partition 9 into $6 + 3$)

$$2x + 3 = 9$$
$$2x + 3 = 6 + 3$$
$$-3 \quad | \quad -3$$
$$2x = 6$$
$$\times \tfrac{1}{2} \quad | \quad \times \tfrac{1}{2}$$
$$x = 3$$

Multiply by the reciprocal of 2

Solve: $5x + 2 = 2x + 8$ (Partition $5x$ into $2x + 3x$)

$$5x + 2 = 2x + 8$$
$$2x + 3x + 2 = 2x + 8$$
$$-2x \quad | \quad -2x$$
$$3x + 2 = 8$$

Partition 8 into $6 + 2$

$$3x + 2 = 6 + 2$$
$$-2 \quad | \quad -2$$
$$3x = 6$$
$$\times \tfrac{1}{3} \quad | \quad \times \tfrac{1}{3}$$
$$x = 2$$

Multiply by the reciprocal of 3

If there is an unknown on both sides, make a zero-pair with your x (or whatever your unknown is) first, and then solve as normal…

Key Points:

- Partition before zero pairs
- Always show zero pairs
- To isolate the x multiply by the reciprocal

Solving equations formal working – Subtraction

You **don't need to partition**, just show **zero pairs**

Solve: $x - 3 = 9$

$$x - 3 = 9$$
$$+3 \quad | \quad +3$$
$$x = 12$$

Solve: $6x - 4 = -28$

$$6x - 4 = -28$$
$$+4 \quad | \quad +4$$
$$6x = -24$$
$$\times \tfrac{1}{6} \quad | \quad \times \tfrac{1}{6}$$
$$x = -4$$

Remember to make zero pairs, and then multiply by the reciprocal to isolate the x…

Solve: $6x - 9 = 10x - 25$

$$6x - 9 = 6x + 4x - 25$$
$$-6x \quad | \quad -6x$$
$$-9 = 4x - 25$$
$$+25 \quad | \quad +25$$
$$16 = 4x$$
$$\times \tfrac{1}{4} \quad | \quad \times \tfrac{1}{4}$$
$$4 = x$$
$$x = 4$$

Multiply by the reciprocal of 4

Key Points:

- No need to partition when subtracting.
- Always show zero pairs
- To isolate the x multiply by the reciprocal

Your turn to practice:

Solving equations formal working – Addition

1. $x + 5 = 17$
2. $15 + x = 24$
3. $x + 7 = 12$
4. $x + 8 = 19$
5. $4 + x = 21$
6. $2x + 3 = 13$
7. $4x + 1 = 17$
8. $9 + 3x = 27$
9. $18 = 5x + 3$
10. $2x + 1 = 5$

Solving equations formal working – Subtraction

1. $x - 3 = 7$
2. $x - 11 = 15$
3. $5 - x = 2$
4. $x - 8 = 20$
5. $13 = x - 4$
6. $2x - 3 = 5$
7. $4a - 5 = 11$
8. $7m - 3 = 18$
9. $6k - 9 = 15$
10. $3x - 2 = 13$

Challenge:

1. $3(2d + 1) = 9$
2. $2(5y - 3) = 14$
3. $15 = \frac{b}{2} + 6$
4. $\frac{x+6}{2} = 10$
5. $7 + 5y = 3y - 5$
6. $4y - 3 = 3y + 1$
7. $5(x - 4) = 3x - 7$
8. $2(3p - 3) = 5(p - 1)$

Answers
Addition
1. $x = 12$
2. $x = 9$
3. $x = 5$
4. $x = 11$
5. $x = 17$
6. $x = 5$
7. $x = 4$
8. $x = 6$
9. $x = 3$
10. $x = 2$

Answers
Subtraction
1. $x = 10$
2. $x = 26$
3. $x = 3$
4. $x = 28$
5. $x = 17$
6. $x = 4$
7. $x = 4$
8. $x = 3$
9. $x = 4$
10. $x = 5$

Challenge
1. $d = 1$
2. $y = 2$
3. $b = 18$
4. $x = 14$
5. $y = -6$
6. $y = 4$
7. $x = 6.5$
8. $p = 1$

HCF / LCM using Venn Diagrams

Venn Diagrams – Set Notation

Sets are collections of things

We call the things **elements**

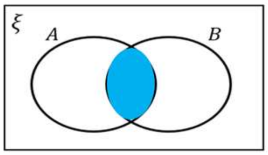
Elements in a set are shown in { }

ξ is the **universal** set
– this is the group that the elements of a set are selected from

This is called the **intersection** of A and B

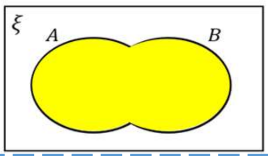
We write this as $A \cap B$

It is a subset of A and of B



This is called the **union** of A and B

We write this as $A \cup B$

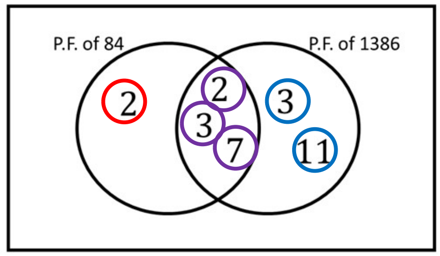


Filling in a Venn Diagram using prime factors

Add common factors to the intersection

$84 = 2 \times 2 \times 3 \times 7$

$1386 = 2 \times 3 \times 3 \times 7 \times 11$



Add the remaining prime factors to complete the sets

Common factors

2

3

7

$2 \times 3 = 6$

$2 \times 7 = 14$

$3 \times 7 = 21$

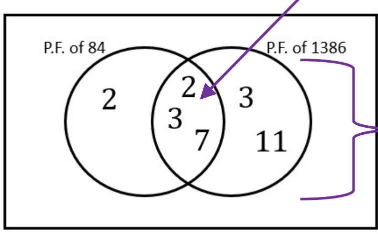
$2 \times 3 \times 7 = 42$

Finding highest common factor (HCF) and lowest common multiple (LCM)

Using a Venn Diagram

$84 = 2 \times 2 \times 3 \times 7$

$1386 = 2 \times 3 \times 3 \times 7 \times 11$



All common factors can be found by finding the products of the prime factors that are in the intersection.
The HCF is the product of all the primes in the intersection.

The LCM is the product of the primes in the union of both sets

Using prime factors

$84 = 2 \times 2 \times 3 \times 7$

$1386 = 2 \times 3 \times 3 \times 7 \times 11$

$\text{HCF}(84,1386) = 2 \times 3 \times 7$

$84 = 2 \times 2 \times 3 \times 7$

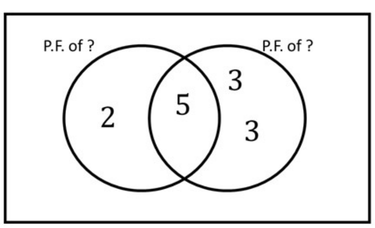
$1386 = 2 \times 3 \times 3 \times 7 \times 11$

$\text{LCM}(84,1386) = 2 \times 3 \times 7 \times 2 \times 3 \times 11$

Problem solving with HCF and LCM

The HCF is 5 and the LCM is 90. What could the two numbers be?

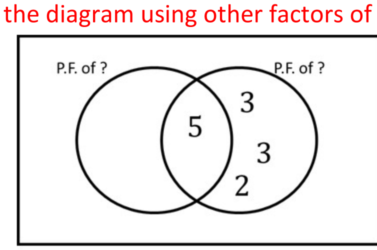
$90 = 2 \times 3 \times 3 \times 5$



$2 \times 5 = 10$ $\quad$ $5 \times 3 \times 3 = 45$

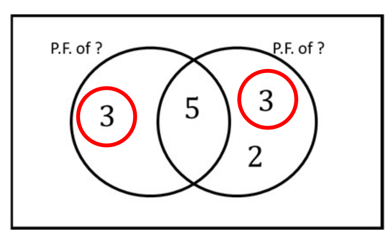
or

.. 5 is in the intersection, complete the diagram using other factors of 90



5 $\quad$ $5 \times 2 \times 3 \times 3 = 90$

.. but not this solution because 3 would be in the intersection

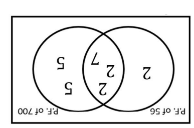


Your turn to practice:

1. Draw a Venn diagram to show the prime factors of 56 and 700
2. **Use your Venn diagram** to find the HCF of 56 and 700
3. **Use your Venn diagram** to find the LCM of 56 and 700
4. By **finding the prime factors**, find the HCF of 56 and 84
5. By **finding the prime factors**, find the LCM of 56 and 84
6. The HCF of two numbers is 10, the LCM is 210. What could the two numbers be?

Answers

1.



2. HCF =28
3. LCM = 1400
4. HCF = 28
5. LCM = 168
6. 70 and 30

Linear Inequalities

Keywords and Phrases:

Inequalities – **Inequality** tells us about the **relative size** of two values.

Critical values – The value in the inequality, e.g

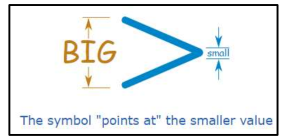
$x < 3$ the critical value will be 3.

$-2 < x \leq 6$ the critical values will be -2 and 6.

Integer – A number with no fractional part (no decimals)

e.g. $-2, -3, -1, 0, 1, 2, 3, 4, 5,$ are all integers.

