NUMB3RS Activity: Checksum
Episode: "Uncertainty Principle"

Topic: Checksum algorithms **Grade Level:** 9 - 10
Objective: Students will learn to check the validity of checking routing numbers, as well as use an algorithm to write their own routing numbers.
Time: 20 - 30 minutes

Introduction

In "Uncertainty Principle," the FBI discovers that concealed in a series of bank robberies is the plan for an even larger heist. Charlie helps discover the nature of the scheme when he sees a list of numbers and recognizes them as bank routing numbers.

Routing numbers are printed on a check along with the account and check numbers. It is this routing number that allows the check to be tracked back to the bank in which the money has been deposited. Because this number is read by computers, the computer uses an algorithm to verify that it has correctly read the routing number. Key to this algorithm is the checksum.

Discuss with Students

Students will be calculating the validity of the routing number on Charlie's check. Many students may have their own checks and wish to check the validity of their own checks as well. They will find that the same algorithm will test the validity of their routing numbers as well.

When using the calculators students may find data already in the L_1 and L_2 columns. To clear the data in the list, place your cursor on the top of the column over the desired label and press CLEAR.

Student Page Answers:
1. *The checksum of 110 is divisible by 10* **2.** *6* **3.** *3* **4.** *9*

Extensions Answers:
1. *The sum is divisible by 11.* **2.** *10; the sum is divisible by 11*

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Name: _____ Date: _____

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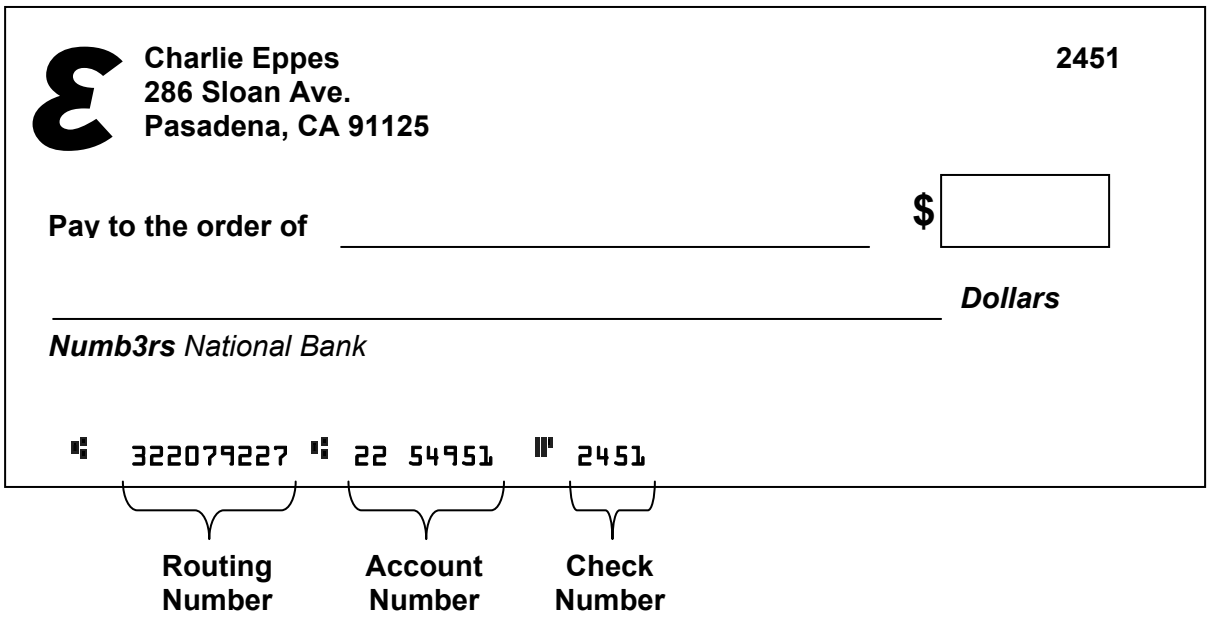

A routing number is composed of nine digits; the first four digits specify the Federal Reserve District, the second four digits identify the institution, and the last digit is the checksum. A checksum uses an algorithm to verify the validity of the routing number.

