The ORIGO Handbook
of Mathematics Education

Sample Pages

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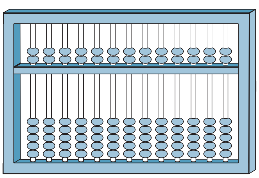
ORIGO®
EDUCATION

Contents

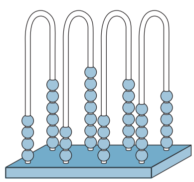
Aa

abacus

An **abacus** is a device used for addition and subtraction. It can also be used for multiplication (through repeated addition), and division (through repeated subtraction). It consists of a number of beads that can slide upwards and downwards on columns. Each column has a place value corresponding to the places of the decimal system. Sometimes the columns are divided into two parts by a horizontal bar. The beads below the bar have a value of 1; those above have a value of 5.



Chinese abacus



loop abacus

Plurals for *abacus*: abaci or abacuses

Related entries: *operation*; *place value*

accuracy

The **accuracy** of a measurement refers to how exact it is. When reporting a measurement, it is useful to indicate its level of accuracy. For example, 'the circumference of the Earth is 40 075 km, to the nearest km'.

Any measurement of a continuous quantity, such as length is an **approximation** only. It cannot be exact as the level of accuracy can be continuously increased by using smaller units of measure. An **estimate** involves using approximations to obtain an answer that is close to the exact answer. For example, the product of 2.1 and 3.9 can be calculated exactly (8.19). Alternatively, by recognising that 2 is approximately 2.1, and 4 is approximately 3.9, an estimate of 8 can be obtained.

Related entries: *computation*; *rounding and truncating*

addition

Addition (symbol: +) is a mathematical operation in which two or more numbers (**addends**) are joined to form a total (**sum**). '**Add**' and '**plus**' are instructions to perform addition. For example, 'seven add five' and 'seven plus five' both mean that five should be added to seven.

$$\underset{\text{addend}}{7} + \underset{\text{addend}}{5} = \underset{\text{sum}}{12}$$

Any number can be written as the sum of two or more addends; this process is called **partitioning**. For example, 17 can be thought of as 10 + 7, or 15 + 2, or 8 + 8 + 1.

Related entries: *addition properties*; *problem types*; *subtraction*

appendix 2.4 3.1 4.1 6.16 6.18 6.20

addition properties

Addition has certain properties that allow terms to be moved around to make an expression easier to work with.

The **identity property** allows a number to remain unchanged when it is added to zero. For example, 3 + 0 = 3 and 0 + 3 = 3.

The **commutative property** allows the order of the addends to be changed without affecting the sum. For example, the expression 5 + 3 is equivalent to 3 + 5.