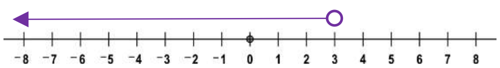
Symbol	Words
>	greater than
<	less than
≥	greater than or equal to
≤	less than or equal to



Representing inequalities on a number line

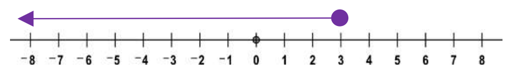
$x < 3$ "x is less than three"

What integer values could x take? $2, 1, 0, -1$ ...



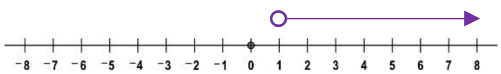
$x \leq 3$ "x is less than or equal to three"

What integer values could x take? $3, 2, 1, 0, -1$ ...



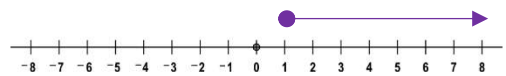
$x > 1$ "x is greater than one"

What integer values could x take? $2, 3, 4$ ...



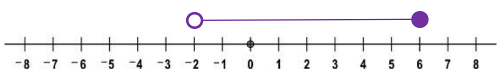
$x \geq 1$ "x is greater than or equal to one"

What integer values could x take? $1, 2, 3,$ ...



$-2 < x \leq 6$ "x is greater than negative two and less than or equal to six"

What integer values could x take? $-1, 0, 1, 2, 3, 4, 5, 6$



Key Points:

● $\leq$ or $\geq$ equal to

○ $<$ or $>$ NOT equal to

Solving inequalities

Use formal working to solve inequalities, we use the same steps because they all of the same critical values

Example 1

Solve $3x + 1 = 10$

$3x + 1 = 10$

$3x + 1 = 9 + 1$ (-1 | -1)

$3x = 9$ ($\times\frac{1}{3}$ | $\times\frac{1}{3}$)

$x = 3$

Solve $3x + 1 < 10$

$3x + 1 < 10$

$3x + 1 < 9 + 1$ (-1 | -1)

$3x < 9$ ($\times\frac{1}{3}$ | $\times\frac{1}{3}$)

$x < 3$

Solve $3x + 1 \geq 10$

$3x + 1 \geq 10$

$3x + 1 \geq 9 + 1$ (-1 | -1)

$3x \geq 9$ ($\times\frac{1}{3}$ | $\times\frac{1}{3}$)

$x \geq 3$

Example 2

Solve $6x - 4 = 2x + 1$

$2x + 4x - 4 = 2x + 1$ ($-2x$ | $-2x$)

$4x - 4 = +1$ ($+4$ | $+4$)

$4x = 5$ ($\times\frac{1}{4}$ | $\times\frac{1}{4}$)

$x = \frac{5}{4}$

Solve $6x - 4 < 2x + 1$

$2x + 4x - 4 < 2x + 1$ ($-2x$ | $-2x$)

$4x - 4 < +1$ ($+4$ | $+4$)

$4x < 5$ ($\times\frac{1}{4}$ | $\times\frac{1}{4}$)

$x < \frac{5}{4}$

Solve $6x - 4 \geq 2x + 1$

$2x + 4x - 4 \geq 2x + 1$ ($-2x$ | $-2x$)

$4x - 4 \geq +1$ ($+4$ | $+4$)

$4x \geq 5$ ($\times\frac{1}{4}$ | $\times\frac{1}{4}$)

$x \geq \frac{5}{4}$

Your turn to practice

In your books, draw a number line from -4 to 12 for each question.

Represent the following inequalities on each number line

1) $x \leq 8$
2) $x < 4$
3) $7 \leq x \leq 12$
4) $0 < x < 4$
5) $-3 < x \leq 8$
6) $-2 \leq x < 6$
7) $x + 7 = 10$
8) $x - 5 < 11$
9) $7 \leq x + 4$
10) $7 + x = 7$
11) $2x \geq 20$
12) $3x + 1 = 10$
13) $4x + 2 \geq 22$
14) $5x + 3 < 18$
15) $2n - 3 = 1$
16) $4a + 3 \leq 3$
17) $2x + 4 = x - 3$
18) $x - 3 \leq 3x + 7$
19) $a - 3 > 3a - 7$

Answers

$x \leq 8$

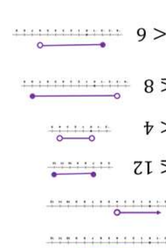
$x < 4$

$7 \leq x \leq 12$

$0 < x < 4$

$-3 < x \leq 8$

$-2 \leq x < 6$



7) $x = 3$
8) $x < 16$
9) $x \geq 3$
10) $x = 0$
11) $x \geq 10$
12) $x = 3$
13) $x \geq 5$
14) $x < 3$
15) $n = 2$
16) $a \leq 0$
17) $x = -7$
18) $x \geq -5$
19) $a < 2$

Division

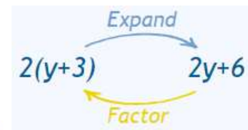
Keywords and Phrases:

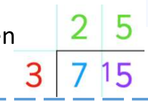
Inverse - Inverse means the opposite in effect. The reverse of.

Factorise – the process of finding factors.

Finding what to multiply together to get an expression.

Division – There are lots of different ways of dividing, in primary school many children have been taught a "chunking" method and then the "bus stop" method.





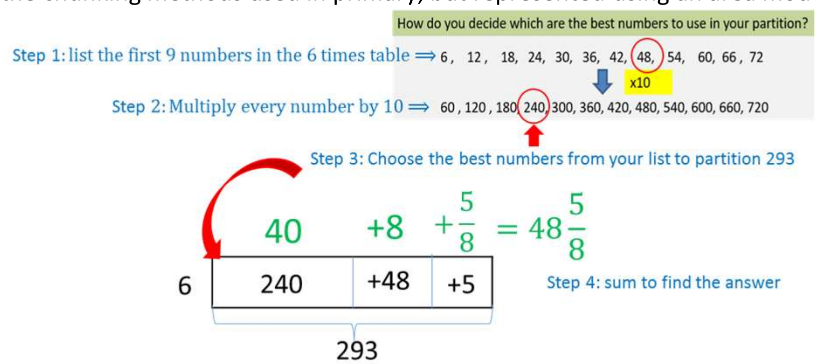
Inverse of area model for division of large numbers

This model is very similar to the chunking methods used in primary, but represented using an area model.

$293 \div 6 =$

?

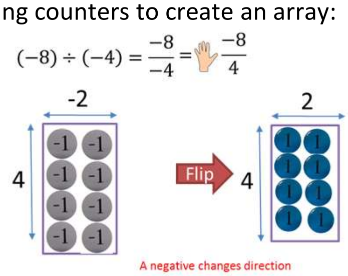
6 | 293



Dividing negative numbers

There are two representations for this:

Using counters to create an array:



Using fractions as division:

$$(-8) \div (-4) = \frac{-8}{-4}$$

$$= -\frac{-8}{4}$$

$$= -\frac{-2 \times 4}{4}$$

$$= -(-2) \times \frac{4}{4}$$

$$= 2 \times 1$$

$$= 2$$

Factorising

Factorise $3x + 6$

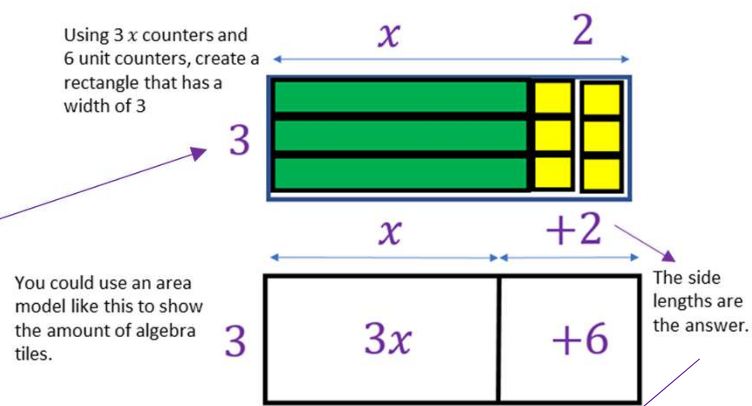
Step 1 - What is the HCF of $3x$ and 6?

Factor pairs of $3x$: $1 \times 3x$, $3 \times x$

Factor pairs of 6: 1×6, 3×2

HCF of $3x$ and $6 = 3$

$\text{HCF}(3x, 6) = 3$



$3x + 6 \equiv 3(x + 2)$

Your turn to practice

Calculate the following using area model for division, leaving your answer as a mixed number fraction

1) $228 \div 3$
2) $528 \div 3$
3) $528 \div 4$
4) $524 \div 3$
5) $169 \div 8$

6) $(+6) \div (-3) =$
7) $(-12) \div (-6) =$
8) $(-10) \div (-5) =$
9) $(+15) \div (-5) =$
10) $(-16) \div (-4) =$

Factorise:

11) $2x + 4$
12) $10x + 5$
13) $6x - 18$
14) $18y - 27x$
15) $60x - 36xy$

Answers
1) 76
2) 176
3) 132
4) $174\frac{2}{3}$
5) $21\frac{1}{8}$
6) -2
7) 2
8) 2
9) -3
10) 4
11) $2(x + 2)$
12) $5(2x + 1)$
13) $6(x - 3)$
14) $9(2y - 3x)$
15) $12x(5 - 3y)$

The Square and the Cube

Keywords and Phrases:

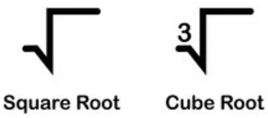
Square number – Means multiply by itself.

