Prime Factors
Teacher Answers

TI-Nspire CAS   Investigation   Student   30min

Aim

The aim of this investigation is to learn how to find the prime factors of composite numbers.

Equipment

For this activity you will need:

- TI-Nspire CAS (or TI-Nspire)
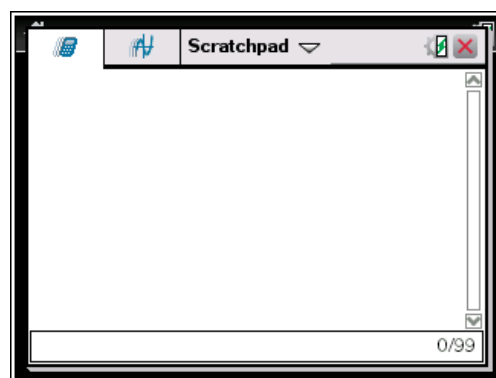- TI-Nspire file – Prime Factors

Introduction – Setting up the calculations

This activity requires access to the "Prime Factors" TI-Nspire file. This file should be loaded on your device before proceeding.

Once the file is on your handheld, press **home** and select **My Documents**. Locate the "Prime Factors" file and press **enter** to open.
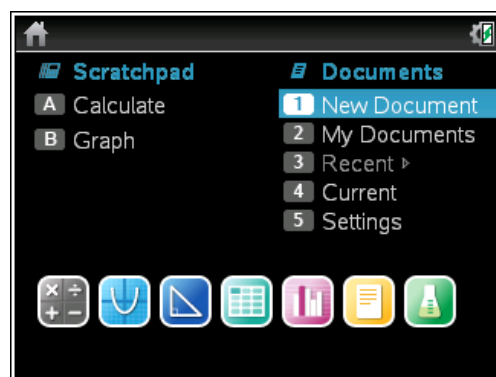
Part of in this investigation requires calculations to be performed. The Scratchpad is a place where calculations can be computed and then discarded. To access the Scratchpad press **home** and select **Scratchpad** (or press **A**). Alternatively, press the ⊞ key (this key is not available on a Clickpad).

Author: Neale Woods

Teachers Teaching with Technology™
Professional Development from Texas Instruments

Factors

A **factor** is number that divides evenly into another number. For example, the factors of 10 are 2 and 5 because 10÷2 = 5 and 10÷5 = 2. After doing the division, there is no remainder so 2 and 5 are factors. The numbers 10 and 1 are also considered to be factors of 10.

Prime Numbers

A **prime number** is a number whose only factors are itself and 1. For example, 5 is a prime number because 1 and 5 are its only factors. Below is the list of the first 10 prime numbers:

2, 3, 5, 7, 11, 13, 17, 19, 23, 29, . . .

You will notice that except for the first number, they are all odd numbers. The other even numbers are not prime numbers because they all have 2 as a factor. For example:

4 = 2×2, **6** = 2×3, **8** =2×4, **10** = 2×5, etc.

You may also have noticed that some odd numbers are not in this list. This is because they have factors other than 2. For example:

9 = 3×3, **15** = 3×5, **21** = 3×7, **25** = 5×5, **27** = 3×9, etc.

Composite Numbers

If a number has more than two factors (1 and itself) then it is known as a **composite number**. 6 is a composite number because it has the factors 1, 2, 3 and 6. The number 1 is a special case in that it is considered neither prime nor composite.
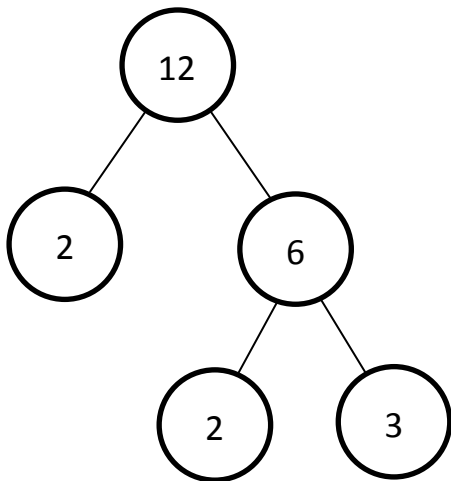
Prime Factors

A **prime factor** is a prime number which is a factor of another number. All composite numbers can be written as a product of prime factors. In fact, every composite number has a unique set of prime factors. The **factors** of 6 are 1, 2, 3 and 6 but the **prime factors** of 6 are 2 and 3. The number 6 is the only number to have the prime factors of 2×3.