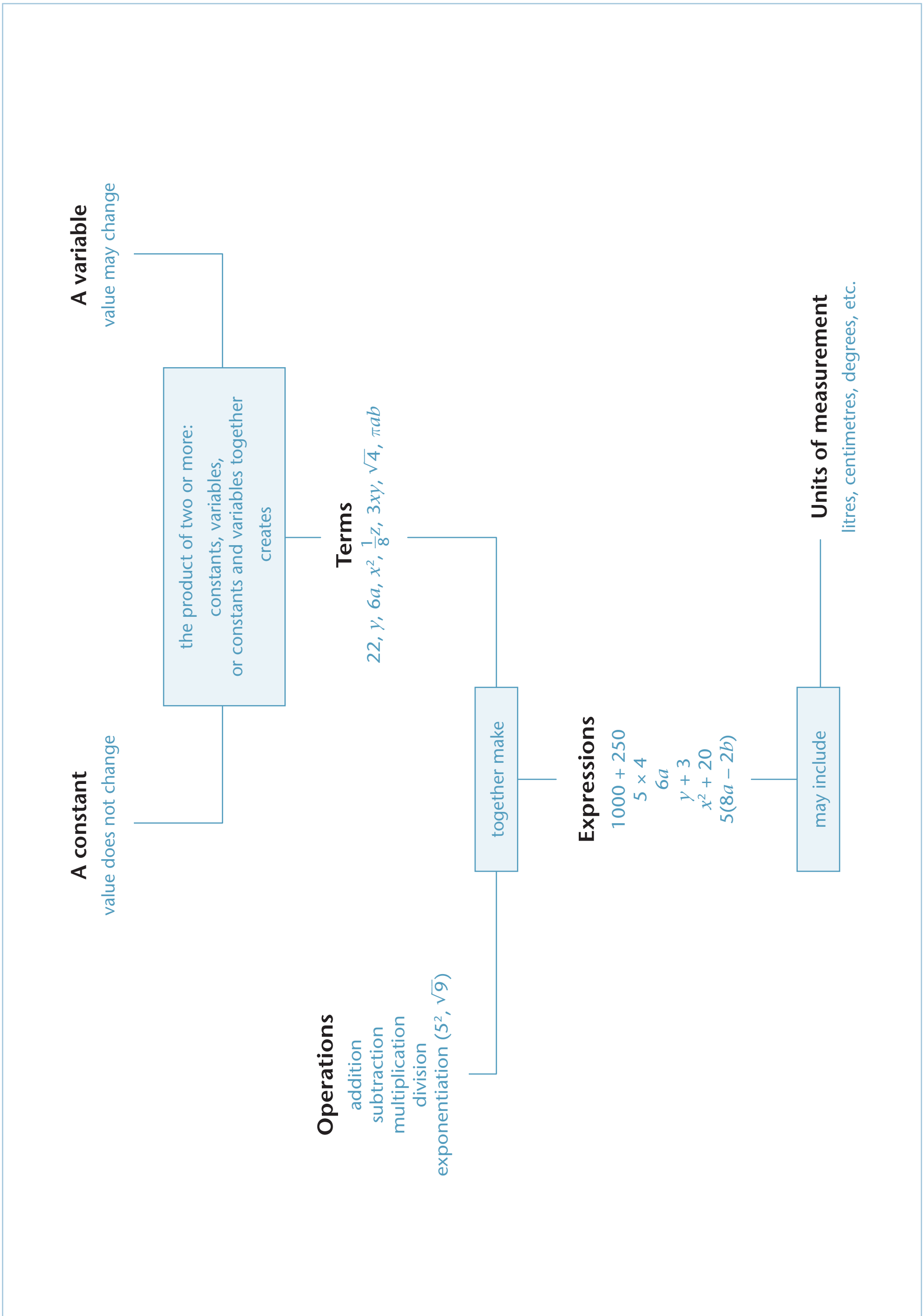
The **associative property** allows multiple addends to be added in any order. For example, the expression 2 + 5 + 9 could be rewritten as (2 + 5) + 9 or as 2 + (5 + 9). The sum will be the same for both.

Synonyms: addition property of zero (for *identity property*); associative law (for *associative property*); commutative law (for *commutative property*); identity element (for *identity property*)

Related entries: *addition*; *multiplication properties*

Expressions

2.4



Addition

3.1 7 + 5 = 12

addend addend sum

‘adding the places’

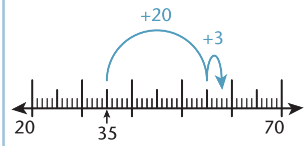
Start with one addend, then add the value of the digits of the other addend(s).

see

35 + 23 = __

think

35 + 20 + 3



‘bridging to ten’

Start with one addend, count up to the next multiple of 10 (100, 1000, etc.), then add the balance of the second addend.

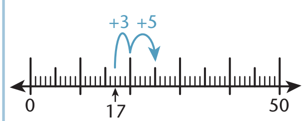
Synonyms: ‘bridge the decades’; ‘bridge to ten’; ‘make a ten’; ‘make to ten’; ‘use ten’

see

17 + 8 = __

think

17 + 3 + 5



‘compensating’

Round one or both addends before adding. Then adjust the answer to compensate for the rounding.

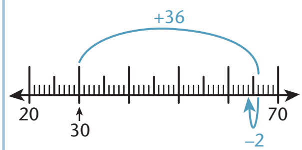
Synonyms: ‘compensation’; ‘round and adjust’; ‘round or adjust’

see

28 + 36 = __

think

(30 + 36) – 2



‘counting on’

Start with one addend, then count on parts (not places) of the other addend.