Squared - is often written as a little 2 like this: $4^2 = 16$ Which says 4 squared is equal to 16

Square root - a value that can be multiplied by itself to give the original number.

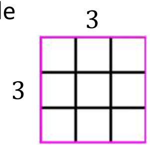
Cube number – is the result when multiplying a number by its self three times.

Cube root – The inverse of cubing a number.



Squares and square roots

Example

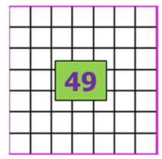


$3 \times 3 = 9$

$3^2 = 9$

3 squared equals 9

Key point
9 represents the **area** of the square.



$\sqrt{49} = 7$

$\sqrt[2]{49} = 7$

Square root of 49 equals 7 (7 is the length of the side)

Key point
Square root the area to find the **side length** of the square.

You need to remember the first 15 square numbers for your GCSEs

MULTIPLICAND **SQUARE ROOT** → $5 \times 5 = 25$ ← PRODUCT **SQUARE NUMBER**

↑ MULTIPLIER **SQUARE ROOT**

MULTIPLICAND **SQUARE ROOT** → $a \times a \equiv a^2$ ← PRODUCT **SQUARE NUMBER**

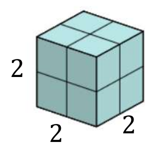
↑ MULTIPLIER **SQUARE ROOT**

When the MULTIPLICAND and the MULTIPLIER are the same number they are called the **SQUARE ROOT**

Therefore - $\sqrt{a} \times \sqrt{a} \equiv a$ $\sqrt{a^2} = a$

Cubes and cube roots

Example

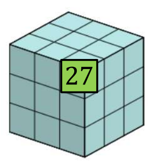


$2 \times 2 \times 2 = 8$

$2^3 = 8$

2 cubed equals 8

Key point
8 represents the **volume** of the cube.



$\sqrt[3]{27} = 3$

Cube root of 27 equals 3 (3 is the length of the side)

Key point
Cube root the volume to find the **side length** of the cube.

You need to remember the first 15 square numbers for your GCSE's

MULTIPLICAND **CUBE ROOT** → $5 \times 5 \times 5 = 125$ ← PRODUCT **CUBE NUMBER**

↑ MULTIPLIER **CUBE ROOT** ↑ MULTIPLIER **CUBE ROOT**

MULTIPLICAND **CUBE ROOT** → $a \times a \times a \equiv a^3$ ← PRODUCT **CUBE NUMBER**

↑ MULTIPLIER **CUBE ROOT** ↑ MULTIPLIER **CUBE ROOT**

When the MULTIPLICAND and the MULTIPLIERS are the same number they are called the **CUBE ROOT**

Therefore - $\sqrt[3]{a} \times \sqrt[3]{a} \times \sqrt[3]{a} \equiv a$

$\sqrt[3]{a^3} \equiv a$

Your turn to practice

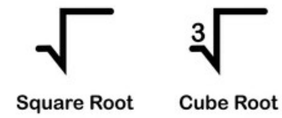
Length of side a	Square number a^2	Square root $\sqrt[2]{\square}$
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Length of side a	Cube number a^3	Cube root $\sqrt[3]{\ }$
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

The Square and the Cube 2

Keywords and Phrases:

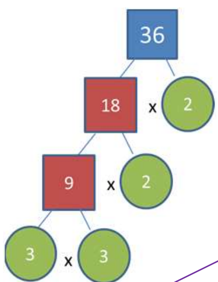
Square number – Means multiply by itself.
Squared - is often written as a little 2 like this: $4^2 = 16$ Which says 4 squared is equal to 16
Square root - a value that can be multiplied by itself to give the original number.
Cube number – is the result when multiplying a number by its self three times.
Cube root – The inverse of cubing a number.



Show that a number is a square root

Using product of primes you can show that a number is a square number, by collecting pairs of roots together.

Example:
Show that 36 is a square number

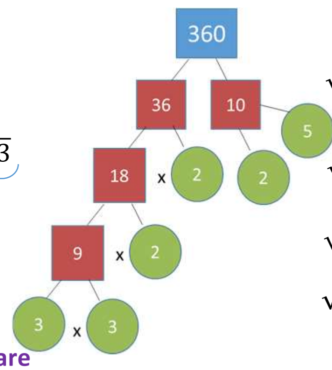


$$36 = 2 \times 2 \times 3 \times 3$$
$$\sqrt{36} = \sqrt{2} \times \sqrt{2} \times \sqrt{3} \times \sqrt{3}$$
$$\sqrt{36} = \sqrt{2^2} \times \sqrt{3^2}$$
$$2 \times 3$$
$$\sqrt{36} = 6$$

$$\sqrt{a^2} = a$$

So 36 is a **square number** as we have found that it has an **integer SQUARE ROOT**.

Example 2:
By defining the prime factors, show that 360 is not a square number



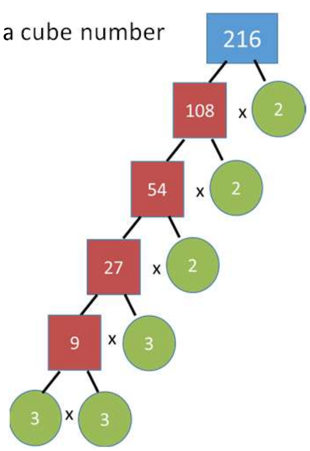
$$36 = 2 \times 2 \times 3 \times 3 \times 5 \times 2$$
$$\sqrt{36} = \sqrt{2} \times \sqrt{2} \times \sqrt{3} \times \sqrt{3} \times \sqrt{5} \times \sqrt{2}$$
$$\sqrt{36} = \sqrt{2^2} \times \sqrt{3^2} \times \sqrt{5} \times \sqrt{2}$$
$$\sqrt{36} = 2 \times 3 \times \sqrt{5} \times \sqrt{2}$$
$$\sqrt{36} = 6 \times \sqrt{5} \times \sqrt{2}$$

So 360 is **NOT** a **square number** as we have found that it does not have an **integer SQUARE ROOT**.

Show that a number is a cube root

Using product of primes you can show that a number is a cube number, by collecting triple roots together.

Example:
Show that 216 is a cube number



$$216 = 2 \times 2 \times 2 \times 3 \times 3 \times 3$$
$$\sqrt{216} = \sqrt[3]{2} \times \sqrt[3]{2} \times \sqrt[3]{2} \times \sqrt[3]{3} \times \sqrt[3]{3} \times \sqrt[3]{3}$$
$$\sqrt{216} = \sqrt[3]{2^3} \times \sqrt[3]{3^3}$$
$$2 \times 3$$
$$\sqrt{216} = 6$$

So 216 is a **cube number** as we have found that it has an **integer CUBE ROOT**.

Your turn to practice

Show whether these numbers are Square numbers by defining prime factors

1. 64
2. 400
3. 225
4. 840
5. 3600
6. 1024
7. 441
8. 810

Show whether these numbers are Cube numbers by defining prime factors

9. 1000
10. 1728
11. 5400
12. 8000
13. 5832
14. 4032
15. 3375

Answers

1. 8 - Square
2. 20 - Square
3. 15 - Square
4. 28.98 – not square
5. 60 - Square
6. 32 - Square
7. 21 - Square
8. 28.46 – Not square
9. $\sqrt[3]{1000}$ = 10 Cube
10. $\sqrt[3]{1728}$ = 12 Cube
11. $\sqrt[3]{5400}$ = 17.544 . . . Not Cube
12. $\sqrt[3]{8000}$ = 20 Cube
13. $\sqrt[3]{5832}$ = 18 Cube
14. $\sqrt[3]{4032}$ = 15.916 . . . Not Cube
15. $\sqrt[3]{3375}$ = 15 Cube

Standard form

Keywords and Phrases:

Standard form - A general term meaning "written down in the way most commonly accepted"
This common way depends upon the subject and country, in the UK we use "Scientific Notation"
Standard form can also be referred to as standard index form.

Digits / Power of 10
$5326.6 = 5.3266 \times 10^3$
A Number / In Scientific Notation

Standard form:

To be in standard form a number must be written as: $a \times 10^m$ where $1 \leq a < 10$ and m is an integer

Using a number line can help, as per below:

E.g:
Convert 5 000 000 into standard form

$= 5 \times 10^6$

Billion			Million			Thousands			Unit			Decimals		
Hundred billions	Ten Billions	billion	Hundred Millions	Ten Millions	One Million	Hundred Thousands	Ten thousands	Thousand	Hundreds	Tens	Ones	Tenths	Hundredths	Thousandths
10^{11}	10^{10}	10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0	10^{-1}	10^{-2}	10^{-3}
100 000 000 000	10 000 000 000	1 000 000 000	100 000 000	10 000 000	1 000 000	100 000	10 000	1 000	100	10	1	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$
					5	0	0	0	0	0	0			

E.g: 2 750 000 $= 2.75 \times 10^6$ — For these types of numbers use the most significant number

Standard form is also used for really small numbers:

E.g: 0.004 $= 4 \times 10^{-3}$ 0.00000012 $= 1.2 \times 10^{-7}$

You will also need to know how to convert numbers from standard form into ordinary numbers

Adjusting into standard form:

Sometimes a number looks like it is in standard form, but it is not. You need to adjust it into standard form:

E.g: 12×10^2 — This number is not in standard form

Adjust 12 to be in standard form:
$12 = 1.2 \times 10^1$

$1.2 \times 10^1 \times 10^2$

Standard form: $= 1.2 \times 10^3$

E.g: 0.00012×10^5 — This number is not in standard form

Adjust to standard form:
$0.00012 = 1.2 \times 10^{-4}$

$1.2 \times 10^{-4} \times 10^5$

Standard form: $= 1.2 \times 10^1$

Ordering in standard form:

Example: Put these numbers in order of size, starting with the smallest?

