

Barcodes – Check Digits

Teacher Notes and Answers

7 8 9 10 11 12



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: $(3 + 0 + 7 + 0 + 1) \times 3 = 33$
- 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.

Answer: 7

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.

Answer: 8

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.

Answer: 4



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.

Answer: 4

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 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.

Answer: Answers will vary.

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 |

Answer: a) valid b) valid c) invalid d) valid

Strings of Numbers

Barcodes can be represented 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.

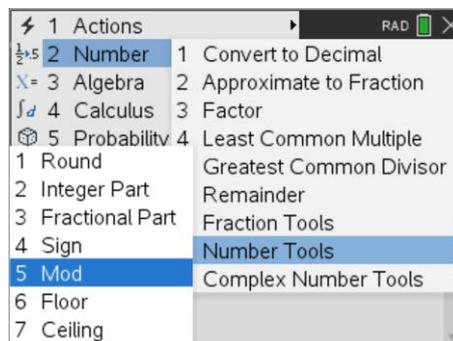
Press $\left[\text{menu} \right]$ > **Number** > **Number Tools** > **Mod**

$\text{mod}(37,4)$

Try the following:

$\text{mod}(29,5)$

$\text{mod}(53,10)$

**Question: 8.**

What does the "mod" command do?

Answer: The $\text{mod}(x,y)$ command returns the remainder when y is divided into x.

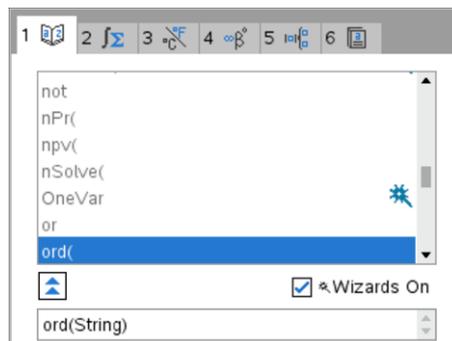
There are so many commands built into TI-Nspire that some are not available from the regular menu structure. The “ord” command can be typed directly or located in the catalogue.

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?

Answer: 48

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)`

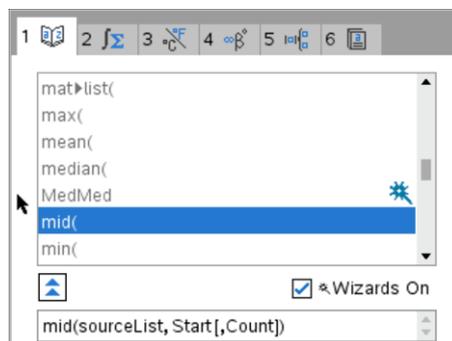
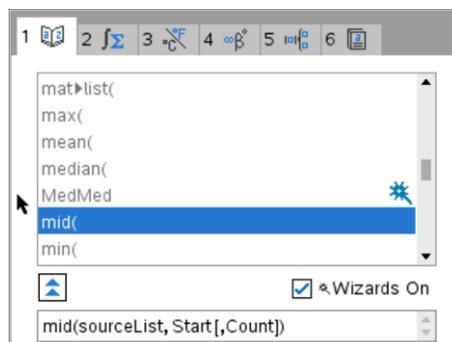
The syntax for the mid command starts with “source list”. In the previous examples text was used. The source list may consist of a list of values.

`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.

Answer: This command works the same as the equivalent Excel command. The ‘mid’ command returns any section of a text string where the first part of the command syntax is the text string; the second part determines the starting location and the third is the length of the string returned. Examples: `mid("Maths",2,1) = a;` `mid("Maths",1,3) = Mat.`



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
```

The last piece in this puzzle is the “dim” command.

Try each of following:

```
dim("456")
```

```
dim("Puzzle")
```

```
1.1 *Doc RAD
ord("5") 53
mid("456",2,1) "5"
ord(mid("456",2,1))-48
```

```
1 2 3 4 5 6
dim(
Disp
DispAt
domain(
dominantTerm(
DMS
dotP(
Wizards On
dim(List)
```

Question: 11.

What does the dim() command do?

Answer: dim(string) returns the number of characters in the string.

Check Digit Programs

You are now ready to write your programs

(1) 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

(2) Another similar 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.

```

Define ean13()=
Prgm
  © This program calculates the 13th checkdigit of an EAN
    13 barcode
  Disp "This program finds the 13th check digit"
  Local bcode,length,n,i
  Local podd,peven,total,checkdigit
  length:=0
  © EAN 13 code
  © Input the character string
  While length≠12
  RequestStr "Enter the first 12 digits of a 13 digit barcode",l
  length:=dim(bcode)
  EndWhile
  © Convert the string into a numeric array
  n:=seq(0,x,1,length)
  For i,1,length
    n[i]:=ord(mid(bcode,i,1))-48
  EndFor
  © Calculate the check digit
  podd:=0
  peven:=0
  For i,1,length
    If mod(i,2)=0 Then
      peven:=peven+n[i]
    Else
      podd:=podd+n[i]
    EndIf
  EndFor
  total:=3·peven+podd
  checkdigit:=10-mod(total,10)
  If checkdigit=10 Then
    checkdigit:=0
  EndIf
  Disp "The check digit is ",checkdigit
EndPrgm

```

```

Define checkean()=
Prgm
© This program verifies an EAN 13 barcode
Local bcode,length,n,i
Local podd,peven,total,checkdigit
length:=0
© EAN 13 code
© Input the character string
While length≠13
RequestStr "Enter a 13 digit number",bcode
length:=dim(bcode)
EndWhile
© Convert the string into a numeric array
n:=seq(0,x,1,length)
For i,1,length
  n[i]:=ord(mid(bcode,i,1))-48
EndFor
© Calculate the check digit
podd:=0
peven:=0
For i,1,length-1
  If mod(i,2)=0 Then
    peven:=peven+n[i]
  Else
    podd:=podd+n[i]
  EndIf
EndFor
total:=3·peven+podd
checkdigit:=10-mod(total,10)
If checkdigit=10 Then
  checkdigit:=0
EndIf
If checkdigit=n[13] Then
  Disp "This is a valid EAN barcode "
Else
  Disp "This is not a valid EAN barcode"
EndIf
EndPrgm

```

Question: 12.

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

Answer: Answers will vary.

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

Answer: a) 9

b) 0

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.

- 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.
- 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.
- Modify the program so that it calculates the check digit of an 8 digit barcode.
- Run the program to verify your results.
- 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.

Answer:

a) The final digit, the check digit is calculated in a similar way to the UPC calculations, the sum of the **odd** numbered positions are summed together and multiplied by three and added to the sum of the **even** numbered digits.

b) 0 3