Author: Neale Woods

Finding the Prime Factors of Composite Numbers

There are several methods you can use to find the prime factors of a composite number. One method is to use factor trees, where you keep splitting up a number until the end of each branch is a prime number. No matter how you initially split the number, you will eventually get a unique set of prime factors for every composite number.

There are two factor trees below showing how to split the number 12. They both arrive at the unique set of prime factors for 12, which are 2×2×3.
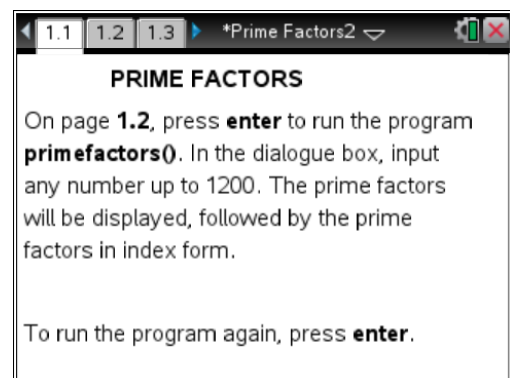
Factor tree starting with 2×6   **Factor tree starting with 3×4**
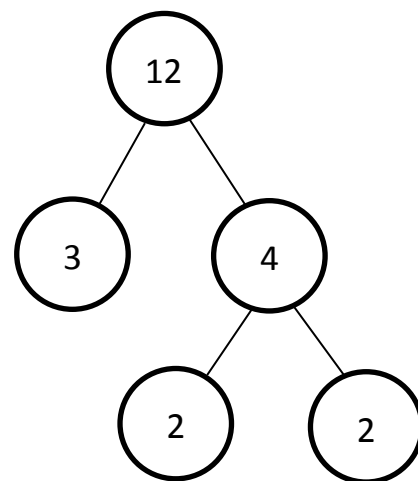
Using either method, the prime factors of **12** are **2**, **2** and **3**. This can be written index form as **12** = $2^2×3$.
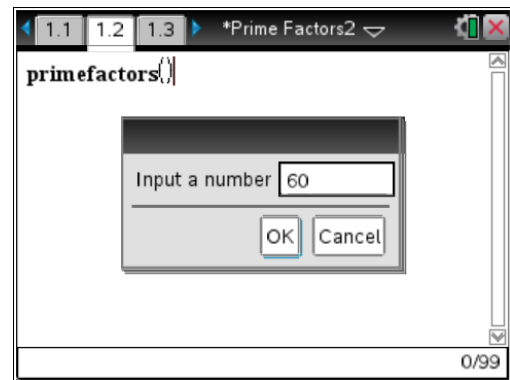
Using the Prime Factor Program

Open the **Prime Factors** file on your calculator.

PRIME FACTORS

On page **1.2**, press **enter** to run the program **primefactors()**. In the dialogue box, input any number up to 1200. The prime factors will be displayed, followed by the prime factors in index form.

To run the program again, press **enter**.

Author: Neale Woods

Teachers Teaching with Technology™
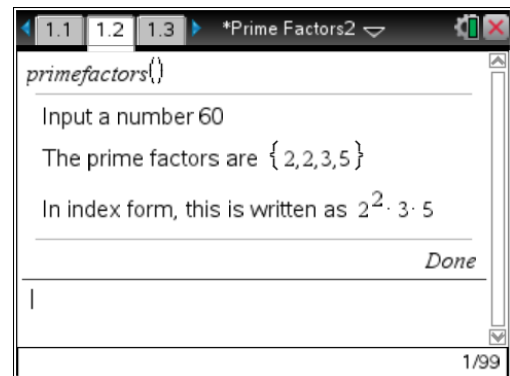Professional Development from Texas Instruments

Go to page **1.2**.

Press **enter** to run the **primefactors** program. In the dialogue box, input any number up to 1200. Press **OK**.

The set of prime factors will be displayed followed by the prime factors in index form.

