

Starter

Name two things you learned this year about math.

The Imitation Game

Check That Digit!

The first patent for barcodes was issued to Bernard Silver and Norman Woodland in 1952. Since then these coding systems have expanded, been modified, and applied to a variety of areas. One of the most common uses is in retail and grocery stores. Although the barcode is not the price of the item, it does allow for the item to be registered with an associated price. When the bar code is scanned, the associated price will be read by the cash register. Other uses are found in monitoring blood supplies, identification on prescription drugs, book checkout at libraries, tracking luggage, and express shipping services.

Another advantage to the barcode system is that when an additional digit is included, known as the *check digit*, many errors that occur during data entry can be detected. These errors occur when passing information over the phone or internet. It is quite easy for people to transpose numbers (45 when it should be 54), replace a single digit with another, omit digits, or double an incorrect digit (799 is entered as 779). Using a check digit within a check equation helps to catch these errors and verify the validity of the number. As students will see in the ISBN barcode, the number is also used for identification purposes.



UPC

For the first example, use the given UPC symbol 7-86936-24425-0 from the movie "The Incredibles."



To verify this number, follow the steps: $0(1) + 5(3) + 2(1) + \dots$

1. Every even-positioned digit, counting from the right to left, will be multiplied by 3. All odd-positioned digits will be multiplied by 1.
 $1(0) + 3(5) + 1(2) + 3(4) + 1(4) + 3(2) + 1(6) + 3(3) + 1(9) + 3(6) + 1(8) + 3(7)$
2. Sum the products.
 $0 + 15 + 2 + 12 + 4 + 6 + 6 + 9 + 9 + 18 + 8 + 21 = 110$
3. Determine the validity by dividing the sum by 10.
 $110 \div 10 = 11$ remainder 0. Therefore $110 \bmod 10 = 0$. This is a valid UPC number.

ISBN

Has four parts to the number:

- 1 - The first part identifies the language or country (referred to as the group identifier) and is at most five digits.
- 2 - The second part identifies the publisher and may be at most seven digits.
- 3 - The third part represents the item number or edition for that publisher. It may consist of no more than six digits.
- 4 - The final part is the check digit.



The check digit is calculated differently than that of the UPC system. Begin by multiplying the first digit by 10, the second by 9, the third by 8, and continue in this fashion until the ninth digit is multiplied by 2. Next, determine the sum of these products. This is a modulus-11 system, which means that the sum of the products of the first nine digits plus the check digit must be a multiple of 11. One problem that arises in this process is that the check digit might need to be a 10. Because we only have digits 0-9, an X is written in the check-digit place. (The X is reflective of the Roman numeral for 10.) Questions 3-6 on the Check That Digit Activity Sheet deal specifically with the ISBN. Note: Since January 1, 2007, the ISBN system was replaced with the ISBN-13 system (for further information, see the ISO Web Site). It is a 13-digit number beginning with 978, followed by the current nine digits of the ISBN, and it will have a new check digit. The check digit will be found using a method different from the current one. When all old ISBN's have been used, the next series will begin with 979.

Credit Cards

Credit cards use a system of blocked numbers similar to the ISBN. One obvious difference is that the maximum length for the number is 19 digits, although many numbers range from 13-16 digits.

ISSUER	IDENTIFIER	CARD NUMBER LENGTH
Diner's Club/ Carte Blanche	300xxx -- 305xxx, 36xxxx, 38xxxx	14
American Express	34xxxx, 37xxxx	15
VISA	4xxxxx	13,16
MasterCard	51xxxx -- 55xxxx	16
Discover	6011xx	16

The first digit of a credit card number is the Major Industry Identifier (MII) and identifies which group issued the card, as shown below.

MII DIGIT VALUE	ISSUER CATEGORY
0	ISO/TC 68 and other industry assignments
1	Airlines
2	Airlines and other industry assignments
3	Travel and Entertainment
4	Banking and Financial
5	Banking and Financial
6	Merchandizing and Banking
7	Petroleum
8	Telecommunications and other industry assignments
9	National assignment



The process used to determine the check digit is the Luhn algorithm (mod 10), named after IBM scientist Hans Peter Luhn. This algorithm works as follows:

1. Begin by doubling all even-positioned digits when counting from right to left. If doubling results in a two-digit number, add the digits. For instance, if the original digit were a 6, doubling it would give 12, so use $1 + 2 = 3$.
2. Determine the sum of the results from Step 1 and each of the unaffected (odd-positioned) digits in the original number.
3. Verify the account number by determining if the sum from Step 2 is a multiple of 10.

Verify the following account

5314 7726 8593 2112