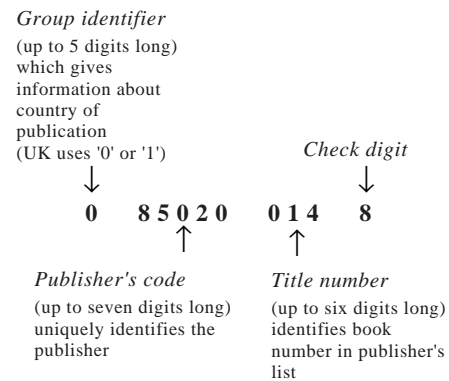


4 ISBN Numbers

Many codes have been designed for use with new technology. These include bar codes, ISBN numbers, ASCII codes, post codes, bank account codes. Many of these modern codes employ a checking device, often referred to as a *check digit*.

An example of this is the ISBN (International Standard Book Number) numbers, used universally on all books published since 1972. An ISBN is preceded by the letters ISBN and has *ten* digits made up from components, as illustrated opposite. The digits are arranged according to the number of digits in each component part, with a space or a hyphen between each part.

The check digit is designed so that any *one* error in the previous nine digits is spotted. It is calculated in the following way.



ISBN number

Multiply the first nine numbers by 10, 9, 8, ..., 2 respectively and find the sum of the resulting numbers. The check digit is the smallest number that needs to be added to this total so that it is exactly divisible by 11.

For the example above, we have

$$0 \times 10 + (8 \times 9 + 5 \times 8 + 0 \times 7 + 2 \times 6 + 0 \times 5) + (0 \times 4 + 1 \times 3 + 4 \times 2) = 135$$

so the check digit must be 8, since 143 is divisible by 11. Note that if the number 10 is needed for the check digit, the symbol X is used.



Example

Determine the check digit, a , for the following ISBN numbers:

- (a) 1 869931 00 a (b) 0 7135 2272 a



Solution

- (a) The number

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

must be divisible by 11; i.e. $266 + a$ must be divisible by 11 and $0 \leq a \leq 10$.

Hence $a = 9$.

- (b) Again, the number

$$1 \times 10 + (7 \times 9 + 1 \times 8 + 3 \times 7 + 5 \times 6) + (2 \times 5 + 2 \times 4 + 7 \times 3 + 2 \times 2 + 1 \times a)$$

must be divisible by 11; i.e. 11 divides $(175 + a)$, giving $a = 1$.

**Activity 1 Check digit**

Suggest some reasons for the use of a check digit of this particular form for ISBN numbers.

**Activity 2 Error detection and correction**

There is one error in each of these ISBN numbers. Can you correct them?

- (a) 1 869932 23 8 (b) 0 7467 1078 5

**Activity 3**

A publisher is given a set of ISBN numbers of the form

$$1\ 834721\ m\ n\ x$$

for $0 \leq m, n \leq 99$, and x is the check digit. Design a ready reckoner or algorithm to determine the check digit for all appropriate values of m and n .