Taxicab Geometry
ISBN 0-486-25202-7

There are over 100,000 books published every year and every one of them needs a unique number, the International Standard Book Number (ISBN).

0-486-25202-7

A single digit language code. '0' means the book is written in English.

A code for the publisher.

A code for the individual book.

This final digit is the check digit.

- Some publisher codes have two digits. Some have more. Why?

- The first **publisher code** for Penguin Books was **14**.

- How many books could they issue with this?

- Their current code is **713** – how many books will this allow?

- How many books does **6-digit publisher code** allow?

ISBNs can be bought in blocks of 10, 100 or 1,000.

How many blocks of 1000 did Penguin buy each time?

shopping around

Books are ordered using ISBNs. Computers need automatic checks on the accuracy of the data input. **To do this ISBNs use a check digit**.
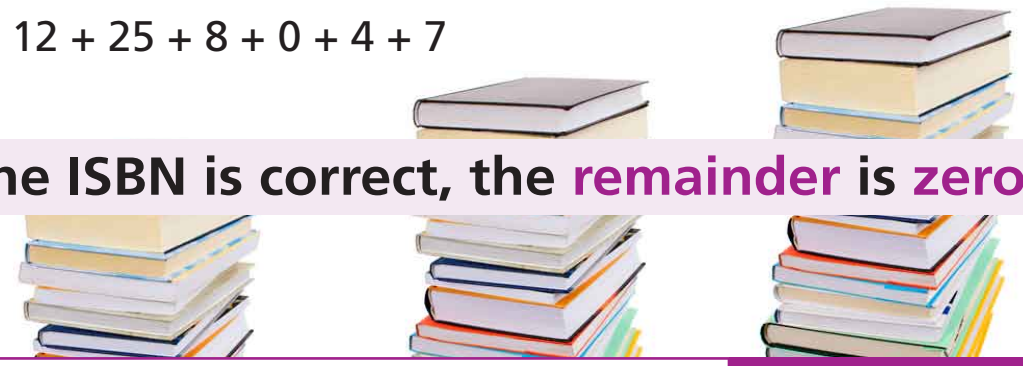
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> This final digit is the check digit.

- Multiply the first digit by 10, the second by 9, the third by 8 and so on and then find the sum.
- Divide by 11 and write down the remainder.

$(0\times\mathbf{10}) + (4\times\mathbf{9}) + (8\times\mathbf{8}) + (6\times\mathbf{7}) + (2\times\mathbf{6}) + (5\times\mathbf{5}) + (2\times\mathbf{4}) + (0\times\mathbf{3}) + (2\times\mathbf{2}) + (7\times\mathbf{1})$

$= 0 + 36 + 64 + 42 + 12 + 25 + 8 + 0 + 4 + 7$

$= \mathbf{198}$

$198 \div 11 = 0$ If the ISBN is correct, the **remainder** is **zero**.

Check some other ISBNs.

Two of these ISBNs are incorrect. Which ones?

The Colossal Book of Short Puzzles and Problems	0-393-06124-0
Celtic Design	0-500-27629-3
Can You Solve These?	0-906212-22-7

Work out the check digit for *Euclid's Window ISBN 0-14-100909-?*

Explain how to calculate a check digit.

This ISBN ends in X. *The Book of Numbers ISBN 0-387-97993-**X*** *When is **X** used as a check digit?*

shopping around

People make mistakes when inputting data.

There are different kinds of common error.

- a single transcription error

- a transposition error (when two numbers are swapped over)

- a double transposition error.

How good is the weighted **modulo 11 test** *at detecting errors?*

Experiment to find out which kinds of error are detected by this test.

Which are always detected?

Which are sometimes detected?

Find an error in an ISBN which the computer will **not** *detect.*

shopping around

Shopping around : ISBNs

Description

Computer codes with check digits are widely used in the retail and banking sector. This activity focuses on one long-established code – the International Standard Book Number (ISBN).

Activity 1: How many books?

Activity 2: The check digit

Activity 3: Checking for errors

Resources

a selection of interesting mathematics books.

In How many books? pupils are introduced to the structure of ISBNs: the first and last field being of fixed length one but the publisher and book codes of variable length comprising eight digits when taken together. They are asked some questions which require place value thinking.
For example, if the book code has 5 digits, then 100,000 books can be coded, counting from 00000 to 99999. This would represent 100 blocks of 1000 ISBNs.

The check digit introduces the weighted modulo 11 test which is used in constructing ISBNs. Pupils should be able to detect errors reasonably easily but moving to finding and, particularly, to explaining a method for calculating check digits is more demanding. They may want to use calculators or you might choose to introduce them to the test for divisibility by 11 – adding alternate digits and finding the difference between the two should produce zero. An extension question is to ask them to explain why this works.

Weighted modulo tests are good at detecting most inputting common errors. Checking for errors invites the pupils to explore when the test is effective and to uncover its limitations.

The mathematics

This set of activities requires pupils think about place value, divisibility and remainders. It also requires logical thinking.