Synonym: ‘jump’

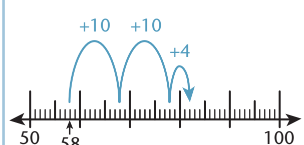
Sub-strategies: ‘count-on-1’; ‘count-on-2’; ‘count-on-3’

see

58 + 24 = __

think

58 + 10 + 10 + 4



Addition

4.1

Written computation methods

The traditional methods described in this section are shown using sets of general steps together with specific examples. The steps can be applied to numbers greater than those used in the examples, or to decimal fractions.

Digits that are the result of regrouping or a similar action ('carry' digits) are usually written using a smaller digit that is raised above (superscript) or lowered below (subscript) the surrounding text. This convention is followed in this section, with the additional use of colour to highlight such digits.

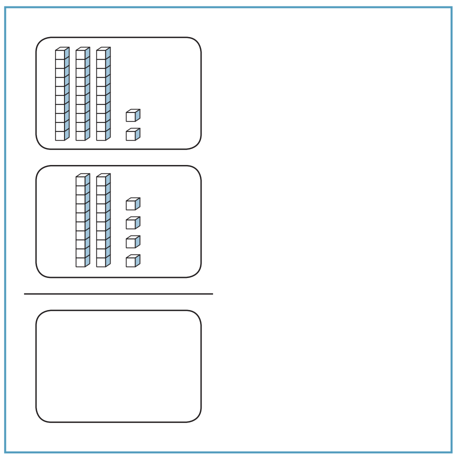
Addition — Without regrouping

Step 1

Write the numbers in place-value columns.

Example:
32 add 24.

Action



Written Format

	T	O
	3	2
+	2	4

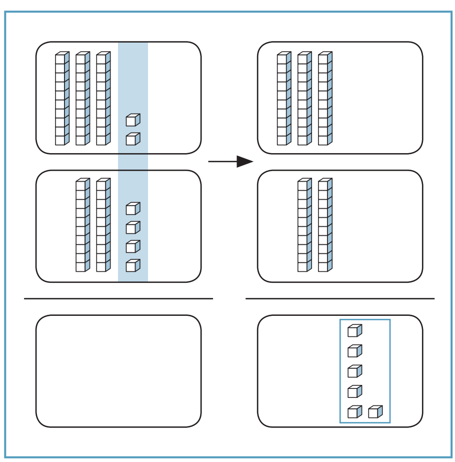
Step 2

Add the digits in the far right column. Write the total in the answer space of that column.

Example:

- 2 ones add 4 ones is 6 ones.
- Write 6 in the ones place of the answer.

Action



Written Format

	T	O
	3	2
+	2	4
		6

Addition and multiplication properties

Addition property	General form	Example
identity	$a + 0 = a = 0 + a$	$2 + 0 = 2 = 0 + 2$
commutative	$a + b = b + a$	$2 + 3 = 3 + 2$ $5 = 5$
associative	$a + (b + c) = (a + b) + c$	$2 + (3 + 4) = (2 + 3) + 4$ $2 + 7 = 5 + 4$ $9 = 9$

Multiplication property	General form	Example
null factor	$a \bullet 0 = 0 = 0 \bullet a$	$2 \times 0 = 0 = 0 \times 2$
identity	$a \bullet 1 = a = 1 \bullet a$	$2 \times 1 = 2 = 2 \times 1$
commutative	$a \bullet b = b \bullet a$	$2 \times 3 = 3 \times 2$ $6 = 6$
associative	$a \bullet (b \bullet c) = (a \bullet b) \bullet c$	$2 \times (3 \times 4) = (2 \times 3) \times 4$ $2 \times 12 = 6 \times 4$ $24 = 24$
distributive	$a \bullet (b + c) = (a \bullet b) + (a \bullet c)$	$2 \times (3 + 4) = (2 \times 3) + (2 \times 4)$ $2 \times 7 = 6 + 8$ $14 = 14$

Synonym for *null factor:* zero multiplication