To run the program again, press **enter**.

Run the **primefactors** program to find the prime factors of the following numbers. In the second column, write the set of individual prime factors. In the third column, write the prime factors in index form. The first entry has been completed for you.

Number	Prime Factors (set of factors)	Prime Factors (index form)
75	$\{3,5,5\}$	$3\cdot5^2$
144	$\{2,2,2,2,3,3\}$	$2^4\cdot3^2$
169	$\{13,13\}$	13^2
414	$\{2,3,3,23\}$	$2\cdot3^2\cdot23$
855	$\{3,3,5,19\}$	$3^2\cdot5\cdot19$
1001	$\{7,11,13\}$	$7\cdot11\cdot13$

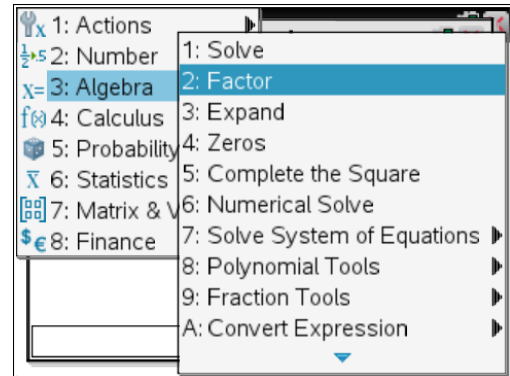Note – to clear the screen on the Calculator page, press **menu > Actions > Clear History**. If you accidentally delete the word **primefactors**, press **var** and select it from the menu.

Using the Factor Command

The **factor** command on your calculator will find the prime factors of a number written in index form.
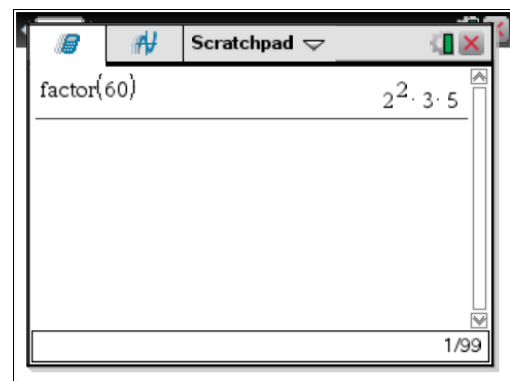
Open the **Scratchpad.**

Press **menu > Algebra > Factor**.

Input a whole number up 1200.
(in this example, we used **60**)

Press **enter** to display the prime factors.

Therefore **60 = 2²×3×5** = **2×2×3×5**.

Open **Scratchpad** and use the **factor** command to find the prime factors of the following numbers. In the second column, write the Scratchpad answer, which will be in index form. In the third column, write the prime factors without using index form. The first entry has been completed for you.

Number	Prime Factors (index form)	Prime Factors (individual factors)
60	$2^2 \cdot 3 \cdot 5$	$2 \times 2 \times 3 \times 5$
175	$5^2 \cdot 7$	$5 \times 5 \times 7$
385	$5 \times 7 \times 11$	$5 \times 7 \times 11$
440	$2^3 \cdot 5 \cdot 11$	$2 \times 2 \times 2 \times 5 \times 11$
600	$2^3 \cdot 3 \cdot 5^2$	$2 \times 2 \times 2 \times 3 \times 5 \times 5$
864	$2^5 \cdot 3^3$	$2 \times 2 \times 2 \times 2 \times 2 \times 3 \times 3 \times 3$

Author: Neale Woods

Teachers Teaching with Technology™
Professional Development from Texas Instruments

Extension Activity

The code for the **primefactors** program is shown on page **1.3**. If you scroll through the program, you will see a series of **While/EndWhile** loops. When you input a number, the program goes through these loops to check for prime factors, starting with 2 and working through each prime factor up to 31. The next prime number after 31 is 37. Since 37×37 = 1369, this program will find the prime factors of all composite numbers up to but not including 1369.

Run the **primefactors** program for 1369. What do you notice?

The list of prime factors is empty but the program still displays the prime factors in index form.

How could you extend the **primefactors** program so that it can find prime factors for numbers greater than 1368?

The program could be extended by adding more While/EndWhile loops for each of the subsequent prime factors.