Barcodes – Check Digits

Introduction   EAN-13 Barcodes

A barcode is used to store a sequence of numbers that correspond to a specific item for sale in a shop. A barcode consists of a series of black and white stripes which can be read by a scanner. Barcodes were first introduced in 1973. Most items in Australian supermarkets use the: EAN-13 barcode, EAN stands for European Article Number. These barcodes can be read right-side-up or upside-down. An EAN-13 barcode contains 13 digits, the first 12 digits of the number identify the product and the final digit is a 'check digit'. Although barcodes are used for stock control and checkout scanning, they do not contain information about price. When an item is scanned at the register the store's database checks the assigned price and applies that to the point of sale. In this activity you will learn how to calculate the check digit, and write a program using TI-Nspire to automate the algorithm.

Let's look at the barcode from a 2 litre bottle of Coca-Cola™ (shown opposite). Follow the steps below to calculate and verify the check digit:

- Digit positions are numbered from the left to the right.
- Sum the digits in odd positions: 9 # 0 # 6 # 5 # 0 # 0 yeilds: 20.
  Important: The final digit: 7 is not included, this is the check digit.
- Sum the digits in even positions and multiply this sum by 3:
  #3 # 0 # 7 # 0 # 1 # 0 becomes: (3 + 0 + 7 + 0 + 1) x 3 = 33
- Add the results from the previous two steps: 20 + 33 = 53
- Subtract the 'units' digit in the previous answer from 10: 10 – 3 = 7. This is the "check digit".

Question: 1.

A 1.25 Litre bottle of Diet Coca-Cola, has its first 12 digits of the barcode as 9 300675 01103X. Calculate the value of 'X', the check digit.

Question: 2.

A 280gm jar of Vegemite™, has the barcode: 9 352042 000311. Verify this is a legitimate barcode.

Question: 3.

A 380gm jar of Vegemite, has the first 12 digits of its barcode: 9 352042 00032 X. Determine the value of the check digit: X. Check your answer with the jar shown opposite.

Question: 4.

A 325g jar of Bega Peanut butter has the first 12 digits of its barcode: 9 352042 00212 X. Determine the value of the check digit X.

Question: 5.

One of the digits on a different jar of Vegemite is illegible. The barcode is: 9 352042 0X032 4 Determine the value of the illegible digit: X.

Each barcode is unique to a specific product. In other words, a product having the same manufacturer and size has the same barcode. You may have noticed that the first 7 digits on each of the Vegemite products is the same, these refer to

Author: Raymond Rozen

the company code, the manufacturer of the items. The next 6 digits correspond to the product code. Companies cannot make up their own barcode. GS1 is an official licenced barcode provider with authority to supply barcodes.

The first two digits do not necessarily show the country of origin, but they may indicate the product was manufactured in a specific country. In the case of our Vegemite example, the first two digits 93 most likely indicate the product was made in Australia. The spaces in the numerical part of the barcode are not used by scanners, they include spaces to make the number easier to read by humans in the event that a manual entry is required.

Question: 6.

Choose at least two items from the supermarket, your fridge or pantry which have an EAN-13 digit barcode and verify that the check digit is correct.

Question: 7.

An ISBN is an International Standard Book Number, which is also an EAN-13 digit barcode. The ISBN is printed on the back of most books and can be used to identify the book. Which of the following are valid ISBN numbers?

a) 978-0-730-32456-0

b) 978-0-486-60288-2

c) 978-1-107-56747-5

d) 978-0-730-32303-7

Strings of Numbers

Barcodes can be respresented numerically, however they are a little bit like mobile phone numbers, they often contain a leading zero, for this reason it is appropriate to initially treat them as text. The following instructions introduce some commands that will be useful in the formulation of a program to validate Barcodes.

