

Multiplication Chart



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Read across **and** down
to find the product of any two green numbers.

	0	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7	8	9	10
2	0	2	4	6	8	10	12	14	16	18	20
3	0	3	6	9	12	15	18	21	24	27	30
4	0	4	8	12	16	20	24	28	32	36	40
5	0	5	10	15	20	25	30	35	40	45	50
6	0	6	12	18	24	30	36	42	48	54	60
7	0	7	14	21	28	35	42	49	56	63	70
8	0	8	16	24	32	40	48	56	64	72	80
9	0	9	18	27	36	45	54	63	72	81	90
10	0	10	20	30	40	50	60	70	80	90	100

Read across **or** down to find the multiples of
any green number.



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Division 2

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$$\begin{array}{ccccc} 56 & \div & 8 & = & 7 \\ \text{dividend} & & \text{divisor} & & \text{quotient} \end{array}$$



Division Key Words: divide, divided by, remainder, dividend, divisor, quotient.

To divide larger numbers a horizontal algorithm is used with a division symbol often called the division bracket.

$$\begin{array}{r} 7 \text{ quotient (answer)} \\ \text{divisor } 8 \overline{) 56} \text{ dividend} \end{array}$$

Start at the left and work to the right.

Any remainders are moved to become the tens in the next place to the right.

Any final remainder may be written as shown.

$$\begin{array}{r} 13 \text{ r } 2 \\ 7 \overline{) 93} \end{array}$$

Remainder as a whole number.

$$\begin{array}{r} 239 \frac{1}{4} \\ 4 \overline{) 957} \end{array}$$

Remainder as a fraction.

$$\begin{array}{r} 117.25 \\ 8 \overline{) 938} \end{array}$$

Remainder as a decimal fraction.

Remainders may be written as whole numbers, fractions or decimal fractions.



Times Tables



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$1 \times 1 = 1$
 $2 \times 1 = 2$
 $3 \times 1 = 3$
 $4 \times 1 = 4$
 $5 \times 1 = 5$
 $6 \times 1 = 6$
 $7 \times 1 = 7$
 $8 \times 1 = 8$
 $9 \times 1 = 9$
 $10 \times 1 = 10$
 $11 \times 1 = 11$
 $12 \times 1 = 12$

$1 \times 2 = 2$
 $2 \times 2 = 4$
 $3 \times 2 = 6$
 $4 \times 2 = 8$
 $5 \times 2 = 10$
 $6 \times 2 = 12$
 $7 \times 2 = 14$
 $8 \times 2 = 16$
 $9 \times 2 = 18$
 $10 \times 2 = 20$
 $11 \times 2 = 22$
 $12 \times 2 = 24$

$1 \times 3 = 3$
 $2 \times 3 = 6$
 $3 \times 3 = 9$
 $4 \times 3 = 12$
 $5 \times 3 = 15$
 $6 \times 3 = 18$
 $7 \times 3 = 21$
 $8 \times 3 = 24$
 $9 \times 3 = 27$
 $10 \times 3 = 30$
 $11 \times 3 = 33$
 $12 \times 3 = 36$

$1 \times 4 = 4$
 $2 \times 4 = 8$
 $3 \times 4 = 12$
 $4 \times 4 = 16$
 $5 \times 4 = 20$
 $6 \times 4 = 24$
 $7 \times 4 = 28$
 $8 \times 4 = 32$
 $9 \times 4 = 36$
 $10 \times 4 = 40$
 $11 \times 4 = 44$
 $12 \times 4 = 48$

$1 \times 5 = 5$
 $2 \times 5 = 10$
 $3 \times 5 = 15$
 $4 \times 5 = 20$
 $5 \times 5 = 25$
 $6 \times 5 = 30$
 $7 \times 5 = 35$
 $8 \times 5 = 40$
 $9 \times 5 = 45$
 $10 \times 5 = 50$
 $11 \times 5 = 55$
 $12 \times 5 = 60$

$1 \times 6 = 6$
 $2 \times 6 = 12$
 $3 \times 6 = 18$
 $4 \times 6 = 24$
 $5 \times 6 = 30$
 $6 \times 6 = 36$
 $7 \times 6 = 42$
 $8 \times 6 = 48$
 $9 \times 6 = 54$
 $10 \times 6 = 60$
 $11 \times 6 = 66$
 $12 \times 6 = 72$

$1 \times 7 = 7$
 $2 \times 7 = 14$
 $3 \times 7 = 21$
 $4 \times 7 = 28$
 $5 \times 7 = 35$
 $6 \times 7 = 42$
 $7 \times 7 = 49$
 $8 \times 7 = 56$
 $9 \times 7 = 63$
 $10 \times 7 = 70$
 $11 \times 7 = 77$
 $12 \times 7 = 84$

$1 \times 8 = 8$
 $2 \times 8 = 16$
 $3 \times 8 = 24$
 $4 \times 8 = 32$
 $5 \times 8 = 40$
 $6 \times 8 = 48$
 $7 \times 8 = 56$
 $8 \times 8 = 64$
 $9 \times 8 = 72$
 $10 \times 8 = 80$
 $11 \times 8 = 88$
 $12 \times 8 = 96$

$1 \times 9 = 9$
 $2 \times 9 = 18$
 $3 \times 9 = 27$
 $4 \times 9 = 36$
 $5 \times 9 = 45$
 $6 \times 9 = 54$
 $7 \times 9 = 63$
 $8 \times 9 = 72$
 $9 \times 9 = 81$
 $10 \times 9 = 90$
 $11 \times 9 = 99$
 $12 \times 9 = 108$

$1 \times 10 = 10$
 $2 \times 10 = 20$
 $3 \times 10 = 30$
 $4 \times 10 = 40$
 $5 \times 10 = 50$
 $6 \times 10 = 60$
 $7 \times 10 = 70$
 $8 \times 10 = 80$
 $9 \times 10 = 90$
 $10 \times 10 = 100$
 $11 \times 10 = 110$
 $12 \times 10 = 120$

$1 \times 11 = 11$
 $2 \times 11 = 22$
 $3 \times 11 = 33$
 $4 \times 11 = 44$
 $5 \times 11 = 55$
 $6 \times 11 = 66$
 $7 \times 11 = 77$
 $8 \times 11 = 88$
 $9 \times 11 = 99$
 $10 \times 11 = 110$
 $11 \times 11 = 121$
 $12 \times 11 = 132$

$1 \times 12 = 12$
 $2 \times 12 = 24$
 $3 \times 12 = 36$
 $4 \times 12 = 48$
 $5 \times 12 = 60$
 $6 \times 12 = 72$
 $7 \times 12 = 84$
 $8 \times 12 = 96$
 $9 \times 12 = 108$
 $10 \times 12 = 120$
 $11 \times 12 = 132$
 $12 \times 12 = 144$

Factors and HCF

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A factor is a whole number that divides exactly into another given number.

That is, a whole number that multiplies with another number to make a third number.



To find the factors of a number, first divide by 1 and then keep working down using the next lowest number that will divide exactly. Record each factor pair.

$$\begin{array}{c} 20 \\ \wedge \\ 1 \times 20 \\ \wedge \\ 2 \times 10 \\ \wedge \\ 4 \times 5 \end{array}$$

$$\begin{array}{c} 24 \\ \wedge \\ 1 \times 24 \\ \wedge \\ 2 \times 12 \\ \wedge \\ 3 \times 8 \\ \wedge \\ 4 \times 6 \end{array}$$

$$\begin{array}{c} 48 \\ \wedge \\ 1 \times 48 \\ \wedge \\ 2 \times 24 \\ \wedge \\ 3 \times 16 \\ \wedge \\ 4 \times 12 \\ \wedge \\ 6 \times 8 \end{array}$$

$$\begin{array}{c} 96 \\ \wedge \\ 1 \times 96 \\ \wedge \\ 2 \times 48 \\ \wedge \\ 3 \times 32 \\ \wedge \\ 4 \times 24 \\ \wedge \\ 6 \times 16 \\ \wedge \\ 8 \times 12 \end{array}$$



The HCF or GCF is the highest or greatest common factor that will divide two or more other numbers exactly.

Finding the HCF or GCF

1. List the factors for each number.

20 1, 2, 4, 5, 10, 20

24 1, 2, 3, 4, 6, 8, 12, 24

2. List the common factors.

1, 2, 4

3. Record the highest.

HCF or GCF = 4



Divisibility rules

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A number is divisible by another number if it can be divided exactly without leaving a remainder.

Divisibility Chart



A number is divisible by ...	If ...	Divisible	Not Divisible
2	the last digit is divisible by 2	872 4	872 1
3	the sum of the digits is divisible by 3	8724 21	8722
4	the number made by the last two digits is divisible by 4	87 24	87 23
5	the last digit is 0 or 5	872 5	872 4
6	the number is divisible by both 2 and 3	8724	8722
7	the number is 0 or divisible by 7, after removing, doubling and subtracting the last digit from the number	8722 868	8724
8	the number made by the last three digits is divisible by 8	8 720	8 724
9	the sum of the digits is divisible by 9	8721 18	8724
10	the last digit is 0	872 0	872 4

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Long multiplication

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A traditional method used to multiply by a number which contains more than one digit.

The larger number to be multiplied is usually written on the top line with the smaller number written underneath.

Numbers are written underneath each other according to their place value. The numbers are multiplied vertically, starting with the ones column then moving left column by column.

The multiplication lines are then added together to give the final answer.

Example

$$\text{\$}43,864 \times 423 =$$

Multiply by
the digit in:

- the 1s column
- the 10s column
- the 100s column

Add the results

$$\begin{array}{r} 43864 \\ \times 423 \\ \hline 131592 \\ 877280 \\ 17545600 \\ \hline 18554472 \end{array}$$

Zero or blank spaces may be used as placeholders.

$$\text{\$}43,864 \times 423 = \text{\$}18,554,472$$

When a column is more than ten, the **tens** go into the next column left and are added to the answer in that line, the ones stay in their own column.

Rounding numbers 2

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Numbers are rounded to change them to a more convenient value.

← whole numbers decimal fractions →

Thousands	Hundreds	Tens	Ones	Decimal Point	Tenths	Hundredths	Thousandths	Ten-thousandths
6	9	4	5	.	3	7	2	8



The number of decimal places is the number of digits to the right of a decimal point.

A rounding instruction tells how many digits to keep.

1. Look at **the digit in the place value** to be rounded to.
2. Increase it by 1 if the **digit to the right of it** is 5 or more.
3. Leave it the same if the **digit to the right of it** is less than 5.
4. Remove everything to the right of the digit.



Round to the nearest ...

3 decimal places
(thousandth)

6945.37**28**

6945.37**3**

2 decimal places
(hundredth)

6945.3**728**

6945.3**7**

1 decimal place
(tenth)

6945.**3728**

6945.**4**

whole number

694**5.3728**

694**5**

When rounding to 10 or above
there's an important change to step 4.

4. Replace whole numbers to the right of the digit with zero(s), then remove everything to their right.

Round to the nearest ...

ten

69**45**.3728

69**50**

hundred

6**945**.3728

6**900**

thousand

6945.3728

7000



Long division

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To divide larger numbers a horizontal algorithm is used with a division symbol often called the division bracket.

Long Division Steps

Repeat the first four steps as often as necessary.

1. **D**ivide
2. **M**ultiply
3. **S**ubtract
4. **B**ring next digit down

Remainder

divisor 15) 8460 dividend

M 564 quotient (answer)

D 84 ÷ 15 = 5

M 5 x 15 = 75

S 84 - 75 = 9

B 6 to make 96

S 96

Example

$$\begin{array}{r}
 1225 \frac{13}{21} \\
 21 \overline{) 25738} \\
 \underline{-21} \\
 47 \\
 \underline{-42} \\
 53 \\
 \underline{-42} \\
 118 \\
 \underline{-105} \\
 13
 \end{array}$$

To calculate the final remainder as a decimal fraction, add a decimal point to the dividend and the quotient. Then add zeros as necessary and keep dividing until the required number of decimal places is reached.

$$\begin{array}{r}
 1225.619 \\
 21 \overline{) 25738.0000} \\
 1225.62 \\
 21 \overline{) 25738.000}
 \end{array}$$

The final remainder may be written as a fraction or decimal fraction, whole number(s) after the letter R or may be used to round the quotient (answer) to a whole number.

Key Words

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Key words can help us solve mathematical word problems.

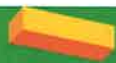


Addition

add
add to, added to
addition of
altogether
and
both

combined
extra
in all
increase by
increased by
join

more, more than
plus
sum
together
total, total of
whole amount



Subtraction

decrease, decreased
deduct
difference
difference between
dropped, fell
fewer, fewer than

how much less
how many more
how much more
how many left
how much left
less, less than

minus
nearer, further
reduce, reduced by
remaining
subtract
take away



Multiplication

area of
at
by
double, doubled
each had
groups of

multiplied by
of
multiple
per
product, product of
rate

rows of
sets of
times
triple
twice



Division

divide evenly
divided by
equal parts
equal pieces
fraction

for each, per
half, quarter
how many each
out of
percent, percentage

quotient
ratio, ratio of
share, share of
shared equally
split



Equals

answer to
corresponds to
equals
equates to
gives

is equal to
is identical to
is, are, would be
makes
matches

result is, results in
same amount, value
the same, same as
yields, produces

Order of operations

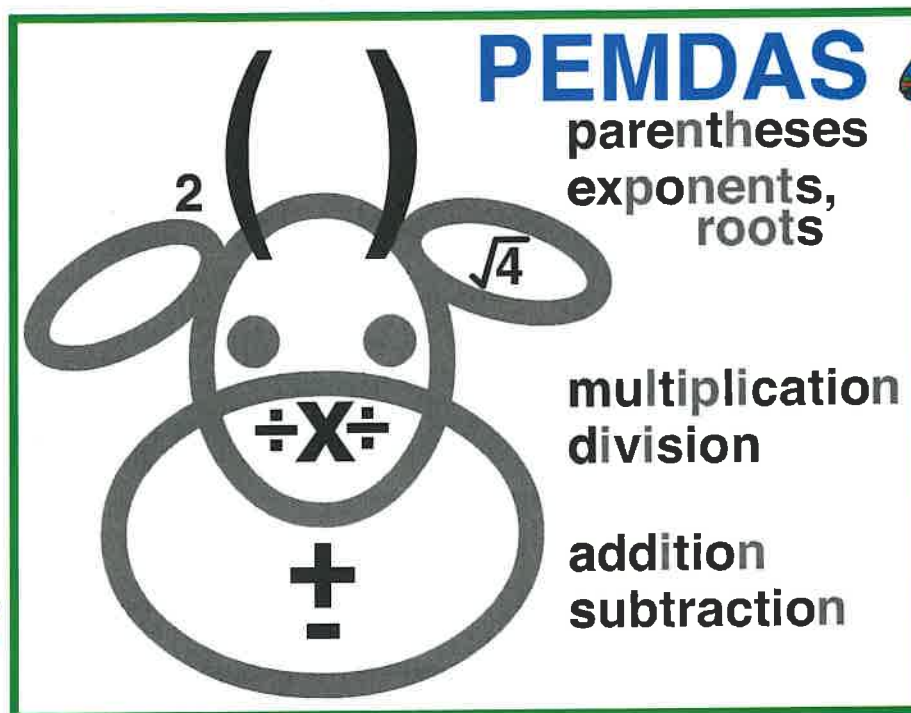
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In mathematics, the order of operations is the order in which operations should be done.

If you do the operations in the wrong order
– you will get the wrong answer!!

Often acronyms such as PEMDAS, BIDMAS or BODMAS are used to help remember the sequence.



PEMDAS

1. **P**arentheses () or { } or [] , brackets
2. **E**xponents (indices, orders, powers), roots
3. **M**ultiplication (times) **D**ivision (divided by)
Multiplication and division have equal precedence.
4. **A**ddition (plus) **S**ubtraction (minus)
Addition and subtraction have equal precedence.

RULE: Always work left to right.

12 Exponents, indices, powers, orders

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Exponents, indices, powers and orders all mean the same thing.

Exponent or index or power or order

An exponent (index, power or order) is a small number placed to the upper-right of a number which shows how many copies of the base number are multiplied together.

$5^4 = 5 \times 5 \times 5 \times 5 = 625$

base exponent, index, power or order expanded value

Examples

Base	Exponent, Index or Power	Expanded	Value	Read as
3	2	3 x 3	9	three squared OR three to the power of two
5	3	5 x 5 x 5	125	five cubed OR five to the power of three
10	4	10 x 10 x 10 x 10	10 000	ten to the power of four
4	5	4 x 4 x 4 x 4 x 4	1024	four to the power of five

10^3 10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}

1000 100 10 1 0.1 0.01 0.001

Types of fractions

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There are three main types of fractions.



Proper fraction

$$\frac{1}{2}$$

numerator
denominator

The numerator is less than the denominator.



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



$$\frac{2}{3}$$



$$\frac{7}{10}$$



Improper fraction

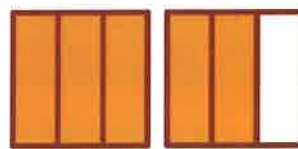
$$\frac{5}{2}$$

numerator
denominator

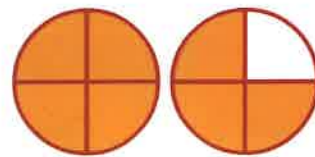
The numerator is larger than or equal to the denominator.



$$\frac{4}{4}$$



$$\frac{5}{3}$$



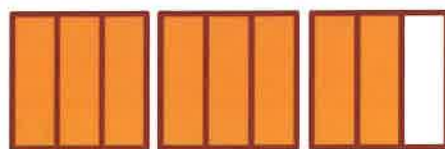
$$\frac{7}{4}$$



Mixed number

$$2\frac{1}{2}$$

A number written as a whole number with a proper fraction.

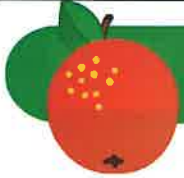


$$2\frac{2}{3}$$



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





Mixed number to improper fraction

1. Multiply the whole number by the denominator.
2. Add to the numerator.

Diagram illustrating the conversion of a mixed number to an improper fraction:

Whole number: 2, Numerator: 1, Denominator: 2. An arrow with a '+' sign points from the whole number to the numerator, and an arrow with a 'x' sign points from the whole number to the denominator. This is followed by a large red arrow pointing to the resulting improper fraction.

Resulting Improper fraction: Numerator: 5, Denominator: 2.

Mixed number

A whole number with a proper fraction.

Improper fraction

Numerator is larger than or equal to the denominator.



Improper fraction to mixed number.