There is a variety of numbers used everyday that utilizes checksums, and there are many systems to calculate these checksums. The algorithm to calculate the routing number checksum is to break the number into the individual digits then multiply the first one by 3, the second by 7 and the third by 1 and continue on with this three-digit cycle beginning again with 3. The sum of these numbers should be a multiple of 10. The checksum algorithm is designed to force the sum to be a multiple of 10. If the checksum is a multiple of 10, then the routing number was read correctly by the scanning process. If the checksum is not a multiple of 10, then the scan was incorrect, and the check is routed to an error bin.

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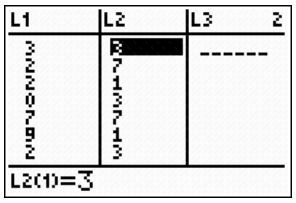
1. Check the routing number on Charlie's check to verify its checksum is a multiple of 10.

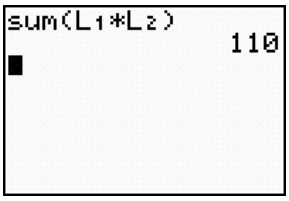
3	2	2	0	7	9	2	2	7
× 3	× 7	× 1	× 3	× 7	× 1	× 3	× 7	× 1

The calculator can quickly evaluate the checksum by using the Lists and the sum function. The **sum(** command gives the sum of a series of numbers. In this case, use the product of the L_1 and L_2 lists.

Press [STAT] and select **1:Edit...**. Then enter the routing number for Charlie's check in L_1. Enter the sequence 3, 7, 1, 3, 7, 1, 3, 7, 1 in L_2.



Next go to the home screen and find **sum(**, press [2nd] [LIST], go to the **MATH** menu, and select **5:sum(**. Then press [ENTER]. The result should be a number that is a multiple of 10 (that is, it ends in 0).



2. If you were only given the first eight digits, determine what the missing checksum would be for 56781234.

Suppose that on a check, the first number of the routing number was smudged, and the checksum appears as "▒14324568." Using the checksum, you can find the missing number.

3. What is the multiplier of the missing number?

4. What is the missing number?

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The goal of this activity is to give your students a short and simple snapshot into a very extensive mathematical topic. TI and NCTM encourage you and your students to learn more about this topic using the extensions provided below and through your own independent research.

Extensions

Introduction

There are numerous systems that use checksums, such as ISBNs and credit card numbers. Each system has a unique algorithm for finding the checksum. In this extension, you will look more closely at an ISBN.

The ISBN number is composed of ten digits. The first two digits specify the country, the next five specify the publisher, and the next two identify the title or edition of the book. The final checksum digit is calculated by multiplying the first nine digits by their position number. The checksum is the number that, when multiplied by 10, would make the sum divisible by 11.

1. Verify the ISBN for the book *Feynman Lectures on Physics*.

0	8	0	5	3	9	0	4	5	6
× 1	× 2	× 3	× 4	× 5	× 6	× 7	× 8	× 9	× 10

Since the checksum for the ISBN is the number to make the sum divisible by 11, what number would you have to add to 23 to make it divisible by 11? The answer is 10 (because 23 + 10 = 33, and 33 is divisible by 11). In the ISBN, the number 10 is represented by the letter X.

2. Verify the ISBN number for the book *Flatland*.

0	4	8	6	2	7	2	6	3	X
× 1	× 2	× 3	× 4	× 5	× 6	× 7	× 8	× 9	× 10

Additional Resources

The Federal Reserve Education (FRED) Web site has lessons and activities for teachers and students that explain the Federal Reserve System and routing numbers.
http://www.federalreserveeducation.org/FRED

This Web site has an applet that validates bank routing numbers and gives a further explanation: **http://www.brainjar.com/js/validation**

FigureThis.org website from NCTM has a problem called bar codes that poses questions about codes – and includes in the Did you Know section another check number.
http://figurethis.org/challenges/c51/challenge.htm

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