12.2×10^2 1.22×10^5 122×10^{-3} 0.00122×10^7

There are a few ways of ordering with standard form.

Order by converting into ordinary numbers:

$12.2 \times 10^2 = 1\,220$ 2nd
$1.22 \times 10^5 = 122\,000$ 4th
$122 \times 10^{-3} = 0.122$ 1st
$0.00122 \times 10^7 = 12\,200$ 3rd

Or convert them all into standard form:

$12.2 \times 10^2 = 1.2 \times 10^3$ 2nd
1.22×10^5 4th
$122 \times 10^{-3} = 1.22 \times 10^{-1}$ 1st
$0.00122 \times 10^7 = 1.22 \times 10^4$ 3rd

Smallest 122×10^{-3} 12.2×10^2 0.00122×10^7 1.22×10^5 Largest

Your turn to practice

Convert these numbers into standard form:

1) 80 000
2) 9 000
3) 410 000
4) 4 600
5) 450
6) 0.04
7) 0.000 000 005
8) 0.0234
9) 0.000 0023
10) 0.0067

Convert these numbers into ordinary numbers:

11) 5×10^7
12) 9×10^8
13) 3.7×10^9
14) 2.8×10^1
15) 9.9×10^5
16) 3.2×10^{-5}
17) 2.9×10^{-2}
18) 3.167×10^{-1}
19) 1.115×10^{-4}
20) 1.412×10^{-3}

Order these numbers from smallest to largest:

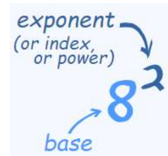
21) 9×10^5 9×10^3 9×10^2 9×10^7
22) 3×10^5 3×10^{-3} 3×10^2 3×10^{-7}
23) 2×10^3 5×10^3 9.2×10^3 6.3×10^3
24) 4×10^7 7×10^4 3×10^4 5×10^7
25) 83000 8×10^4 8.3×10^3 8000

Answers
1) 8×10^4
2) 9×10^3
3) 4.1×10^5
4) 4.6×10^3
5) 4.5×10^2
6) 4×10^{-2}
7) 5×10^{-9}
8) 2.34×10^{-2}
9) 2.3×10^{-6}
10) 6.7×10^{-3}
11) 50000000
12) 900000000
13) 3700000000
14) 28
15) 990000
16) 0.000032
17) 0.029
18) 0.3167
19) 0.0001115
20) 0.001412
21) 9×10^2 9×10^3 9×10^5 9×10^7
22) 3×10^{-7} 3×10^{-3} 3×10^2 3×10^5
23) 2×10^3 5×10^3 6.3×10^3 9.2×10^3
24) 3×10^4 7×10^4 4×10^7 5×10^7
25) 8000 8.3×10^3 8×10^4 83000

Base numbers with Exponents

Keywords and Phrases:

Exponent - Exponents are also called **Powers** or **Indices** or Index.
The exponent of a number says **how many times** to use the number in a **multiplication.**



In this example:
$8^2 = 8 \times 8 = 64$

Base number – In the example of 8^2, 8 is the base number.
Evaluate – Work out the answer
Simplify - To make an expression, equation, or fraction easier to work with by reducing it to its most basic form without changing its value.

Exponents

2^7 We read this as "2 to the power of 7"

$2^7 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$

Special cases:

An index of 2 can also be read as **squared** 3^2

An index of 3 can also be read as **cubed** 4^3

An index of 1 is not written $4^1 = 4$

Fractional bases:
If the base is a fraction, we put it in brackets:

Example: $\left(\frac{2}{3}\right)^2 = \frac{2}{3} \times \frac{2}{3} = \frac{4}{9}$

Decimal bases:
If the base is a decimal, turn it into a fraction, then it is a fractional base:

Example: Evaluate 0.2^3

$$0.2^3 = \left(\frac{2}{10}\right)^3 = \frac{8}{1000} = 0.008$$

Negative bases:
If the base is a negative number, we put it in brackets:

Example: Evaluate -2^3

$$(-2)^3 = -2 \times -2 \times -2 = -8$$

When is the answer going to be a positive or negative number, given a negative base.

If the index is **odd**, then answer will be **negative** $(-1)^5 = -1$

If the index is **even**, then answer will be **positive** $(-1)^{82} = +1$

Your turn to practice

1) $\left(\frac{1}{3}\right)^2$
2) $\left(\frac{4}{5}\right)^3$
3) $\left(\frac{5}{6}\right)^1$
4) $\left(\frac{3}{8}\right)^2$
5) $\left(\frac{2}{3}\right)^3$
6) $\left(\frac{1}{10}\right)^2$
7) $\left(\frac{6}{7}\right)^2$
8) $(0.5)^2$
9) $(0.2)^3$
10) $(1.1)^2$
11) $(0.25)^2$
12) $(0.75)^3$
13) $(1.5)^2$
14) $(0.6)^4$
15) $(1.2)^3$
16) $(0.9)^5$
17) $(1.05)^4$
18) $(-2)^2$
19) $(-3)^3$
20) $(-1)^4$
21) $(-0.5)^2$
22) $(-4)^5$
23) $(-2.5)^3$
24) $(-1.2)^4$
25) $(-0.8)^6$
26) $(-10)^2$
27) $(-3.1)^3$

Answers

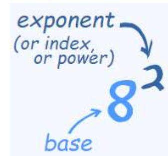
1) $\frac{1}{9}$
2) $\frac{64}{125}$
3) $\frac{5}{6}$
4) $\frac{9}{64}$
5) $\frac{8}{27}$
6) $\frac{1}{100}$
7) $\frac{36}{49}$
8) 0.25
9) 0.008
10) 1.21
11) 0.0625
12) 0.421875
13) 2.25
14) 0.1296
15) 1.728
16) 0.59049
17) 1.21550625
18) 4
19) -27
20) 1
21) 0.25
22) -1024
23) -15.625
24) 2.0736
25) 0.262144
26) 100
27) -29.791

Exponents

Keywords and Phrases:

Exponent - Exponents are also called **Powers** or **Indices** or Index. The exponent of a number says **how many times** to use the number in a **multiplication.**

Base number – In the example of 8^2, 8 is the base number.



In this example:
$\mathbf{8^2 = 8 \times 8 = 64}$

Multiplication rule of Exponents:

$2^3 \times 2^4 = \underbrace{(2 \times 2 \times 2)}_{3} \times \underbrace{(2 \times 2 \times 2 \times 2)}_{4}$ (7 in total)

$= 2^7$

Could we work out the answer without writing it out the calculation in full?

$2^3 \times 2^4 = 2^{3+4}$

$= 2^7$

$$a^m \times a^n = a^{m+n}$$

For this rule to work the base numbers must be the same.

Division rule of Exponents:

$\frac{2^7}{2^3} = \frac{2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2}{2 \times 2 \times 2}$

$= \underbrace{\frac{2}{2} \times \frac{2}{2} \times \frac{2}{2}}_{3} \times \underbrace{2 \times 2 \times 2 \times 2}_{4}$ (7 in total)

Could we work out the answer without writing it out the calculation in full?

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

$2^7 \div 2^3 = 2^{7-3}$

$= 2^4$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

For this rule to work the base numbers must be the same.

Zero Exponent:

Anything to the power of zero = 1

$$a^0 = 1 \qquad a^1 = a$$

Multiple Operations:

Simplify $8^5 \times 8^2 \times 8^3$

Using the multiplication law

$8^{5+2+3} = \mathbf{8^{10}}$

Simplify $\frac{8^2 \times 8^5}{8^3}$

$\frac{8^2 \times 8^5}{8^3} = \frac{8^7}{8^3} = 8^{7-3} = \mathbf{8^4}$

Brackets rule of Exponents:

$(2^4)^3 = 2^4 \times 2^4 \times 2^4$

$3 \times 4 = 12$

$= \underbrace{(2 \times 2 \times 2 \times 2)}_{4} \times \underbrace{(2 \times 2 \times 2 \times 2)}_{4} \times \underbrace{(2 \times 2 \times 2 \times 2)}_{4}$

$= 2^{12}$

Could we work out the answer without writing it out the calculation in full?

$(2^4)^3 = 2^{4 \times 3}$

$= 2^{12}$

$$(a^m)^n = (a^n)^m = a^{nm}$$

For this rule to work the base numbers must be the same.