1. Divide the numerator by the denominator.
2. Write as a whole number with fraction remainder.

Diagram illustrating the conversion of an improper fraction to a mixed number:

Improper fraction: Numerator: 5, Denominator: 2. A division symbol (÷) is shown to the left of the fraction, with a curved arrow pointing from the numerator to the denominator. This is followed by a large red arrow pointing to the resulting mixed number.

Resulting Mixed number: Whole number: 2, Numerator: 1, Denominator: 2.

Improper fraction

Numerator is larger than or equal to the denominator.

Mixed number

A whole number with a proper fraction.

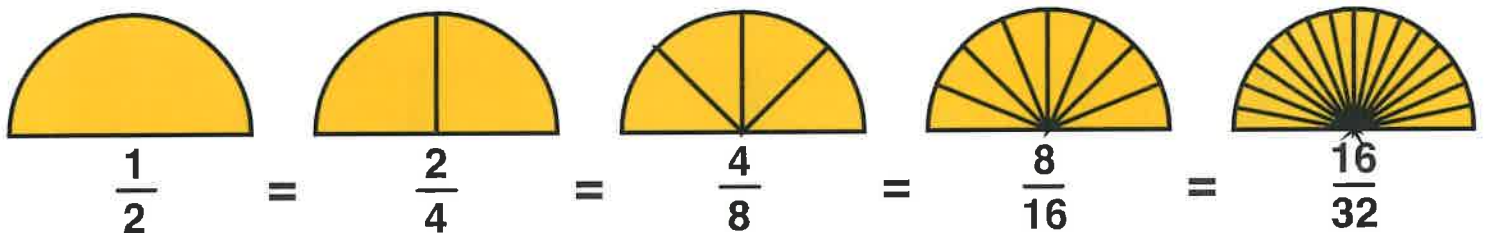
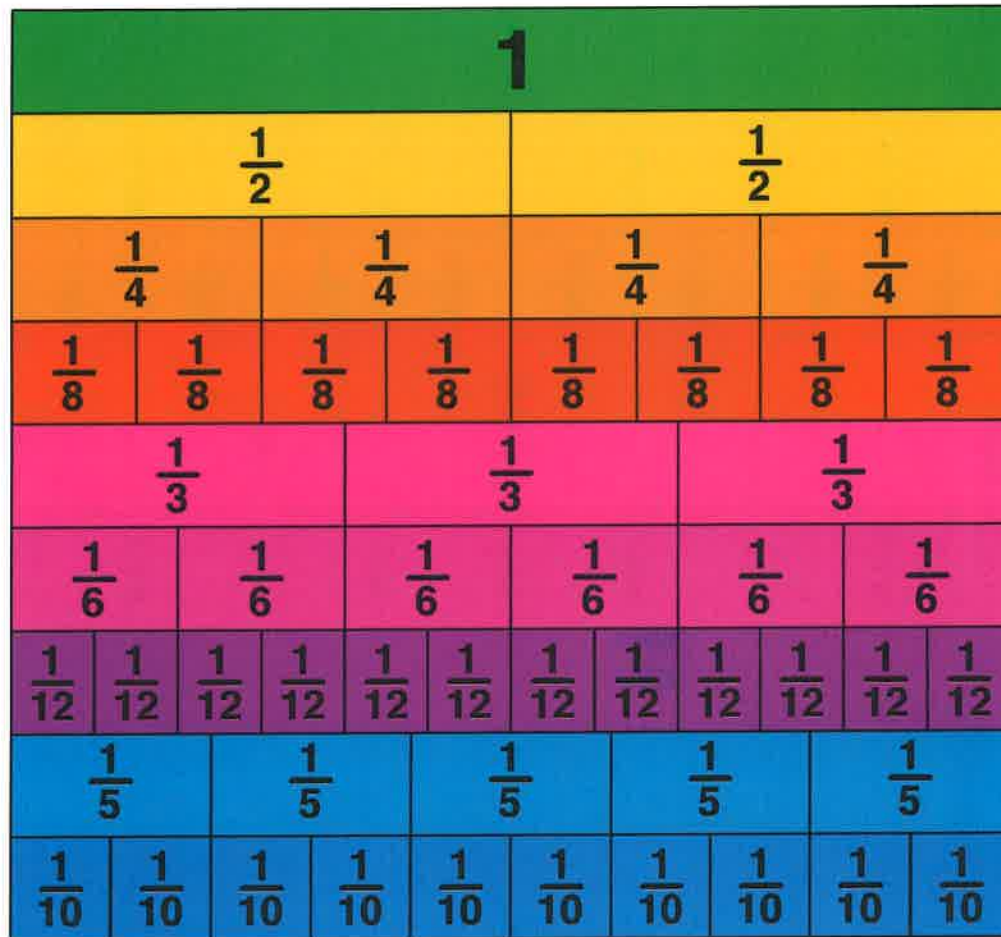


Equivalent Fractions

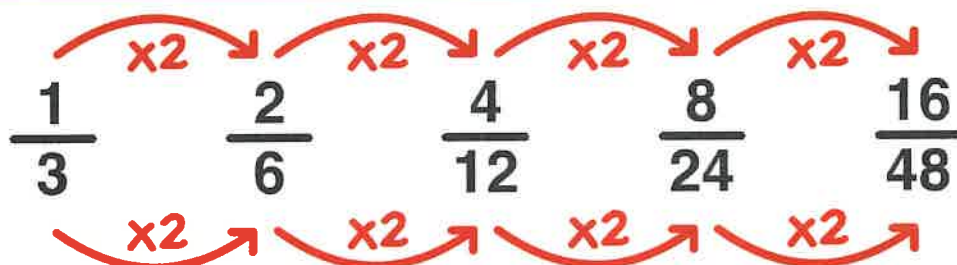
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Equivalent fractions have the same value.



You can make equivalent fractions by multiplying the numerator and the denominator by the same number.

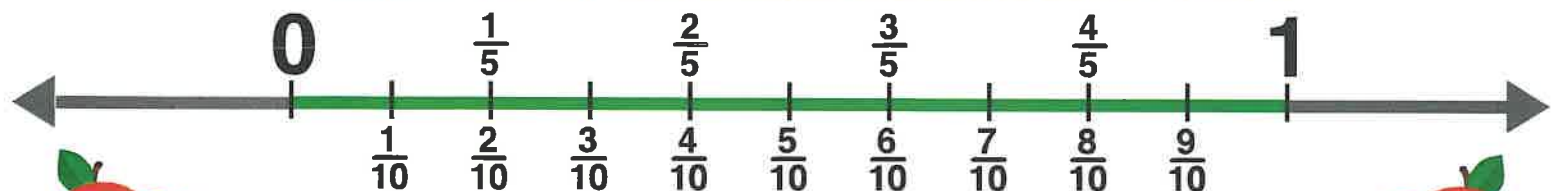
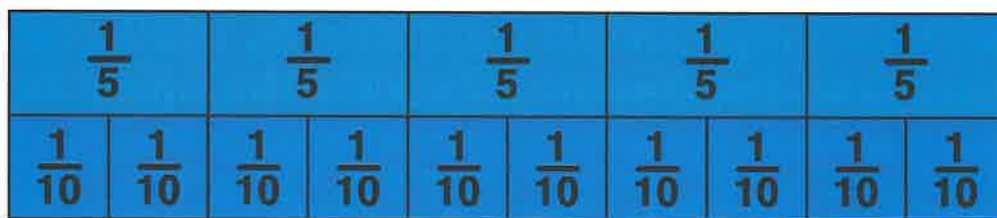
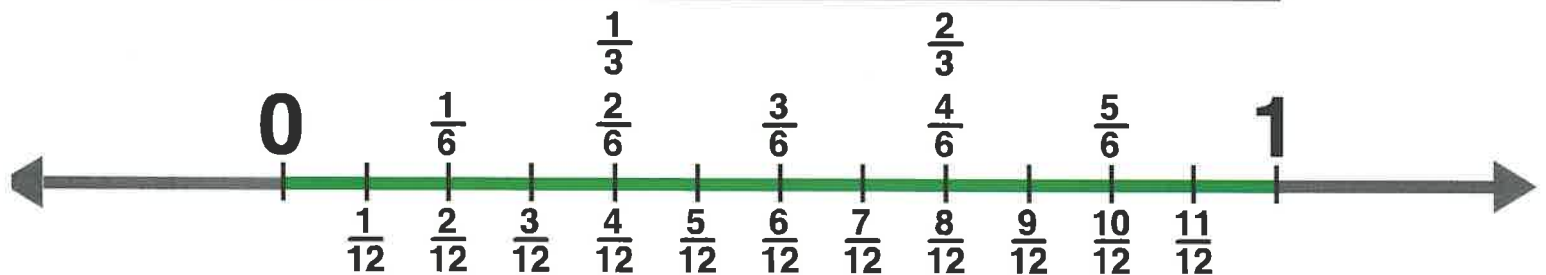
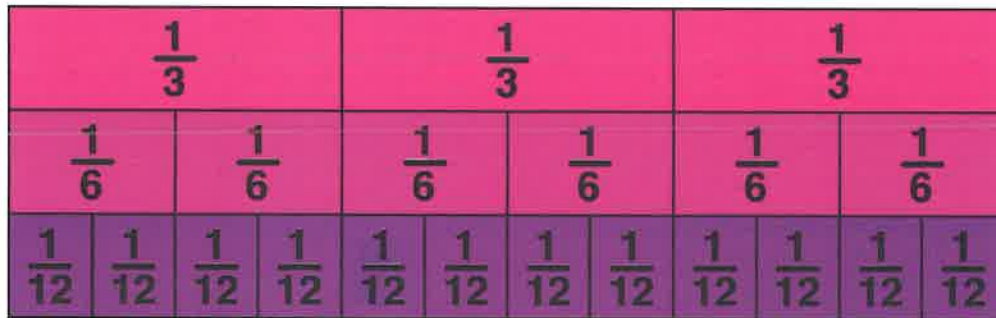
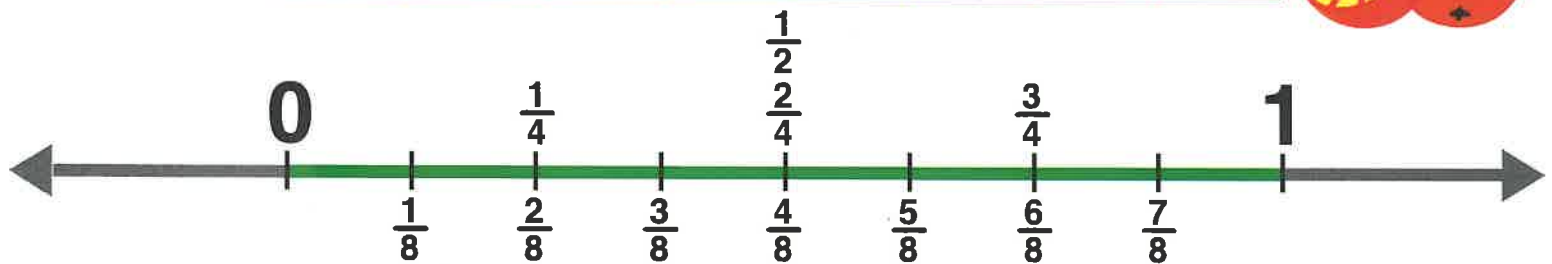
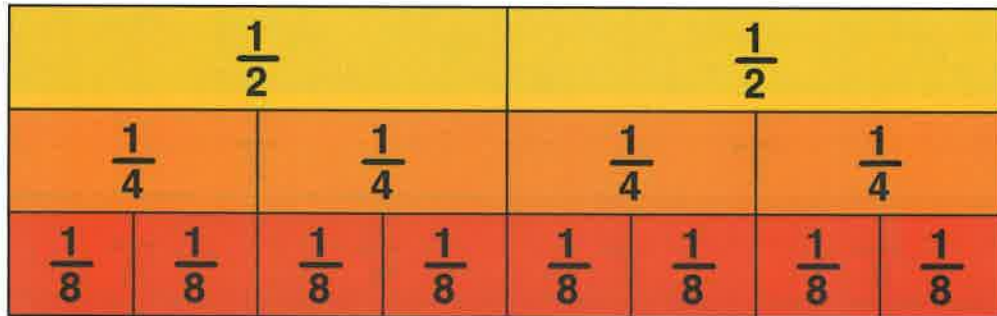


16 Ordering proper fractions

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Proper fractions can be ordered on a number line between 0 and 1.



Simplifying fractions

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Simplifying (or reducing) a fraction means reducing the fraction to an equivalent fraction that uses the lowest possible numbers for the numerator and the denominator.



This is done by dividing both the numerator and the denominator by the same number.

We can use a series of small numbers,

numerator $27 \xrightarrow{\div 3} 9 \xrightarrow{\div 3} 3 \xrightarrow{\div 3} 1$

denominator $54 \xrightarrow{\div 3} 18 \xrightarrow{\div 3} 6 \xrightarrow{\div 3} 2$

$\xrightarrow{\div 27}$

or, use the largest number possible.



This largest number is called the highest common factor (HCF) or greatest common factor (GCF).

$\frac{15}{20} \xrightarrow{\div 5} \frac{3}{4}$

$\frac{16}{40} \xrightarrow{\div 8} \frac{2}{5}$

$\frac{25}{100} \xrightarrow{\div 25} \frac{1}{4}$



To find the HCF or GCF ...

1. List the factors for the numerator and the denominator.

Example 16 1, 2, 4, 8, 16
 40 1, 2, 4, 5, 8, 10, 20, 40

2. List the common factors.

1, 2, 4, **8**

3. Circle the HCF/GCF.

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Adding fractions

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To add fractions ...



with the same denominators (like fractions).

- add the numerators
- the denominators stays the same
- simplify (reduce) the answer

EXAMPLE: $\frac{3}{10} + \frac{2}{10} = \frac{5}{10} = \frac{1}{2}$



with different denominators (unlike fractions).

- convert the fractions so they have a common denominator  Multiply the denominators
- add the numerators
- the denominators stay the same
- simplify (reduce) the answer

EXAMPLE: $\frac{1}{4} + \frac{3}{10} = \frac{10}{40} + \frac{12}{40} = \frac{22}{40} = \frac{11}{20}$



To simplify or reduce a fraction.

That is, reduce the numerator and denominator in a fraction to the smallest numbers possible.

- divide the numerator and denominator by their highest common factor (HCF or GCF)

$$\frac{15}{20} = \frac{3}{4}$$

Diagram showing division by 5: $15 \div 5 = 3$ and $20 \div 5 = 4$.

$$\frac{16}{40} = \frac{2}{5}$$

Diagram showing division by 8: $16 \div 8 = 2$ and $40 \div 8 = 5$.

$$\frac{25}{100} = \frac{1}{4}$$

Diagram showing division by 25: $25 \div 25 = 1$ and $100 \div 25 = 4$.



Subtracting fractions

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To subtract fractions ...



with the same denominators (like fractions).

- subtract the numerators
- the denominators stays the same
- simplify (reduce) the answer

EXAMPLE: $\frac{7}{10} - \frac{2}{10} = \frac{5}{10} = \frac{1}{2}$



with different denominators (unlike fractions).

- convert the fractions so they have a common denominator  Multiply the denominators
- subtract the numerators
- the denominators stay the same
- simplify (reduce) the answer

EXAMPLE: $\frac{3}{4} - \frac{1}{10} = \frac{30}{40} - \frac{4}{40} = \frac{26}{40} = \frac{13}{20}$



To simplify or reduce a fraction.

That is, reduce the numerator and denominator in a fraction to the smallest numbers possible.

- divide the numerator and denominator by their highest common factor (HCF or GCF)

$$\frac{15}{20} = \frac{3}{4}$$

Diagram showing division by 5: $15 \div 5 = 3$ and $20 \div 5 = 4$.

$$\frac{26}{40} = \frac{13}{20}$$

Diagram showing division by 2: $26 \div 2 = 13$ and $40 \div 2 = 20$.

$$\frac{25}{100} = \frac{1}{4}$$

Diagram showing division by 25: $25 \div 25 = 1$ and $100 \div 25 = 4$.



Multiplying fractions

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To multiply a fraction ...



by a whole number.

- multiply the numerator
- the denominator stays the same
- simplify (reduce) the answer

EXAMPLE: $5 \times \frac{3}{5} = \frac{15}{5} = \frac{3}{1} = 3$



by another fraction.

- multiply the numerators
- multiply the denominators
- simplify (reduce) the answer

EXAMPLE: $\frac{3}{4} \times \frac{4}{5} = \frac{12}{20} = \frac{3}{5}$



To simplify or reduce a fraction.

That is, reduce the numerator and denominator in a fraction to the smallest numbers possible.

- divide the numerator and denominator by their highest common factor (HCF or GCF)

$$\frac{6}{12} = \frac{1}{2}$$

Diagram showing division by 6: $\frac{6 \div 6}{12 \div 6} = \frac{1}{2}$

$$\frac{15}{20} = \frac{3}{4}$$

Diagram showing division by 5: $\frac{15 \div 5}{20 \div 5} = \frac{3}{4}$

$$\frac{25}{100} = \frac{1}{4}$$

Diagram showing division by 25: $\frac{25 \div 25}{100 \div 25} = \frac{1}{4}$



Dividing fractions

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Because division is the opposite of multiplication, to divide a fraction, invert the fraction doing the dividing and then multiply.



by another fraction.

- invert the dividing fraction
- multiply the numerators
- multiply the denominators
- simplify (reduce) the answer

EXAMPLE: $\frac{3}{4} \div \frac{1}{3} = \frac{3}{4} \times \frac{3}{1} = \frac{9}{4}$ OR $2\frac{1}{4}$



by a whole number.

- write the whole number as a fraction, invert
- multiply the numerators
- multiply the denominators
- simplify (reduce) the answer if necessary

EXAMPLE: $\frac{3}{4} \div 5 = \frac{3}{4} \div \frac{5}{1} = \frac{3}{4} \times \frac{1}{5} = \frac{3}{20}$



To simplify or reduce a fraction.

That is, reduce the numerator and denominator in a fraction to the smallest numbers possible.

- divide the numerator and denominator by their highest common factor (HCF or GCF)

$$\frac{6}{12} = \frac{1}{2}$$

Diagram showing division by 6: $6 \div 6 = 1$ and $12 \div 6 = 2$.

$$\frac{15}{20} = \frac{3}{4}$$

Diagram showing division by 5: $15 \div 5 = 3$ and $20 \div 5 = 4$.

$$\frac{25}{100} = \frac{1}{4}$$

Diagram showing division by 25: $25 \div 25 = 1$ and $100 \div 25 = 4$.



Reciprocals of fractions

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Two fractions are reciprocals of each other if their product equals 1.