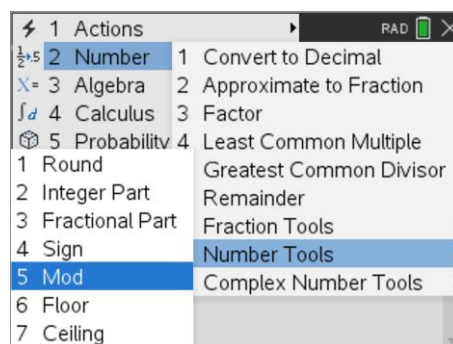Start a new TI-Nspire document and insert Calculator Application.

Press menu > **Number** > **Number Tools** > **Mod**

mod(37,4)

Try the following:

mod(29,5)

mod(53,10)

Question: 8.
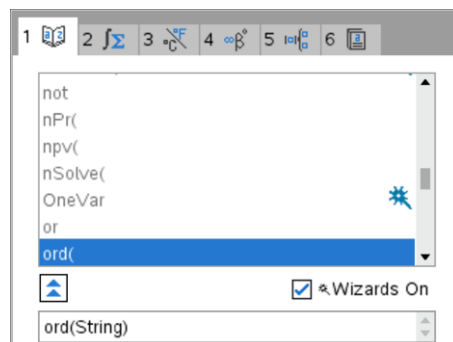
What does the "mod" command do?

There are so many commands built into TI-Nspire that some are not available from the regular menu structure. The "ord" command can be typed directly or located in the catalogue.

Press 📖 select Tab 1 and type "O", then scroll down to locate the ord command.

Try each of the following:

ord("3")

ord("1")

Question: 9.

What value needs to be subtracted from the result to compute the value of a number when represented as text?

Author: Raymond Rozen

TEXAS INSTRUMENTS

The 'mid' command is another command that is not featured in the regular menu structure. It too can be accessed from the catalogue. One advantage of accessing commands from the catalogue is that it provides some detail about the syntax.

Mid(sourceList, Start [,Count])

Syntax contained within " [   ] " is optional.

Press ⌨ select Tab 1 and type "M", then scroll down to locate the mid command.
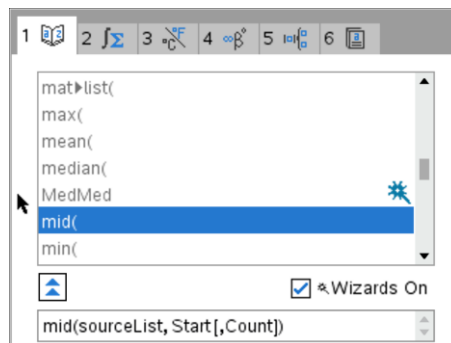
Try each of the following: mid("0456",1,1)   mid("0456",1,2)   mid("0456",2,3)
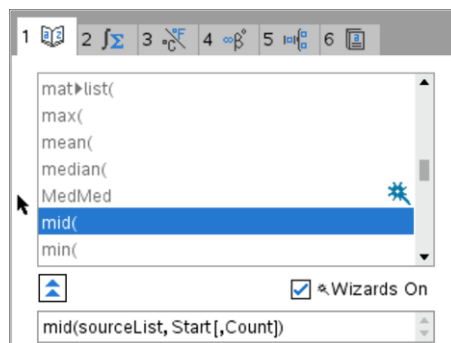
The syntax for the mid command starts with "source list". In the previous examples text was used. The source list may consist of a list of values.

> Data:={1,8,0,0,1,3,8,1,4,0}

Now try each of the following:

> Mid(data,5,3)

> Mid(data,3,1)

Question: 10.

> Explain what the 'mid' command does, including each part of the syntax.

In mathematics one function can be embedded inside another, these are referred to as composite functions. The output of one function feeds becomes the input of another. This can be expressed as: $f(g(x))$. The variable x is the input for rule: g ; the result becomes the input for rule: f .