Your turn to practice

1) $2^2 \times 2^3$
2) $3^1 \times 3^2$
3) $5^2 \times 5^1$
4) $4^3 \times 4^2$
5) $6^1 \times 6^2$
6) $2^3 \times 3^2$
7) $2^2 \times 3^3 \times 2^1$
8) $5^1 \times 2^2 \times 3^3$
9) $2^3 \times 2^4 \times 2^{-2}$
10) $3^2 \times 3^{-1} \times 3^4$
11) $2^5 \div 2^2$
12) $\frac{3^3}{3^1}$
13) $5^4 \div 5^2$
14) $\frac{4^6}{4^3}$
15) $6^5 \div 6$
16) $2^7 \div 2^4$
17) $3^5 \div 3^{-2}$
18) $\frac{10^{-3}}{10^{-5}}$
19) $2^{-2} \div 2^{-4}$
20) $5^6 \div 5^{-3}$
21) $\frac{2^3 \times 2^2}{2^1}$
22) $\frac{3^4}{3^2 \times 3^1}$
23) $\frac{5^2 \times 5^3}{5^4}$
24) $\frac{4^5}{4^{-2} \times 4^1}$
25) $\frac{6^3 \times 6}{6^2}$
26) $\frac{2^4 \times 2^2}{2^{-2}}$
27) $\frac{3^{-3} \times 3^{-2}}{3}$
28) $(2^3)^2$
29) $(3^2)^3$
30) $(5^4)^2$
31) $(4^{-2})^3$
32) $(6^{-1})^2$
33) $(2^5)^4$
34) $(3^{-3})^2$
35) $(10^2)^{-3}$
36) $(7^4)^0$

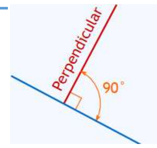
Answers

1) 2^5
2) 3^3
3) 5^3
4) 4^5
5) 6^3
6) $2^3 \times 3^2$
7) $2^3 \times 3^3$
8) $5 \times 2^2 \times 3^3$
9) 2^5
10) 3^5
11) 2^3
12) 3^2
13) 5^2
14) 4^3
15) 6^4
16) 2^3
17) 3^7
18) 10^2
19) 2^2
20) 5^9
21) 2^4
22) 3^3
23) 5^1
24) 4^6
25) 6^2
26) 2^8
27) 3^{-6}
28) 2^6
29) 3^6
30) 5^8
31) 4^{-6}
32) 6^{-2}
33) 2^{20}
34) 3^{-6}
35) 10^{-6}
36) 7^0
37) 9^4

Area

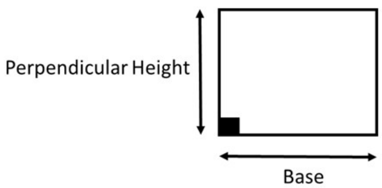
Keywords and Phrases:

Perpendicular – At right angles (90°) to



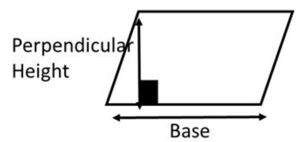
Key Formula:

Area of a Rectangle = Base × Perpendicular Height



$$A = b \times h$$

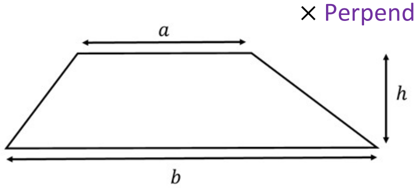
Area of a Parallelogram = Base × Perpendicular Height



$$A = b \times h$$

A rhombus is a parallelogram with four equal sides. This formula also applies to a rhombus.

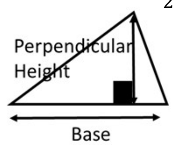
Area of a Trapezium = Half the sum of the parallel sides × Perpendicular Height



$$A = \frac{(a+b)}{2} \times h$$

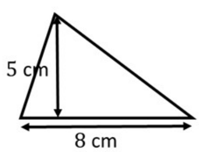
$$A = \frac{1}{2}(a+b) \times h$$

Area of a Triangle = $\frac{1}{2}$ × Base × Perpendicular Height



$$A = \frac{1}{2} \times b \times h$$

Example: Find the area of this triangle.



State the formula first!

$$A = \frac{1}{2} \times b \times h$$

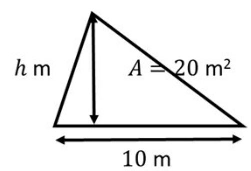
$$= \frac{1}{2} \times 8 \times 5$$

$$= 4 \times 5$$

$$= 20 \text{ cm}^2$$

Always give the units!

Example: Find the perpendicular height of this triangle.



$$A = \frac{1}{2} \times b \times h$$

$$20 = \frac{1}{2} \times 10 \times h$$

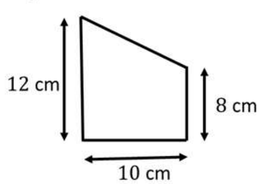
$$20 = 5 \times h$$

÷ 5 | ÷ 5

$$4 = h$$

$$h = 4 \text{ m}$$

Example: Find the area of this trapezium



State the formula first!

$$A = \frac{(a+b)}{2} \times h$$

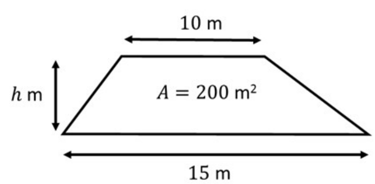
$$= \frac{(12+8)}{2} \times 10$$

$$= 10 \times 10$$

$$= 100 \text{ cm}^2$$

Always give the units!

Example: Find the perpendicular height of this trapezium.



$$A = \frac{(a+b)}{2} \times h$$

$$200 = \frac{15+10}{2} \times h$$

× 2 | × 2

$$400 = 25 \times h$$

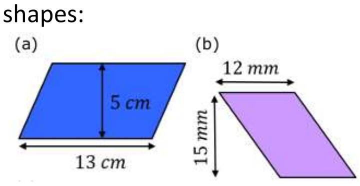
÷ 25 | ÷ 25

$$16 = h$$

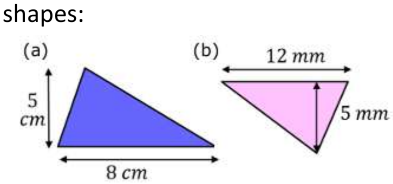
$$h = 16 \text{ m}$$

Your turn to practice

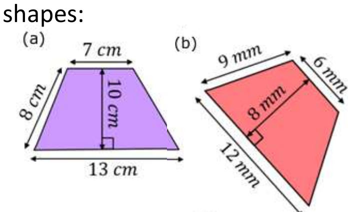
1) Calculate the area of these shapes:



3) Calculate the area of these shapes:

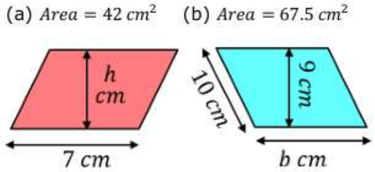


5) Calculate the area of these shapes:



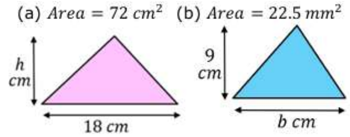
2) Given the area, calculate the missing length:

(a) $Area = 42\ cm^2$ (b) $Area = 67.5\ cm^2$



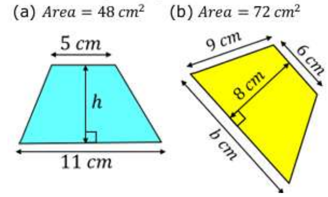
4) Given the area, calculate the missing length:

(a) $Area = 72\ cm^2$ (b) $Area = 22.5\ mm^2$



6) Given the area, calculate the missing length:

(a) $Area = 48\ cm^2$ (b) $Area = 72\ cm^2$



Answers

1) a) $65cm^2$
b) $180mm^2$

2) a) $h = 6cm$
b) $b = 7.5cm$

3) a) $20cm^2$
b) $30mm^2$

4) a) $h = 8cm$
b) $b = 5cm$

5) a) $100cm^2$
b) $72mm^2$

6) a) $h = 6cm$
b) $12cm$

Collecting like terms

Keywords and Phrases:

Like terms - are terms whose variables (and their exponents such as the 2 in x^2) are the same.

E.g: $5x$ $7x$ $-x$ $12x$ are all like terms because the variables are all x

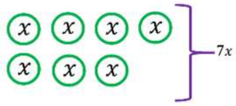
Coefficients - A number used to multiply a variable.

E.g: $6z$ means 6 times z, and "z" is a variable, so 6 is a coefficient.

Collecting Like Terms – Linear expressions

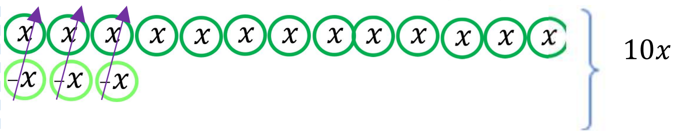
A term is separated by a (+) or (–) sign in an expression. When you collect the terms you are adding them together. Like terms have the same variable such as x or y

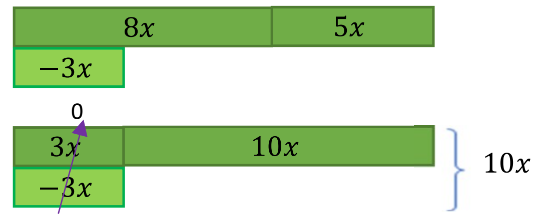
$4x + 3x \equiv$



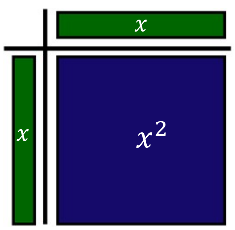
Or using a bar model

$8x - 3x + 5x \equiv$ $(+8x) + (-3x) + (+5x) \equiv$



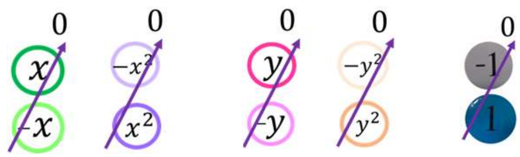


Key points - Quadratics:



$x \times x \equiv x^2$

Zero pairs:



Collect like terms - Quadratic

Example 1: $4x^2 + 6x - 3x + 2x^2 = (+4x^2) + (+2x^2) + (+6x) + (-3x)$

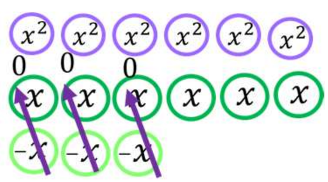
Like terms

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

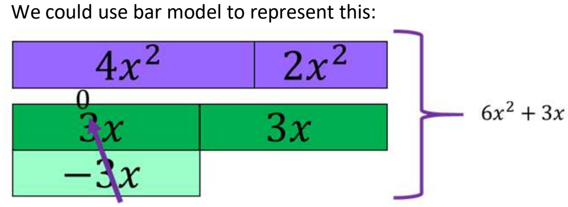
Like terms

$(+6x) + (-3x)$

We could use counters to represent this:



We could use bar model to represent this:



Example 2: $3y^2 - 2x - 5 + 4x - 4y^2 + 6 = (+3y^2) + (-4y^2) + (-2x) + (+4x) + (-5) + (+6)$

Like terms

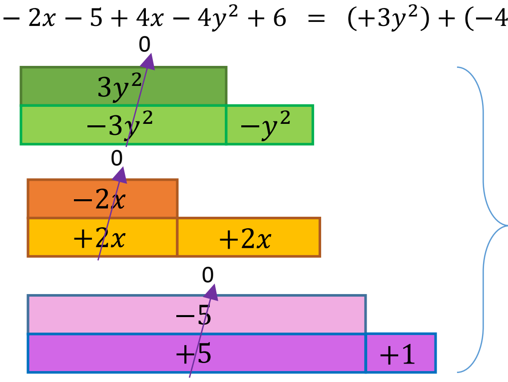
$(+3y^2) + (-4y^2)$

Like terms

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

Like terms

$(-5) + (+6)$



$\equiv -y^2 + 2x + 1$

Your turn to practice

1) $x^2 - y^2 + x^2 - y^2$
2) $3x^2 + 2y^2 + 2x^2 + y^2$
3) $3x^2 + 2y^2 - 2x^2 + y^2$
4) $-3x^2 + 2y^2 - 2x^2 - y^2$
5) $2x^2 + x^2 + y^2 + y^2 + 2x^2 + y^2$
6) $3x^2 + 2x^2 + 3x + 4y^2 + y^2 - 4x + 3$
7) $5y^2 + 3x^2 + 2y + 2y^2 + 5y - 3x$
8) $4x^2 + 2x + 2 + 5x^2 - 6y^2 + 11x + 2y^2 - 15$
9) $-7x^2 + 7x + 3x^2 + 7y - 10x + 3y$
10) $2x^2 - 3x + 3x^2 + 2y^2 + 5x + 6y^2 + 2y$

Answers

1) $2x^2 - 2y^2$
2) $5x^2 + 3y^2$
3) $x^2 + 3y^2$
4) $-5x^2 + y^2$
5) $5x^2 + 3y^2$
6) $5x^2 - x + 5y^2 + 3$
7) $7y^2 + 3x^2 + 7y - 3x$
8) $9x^2 - 4y^2 + 13x - 13$
9) $-4x^2 - 3x + 10y$
10) $5x^2 + 8y^2 + 2x + 2y$

BIPS and Substitution

Keywords and Phrases:

BIDMAS or BIPS - BIDMAS gives us a rule to follow for the order of our operations.

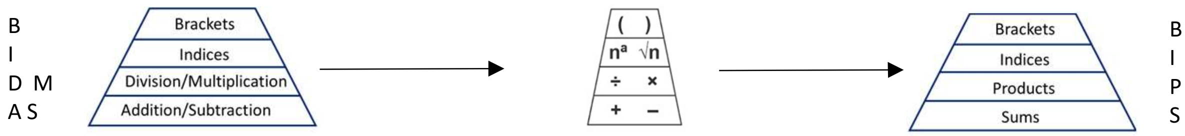
Formula - A formula is a fact or rule that uses mathematical symbols. Has an equals sign and at least two different variables.

Substitution - In Algebra "Substitution" means putting numbers in place of where the letters are

BIPS

Sometimes referred to as BIDMAS.

Since we can always rewrite a division as a multiplication and a subtraction as an addition, we are going to use...



Calculate these by working left to right:

$2 + 4 - 3$ → (Alternative calculation) $2 + 4 + (-3)$

We have turned this into an addition of a negative and so now we can use the commutative law.

$2 - 3 + 4$ → (Alternative calculation) $2 + (-3) + 4$

Calculate these by working left to right:

$20 \times 4 \div 2$ → (Alternative calculation) $20 \times 4 \times \frac{1}{2}$

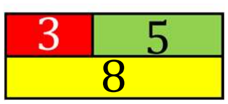
We have turned this into an multiplication by a fraction and so now we can use the commutative law.

$20 \div 2 \times 4$ → (Alternative calculation) $20 \times \frac{1}{2} \times 4$

Substituting into a formula

Work out the value of

Example 1: $y = r + l$ Substitute $r = 3$ and $l = 5$ to evaluate y

	Bar model method	Formal method
Step 1 State the formula		$y = r + l$
Step 2 Substitute in values		$y = 3 + 5$
Step 3 Use BIPS to solve		$y = 8$

Example 2: $v = u + at$

Evaluate v when $u = 10, a = -4\ t = 6$

Step 1
State the formula

$v = u + at$

Step 2
Substitute in values

$v = 10 + (-4) \times 6$

$v = 10 + (-24)$

Step 3
Use BIPS to solve

$v = -14$

Key misconceptions:

Evaluate $3x^2$ when $x = 5$

$3x^2 = 3 \times 5^2$
$= 15^2$
$= 225$ ✗

$3x^2 = 3 \times 5^2$
$= 3 \times 25$
$= 75$ ✓

Just x is squared

$3x^2 = 3 \times x^2$

$(3x)^2 = (3 \times x)^2$

$3 \times x$ is squared

Your turn to practice

1) $4 + 1 \times 5$
2) $6 \div 3 + 9$
3) $6 \times (5 - 2)$
4) $36 - 2 + 32 \div 8$
5) $(16 - 3) + 8 \div 2$
6) $(8 + 2 \times 4)^2$
7) $(5 - 12)^2$
8) 6×3^2
9) $-11 - 50 \div \sqrt{25} \times 2$
10) $(12 - 2)^4 - (47 + 3^2)$

11) If $a = 6$ and $b = 2$ find the value of:

a. $a + b$
b. $3a + 2b$
c. $5b - a$
d. $2a^2 - 6b$
e. $\frac{1}{3}ab$
f. $\frac{a^2}{b}$

12) If $p = 5$ and $q = -3$ find the value of:

a. $p + q$
b. $2p + 5q$
c. $6p - q$
d. $4p^2 - 2q$
e. $\frac{pq}{5}$
f. $(2p)^2 - q$

Answers
1) 9
2) 11
3) 18
4) 38
5) 17
6) 256
7) 49
8) 54
9) -31
10) 9944
11) a) 8 b) 22 c) 4
d) 60 e) 4 f) 18
12) a) 2 b) -5 c) 33
d) 106 e) -3 f) 103

Changing the subject of a formula

22

Keywords and Phrases:

Formula - A formula is a fact or rule that uses mathematical symbols. Has an equals sign and at least two different variables.

Subject - The "subject" of a formula is the single variable (usually on the left of the "=") to which everything else is equal.

$$s = ut + \frac{1}{2}at^2$$

s is the subject of this formula

Changing the subject of a formula – using bar models:

$$y = r + l$$

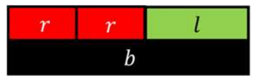
y is the subject of the formula

Make r the subject of the formula:

$$y = r + l$$
$$-l \qquad -l$$
$$y - l = r$$

r is the subject of the formula

$$r = y - l$$



$$b = 2r + l$$

b is the subject of the formula

Make r the subject of the formula:

$$b = 2r + l$$
$$-l \qquad -l$$
$$b - l = 2r$$
$$\div 2 \qquad \div 2$$
$$\frac{b-l}{2} = r$$

r is the subject of the formula

Or can be written like this:

$$r = \frac{b-l}{2}$$

$$r = \frac{1}{2}(b-l)$$

Changing the subject of a formula – using formal methods only:

Make x the subject of these formulas:

1)
$$y = 3x - 7$$
$$+7 \qquad +7$$
$$y + 7 = 3x$$
$$\div 3 \qquad \div 3$$
$$\frac{y+7}{3} = x$$

2)
$$y = \frac{x}{2} + 3$$
$$-3 \qquad -3$$
$$y - 3 = \frac{x}{2}$$
$$\times 2 \qquad \times 2$$
$$2(y-3) = x$$
$$\Updownarrow$$
$$2y - 6 = x$$

3)
$$y = \frac{x+5}{3}$$
$$\times 3 \qquad \times 3$$
$$3y = x + 5$$
$$-5 \qquad -5$$
$$3y - 5 = x$$

Your turn to practice

Make y the subject of these formulas:

1) $y + w = c$
2) $y - 2g = n$
3) $3y = c$
4) $ay = w$
5) $\frac{y}{c} = w$
6) $c = y - k$

Make x the subject of these formulas:

7) $4x + c = w$
8) $dx - t = 8$
9) $2x + 2y = P$
10) $y = xz + s$
11) $3y = 4x + 1$
12) $\frac{x+t}{m} = 2c$

Answers

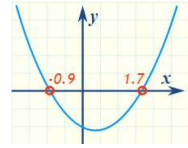
1) $y = c - w$
2) $y = n + 2g$
3) $y = \frac{c}{3}$
4) $y = \frac{w}{a}$
5) $y = wc$
6) $c + k = y$
7) $x = \frac{w-c}{4}$
8) $x = \frac{8+t}{d}$
9) $x = \frac{P-2y}{2}$
10) $x = \frac{y-s}{z}$
11) $x = \frac{3y-1}{4}$
12) $x = 2cm - t$

Single bracket - Quadratic

Keywords and Phrases:

Quadratic - The name **Quadratic** comes from "quad" meaning square, because the variable is squared (like x^2).
The standard form to see a quadratic is: $ax^2 + bx + c$
Where a, b and c are known values, $a \neq 0$.