To get the reciprocal of a fraction ...

turn it upside down.

reciprocal

$$\frac{1}{2} \rightarrow \frac{2}{1}$$

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

reciprocal

$$\frac{2}{3} \rightarrow \frac{3}{2}$$

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

reciprocal

$$\frac{7}{8} \rightarrow \frac{8}{7}$$

$$\frac{7}{8} \times \frac{8}{7} = \frac{56}{56} = 1$$



Fractions, decimals, percentages 23

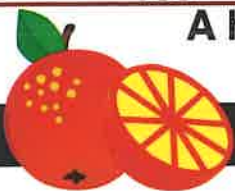
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Fraction	Equivalent Fractions	Decimal	Percent
$\frac{1}{2}$	$\frac{2}{4}$ $\frac{3}{6}$ $\frac{5}{10}$ $\frac{10}{20}$ $\frac{50}{100}$	0.5	50%
$\frac{1}{3}$	$\frac{2}{6}$ $\frac{3}{9}$ $\frac{4}{12}$ $\frac{10}{30}$ $\frac{30}{90}$	$0.\bar{3}$	33.3%
$\frac{2}{3}$	$\frac{4}{6}$ $\frac{6}{9}$ $\frac{8}{12}$ $\frac{20}{30}$ $\frac{60}{90}$	$0.\bar{6}$	66.6%
$\frac{1}{4}$	$\frac{2}{8}$ $\frac{3}{12}$ $\frac{4}{16}$ $\frac{10}{40}$ $\frac{25}{100}$	0.25	25%
$\frac{3}{4}$	$\frac{6}{8}$ $\frac{9}{12}$ $\frac{12}{16}$ $\frac{30}{40}$ $\frac{75}{100}$	0.75	75%
$\frac{1}{5}$	$\frac{2}{10}$ $\frac{3}{15}$ $\frac{4}{20}$ $\frac{10}{50}$ $\frac{20}{100}$	0.2	20%
$\frac{3}{5}$	$\frac{6}{10}$ $\frac{9}{15}$ $\frac{12}{20}$ $\frac{30}{50}$ $\frac{60}{100}$	0.6	60%
$\frac{4}{5}$	$\frac{8}{10}$ $\frac{12}{15}$ $\frac{16}{20}$ $\frac{40}{50}$ $\frac{80}{100}$	0.8	80%
$\frac{1}{6}$	$\frac{2}{12}$ $\frac{3}{18}$ $\frac{4}{24}$ $\frac{10}{60}$ $\frac{20}{120}$	$0.1\bar{6}$	16.7%
$\frac{5}{6}$	$\frac{10}{12}$ $\frac{15}{18}$ $\frac{20}{24}$ $\frac{50}{60}$ $\frac{100}{120}$	$0.8\bar{3}$	83.3%
$\frac{1}{7}$	$\frac{2}{14}$ $\frac{3}{21}$ $\frac{4}{28}$ $\frac{10}{70}$ $\frac{20}{140}$	0.142857	14.3%
$\frac{1}{8}$	$\frac{2}{16}$ $\frac{3}{24}$ $\frac{4}{32}$ $\frac{10}{80}$ $\frac{20}{160}$	0.125	12.5%
$\frac{3}{8}$	$\frac{6}{16}$ $\frac{9}{24}$ $\frac{12}{32}$ $\frac{30}{80}$ $\frac{60}{160}$	0.375	37.5%
$\frac{5}{8}$	$\frac{10}{16}$ $\frac{15}{24}$ $\frac{20}{32}$ $\frac{50}{80}$ $\frac{100}{160}$	0.625	62.5%
$\frac{1}{9}$	$\frac{2}{18}$ $\frac{3}{27}$ $\frac{4}{36}$ $\frac{10}{90}$ $\frac{20}{180}$	$0.\bar{1}$	11.1%
$\frac{2}{9}$	$\frac{4}{18}$ $\frac{6}{27}$ $\frac{8}{36}$ $\frac{20}{90}$ $\frac{40}{180}$	$0.\bar{2}$	22.2%
$\frac{4}{9}$	$\frac{8}{18}$ $\frac{12}{27}$ $\frac{16}{36}$ $\frac{40}{90}$ $\frac{80}{180}$	$0.\bar{4}$	44.4%
$\frac{5}{9}$	$\frac{10}{18}$ $\frac{15}{27}$ $\frac{20}{36}$ $\frac{50}{90}$ $\frac{100}{180}$	$0.\bar{5}$	55.5%
$\frac{7}{9}$	$\frac{14}{18}$ $\frac{21}{27}$ $\frac{28}{36}$ $\frac{70}{90}$ $\frac{140}{180}$	$0.\bar{7}$	77.8%
$\frac{8}{9}$	$\frac{16}{18}$ $\frac{24}{27}$ $\frac{32}{36}$ $\frac{80}{90}$ $\frac{160}{180}$	$0.\bar{8}$	88.9%
$\frac{1}{10}$	$\frac{2}{20}$ $\frac{3}{30}$ $\frac{4}{40}$ $\frac{5}{50}$ $\frac{10}{100}$	0.1	10%
$\frac{1}{100}$	$\frac{2}{200}$ $\frac{3}{300}$ $\frac{4}{400}$ $\frac{5}{500}$ $\frac{10}{1000}$	0.01	1%

A horizontal bar over a digit in a decimal means that digit repeats forever, eg, $0.\bar{3} = 0.333333333 \dots$

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Fractions, decimals, percentages ... conversions.

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Fraction to Decimal

Divide the numerator by the denominator.

$$\frac{1}{4} \quad 4 \overline{) 1.00} \quad \begin{array}{r} 0.25 \\ 1.00 \end{array}$$

Decimal to Fraction

Write the decimal over the number of its place value, then simplify (reduce).

$$0.25 = \frac{25}{100} = \frac{1}{4}$$



Fraction to Percent

Multiply the fraction by 100, simplify (reduce), add the % symbol.

$$\frac{1}{4} \times \frac{100}{1} = \frac{100}{4} = 25\%$$

Percent to Fraction

Remove the % symbol, write as a fraction with a denominator of 100, then simplify (reduce).

$$25\% = \frac{25}{100} = \frac{1}{4}$$

With a decimal percentage, first multiply the numerator and the denominator by 10 until the numerator is a whole number.

$$2.5\% = \frac{25}{1000} = \frac{1}{40}$$



Percent to Decimal

Remove the % symbol, divide the number by 100.

$$25\%$$

$$25 \div 100 = 0.25$$

Decimal to Percent

Multiply by 100, add the % symbol.

$$0.25$$

$$0.25 \times 100 = 25\%$$



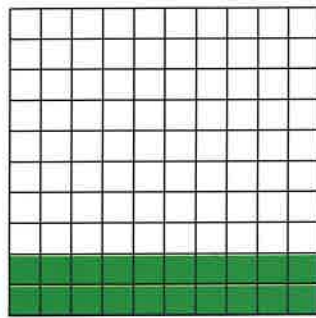
Percent, percentage

25

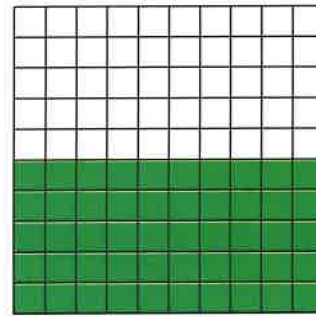
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A percentage is a fraction expressed as a number out of 100 followed by the % symbol.

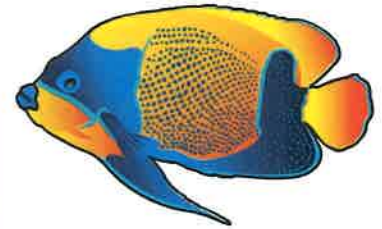
Percent comes from the Latin term 'per centum' meaning per hundred.



$$\frac{20}{100} = 20\%$$



$$\frac{50}{100} = 50\%$$



To convert a fraction or a decimal to a percentage multiply by 100 then add the % symbol.

Fraction

$$\frac{1}{4} \times \frac{100}{1} = \frac{100}{4} = 25\%$$

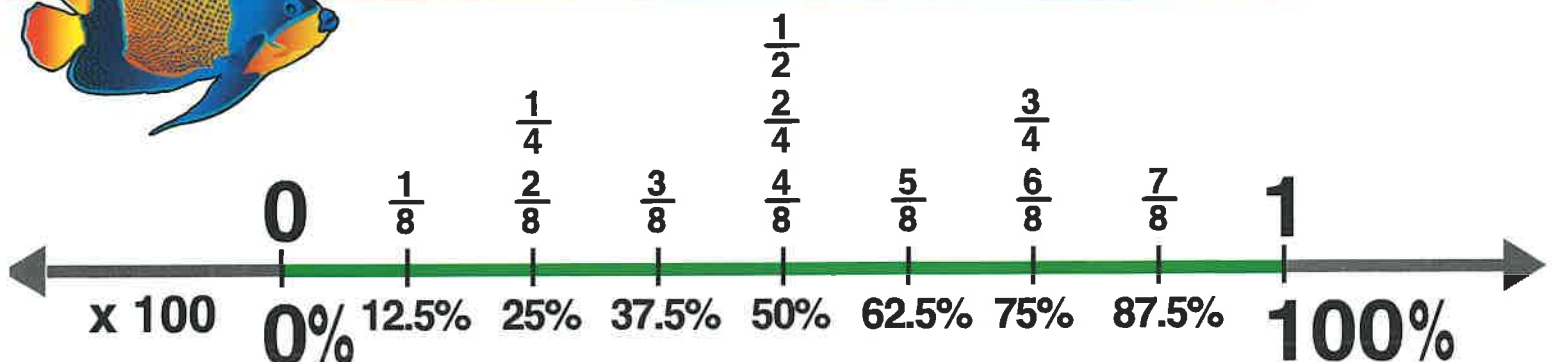
Multiply the fraction by 100, simplify, add the % symbol.

Decimal

$$0.25 \times 100 = 25\%$$

Multiply by 100, add the % symbol.

Comparing fractions and percentages.

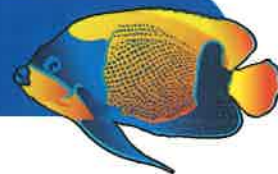


Percentages and amounts

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To calculate a percentage of an amount, write the percent as a fraction and multiply by the amount.

$$\frac{\text{percent}}{100} \times \text{amount} =$$



$$11\% \text{ of } 40 = \frac{11}{100} \times 40 = \frac{440}{100} = 4.4$$

Sometimes, it is easier to simplify the fraction before multiplying.

$$25\% \text{ of } 160 = \frac{25}{100} \times 160 = \frac{1}{4} \times 160 = \frac{160}{4} = 40$$

$$200\% \text{ of } 35 = \frac{200}{100} \times 35 = \frac{2}{1} \times 35 = \frac{70}{1} = 70$$

With a decimal percentage, first multiply the numerator and the denominator by 10 until the numerator is a whole number.

$$33.3\% \text{ of } \$90 = \frac{333}{1000} \times 90 = \frac{29970}{1000} = \$29.97$$

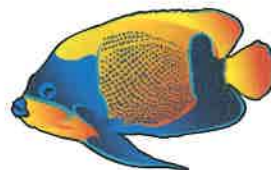
To calculate an amount as a percentage of a total, write the amount over the total as a fraction and multiply by 100.

$$\frac{\text{amount}}{\text{total}} \times 100 =$$

In a fish tank holding 20 fish there are 4 yellow fish and 16 gold fish.
What percentage of fish are yellow?



$$\frac{4}{20} \times 100 = \frac{400}{20} = 20\%$$



Out of 360 students at the school 324 are present today.
What percentage of students are absent ?

(360 - 324 = 36)
324 present so
36 are absent

$$\frac{36}{360} \times 100 = \frac{3600}{360} = 10\%$$

There are 10% of students absent.



Sales tax

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Sales tax is a tax that is added to the price of particular goods and services, usually as a percentage of the purchase price.



$$\text{sales tax} = \left(\frac{\text{percent}}{100} \times \text{price} \right)$$

Sales tax may be called by various names, for example, Goods and Services Tax (GST) or Value Added Tax (VAT).

Examples of different rates of sales tax.

Item and Price	Sales Tax and Total Cost			
Before Sales Tax	10%	15%	20%	25%
 \$10.00	\$1.00 \$11.00	\$1.50 \$11.50	\$2.00 \$12.00	\$2.50 \$12.50
 \$50.00	\$5.00 \$55.00	\$7.50 \$57.50	\$10.00 \$60.00	\$12.50 \$62.50
 \$100.00	\$10.00 \$110.00	\$15.00 \$115.00	\$20.00 \$120.00	\$25.00 \$125.00

Discounts and markdowns

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To calculate the cost of an item when a percentage discount (or markdown) is offered, write the percent as a fraction, multiply by the price, then subtract that amount from the original price.

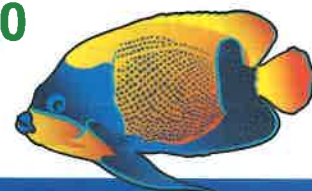
$$\text{discount} = \left(\frac{\text{percent}}{100} \times \text{price} \right) \quad \text{cost} = \text{price} - \text{discount}$$

In a 15% off everything sale, how much would a pair of \$20.00 shoes cost?

$$\text{Discount} = \frac{15}{100} \times 20 = \frac{300}{100} = \$3.00$$

$$\text{Cost} = \$20.00 - \$3.00 = \$17.00$$

The \$20.00 shoes will cost \$17.00.



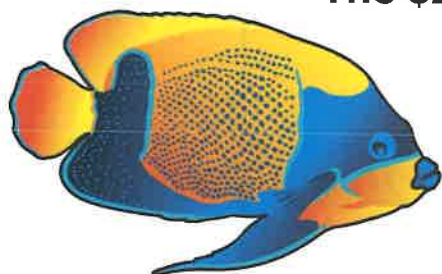
To calculate the percentage discount of an item when a dollar discount (or markdown) is offered, write the discount as a fraction of the original price then multiply by 100.

$$\% \text{ discount} = \left(\frac{\text{discount}}{\text{price}} \times 100 \right)$$

Another shoe shop is offering a \$4.00 discount on shoes over \$15.00. What is the percentage discount on a pair of \$20.00 shoes?

$$\% \text{ Discount} = \frac{4}{20} \times 100 = \frac{400}{20} = 20\%$$

The \$20.00 shoes are discounted by 20%.



Percentages can help find the best deal.



Percentages, decimals, fractions

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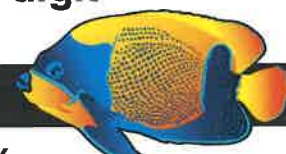
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Percent	Decimal	Fraction	Equivalent Fractions
1%	0.01	$\frac{1}{100}$	$\frac{2}{200}$ $\frac{3}{300}$ $\frac{4}{400}$ $\frac{5}{500}$ $\frac{10}{1000}$
10%	0.1	$\frac{1}{10}$	$\frac{2}{20}$ $\frac{3}{30}$ $\frac{4}{40}$ $\frac{5}{50}$ $\frac{10}{100}$
12.5%	0.125	$\frac{1}{8}$	$\frac{2}{16}$ $\frac{3}{24}$ $\frac{4}{32}$ $\frac{10}{80}$ $\frac{20}{160}$
16.7%	$0.\overline{16}$	$\frac{1}{6}$	$\frac{2}{12}$ $\frac{3}{18}$ $\frac{4}{24}$ $\frac{10}{60}$ $\frac{20}{120}$
20%	0.2	$\frac{1}{5}$	$\frac{2}{10}$ $\frac{3}{15}$ $\frac{4}{20}$ $\frac{10}{50}$ $\frac{20}{100}$
25%	0.25	$\frac{1}{4}$	$\frac{2}{8}$ $\frac{3}{12}$ $\frac{4}{16}$ $\frac{10}{40}$ $\frac{25}{100}$
30%	0.3	$\frac{3}{10}$	$\frac{6}{20}$ $\frac{9}{30}$ $\frac{12}{40}$ $\frac{15}{50}$ $\frac{30}{100}$
33.3%	$0.\overline{3}$	$\frac{1}{3}$	$\frac{2}{6}$ $\frac{3}{9}$ $\frac{4}{12}$ $\frac{10}{30}$ $\frac{30}{90}$
37.5%	0.375	$\frac{3}{8}$	$\frac{6}{16}$ $\frac{9}{24}$ $\frac{12}{32}$ $\frac{30}{80}$ $\frac{60}{160}$
40%	0.4	$\frac{4}{10}$	$\frac{8}{20}$ $\frac{12}{30}$ $\frac{16}{40}$ $\frac{20}{50}$ $\frac{40}{100}$
50%	0.5	$\frac{1}{2}$	$\frac{2}{4}$ $\frac{3}{6}$ $\frac{5}{10}$ $\frac{10}{20}$ $\frac{50}{100}$
60%	0.6	$\frac{3}{5}$	$\frac{6}{10}$ $\frac{9}{15}$ $\frac{12}{20}$ $\frac{30}{50}$ $\frac{60}{100}$
62.5%	0.625	$\frac{5}{8}$	$\frac{10}{16}$ $\frac{15}{24}$ $\frac{20}{32}$ $\frac{50}{80}$ $\frac{100}{160}$
66.6%	$0.\overline{6}$	$\frac{2}{3}$	$\frac{4}{6}$ $\frac{6}{9}$ $\frac{8}{12}$ $\frac{20}{30}$ $\frac{60}{90}$
70%	0.7	$\frac{7}{10}$	$\frac{14}{20}$ $\frac{21}{30}$ $\frac{28}{40}$ $\frac{35}{50}$ $\frac{70}{100}$
75%	0.75	$\frac{3}{4}$	$\frac{6}{8}$ $\frac{9}{12}$ $\frac{12}{16}$ $\frac{30}{40}$ $\frac{75}{100}$
80%	0.8	$\frac{4}{5}$	$\frac{8}{10}$ $\frac{12}{15}$ $\frac{16}{20}$ $\frac{40}{50}$ $\frac{80}{100}$
83.3%	$0.8\overline{3}$	$\frac{5}{6}$	$\frac{10}{12}$ $\frac{15}{18}$ $\frac{20}{24}$ $\frac{50}{60}$ $\frac{100}{120}$
90%	0.9	$\frac{9}{10}$	$\frac{18}{20}$ $\frac{27}{30}$ $\frac{36}{40}$ $\frac{45}{50}$ $\frac{90}{100}$
100%	1	$\frac{1}{1}$	$\frac{100}{100}$ $\frac{200}{200}$ $\frac{300}{300}$ $\frac{500}{500}$ $\frac{1000}{1000}$
150%	1.5	$1\frac{1}{2}$ or $\frac{3}{2}$	$\frac{150}{100}$ $\frac{300}{200}$ $\frac{450}{300}$ $\frac{750}{500}$ $\frac{1500}{1000}$
200%	2	$\frac{2}{1}$	$\frac{200}{100}$ $\frac{400}{200}$ $\frac{600}{300}$ $\frac{1000}{500}$ $\frac{2000}{1000}$