In this case, two programming commands "ord" and "mid" will be combined to produce a single result.
The output from the 'mid' command is fed into the input of the 'ord' command.
Type in the following combination:

> ord(mid("456",2,1))-48
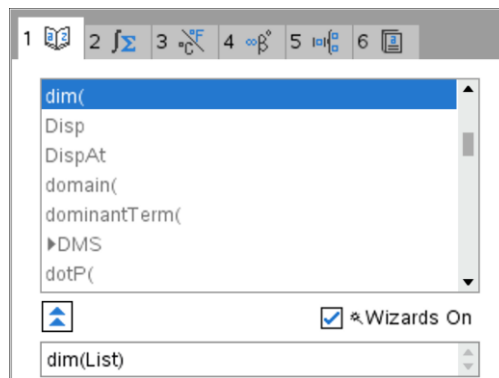
ord("5")	53
mid("456",2,1)	"5"
ord(mid("456",2,1))−48	
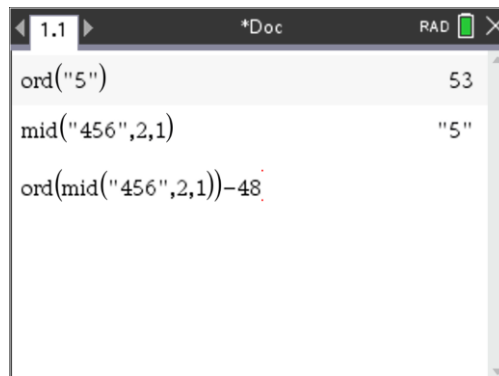
The last piece in this puzzle is the "dim" command.

Try each of following:

> dim("456")

> dim("Puzzle")

Author: Raymond Rozen

TEXAS INSTRUMENTS

Question: 11.

What does the dim() command do?

Check Digit Program

You are now ready to write your program to find the check digit, given the first 12 digits of any EAN-13 barcode.
The following structure outlines the program:

- Request the barcode of the first 12 digits as a string
- Strip each digit from the string and store in a list
- Perform the algorithm for the check digit (Outlined on Page 1)
- Display the 13th digit, which is the checkdigit.

Another version of the program verifies the 13 digits of any EAN-13 barcode.

- The following structure outlines the program:
- Request the barcode as the total 13 digits as a string
- Strip each digit from the string and store in a list
- Perform the algorithm for the check digit (Outlined on Page 1)
- Displays a message whether the barcode is valid or not.

A series of videos have been produced that may help you write your programs. You can use your phone to scan the QR-codes or shortlink to access the videos.

Text to Numbers
This video covers the ord, dim and mid commands, just in case you want some more examples and see how they can be used in a program.
http://bit.ly/10MinCode-Text2Numbers

Building a List
This video demonstrates how to create an empty list and then progressively add elements to the list as the program continues.

http://bit.ly/10MinCode-AugmentLists

Question: 12.

Use the programs to verify the check digit from another two or more items, with an EAN-13 barcode.

Author: Raymond Rozen

UPC-12 Barcodes

While the majority of items in Australian supermarkets and stores use the EAN-13 barcodes, there are several other barcodes in use. A Universal Product Code, consists of 12 digits, the final digit, the check digit is calculated in a similar way to the EAN-13 calculations, except that the sum of the **odd** numbered positions are summed together and multiplied by three and added to the sum of the **even** numbered digits, Other than this, the calculations are the same.

Question: 13.

Verify the following are valid UPC-12 barcodes.

Question: 14.

Determine X the missing check digit of the following UPC-12 barcodes.

a) 6 91300 13145 X

b) 9 38721 04783 X

Question: 15.

Modify or rewrite your program so that it calculates the check digit of a UPC-12 barcode.

Other Barcodes

Other smaller items in the supermarket can have a barcode length consisting of a total of only 8 digits.

Question: 16.

a) Two spice jars have barcodes 9371 6284 and 9371 6123.

Determine how the last digit, the 8th check digit is calculated from the first 7 digits.

b) Two other spice jars from the same manufacturer have bar codes 9371 613X and 9371 683X.

Find the digit X, which represents the check digit for these items.

c) Modify the program so that it calculates the check digit of an 8 digit barcode.

d) Run the program to verify your results.

e) Find two smaller items from the supermarket, your fridge or pantry which have an 8 digit barcode and verify that the check digit is correct.

Author: Raymond Rozen

TEXAS INSTRUMENTS