This is a quadratic curve



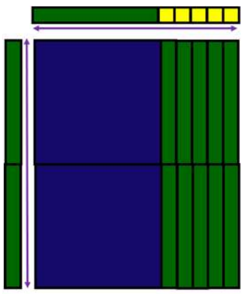
This makes it quadratic

$5x^{2} + 3x + 3 = 0$

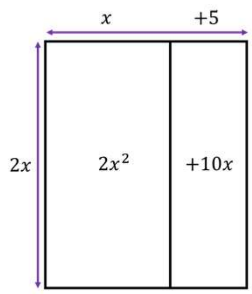
Expanding a single term over a bracket (Quadratic):

Expand $2x(x+5)$

Using algebra tiles

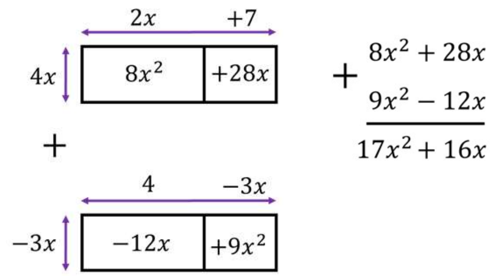


Using area model



$2x(x+5) \equiv 2x^2 + 10x$

Expand and simplify $4(2x+7) - 3(4-3x)$

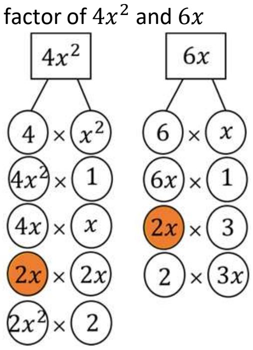


$4x(2x+7) - 3x(4-3x) \equiv 17x^2 + 16x$

Factorise a single term over a bracket (Quadratic):

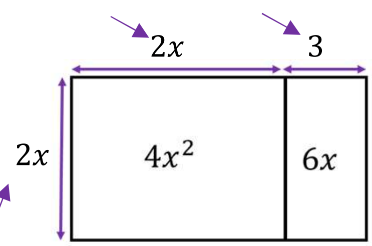
Factorise fully $4x^2 + 6x$

Find the highest common factor of $4x^2$ and $6x$



HCF $(4x^2, 6x) = 2x$

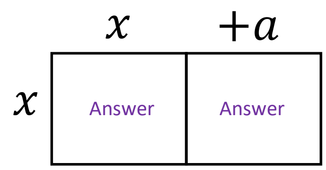
Area Model
If the area is $4x^2 + 6x$, what can the side lengths be?



$4x^2 + 6x = 2x(2x+3)$

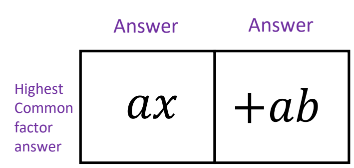
Factorising or Expanding?

Expand $x(x+a)$ Take out of bracket



Write answer out of area model $= x^2 + ax$

Factorise $ax + ab$ Put in bracket



Write answer out of area model $= a(x+b)$

Your turn to practice

Expand using area model

1) $2x(x+4)$
2) $3x(x-2)$
3) $2x(3x+1)$
4) $5(2x-3)$
5) $-2x(x+7)$
6) $-3x(3x-2)$
7) $\frac{1}{2}x(x+6)$
8) $x(3x+2y)$
9) $4x(x+5) + 2x(x+4)$
10) $2x(x-4) + 3x(x+6)$
11) $5x(2x+1) + 4x(4x+3)$
12) $3x(3x-7) + x(2x+9)$
13) $2x(3x+1) - x(6x-3)$
14) $7x(3x+5) - 5x(3x-4)$
15) $2x(9x-2) - 6x(5x-9)$
16) $4x(5x+3) - 3x(2-3x)$

Factorise using area model

17) $x^2 + 4x$
18) $2x^2 + 4x$
19) $4x^2 + 4x$
20) $-4x^2 + 4x$
21) $-4x^2 - 4x$
22) $-4x^2y - 4xy$
23) $3x^2 + 6x$
24) $6x^2 + 9x$

Answers

1) $2x^2 + 8x$
2) $3x^2 - 6x$
3) $6x^2 + 2x$
4) $10x - 15$
5) $-2x^2 - 14x$
6) $-9x^2 + 6x$
7) $\frac{1}{2}x^2 + 3x$
8) $3x^2 + 2xy$
9) $6x^2 + 28x$
10) $5x^2 + 10x$
11) $26x^2 + 17x$
12) $11x^2 - 12x$
13) $5x$
14) $6x^2 + 55x$
15) $-12x^2 + 50x$
16) $29x^2 + 6x$
17) $x(x+4)$
18) $2x(x+2)$
19) $4x(x+1)$
20) $-4x(x-1)$
21) $-4x(x+1)$
22) $-4xy(x+1)$
23) $3x(x+2)$
24) $3x(2x+3)$

Expand a Double bracket

Keywords and Phrases:

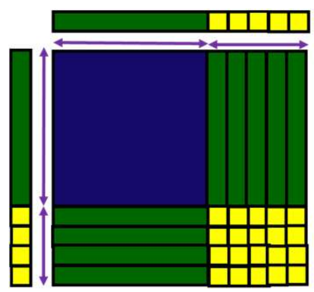
Expand – Means to multiply out the brackets, using algebra tiles or an area model.

Area model - A model used for multiplication, each rectangle represents an area, the side lengths are the question. The area is the answer.

Expanding double brackets - both positive:

Expand $(x+4)(x+5)$

Using algebra tiles



Using area model

	x	$+5$
x	x^2	$+5x$
$+4$	$+4x$	$+20$

Collect like terms $4x + 5x = 9x$

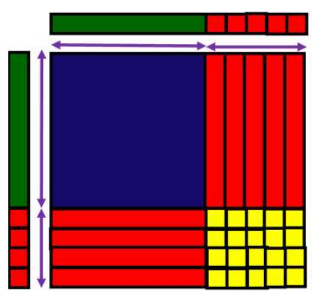
$\equiv x^2 + 4x + 5x + 20$

$\equiv x^2 + 9x + 20$

Expanding double brackets - both negative:

Expand $(x-4)(x-5)$

Using algebra tiles



Using area model

	x	-5
x	x^2	$-5x$
-4	$-4x$	$+20$

Collect like terms $(-4x) + (-5x) = (-9x)$

$\equiv x^2 - 4x - 5x + 20$

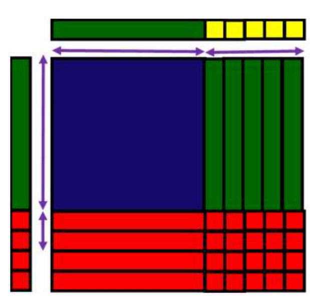
$\equiv x^2 - 9x + 20$

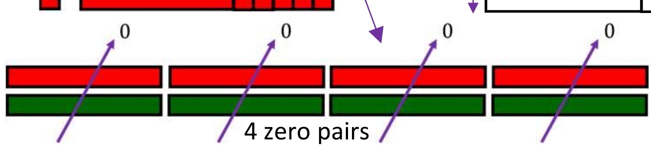
Multiplying by a negative changes the direction. $(-5) \times (-4) = +20$

Expanding double brackets - one positive one negative:

Expand $(x-4)(x+5)$

Using algebra tiles

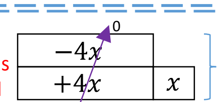




Using area model

	x	$+5$
x	x^2	$+5x$
-4	$-4x$	-20

Collect like terms Using bar model and zero pairs



$\equiv x^2 - 4x + 5x - 20$

$\equiv x^2 + x - 20$

Your turn to practice

Expand the following using the area model, and collect like terms:

1) $(x+2)(x+4)$	*6)* $(x-2)(x-4)$	*11)* $(x-2)(x+4)$
2) $(x+3)(x+5)$	*7)* $(x-3)(x-5)$	*12)* $(x+3)(x-5)$
3) $(x+6)(x+1)$	*8)* $(x-6)(x-1)$	*13)* $(x-6)(x+1)$
4) $(4+x)(x+4)$	*9)* $(4-x)(x-4)$	*14)* $(4+x)(x-4)$
5) $(x+\frac{1}{2})(x+\frac{2}{3})$	*10)* $(x-\frac{1}{2})(x-\frac{2}{3})$	*15)* $(x-\frac{1}{2})(x+\frac{2}{3})$

Answers

1) x^2+6x+8
2) $x^2+8x+15$
3) x^2+7x+6
4) $x^2+8x+16$
5) $x^2+\frac{7}{6}x+\frac{1}{3}$
6) x^2-6x+8
7) $x^2-8x+15$
8) x^2-7x+6
9) $-x^2+8x-16$
10) $x^2-\frac{7}{6}x+\frac{1}{3}$
11) x^2+2x-8
12) $x^2-2x-15$
13) x^2-5x-6
14) x^2-16
15) $x^2+\frac{1}{6}x-\frac{1}{3}$

Factorise a Quadratic

Keywords and Phrases:

Factorise – Factorising is the process of **finding the factors.**
Factorising is the opposite to expanding.