A horizontal bar over a digit in a decimal means that digit repeats forever, eg, $0.\overline{3} = 0.333333333 \dots$

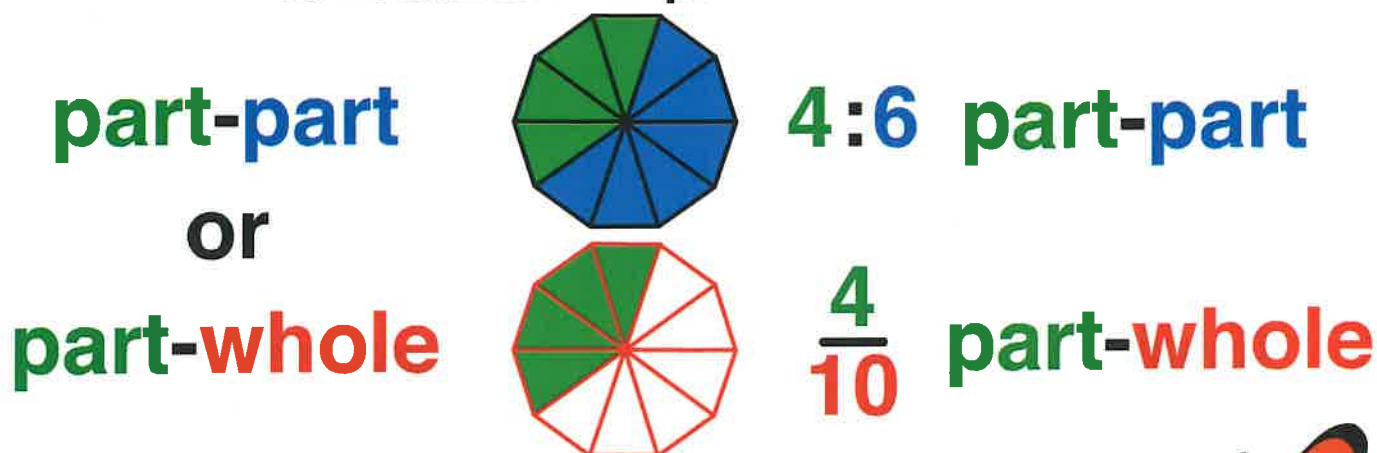
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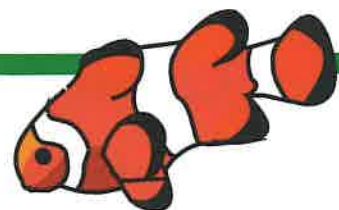


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A ratio shows the relative sizes of two or more like values. A ratio may compare a number of parts to another number of parts in the whole **or** compare a number of parts to the total number of parts in the whole.



A ratio can be written as:
4 to 6 or **4:6** or **$\frac{4}{6}$**



The numbers in a ratio are called terms.
A ratio may have more than two terms, e.g. 4:5:3:1

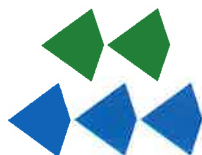
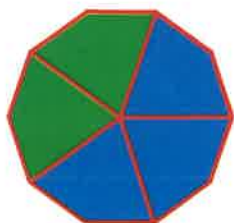
Simplifying a ratio.

Just like simplifying a fraction, a ratio is simplified by finding the highest common factor (HCF or GCF) to divide each term.

EXAMPLE: **4:6 = 2:3** both terms divided by 2

Writing part-part ratios as fractions.

When comparing two terms in a ratio, each term can be written as a fraction of the other.



$$2:3 \quad 2 = \frac{2}{3} \times 3 \quad 3 = \frac{3}{2} \times 2$$

Problem solving with ratios

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Determining quantities when a part is known.

Step 1: Find the value of a single part of the ratio.

Step 2: Multiply this number by the other term(s) to find their share or quantity.

The ratio of slices of tomato to cucumber to onion in a salad is 5:4:2. If there are 20 tomato slices, how many slices of cucumber and onion are there?

$$\begin{aligned}\text{Tomato: } 5 \text{ parts} &= 20 \\ 1 \text{ part} &= 20 \div 5 \\ &= 4\end{aligned}$$

$$\begin{aligned}\text{Cucumber: } 4 \text{ parts} &= 4 \times 4 \\ &= 16\end{aligned}$$

$$\begin{aligned}\text{Onion: } 2 \text{ parts} &= 2 \times 4 \\ &= 8\end{aligned}$$



$$5:4:2$$

$$20:16:8$$

There are 16 cucumber slices and 8 slices of onion.

Determining quantities when the total is known.

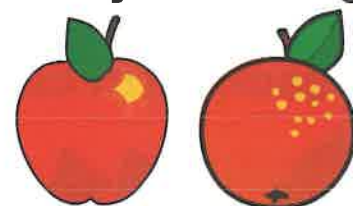
Step 1: Add the terms to get the total of number of parts.

Step 2: Divide the total quantity by number of parts.

Step 3: Multiply this number by the other term(s) to find their share or quantity.

In a fruit bowl containing apples and oranges the ratio is 3:5. If there are 24 pieces of fruit in total, how many are oranges?

$$\begin{aligned}\text{Total parts: } & 3 + 5 = 8 \\ \text{Single part: } & 24 \div 8 = 3 \\ & 1 \text{ part} = 3 \\ \text{Oranges: } 5 \text{ parts} &= 5 \times 3 \\ &= 15\end{aligned}$$



$$3:5 = 9:15$$

There are 15 oranges.

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A **ratio** compares quantities which are measured in the same units.

A **rate** compares quantities which are measured in different units.

A rate is written as the first quantity per ONE of the second quantity.

dollars **per** night
kilometres **per** hour
births **per** year
beats **per** minute



Determining the first quantity when the second quantity is known.

Multiply the first quantity by the number of the second quantity.

Examples: A hotel room costs \$120.00 per night.
How much for 3 nights?
 $\$120.00 \times 3 = \$360.00$

A car travelled at an average of 80 km per hour.
How far would it travel in 5 hours?
 $80 \times 5 = 400$ kilometres

Determining the second quantity when the first quantity is known.

Divide the known quantity by the number of the first quantity.

Examples: The annual birth rate is 2000 births per year.
How many years before there are 6000 births.
 $6000 \div 2000 = 3$ years



A runner's heart rate was 140 beats per minute.
He counted 420 beats. How long did he count?
 $420 \div 140 = 3$ minutes

33 Equivalent ratios and rates

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Equivalent ratios and rates are formed by multiplying or dividing all their terms by the same number.

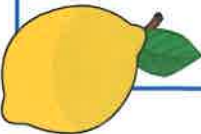
$$\begin{array}{ccccccc} \xrightarrow{\times 2} & \xrightarrow{\times 2} & \xrightarrow{\times 5} & \xrightarrow{\times 10} & & & \\ 2:3 & 4:6 & 8:12 & 40:60 & 400:600 & & \end{array}$$

$$\begin{array}{ccccccc} \xrightarrow{\times 2} & \xrightarrow{\times 2} & \xrightarrow{\times 5} & \xrightarrow{\times 10} & & & \\ \xrightarrow{\div 10} & \xrightarrow{\div 5} & \xrightarrow{\div 2} & \xrightarrow{\div 2} & & & \\ 800:1000 & 80:100 & 16:20 & 8:10 & 4:5 & & \end{array}$$

Tables are useful when comparing equivalent ratios and rates.

Ratio: Lemonade Recipe

Mix cups of water, lemon juice and sugar in the ratio 3:1:1.



Water	3	6	12	24	48
Lemon Juice	1	2	4	8	16
Sugar	1	2	4	8	16

In this table, the terms are doubled each time.

Rate: Hotel Room Rate

The cost of a deluxe room at Hotel Math is \$120.00 per night.

Nights	1	2	3	4	5	6	7
Cost	\$120	\$240	\$360	\$480	\$600	\$720	\$840

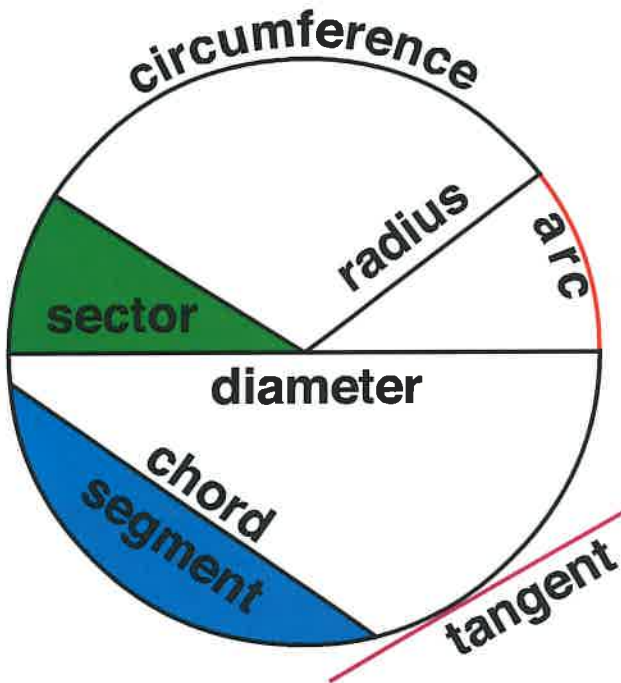
In this table, both terms are multiplied by the numbers 1 - 7.

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A circle is a plane shape bounded by a continuous line which is always the same distance from the centre.



Circle terminology



Circumference The distance around a circle.

Radius The distance from the centre of a circle to the circumference. Half the diameter.

Diameter A straight line passing through the centre of a circle to touch both sides of the circumference. Twice as long as the radius.

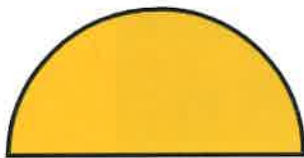
Chord A straight line joining two points on the circumference of a circle. The diameter is a special kind of chord.

Arc A section of the circumference.

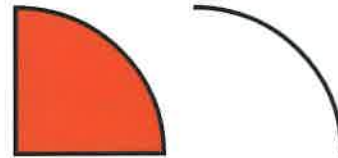
Sector A section of a circle, bounded by two radii and an arc.

Segment A section of a circle, bounded by a chord and an arc.

Tangent A straight line touching the circumference once at a given point.



A semicircle is half of a circle, bounded by the diameter and an arc.



A quadrant is a quarter of a circle or its circumference.

Circumference of a circle.

$$C = 2\pi r$$

(circumference = 2 x π x radius)

Area of a circle.

$$A = \pi r^2$$

(area = π x radius x radius)

π

pi = ratio of the circumference of a circle to its diameter.

= $\frac{22}{7}$ or 3.14 to 2 decimal places.



Adding fractions

From: A Maths Dictionary for Kids by Jenny Eather at www.amathsdictionaryforkids.com

To add fractions ...



with the same denominators (like fractions).

- add the numerators
- the denominators stays the same
- simplify (reduce) the answer

EXAMPLE: $\frac{3}{10} + \frac{2}{10} = \frac{5}{10} = \frac{1}{2}$



with different denominators (unlike fractions).

- convert the fractions so they have a common denominator  Multiply the denominators
- add the numerators
- the denominators stay the same
- simplify (reduce) the answer

EXAMPLE: $\frac{1}{4} + \frac{3}{10} = \frac{10}{40} + \frac{12}{40} = \frac{22}{40} = \frac{11}{20}$



To simplify or reduce a fraction.

That is, reduce the numerator and denominator in a fraction to the smallest numbers possible.

- divide the numerator and denominator by their highest common factor (HCF or GCF)

$$\frac{15}{20} = \frac{3}{4}$$

Diagram showing division by 5: $15 \div 5 = 3$ and $20 \div 5 = 4$.

$$\frac{16}{40} = \frac{2}{5}$$

Diagram showing division by 8: $16 \div 8 = 2$ and $40 \div 8 = 5$.

$$\frac{25}{100} = \frac{1}{4}$$

Diagram showing division by 25: $25 \div 25 = 1$ and $100 \div 25 = 4$.



Subtracting fractions

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To subtract fractions ...



with the same denominators (like fractions).

- subtract the numerators
- the denominators stays the same
- simplify (reduce) the answer

EXAMPLE: $\frac{7}{10} - \frac{2}{10} = \frac{5}{10} = \frac{1}{2}$



with different denominators (unlike fractions).

- convert the fractions so they have a common denominator  Multiply the denominators
- subtract the numerators
- the denominators stay the same
- simplify (reduce) the answer

EXAMPLE: $\frac{3}{4} - \frac{1}{10} = \frac{30}{40} - \frac{4}{40} = \frac{26}{40} = \frac{13}{20}$



To simplify or reduce a fraction.

That is, reduce the numerator and denominator in a fraction to the smallest numbers possible.

- divide the numerator and denominator by their highest common factor (HCF or GCF)

$$\frac{15}{20} = \frac{3}{4}$$

Diagram showing the simplification of 15/20 to 3/4 by dividing both numerator and denominator by 5.

$$\frac{26}{40} = \frac{13}{20}$$

Diagram showing the simplification of 26/40 to 13/20 by dividing both numerator and denominator by 2.

$$\frac{25}{100} = \frac{1}{4}$$

Diagram showing the simplification of 25/100 to 1/4 by dividing both numerator and denominator by 25.



Multiplying fractions

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To multiply a fraction ...



by a whole number.

- multiply the numerator
- the denominator stays the same
- simplify (reduce) the answer

EXAMPLE: $5 \times \frac{3}{5} = \frac{15}{5} = \frac{3}{1} = 3$



by another fraction.

- multiply the numerators
- multiply the denominators
- simplify (reduce) the answer

EXAMPLE: $\frac{3}{4} \times \frac{4}{5} = \frac{12}{20} = \frac{3}{5}$



To simplify or reduce a fraction.

That is, reduce the numerator and denominator in a fraction to the smallest numbers possible.

- divide the numerator and denominator by their highest common factor (HCF or GCF)

$$\frac{6}{12} = \frac{1}{2}$$

Diagram showing division by 6: $\frac{6 \div 6}{12 \div 6} = \frac{1}{2}$

$$\frac{15}{20} = \frac{3}{4}$$

Diagram showing division by 5: $\frac{15 \div 5}{20 \div 5} = \frac{3}{4}$

$$\frac{25}{100} = \frac{1}{4}$$

Diagram showing division by 25: $\frac{25 \div 25}{100 \div 25} = \frac{1}{4}$



Dividing fractions

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Because division is the opposite of multiplication, to divide a fraction, invert the fraction doing the dividing and then multiply.



by another fraction.

- invert the dividing fraction
- multiply the numerators
- multiply the denominators
- simplify (reduce) the answer

EXAMPLE: $\frac{3}{4} \div \frac{1}{3} = \frac{3}{4} \times \frac{3}{1} = \frac{9}{4}$ OR $2\frac{1}{4}$



by a whole number.

- write the whole number as a fraction, invert
- multiply the numerators
- multiply the denominators
- simplify (reduce) the answer if necessary

EXAMPLE: $\frac{3}{4} \div 5 = \frac{3}{4} \div \frac{5}{1} = \frac{3}{4} \times \frac{1}{5} = \frac{3}{20}$



To simplify or reduce a fraction.

That is, reduce the numerator and denominator in a fraction to the smallest numbers possible.

- divide the numerator and denominator by their highest common factor (HCF or GCF)

$$\frac{6}{12} = \frac{1}{2}$$

Diagram showing the simplification of 6/12 to 1/2 by dividing both numerator and denominator by 6.

$$\frac{15}{20} = \frac{3}{4}$$

Diagram showing the simplification of 15/20 to 3/4 by dividing both numerator and denominator by 5.

$$\frac{25}{100} = \frac{1}{4}$$

Diagram showing the simplification of 25/100 to 1/4 by dividing both numerator and denominator by 25.



Reciprocals of fractions

From: A Maths Dictionary for Kids by Jenny Eather at www.amathsdictionaryforkids.com

Two fractions are reciprocals of each other if their product equals 1.



To get the reciprocal of a fraction ...

turn it upside down.

reciprocal

$$\frac{1}{2} \rightarrow \frac{2}{1}$$

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

reciprocal

$$\frac{2}{3} \rightarrow \frac{3}{2}$$

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

reciprocal

$$\frac{7}{8} \rightarrow \frac{8}{7}$$

$$\frac{7}{8} \times \frac{8}{7} = \frac{56}{56} = 1$$



Fractions, decimals, percentages 23

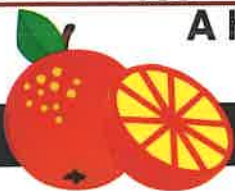
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Fraction	Equivalent Fractions	Decimal	Percent
$\frac{1}{2}$	$\frac{2}{4}$ $\frac{3}{6}$ $\frac{5}{10}$ $\frac{10}{20}$ $\frac{50}{100}$	0.5	50%
$\frac{1}{3}$	$\frac{2}{6}$ $\frac{3}{9}$ $\frac{4}{12}$ $\frac{10}{30}$ $\frac{30}{90}$	$0.\bar{3}$	33.3%
$\frac{2}{3}$	$\frac{4}{6}$ $\frac{6}{9}$ $\frac{8}{12}$ $\frac{20}{30}$ $\frac{60}{90}$	$0.\bar{6}$	66.6%
$\frac{1}{4}$	$\frac{2}{8}$ $\frac{3}{12}$ $\frac{4}{16}$ $\frac{10}{40}$ $\frac{25}{100}$	0.25	25%
$\frac{3}{4}$	$\frac{6}{8}$ $\frac{9}{12}$ $\frac{12}{16}$ $\frac{30}{40}$ $\frac{75}{100}$	0.75	75%
$\frac{1}{5}$	$\frac{2}{10}$ $\frac{3}{15}$ $\frac{4}{20}$ $\frac{10}{50}$ $\frac{20}{100}$	0.2	20%
$\frac{3}{5}$	$\frac{6}{10}$ $\frac{9}{15}$ $\frac{12}{20}$ $\frac{30}{50}$ $\frac{60}{100}$	0.6	60%
$\frac{4}{5}$	$\frac{8}{10}$ $\frac{12}{15}$ $\frac{16}{20}$ $\frac{40}{50}$ $\frac{80}{100}$	0.8	80%
$\frac{1}{6}$	$\frac{2}{12}$ $\frac{3}{18}$ $\frac{4}{24}$ $\frac{10}{60}$ $\frac{20}{120}$	$0.1\bar{6}$	16.7%
$\frac{5}{6}$	$\frac{10}{12}$ $\frac{15}{18}$ $\frac{20}{24}$ $\frac{50}{60}$ $\frac{100}{120}$	$0.8\bar{3}$	83.3%
$\frac{1}{7}$	$\frac{2}{14}$ $\frac{3}{21}$ $\frac{4}{28}$ $\frac{10}{70}$ $\frac{20}{140}$	0.142857	14.3%
$\frac{1}{8}$	$\frac{2}{16}$ $\frac{3}{24}$ $\frac{4}{32}$ $\frac{10}{80}$ $\frac{20}{160}$	0.125	12.5%
$\frac{3}{8}$	$\frac{6}{16}$ $\frac{9}{24}$ $\frac{12}{32}$ $\frac{30}{80}$ $\frac{60}{160}$	0.375	37.5%
$\frac{5}{8}$	$\frac{10}{16}$ $\frac{15}{24}$ $\frac{20}{32}$ $\frac{50}{80}$ $\frac{100}{160}$	0.625	62.5%
$\frac{1}{9}$	$\frac{2}{18}$ $\frac{3}{27}$ $\frac{4}{36}$ $\frac{10}{90}$ $\frac{20}{180}$	$0.\bar{1}$	11.1%
$\frac{2}{9}$	$\frac{4}{18}$ $\frac{6}{27}$ $\frac{8}{36}$ $\frac{20}{90}$ $\frac{40}{180}$	$0.\bar{2}$	22.2%
$\frac{4}{9}$	$\frac{8}{18}$ $\frac{12}{27}$ $\frac{16}{36}$ $\frac{40}{90}$ $\frac{80}{180}$	$0.\bar{4}$	44.4%
$\frac{5}{9}$	$\frac{10}{18}$ $\frac{15}{27}$ $\frac{20}{36}$ $\frac{50}{90}$ $\frac{100}{180}$	$0.\bar{5}$	55.5%
$\frac{7}{9}$	$\frac{14}{18}$ $\frac{21}{27}$ $\frac{28}{36}$ $\frac{70}{90}$ $\frac{140}{180}$	$0.\bar{7}$	77.8%
$\frac{8}{9}$	$\frac{16}{18}$ $\frac{24}{27}$ $\frac{32}{36}$ $\frac{80}{90}$ $\frac{160}{180}$	$0.\bar{8}$	88.9%
$\frac{1}{10}$	$\frac{2}{20}$ $\frac{3}{30}$ $\frac{4}{40}$ $\frac{5}{50}$ $\frac{10}{100}$	0.1	10%
$\frac{1}{100}$	$\frac{2}{200}$ $\frac{3}{300}$ $\frac{4}{400}$ $\frac{5}{500}$ $\frac{10}{1000}$	0.01	1%

A horizontal bar over a digit in a decimal means that digit repeats forever, eg, $0.\bar{3} = 0.333333333 \dots$

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Fractions, decimals, percentages ... conversions.

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Fraction to Decimal

Divide the numerator by the denominator.

$$\frac{1}{4} \quad 4 \overline{) 1.00} \quad \begin{array}{r} 0.25 \\ 1.00 \end{array}$$

Decimal to Fraction

Write the decimal over the number of its place value, then simplify (reduce).

$$0.25 = \frac{25}{100} = \frac{1}{4}$$



Fraction to Percent

Multiply the fraction by 100, simplify (reduce), add the % symbol.

$$\frac{1}{4} \times \frac{100}{1} = \frac{100}{4} = 25\%$$

Percent to Fraction

Remove the % symbol, write as a fraction with a denominator of 100, then simplify (reduce).

$$25\% = \frac{25}{100} = \frac{1}{4}$$

With a decimal percentage, first multiply the numerator and the denominator by 10 until the numerator is a whole number.

$$2.5\% = \frac{25}{1000} = \frac{1}{40}$$



Percent to Decimal

Remove the % symbol, divide the number by 100.

$$25\%$$

$$25 \div 100 = 0.25$$

Decimal to Percent

Multiply by 100, add the % symbol.

$$0.25$$

$$0.25 \times 100 = 25\%$$



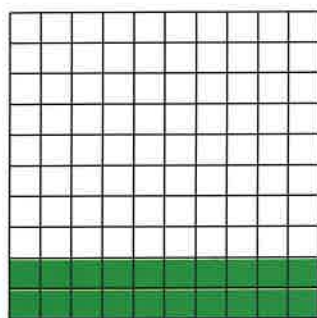
Percent, percentage

25

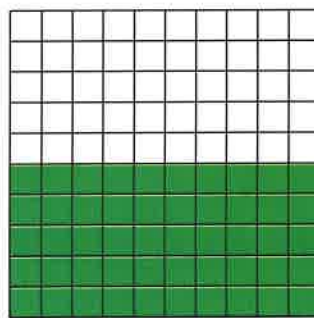
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A percentage is a fraction expressed as a number out of 100 followed by the % symbol.

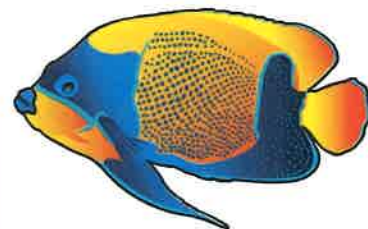
Percent comes from the Latin term 'per centum' meaning per hundred.



$$\frac{20}{100} = 20\%$$



$$\frac{50}{100} = 50\%$$



To convert a fraction or a decimal to a percentage multiply by 100 then add the % symbol.

Fraction

$$\frac{1}{4} \times \frac{100}{1} = \frac{100}{4} = 25\%$$

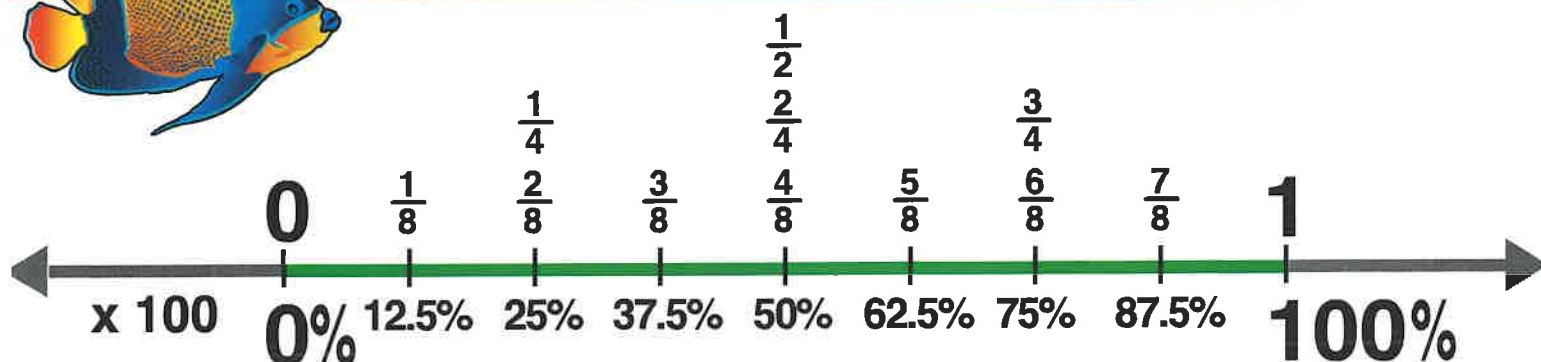
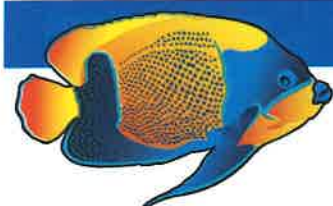
Multiply the fraction by 100, simplify, add the % symbol.

Decimal

$$0.25 \times 100 = 25\%$$

Multiply by 100, add the % symbol.

Comparing fractions and percentages.

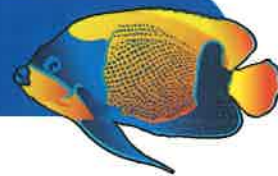


Percentages and amounts

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To calculate a percentage of an amount, write the percent as a fraction and multiply by the amount.

$$\frac{\text{percent}}{100} \times \text{amount} =$$



$$11\% \text{ of } 40 = \frac{11}{100} \times 40 = \frac{440}{100} = 4.4$$

Sometimes, it is easier to simplify the fraction before multiplying.

$$25\% \text{ of } 160 = \frac{25}{100} \times 160 = \frac{1}{4} \times 160 = \frac{160}{4} = 40$$

$$200\% \text{ of } 35 = \frac{200}{100} \times 35 = \frac{2}{1} \times 35 = \frac{70}{1} = 70$$

With a decimal percentage, first multiply the numerator and the denominator by 10 until the numerator is a whole number.

$$33.3\% \text{ of } \$90 = \frac{333}{1000} \times 90 = \frac{29970}{1000} = \$29.97$$

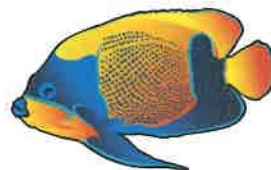
To calculate an amount as a percentage of a total, write the amount over the total as a fraction and multiply by 100.

$$\frac{\text{amount}}{\text{total}} \times 100 =$$

In a fish tank holding 20 fish there are 4 yellow fish and 16 gold fish.
What percentage of fish are yellow?



$$\frac{4}{20} \times 100 = \frac{400}{20} = 20\%$$



Out of 360 students at the school 324 are present today.
What percentage of students are absent ?

(360 - 324 = 36)
324 present so
36 are absent

$$\frac{36}{360} \times 100 = \frac{3600}{360} = 10\%$$

There are 10% of students absent.



Sales tax

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Sales tax is a tax that is added to the price of particular goods and services, usually as a percentage of the purchase price.



$$\text{sales tax} = \left(\frac{\text{percent}}{100} \times \text{price} \right)$$

Sales tax may be called by various names, for example, Goods and Services Tax (GST) or Value Added Tax (VAT).

Examples of different rates of sales tax.

Item and Price	Sales Tax and Total Cost			
Before Sales Tax	10%	15%	20%	25%
 \$10.00	\$1.00 \$11.00	\$1.50 \$11.50	\$2.00 \$12.00	\$2.50 \$12.50
 \$50.00	\$5.00 \$55.00	\$7.50 \$57.50	\$10.00 \$60.00	\$12.50 \$62.50
 \$100.00	\$10.00 \$110.00	\$15.00 \$115.00	\$20.00 \$120.00	\$25.00 \$125.00

Discounts and markdowns

From: A Maths Dictionary for Kids by Jenny Eather at www.amathsdictionaryforkids.com

To calculate the cost of an item when a percentage discount (or markdown) is offered, write the percent as a fraction, multiply by the price, then subtract that amount from the original price.

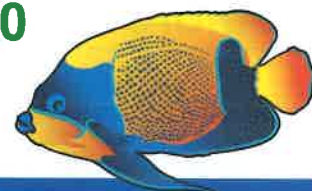
$$\text{discount} = \left(\frac{\text{percent}}{100} \times \text{price} \right) \quad \text{cost} = \text{price} - \text{discount}$$

In a 15% off everything sale, how much would a pair of \$20.00 shoes cost?

$$\text{Discount} = \frac{15}{100} \times 20 = \frac{300}{100} = \$3.00$$

$$\text{Cost} = \$20.00 - \$3.00 = \$17.00$$

The \$20.00 shoes will cost \$17.00.



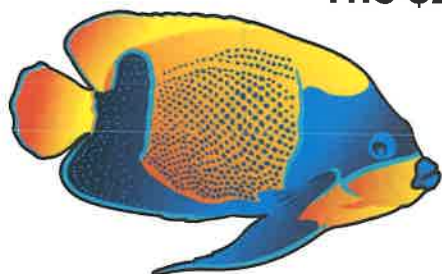
To calculate the percentage discount of an item when a dollar discount (or markdown) is offered, write the discount as a fraction of the original price then multiply by 100.

$$\% \text{ discount} = \left(\frac{\text{discount}}{\text{price}} \times 100 \right)$$

Another shoe shop is offering a \$4.00 discount on shoes over \$15.00. What is the percentage discount on a pair of \$20.00 shoes?

$$\% \text{ Discount} = \frac{4}{20} \times 100 = \frac{400}{20} = 20\%$$

The \$20.00 shoes are discounted by 20%.



Percentages can help find the best deal.



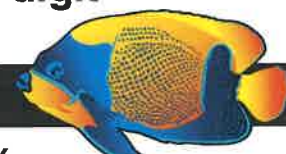
Percentages, decimals, fractions

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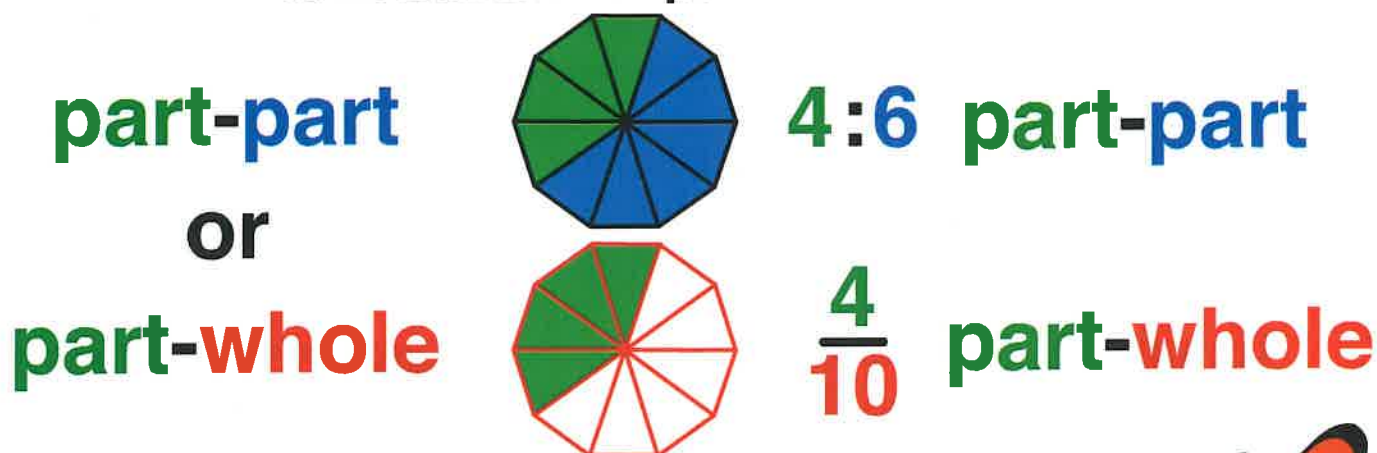
Percent	Decimal	Fraction	Equivalent Fractions
1%	0.01	$\frac{1}{100}$	$\frac{2}{200}$ $\frac{3}{300}$ $\frac{4}{400}$ $\frac{5}{500}$ $\frac{10}{1000}$
10%	0.1	$\frac{1}{10}$	$\frac{2}{20}$ $\frac{3}{30}$ $\frac{4}{40}$ $\frac{5}{50}$ $\frac{10}{100}$
12.5%	0.125	$\frac{1}{8}$	$\frac{2}{16}$ $\frac{3}{24}$ $\frac{4}{32}$ $\frac{10}{80}$ $\frac{20}{160}$
16.7%	$0.\overline{16}$	$\frac{1}{6}$	$\frac{2}{12}$ $\frac{3}{18}$ $\frac{4}{24}$ $\frac{10}{60}$ $\frac{20}{120}$
20%	0.2	$\frac{1}{5}$	$\frac{2}{10}$ $\frac{3}{15}$ $\frac{4}{20}$ $\frac{10}{50}$ $\frac{20}{100}$
25%	0.25	$\frac{1}{4}$	$\frac{2}{8}$ $\frac{3}{12}$ $\frac{4}{16}$ $\frac{10}{40}$ $\frac{25}{100}$
30%	0.3	$\frac{3}{10}$	$\frac{6}{20}$ $\frac{9}{30}$ $\frac{12}{40}$ $\frac{15}{50}$ $\frac{30}{100}$
33.3%	$0.\overline{3}$	$\frac{1}{3}$	$\frac{2}{6}$ $\frac{3}{9}$ $\frac{4}{12}$ $\frac{10}{30}$ $\frac{30}{90}$
37.5%	0.375	$\frac{3}{8}$	$\frac{6}{16}$ $\frac{9}{24}$ $\frac{12}{32}$ $\frac{30}{80}$ $\frac{60}{160}$
40%	0.4	$\frac{4}{10}$	$\frac{8}{20}$ $\frac{12}{30}$ $\frac{16}{40}$ $\frac{20}{50}$ $\frac{40}{100}$
50%	0.5	$\frac{1}{2}$	$\frac{2}{4}$ $\frac{3}{6}$ $\frac{5}{10}$ $\frac{10}{20}$ $\frac{50}{100}$
60%	0.6	$\frac{3}{5}$	$\frac{6}{10}$ $\frac{9}{15}$ $\frac{12}{20}$ $\frac{30}{50}$ $\frac{60}{100}$
62.5%	0.625	$\frac{5}{8}$	$\frac{10}{16}$ $\frac{15}{24}$ $\frac{20}{32}$ $\frac{50}{80}$ $\frac{100}{160}$
66.6%	$0.\overline{6}$	$\frac{2}{3}$	$\frac{4}{6}$ $\frac{6}{9}$ $\frac{8}{12}$ $\frac{20}{30}$ $\frac{60}{90}$
70%	0.7	$\frac{7}{10}$	$\frac{14}{20}$ $\frac{21}{30}$ $\frac{28}{40}$ $\frac{35}{50}$ $\frac{70}{100}$
75%	0.75	$\frac{3}{4}$	$\frac{6}{8}$ $\frac{9}{12}$ $\frac{12}{16}$ $\frac{30}{40}$ $\frac{75}{100}$
80%	0.8	$\frac{4}{5}$	$\frac{8}{10}$ $\frac{12}{15}$ $\frac{16}{20}$ $\frac{40}{50}$ $\frac{80}{100}$
83.3%	$0.8\overline{3}$	$\frac{5}{6}$	$\frac{10}{12}$ $\frac{15}{18}$ $\frac{20}{24}$ $\frac{50}{60}$ $\frac{100}{120}$
90%	0.9	$\frac{9}{10}$	$\frac{18}{20}$ $\frac{27}{30}$ $\frac{36}{40}$ $\frac{45}{50}$ $\frac{90}{100}$
100%	1	$\frac{1}{1}$	$\frac{100}{100}$ $\frac{200}{200}$ $\frac{300}{300}$ $\frac{500}{500}$ $\frac{1000}{1000}$
150%	1.5	$1\frac{1}{2}$ or $\frac{3}{2}$	$\frac{150}{100}$ $\frac{300}{200}$ $\frac{450}{300}$ $\frac{750}{500}$ $\frac{1500}{1000}$
200%	2	$\frac{2}{1}$	$\frac{200}{100}$ $\frac{400}{200}$ $\frac{600}{300}$ $\frac{1000}{500}$ $\frac{2000}{1000}$

A horizontal bar over a digit in a decimal means that digit repeats forever, eg, $0.\overline{3} = 0.333333333 \dots$

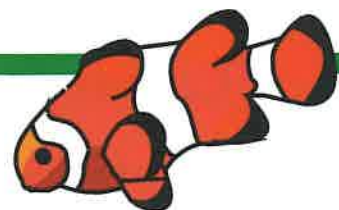


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A ratio shows the relative sizes of two or more like values. A ratio may compare a number of parts to another number of parts in the whole **or** compare a number of parts to the total number of parts in the whole.