Coefficient - A number used to multiply a variable. E.g: $6z$ means 6 times z, and "z" is a variable, so 6 is a coefficient.

Expand: $(x+2)(x+1) \equiv x^2+3x+2$:Factorise

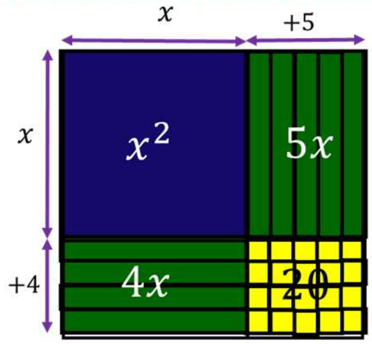
Factorise double brackets – all terms positive:

Factorise $x^2+9x+20$

Multiply to make 20

20
1×20
2×10
4×5

Which two factors sum to give $9x$



$x^2+9x+20 \equiv \mathbf{(x+4)(x+5)}$

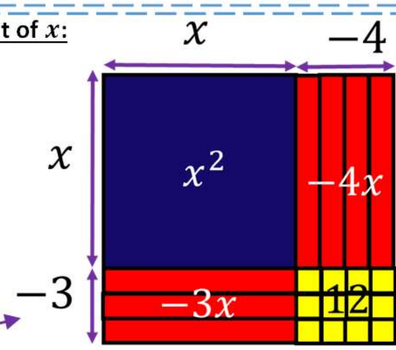
Factorise double brackets – Negative coefficient of x:

Factorise $x^2-7x+12$

Multiply to make 12

12
1×12
-1×-12
2×6
-2×-6
3×4
-3×-4

Which two factors sum to give $-7x$



$x^2-7x+12 \equiv \mathbf{(x-3)(x-4)}$

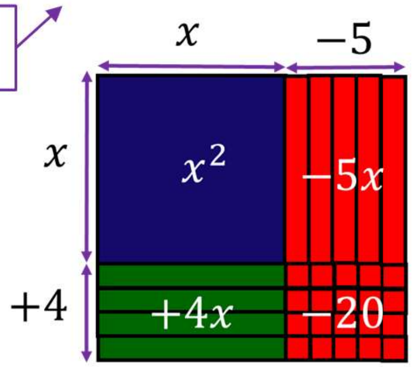
Factorise double brackets – Negative constant:

Factorise x^2-x-20

Multiply to make -20

-20
-1×20
1×-20
-2×10
2×-10
-4×5
4×-5

Which two factors sum to give $-x$



$x^2-x-20 \equiv \mathbf{(x-5)(x+4)}$
$\mathbf{(x+4)(x-5)}$

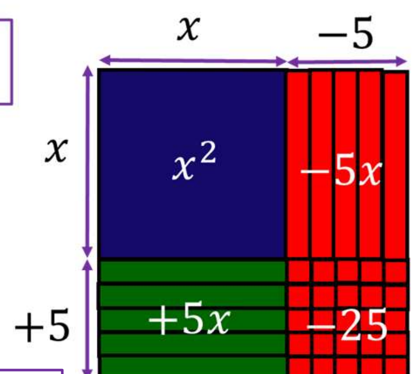
Factorise double brackets – Difference of two squares:

Factorise x^2-25

Multiply to make -25

-25
-1×25
1×-25
-5×5

Which two factors sum to give 0



$x^2-25 \equiv \mathbf{(x-5)(x+5)}$
$\mathbf{(x+5)(x-5)}$

Your turn to practice

1)	x^2+4x+3	6)	x^2-4x+3	11)	$x^2-7x-18$
2)	x^2+6x+9	7)	x^2-9x+8	12)	$x^2-3x-18$
3)	x^2+6x+5	8)	x^2-4x+4	13)	$x^2+17x-18$
4)	x^2+7x+6	9)	$x^2-9x+14$	14)	x^2-x-30
5)	$x^2+8x+16$	10)	$x^2-12x+20$	15)	$x^2-7x-30$

Answers

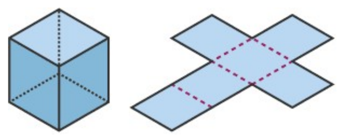
1) $(x+1)(x+3)$
2) $(x+3)(x+3)$
3) $(x+1)(x+5)$
4) $(x+1)(x+6)$
5) $(x+4)(x+4)$
6) $(x-1)(x-3)$
7) $(x-1)(x-8)$
8) $(x-2)(x-2)$
9) $(x-2)(x-7)$
10) $(x-2)(x-10)$
11) $(x-9)(x+2)$
12) $(x-6)(x+3)$
13) $(x+18)(x-1)$
14) $(x-6)(x+5)$
15) $(x-10)(x+3)$

Surface Area

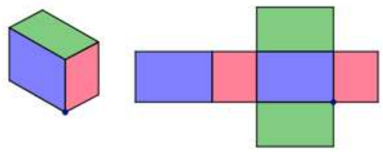
Keywords and Phrases:

Surface Area: The total area of all the faces or surfaces of a 3D shape.
Face: A flat surface on a 3D shape
Net: A 2D representation that can be folded to form a 3D shape
Units: Surface area is measured in square units (e.g. cm², m²).

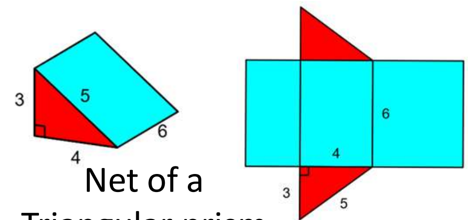
Nets:



Net of a cube

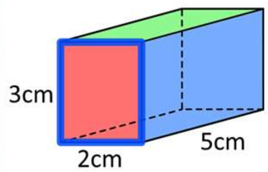


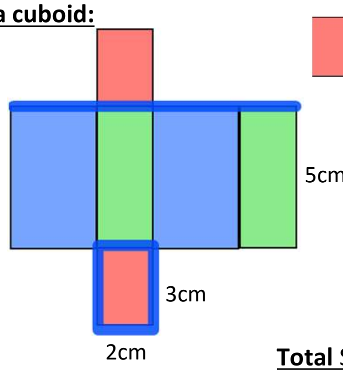
Net of a cuboid



Net of a Triangular prism

Calculating the surface area of a cuboid:





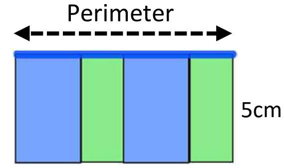
Front face area: $2 \times 3 = 6cm^2$

Back face area: $2 \times 3 = 6cm^2$

Middle face area:

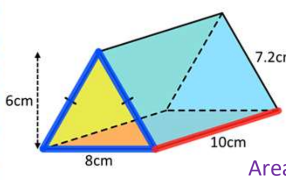
Perimeter $= 3 + 2 + 3 + 2$
$= 10cm$

$10 \times 5 = 50cm^2$



Total Surface area = Front face + back face + middle face
$= 6 + 6 + 50$ $\underline{= \mathbf{72cm^2}}$

Calculating the surface area of any other prism:

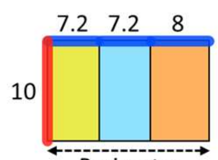


Front $= \frac{6 \times 8}{2} = \mathbf{24}$

Back $= \frac{6 \times 8}{2} = \mathbf{24}$

Area of Front and back faces will be the same

Middle faces



The perimeter of the front face

$22.4 \times 10 = \mathbf{224}$

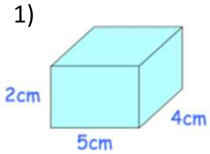
Total surface area

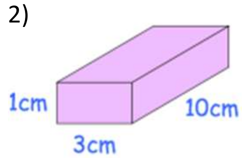
$= 24 + 24 + 224$ $\underline{= \mathbf{272cm^2}}$

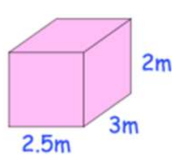
Your turn to practice

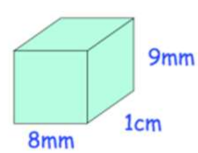
Calculate the surface area of the following 3D shapes:

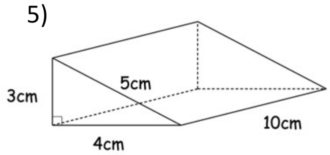
HINT units need to be the same

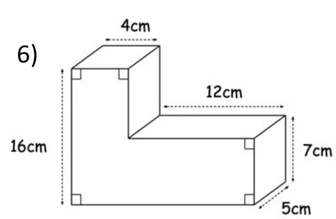
1) 

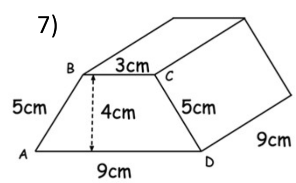
2) 

3) 

4) 

5) 

6) 

7) 

Answers
1) $76cm^2$
2) $86cm^2$
3) $37cm^2$
4) $484mm^2$
5) $132cm^2$
6) $616cm^2$
7) $246cm^2$