A ratio can be written as:
4 to 6 or **4:6** or **$\frac{4}{6}$**



The numbers in a ratio are called terms.
A ratio may have more than two terms, e.g. 4:5:3:1

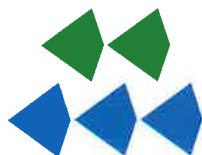
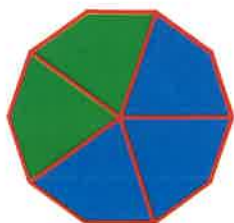
Simplifying a ratio.

Just like simplifying a fraction, a ratio is simplified by finding the highest common factor (HCF or GCF) to divide each term.

EXAMPLE: **4:6 = 2:3** both terms divided by 2

Writing part-part ratios as fractions.

When comparing two terms in a ratio, each term can be written as a fraction of the other.



$$2:3 \quad 2 = \frac{2}{3} \times 3 \quad 3 = \frac{3}{2} \times 2$$

Problem solving with ratios

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Determining quantities when a part is known.

Step 1: Find the value of a single part of the ratio.

Step 2: Multiply this number by the other term(s) to find their share or quantity.

The ratio of slices of tomato to cucumber to onion in a salad is 5:4:2. If there are 20 tomato slices, how many slices of cucumber and onion are there?

$$\begin{aligned}\text{Tomato: } 5 \text{ parts} &= 20 \\ 1 \text{ part} &= 20 \div 5 \\ &= 4\end{aligned}$$

$$\begin{aligned}\text{Cucumber: } 4 \text{ parts} &= 4 \times 4 \\ &= 16\end{aligned}$$

$$\begin{aligned}\text{Onion: } 2 \text{ parts} &= 2 \times 4 \\ &= 8\end{aligned}$$



$$5:4:2$$

$$20:16:8$$

There are 16 cucumber slices and 8 slices of onion.

Determining quantities when the total is known.

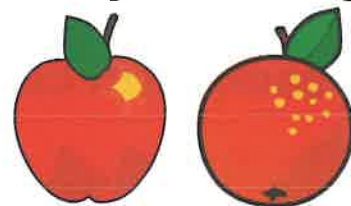
Step 1: Add the terms to get the total of number of parts.

Step 2: Divide the total quantity by number of parts.

Step 3: Multiply this number by the other term(s) to find their share or quantity.

In a fruit bowl containing apples and oranges the ratio is 3:5. If there are 24 pieces of fruit in total, how many are oranges?

$$\begin{aligned}\text{Total parts: } 3 + 5 &= 8 \\ \text{Single part: } 24 \div 8 &= 3 \\ 1 \text{ part} &= 3 \\ \text{Oranges: } 5 \text{ parts} &= 5 \times 3 \\ &= 15\end{aligned}$$



$$3:5 = 9:15$$

There are 15 oranges.

From: A Maths Dictionary for Kids by Jenny Eather at www.amathsdictionaryforkids.com

A **ratio** compares quantities which are measured in the same units.

A **rate** compares quantities which are measured in different units.

A rate is written as the first quantity per ONE of the second quantity.

dollars **per** night
kilometres **per** hour
births **per** year
beats **per** minute



Determining the first quantity when the second quantity is known.

Multiply the first quantity by the number of the second quantity.

Examples: A hotel room costs \$120.00 per night.
How much for 3 nights?
 $\$120.00 \times 3 = \$360.00$

A car travelled at an average of 80 km per hour.
How far would it travel in 5 hours?
 $80 \times 5 = 400$ kilometres

Determining the second quantity when the first quantity is known.

Divide the known quantity by the number of the first quantity.

Examples: The annual birth rate is 2000 births per year.
How many years before there are 6000 births.
 $6000 \div 2000 = 3$ years



A runner's heart rate was 140 beats per minute.
He counted 420 beats. How long did he count?
 $420 \div 140 = 3$ minutes

33 Equivalent ratios and rates

From: A Maths Dictionary for Kids by Jenny Eather at www.amathsdictionaryforkids.com

Equivalent ratios and rates are formed by multiplying or dividing all their terms by the same number.

$$\begin{array}{ccccccccc} \text{x2} & \text{x2} & \text{x5} & \text{x10} \\ \curvearrowright & \curvearrowright & \curvearrowright & \curvearrowright \\ 2:3 & 4:6 & 8:12 & 40:60 & 400:600 \end{array}$$

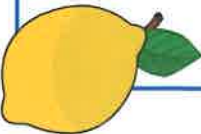
$$\begin{array}{ccccccccc} \text{x2} & \text{x2} & \text{x5} & \text{x10} \\ \curvearrowright & \curvearrowright & \curvearrowright & \curvearrowright \\ 800:1000 & 80:100 & 16:20 & 8:10 & 4:5 \end{array}$$

$$\begin{array}{ccccccc} \div 10 & \div 5 & \div 2 & \div 2 \\ \curvearrowright & \curvearrowright & \curvearrowright & \curvearrowright \end{array}$$

Tables are useful when comparing equivalent ratios and rates.

Ratio: Lemonade Recipe

Mix cups of water, lemon juice and sugar in the ratio 3:1:1.



Water	3	6	12	24	48
Lemon Juice	1	2	4	8	16
Sugar	1	2	4	8	16

In this table, the terms are doubled each time.

Rate: Hotel Room Rate

The cost of a deluxe room at Hotel Math is \$120.00 per night.

Nights	1	2	3	4	5	6	7
Cost	\$120	\$240	\$360	\$480	\$600	\$720	\$840

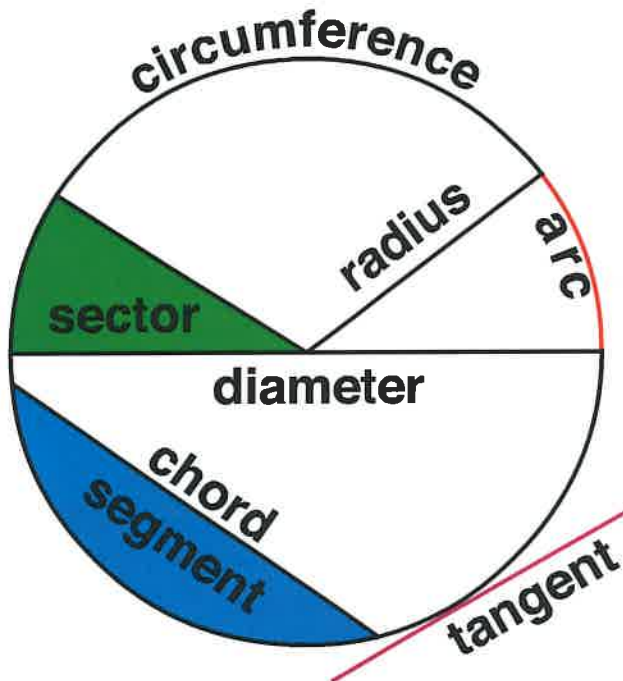
In this table, both terms are multiplied by the numbers 1 - 7.

From: A Maths Dictionary for Kids by Jenny Eather at www.amathsdictionaryforkids.com

A circle is a plane shape bounded by a continuous line which is always the same distance from the centre.



Circle terminology



Circumference The distance around a circle.

Radius The distance from the centre of a circle to the circumference. Half the diameter.

Diameter A straight line passing through the centre of a circle to touch both sides of the circumference. Twice as long as the radius.

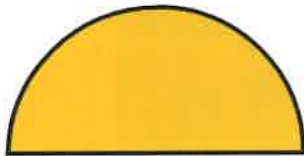
Chord A straight line joining two points on the circumference of a circle. The diameter is a special kind of chord.

Arc A section of the circumference.

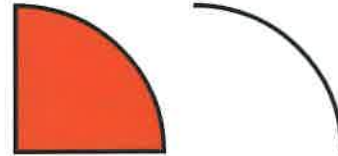
Sector A section of a circle, bounded by two radii and an arc.

Segment A section of a circle, bounded by a chord and an arc.

Tangent A straight line touching the circumference once at a given point.



A semicircle is half of a circle, bounded by the diameter and an arc.



A quadrant is a quarter of a circle or its circumference.

Circumference of a circle.

$$C = 2\pi r$$

(circumference = 2 x π x radius)

Area of a circle.

$$A = \pi r^2$$

(area = π x radius x radius)

π

pi = ratio of the circumference of a circle to its diameter.

= $\frac{22}{7}$ or 3.14 to 2 decimal places.



Square

From: A Maths Dictionary for Kids by Jenny Eather at www.amathsdictionaryforkids.com

A square is a quadrilateral with:

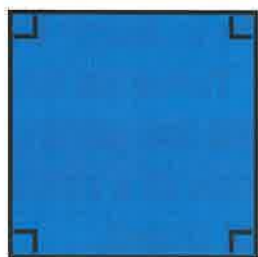
- four equal sides and four right angles
- opposite sides that are parallel
- two diagonals that bisect at right angles
- four lines of symmetry.



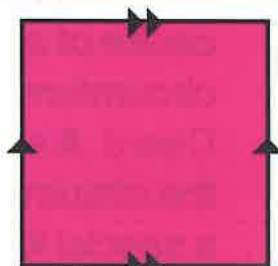
Attributes of a square



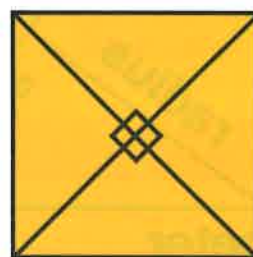
four
equal sides



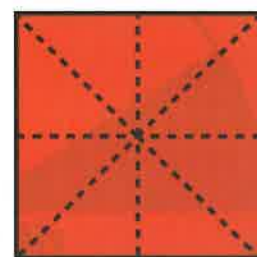
four
right angles



opposite
sides that
are parallel

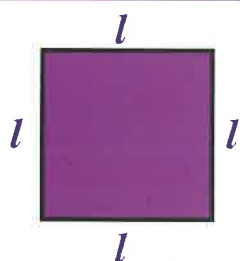


two
diagonals
that bisect
at right
angles



four
lines of
symmetry

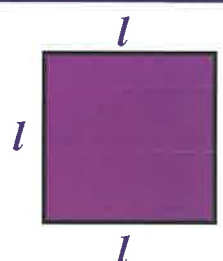
Perimeter of a square.



$$\begin{aligned} P &= l + l + l + l \\ &= 4 \times l \\ &= 4l \end{aligned}$$

l = length of side

Area of a square.



$$\begin{aligned} A &= l \times l \\ &= l^2 \end{aligned}$$

Classifying a square.

Depending on their definitions as quadrilaterals, a square can be a:

Rectangle:

- two pairs of opposite equal parallel sides and four right angles.

Parallelogram:

- two pairs of opposite equal parallel sides and opposite angles that are equal.

Rhombus:

- parallelogram with four equal sides and opposite angles that are equal.

Trapezium (UK) trapezoid (US):

- quadrilateral with at least two sides parallel. (inclusive definition)

Polygons

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A polygon is a plane, two-dimensional or flat shape having three or more straight sides.



Examples



SOME SIMPLE POLYGON TYPES	Sides and vertices	Sum of internal angles	REGULAR All sides and angles equal.	IRREGULAR
triangles	3	180°	 equilateral triangle	 isosceles triangle  right-angle triangle  scalene triangle
quadrilaterals	4	360°	 square	 rhombus  parallelogram  rectangle  trapezoid (US) trapezium (UK)
pentagons	5	540°		 
hexagons	6	720°		  
heptagons	7	900°		  
octagons	8	1080°		  
nonagons	9	1260°		 
decagons	10	1440°		  

NOTE: A trapezium (UK), trapezoid (US) is a quadrilateral with one pair of parallel sides.



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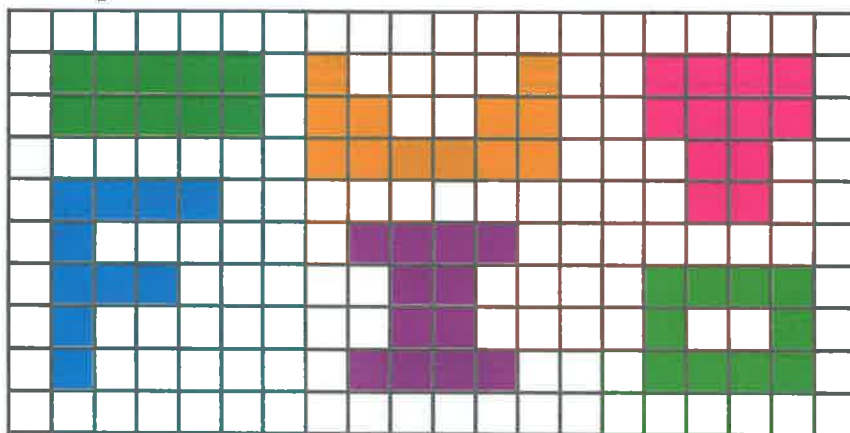


From: A Maths Dictionary for Kids by Jenny Eather at www.amathsdictionaryforkids.com

Area is the size a surface takes up measured in square units. Area can be determined using a grid or a formula.

Using a grid

The squares are counted to find an area.

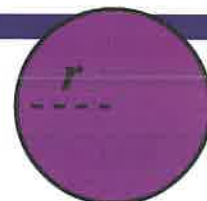


A = area
l = length
b = base
h = height
r = radius
 π = pi

Using a formula

Circle

$$A = \pi \times r^2$$



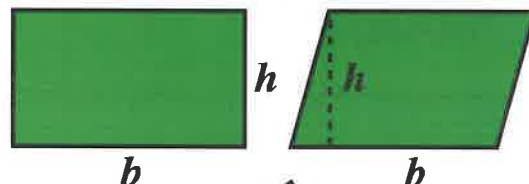
Square

$$A = l \times l$$



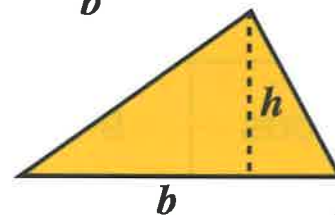
Rectangle
and
Parallelogram

$$A = b \times h$$



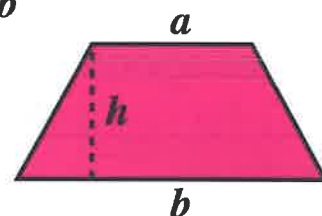
Triangle

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



Isosceles
 Trapezium (UK),
 Trapezoid (US)

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



Perimeter

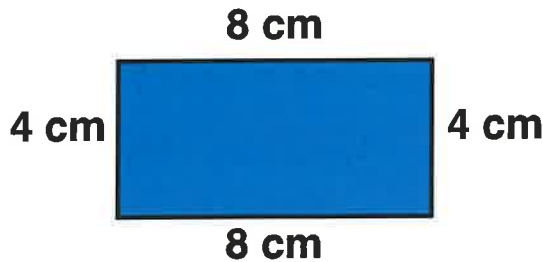
38

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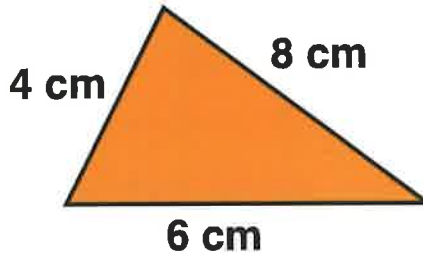
Perimeter is the distance around the outside of a shape.

Adding the length of sides

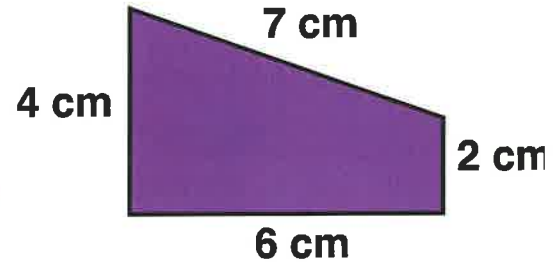
The perimeter of a polygon is the sum of the length of all its sides.



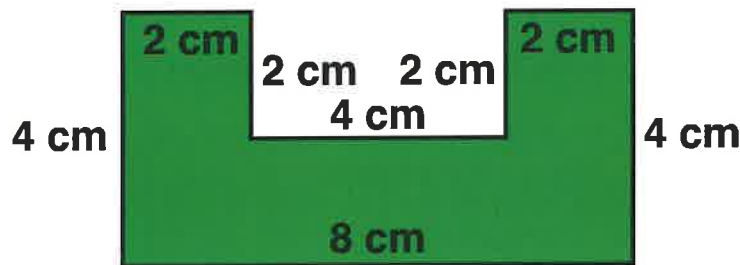
$$P = 4 + 8 + 4 + 8 \\ = 24 \text{ cm}$$



$$P = 4 + 8 + 6 \\ = 18 \text{ cm}$$



$$P = 4 + 7 + 2 + 6 \\ = 19 \text{ cm}$$



$$P = 4 + 2 + 2 + 4 + 2 + 2 + 4 + 8 = 28 \text{ cm}$$

Regular Polygons

The perimeter of a regular polygon is the number of sides multiplied by the length of one side.

$$P = n \times l$$

P = perimeter

n = number of sides

l = length of one side



$$P = 3l$$



$$P = 4l$$



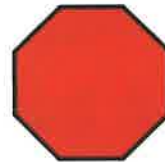
$$P = 5l$$



$$P = 6l$$



$$P = 7l$$



$$P = 8l$$



$$P = 9l$$

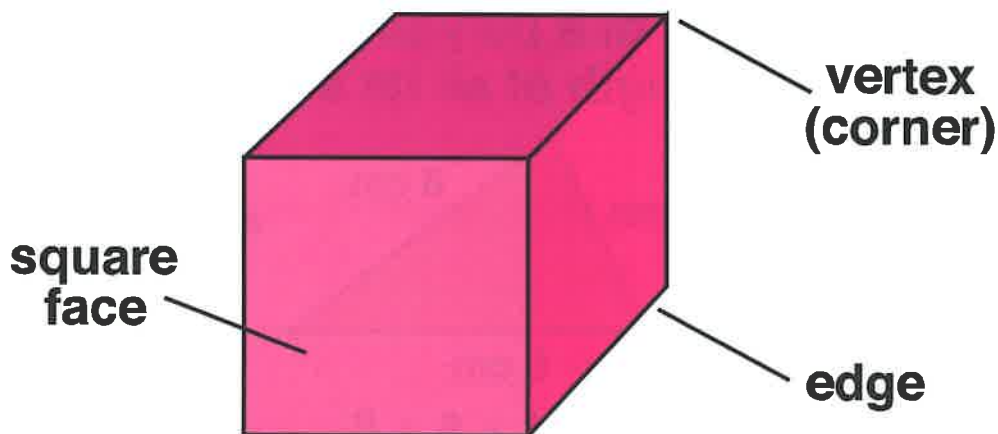


$$P = 10l$$

Cube

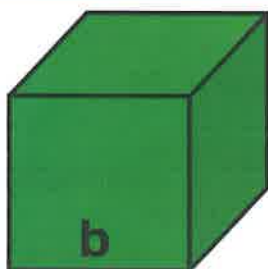
From: A Maths Dictionary for Kids by Jenny Eather at www.amathsdictionaryforkids.com

A cube is a three-dimensional solid that has six congruent square faces.



A cube has 6 square faces, 12 equal edges and 8 vertices.

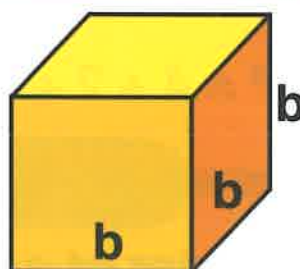
Surface area of a cube



$$6b^2 \text{ OR } 6 \times b^2$$

b = length of one edge

Volume of a cube



$$b^3 \text{ OR } b \times b \times b$$

Platonic solid

A cube is one of the five Platonic solids.

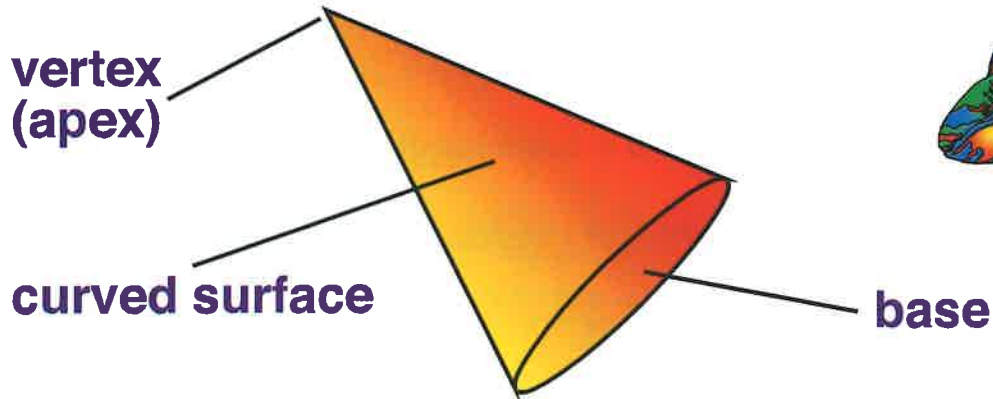


Cone

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From: A Maths Dictionary for Kids by Jenny Eather at www.amathsdictionaryforkids.com

A cone is a three-dimensional solid with a circular base and a curved surface that tapers to a point (vertex or apex).



A cone may be right or oblique.



Surface area

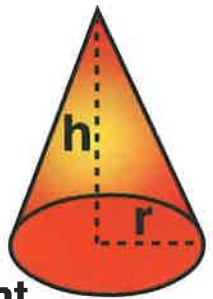
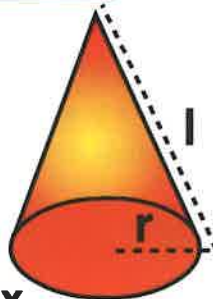
Volume

$$\pi r l + \pi r^2$$

$$\frac{\pi r^2 h}{3}$$

r = radius
 l = length base to vertex

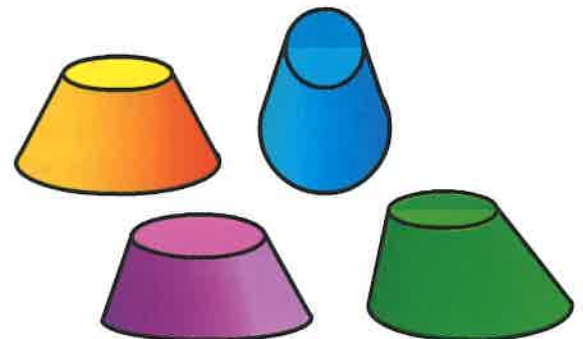
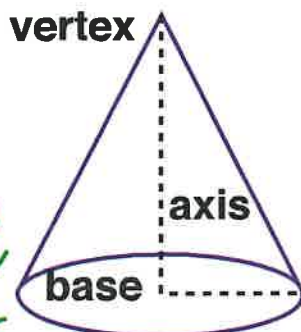
r = radius
 h = perpendicular height



Right cone

Frustum of a cone

A cone where the axis line from the vertex to the centre of the base is perpendicular (at right angles) to the base.



The solid that results from a cone having its top sliced off parallel to its base.



Surface area, volume

From: A Maths Dictionary for Kids by Jenny Eather at www.amathsdictionaryforkids.com

Surface area

The total area of the surface of a three-dimensional object, measured in square units.

Volume

The amount of space occupied by a three-dimensional object, measured in cubic units.

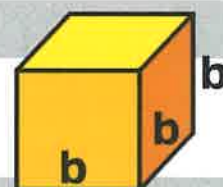


$$6b^2$$

Cube

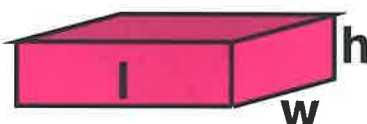
b = base length

$$b^3$$



Rectangular prism

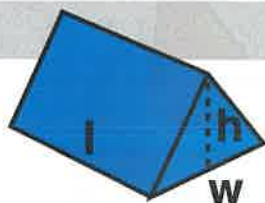
$$2lw + 2lh + 2wh$$



$$lwh$$

l = length
 w = width
 h = height

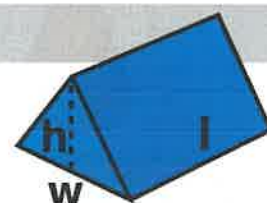
Triangular prism



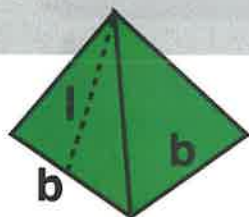
$$3lw + wh$$

l = length
 w = width
 h = height

$$\frac{lwh}{2}$$



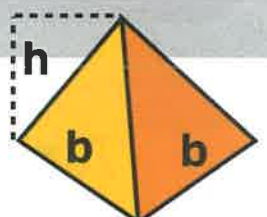
Square pyramid



$$2bl + b^2$$

b = length base side
 l = length base to vertex
 h = perpendicular height

$$\frac{b^2h}{3}$$



Sphere



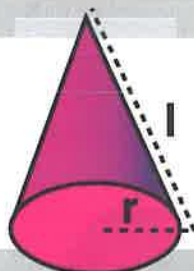
$$4\pi r^2$$

r = radius

$$\frac{4\pi r^3}{3}$$



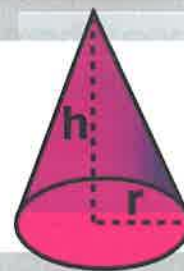
Right circular cone



$$\pi rl + \pi r^2$$

r = radius
 l = length base to vertex
 h = perpendicular height

$$\frac{\pi r^2 h}{3}$$



Cylinder

$$2\pi rh + 2\pi r^2$$

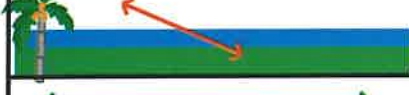
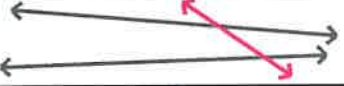
r = radius



$$\pi r^2 h$$

h = height



Types of lines	Name	Description
	line	A straight one-dimensional figure of infinite length.
	horizontal line	Line parallel to the horizon.
	vertical line	Line at right angles to the horizon.
	oblique line	Line at an angle to the horizon.
	parallel lines	Lines exactly the same distance apart.
	converging lines	Lines that head towards one point.
	intersecting lines	Lines that cross over one another.
	concurrent lines	Two or more lines that intersect at one point.
	transversal	A line that intersects at least two others.
	perpendicular lines	Lines that intersect at right angles to each other.
	diagonal lines	Lines that join non-adjacent corners of a polygon.
	line of symmetry	Line that divides an object in half so each side exactly mirrors the other.
	ray	A line of indefinite length extending from an end point in one direction.
	segment	Part of a line.
	interval	Distance between two points on a line.
	end point	Point marking the end of a line segment.

NOTE:

A line segment has two end points, a ray has one end point and a line has none.



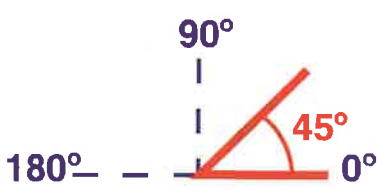
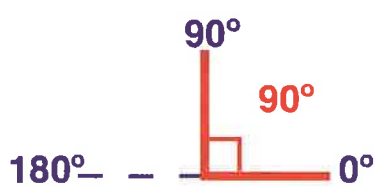
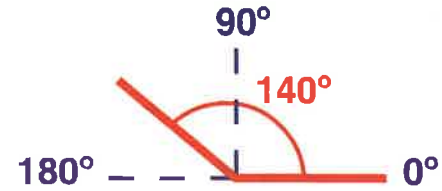
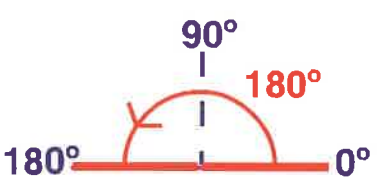
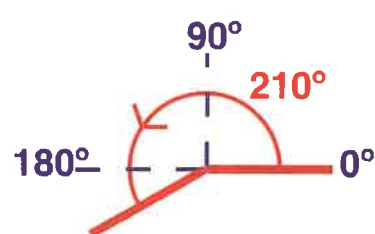
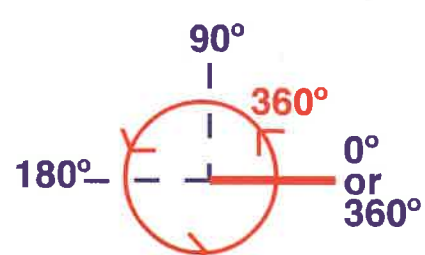
Angles

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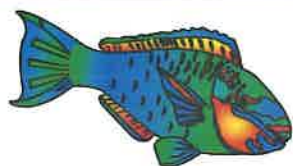
An angle is the amount of turning between two lines meeting at a common point.

The lines are called arms and the point is called a vertex.

Names of angles

Acute angle	Right angle	Obtuse angle
less than 90° 	90° 	between 90° and 180° 
Straight angle	Reflex angle	A revolution
180° 	between 180° and 360° 	360° 

Regular polygons



triangle



square



rectangle



pentagon



hexagon



octagon

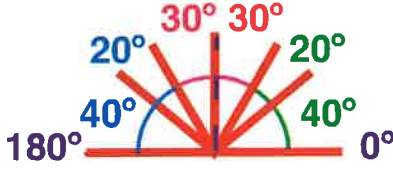
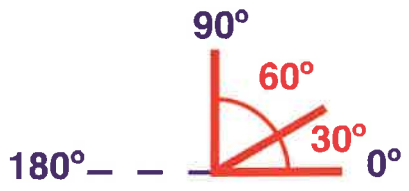
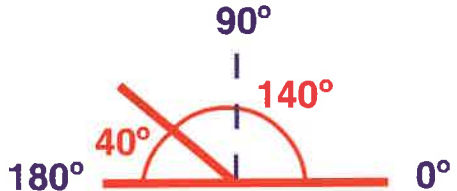
Total angles	180°	360°	360°	540°	720°	1080°
Interior angles	60°	90°	90°	108°	120°	135°
Exterior angles	120°	90°	90°	72°	60°	45°

All angles in a triangle add up to 180° .
All angles in a quadrilateral add up to 360° .

Angle pairs

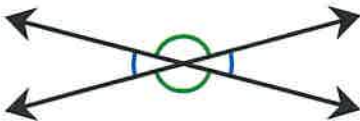
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Adjacent angles	Complementary angles	Supplementary angles
Angles immediately next to each other. 	Two angles whose sum is 90°. 	Two angles whose sum is 180°. 

Vertically opposite angles

Opposite pairs of angles formed when two lines intersect.



Opposite angles are equal.

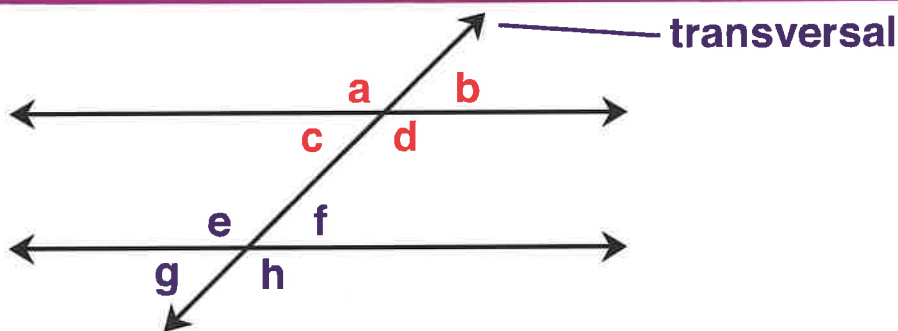
Interior, exterior angles

Angles inside or outside of polygons or parallel lines.



The exterior angles of a polygon total 360° .

Angles associated with parallel lines and transversals



Interior angles

c e , d f

Alternate interior angles

c f , d e

Exterior angles

a g , b h

Alternate exterior angles

a h , b g

Corresponding angles

a e , c g , b f , d h

- inside the parallel lines

- same side of the transversal

- inside the parallel lines

- opposite sides of the transversal

- outside the parallel lines

- same side of the transversal

- outside the parallel lines

- opposite sides of the transversal

- one inside, one outside of the parallel lines

- same side of the transversal

Measuring angles

From: A Maths Dictionary for Kids by Jenny Eather at www.amathsdictionaryforkids.com

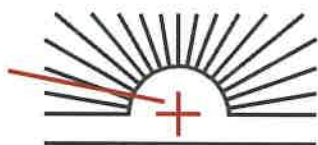
Angles are measured in degrees with an instrument called a protractor. Protractors may be circular, a full rotation of 360° , but many are a semi-circle of 180° .

Placement

The crosshairs of the protractor need to be exactly lined up with the vertex of the angle. The vertex is the point where the two rays of the angle meet.



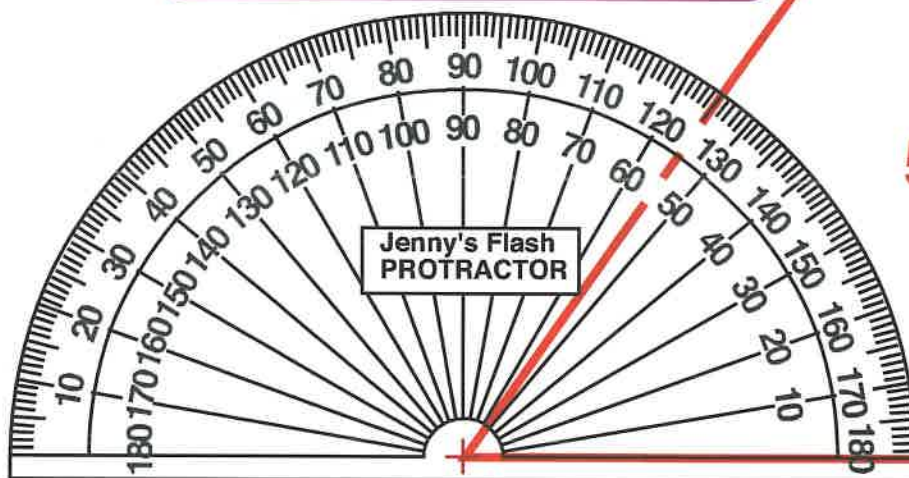
crosshairs



vertex

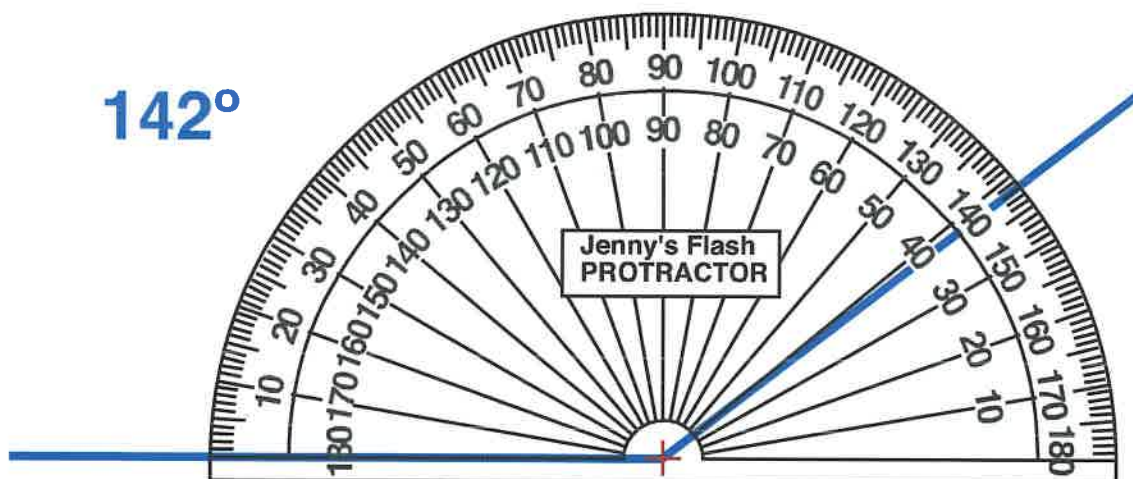


Examples



55°

142°



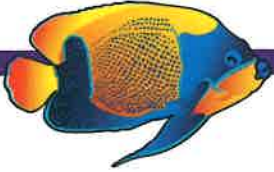
The protractor has two scales from 0° to 180° . Which scale to use depends on whether the angle is acute (less than 90°) or obtuse (90° to 180°).

Coordinates

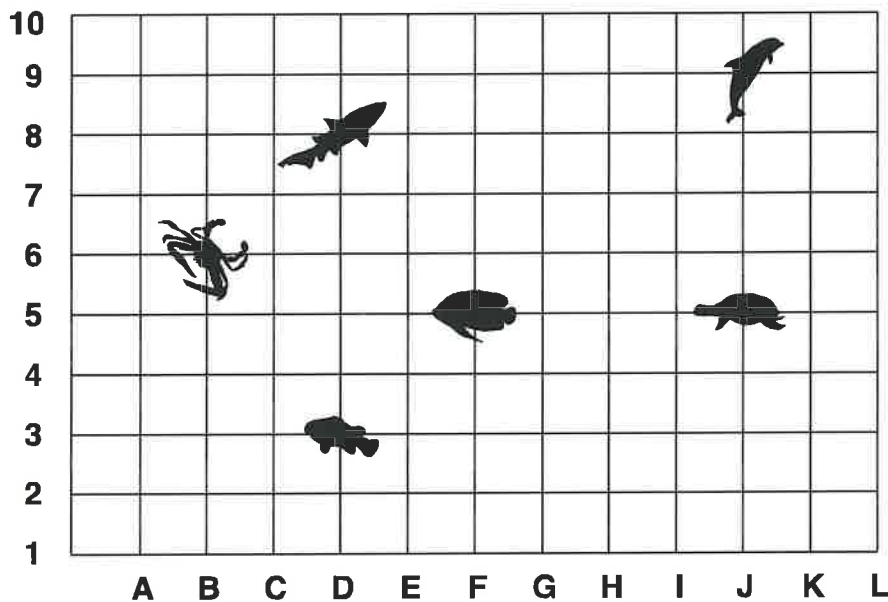
46

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Coordinates are used to show position on a grid, map or coordinate plane. They are shown as pairs of letters and numbers or pairs of numbers, for example, B4 or (2, 4).



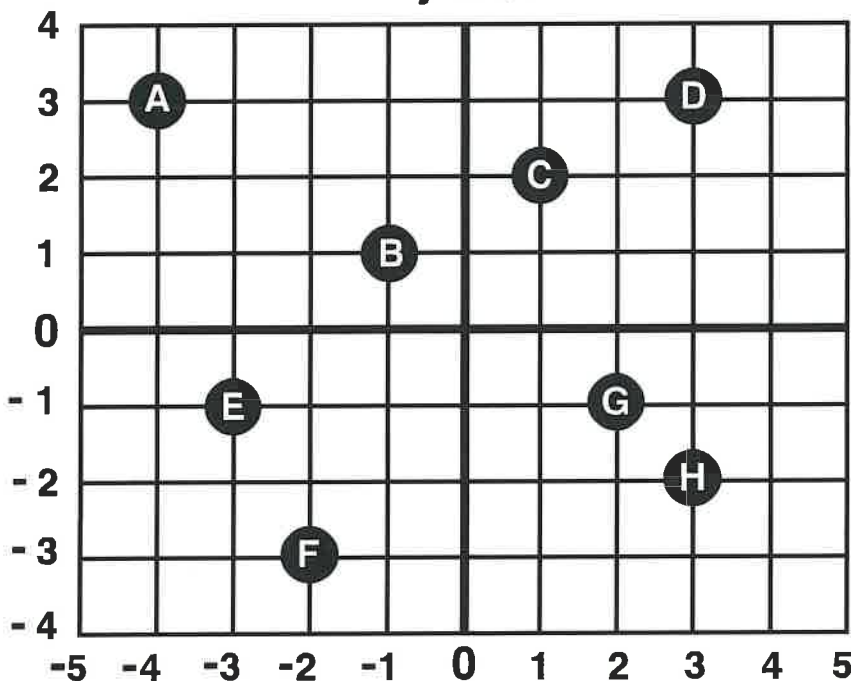
Grids and maps



J9
D8
B6
J5
F5
D3

Coordinate plane

y axis



x axis

The first coordinate is the horizontal position on the x axis. The second coordinate is the vertical position on the y axis.

A (-4, 3)
B (-1, 1)
C (1, 2)
D (3, 3)
E (-3, -1)
F (-2, -3)
G (2, -1)
H (3, -2)

The order used to represent the coordinates is important so they are called ordered pairs.

Square numbers

47

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Square numbers are numbers which can be represented in the shape of a square. A square number results from multiplying an integer by itself and may also be called a perfect square.

4



$$2^2 \text{ or } 2 \times 2 = 4$$

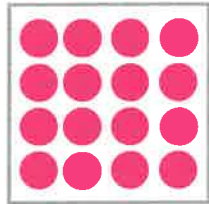


9



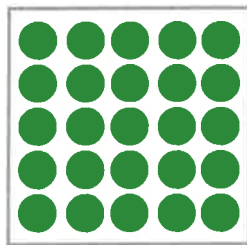
$$3^2 \text{ or } 3 \times 3 = 9$$

16



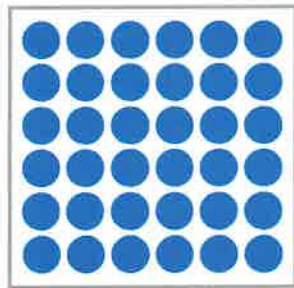
$$4^2 \text{ or } 4 \times 4 = 16$$

25



$$5^2 \text{ or } 5 \times 5 = 25$$

36



$$6^2 \text{ or } 6 \times 6 = 36$$



A number to be squared is indicated by a small 2 placed to its upper-right. This number is called an exponent, index, power or order and shows how many copies of the base number to multiply together.

$$\begin{array}{ccccccc} & & \text{exponent, index,} & & & & \\ & & \text{power or order} & & & & \\ & \swarrow & & \swarrow & & & \\ 2 & = & 2 \times 2 & = & 4 \\ \text{base} & & \text{expanded} & & \text{value} \end{array}$$

Negative and positive numbers 48

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Negative numbers

are numbers
less than zero.

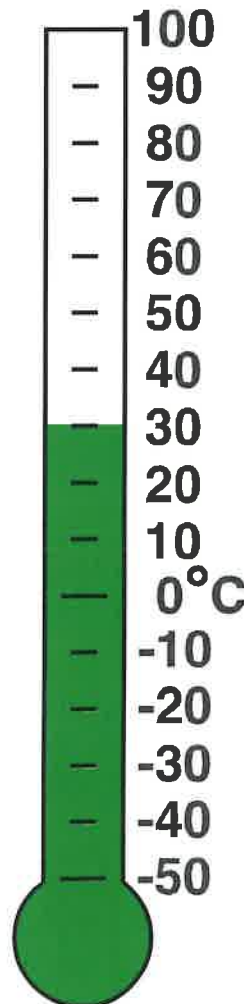
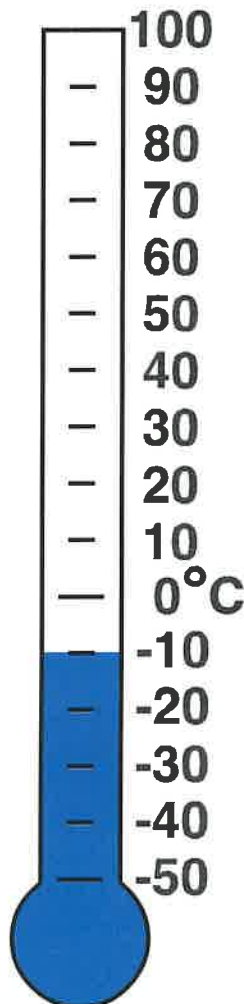
Positive numbers

are numbers
greater than zero.

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

Example: Celsius thermometers

The temperature is
 -10°C
(negative)



The temperature is
 30°C
(positive)



On the Celsius scale, 0° is the freezing point of water
and 100° is the boiling point.

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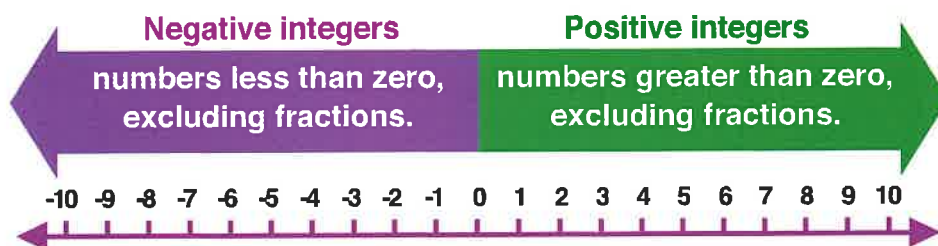
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Integers

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**Integers are positive numbers, negative numbers and zero
... but not fractions or decimal fractions.**



Operations on integers

Addition

Positive + Positive = Positive

$$5 + 3 = 8$$

Negative + Negative = Negative

$$(-5) + (-3) = -8$$

*** Positive + Negative or Negative + Positive**

$$(-5) + 3 = -2$$

- subtract the smaller number from the larger number,
- then use the sign of the larger number in the answer

$$3 + (-5) = -2$$

$$(-3) + 5 = 2$$

$$5 + (-3) = 2$$

Subtraction

Negative - Positive = Negative

$$(-5) - 3 = (-5) + (-3) = -8$$

Positive - Negative = Positive

$$5 - (-3) = 5 + 3 = 8$$

*** Negative - Negative = Negative + Positive**

$$(-5) - (-3) = (-5) + 3 = -2$$

- treat as **Negative + Positive**

$$(-3) - (-5) = (-3) + 5 = 2$$

- subtract the smaller number from the larger number,
- then use the sign of the larger number in the answer

Multiplication

Positive x Positive = Positive

$$5 \times 3 = 15$$

Negative x Negative = Positive

$$(-3) \times (-5) = 15$$

Negative x Positive = Negative

$$(-3) \times 5 = -15$$

Positive x Negative = Negative

$$3 \times (-5) = -15$$

- change double negatives to a positive

Division

Positive ÷ Positive = Positive

$$15 \div 3 = 5$$

Negative ÷ Negative = Positive

$$(-15) \div (-3) = 5$$

Negative ÷ Positive = Negative

$$(-15) \div 3 = -5$$

Positive ÷ Negative = Negative

$$15 \div (-3) = -5$$

- change double negatives to a positive

Operations on positive and negative numbers⁵⁰

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Addition

Positive + Positive = Positive

$$5 + 3 = 8$$

Negative + Negative = Negative

$$(-5) + (-3) = -8$$

*** Positive + Negative or Negative + Positive**

$$(-5) + 3 = -2$$

• subtract the smaller number from the larger number,

$$3 + (-5) = -2$$

• then use the sign of the larger number in the answer

$$(-3) + 5 = 2$$

$$5 + (-3) = 2$$

Subtraction

Negative - Positive = Negative

$$(-5) - 3 = (-5) + (-3) = -8$$

Positive - Negative = Positive

$$5 - (-3) = 5 + 3 = 8$$

*** Negative - Negative = Negative + Positive**

$$(-5) - (-3) = (-5) + 3 = -2$$

• treat as **Negative + Positive**

• subtract the smaller number from the larger number,

$$(-3) - (-5) = (-3) + 5 = 2$$

• then use the sign of the larger number in the answer

Multiplication

Positive x Positive = Positive

$$5 \times 3 = 15$$

Negative x Negative = Positive

$$(-3) \times (-5) = 15$$

Negative x Positive = Negative

$$(-3) \times 5 = -15$$

Positive x Negative = Negative

$$3 \times (-5) = -15$$

• change double negatives to a positive

Division

Positive ÷ Positive = Positive

$$15 \div 3 = 5$$

Negative ÷ Negative = Positive

$$(-15) \div (-3) = 5$$

Negative ÷ Positive = Negative

$$(-15) \div 3 = -5$$

Positive ÷ Negative = Negative

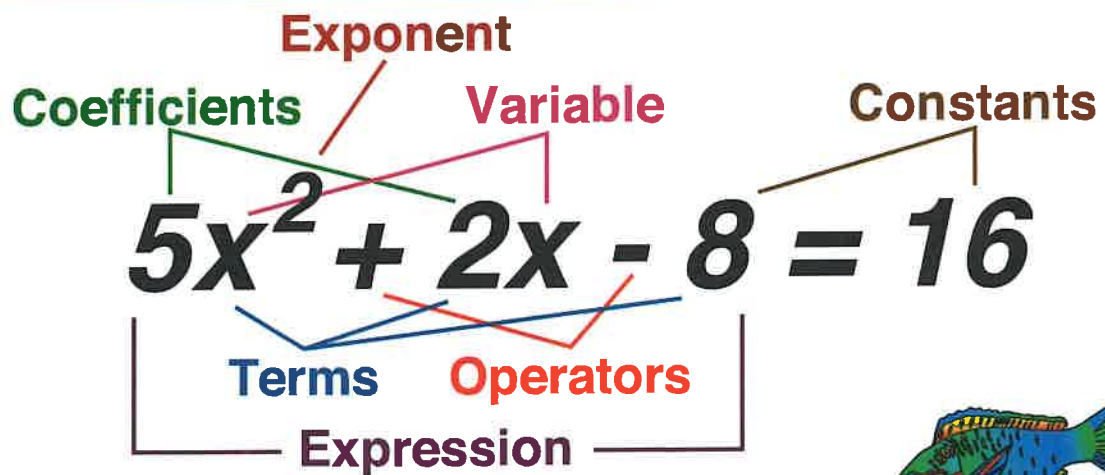
$$15 \div (-3) = -5$$

• change double negatives to a positive

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Elementary algebra is an area of mathematics where numbers and quantities called variables are represented by letters and symbols in expressions and equations.

An equation is a mathematical statement containing an equals sign. One number is represented by an unknown variable. To solve an equation, the value of this variable must be found.



$$5x^2 + 2x - 8 = 16$$

Parts of an equation

- Variable** • varying quantity represented by a letter or symbol, e.g. x
- Constant** • a fixed quantity that does not vary, e.g. a number
- Coefficient** • a number which multiplies a variable, e.g. $5x$
- Exponent** • shows the number of times a variable or number is multiplied by itself, e.g. $y^4 = y \times y \times y \times y$
- Operator** • a symbol indicating what operation must be done, e.g. $+$ $-$ $\times$ $\div$
- Term** • one part of an expression which may be a number, a variable or a product of both, e.g. $5x^2$ $4xy$ 12
- Expression** • one or a group of terms. May include variables, constants, operators and grouping symbols e.g. $3(x + y) - 8 + y^2$
An algebraic expression must contain at least one variable.

Variables

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A variable is a letter or symbol representing a varying quantity, for example, n in $10 + n$.

A variable is the opposite to a constant - a variable can change (vary) but a constant remains the same.

A variable may be represented by any letter of the alphabet.



Variables in expressions

EXAMPLES: To evaluate (work out) each expression if $z = 10$.

$6 + z$	$20 - z$	$2z$	z^2
$= 6 + 10$	$= 20 - 10$	$= 2 \times 10$	$= 10 \times 10$
$= 16$	$= 10$	$= 20$	$= 100$

Variables in equations

EXAMPLE: A variable may be given a number e.g. $n = 3$ so we can work out another variable e.g. t

$t = 10 + n$	$t = 10 - n$	$t = 10n^2$
$t = 10 + 3$	$t = 10 - 3$	$t = 10 \times 9$
$t = 13$	$t = 7$	$t = 90$



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A term is one part of an expression which may be a number, a variable or a product of both.

An expression is one or a group of terms and may include constants, operators and grouping symbols.



Expression	Terms
$2a + b^2$	$2a$ and b^2
$4x^3 + 3xz - 5$	$4x^3$, $3xz$ and 5
$9x^3 + 5x^3 + x + 16$	$9x^3$, $5x^3$, x and 16

Some types of terms

▶ variable term

- a term that contains a variable.

▶ constant term

- a term that has a fixed value and does not contain a variable.

▶ like terms

- terms that are exactly alike or the same except for their numerical coefficients, e.g.
 $2y^2$, $10y^2$, $-2y^2$... all terms have y^2 with a coefficient.
 $2y$, $10y$, y , $-y$... all terms have a single variable, y .
 20 , -5 , 6 , 0.6 ... all terms are constants.

▶ unlike terms

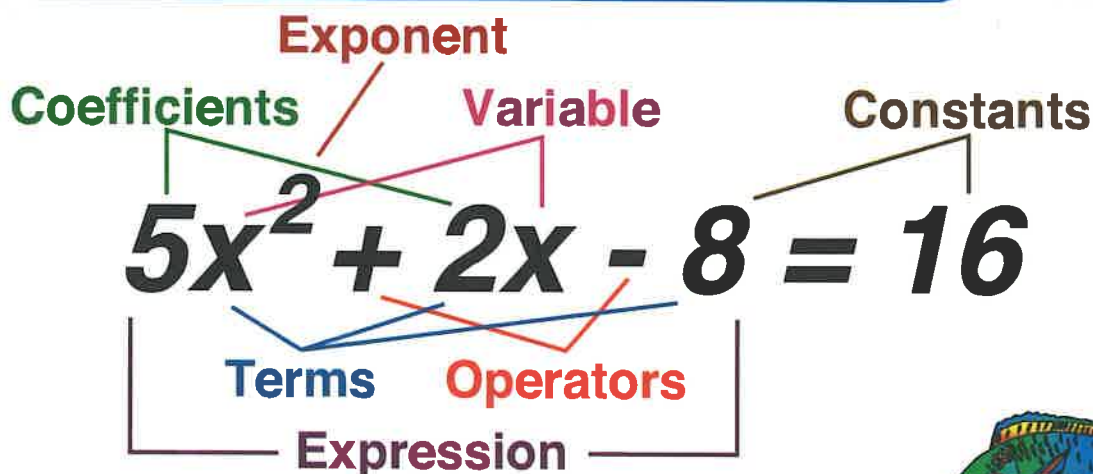
- terms that are not like terms.



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An equation is a mathematical statement containing an equals sign. One number is represented by an unknown variable. To solve an equation, the value of this variable must be found.

Parts of an equation



Solving equations - the basic rule.

Whatever operation is done to one side of an equation, the same operation must be done to the other side.

One step equation, e.g.

- divide both sides by 4

$$4x = 12$$

$$x = 3$$

Two step equation, e.g.

- add 10 to both sides
- divide both sides by 6

$$6y - 10 = 20$$

$$6y = 30$$

$$y = 5$$

Equations with brackets, e.g.

- remove the grouping symbols
- subtract 6 from both sides
- divide both sides by 3

$$3(x + 2) = 24$$

$$3x + 6 = 24$$

$$3x = 18$$

$$x = 6$$