## It's A Rat Race For The Zeros
**ID: 11687**

**Time required**
*15 minutes*

### Activity Overview
*In this introductory activity, students will use a program and graphing to help them explore the Rational Root Theorem. They will compare sets of functions that have at least one real zero or have no real roots and then determine how the factors of the first coefficient and the constant can produce a zero.*

### Topic: Polynomial Functions
- *zeros*
- *Rational Root Theorem*

### Teacher Preparation and Notes
- *This activity has available two versions of the student TI-Nspire document. If TI-Nspire CAS technology is used in the classroom, use the PrecalcWeek14_RatRace_CAS.tns file. If CAS is not available use the PrecalcWeek14_RatRace_nonCAS.tns file.*
- *Students will need guidance in exploring the activity.*
- ***To download the student and TI-Nspire document (.tns file) and student worksheet, go to education.ti.com/exchange and enter "11687" in the quick search box.***

### Associated Materials
- *PrecalcWeek14_RatRace_worksheet_TINspire.doc*
- *PrecalcWeek14_RatRace_nonCAS.tns*
- *PrecalcWeek14_RatRace_CAS.tns*

### Suggested Related Activities
*To download any activity listed, go to education.ti.com/exchange and enter the number in the quick search box.*
- *Watch Your P's and Q's (TI-Nspire technology) — 8517*

## Part 1 – Graphing to find zeros

On pages 1.2 and 1.3, students are given 2 sets of functions. They are to graph the functions one at a time and find the zeros using the **Graph Trace** feature (**MENU > Trace > Graph Trace**).

When students reach a zero a *z* will appear. If the *y*-value of the coordinate is 0, then the *x*-value is rational. If the *y*-value of the coordinate is not 0, then the *x*-value is irrational.

Students should see that the graphs of the first set of functions have at least one real root and the graphs of the second set of functions do not have any real roots.
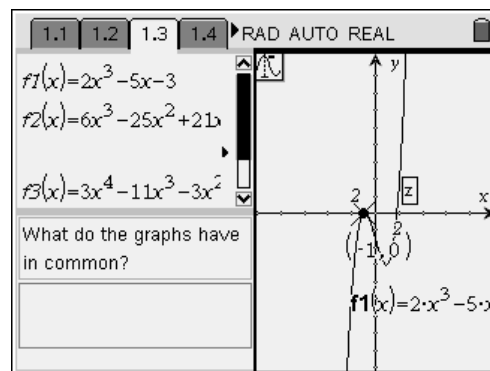


## Part 2 – Exploring Rational Root Theorem

In the second part of this activity, students will enter each of the functions into the command **prgm1**. If the class is not using CAS, students need to enter the function in quotation marks and without multiplication symbols.

Without CAS: **prgm1("2x^3–5x–3")**

With CAS: **prgm1($2x^3$–5*x*–3)**

When the command is executed, it will return two sets. The first set contains the factors of the constant term. The second set contains the factors of the first coefficient. Students are to determine what combination of the values in the sets, if any, will produce a zero (or a root).

Explain to students that they can use all the operators, + – x /, on one number from the first set and one number from the second set. The end result is to find the one formula that works to find all (rational) zeros.

To do this exploration, students should first define the function they entered as *f*(*x*). Then they can replace *x* with a value. It will work this way for both with and without CAS. Remind students that they found the zeros when they graphed the functions on page 1.3. This will give them a starting point.
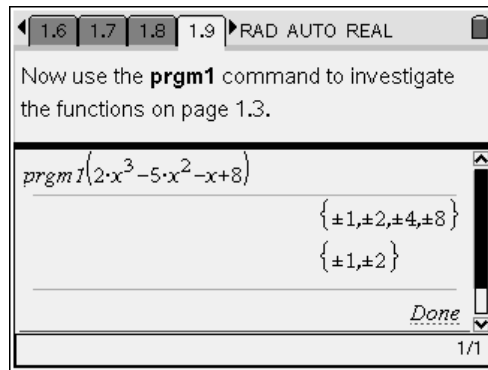
Without CAS:
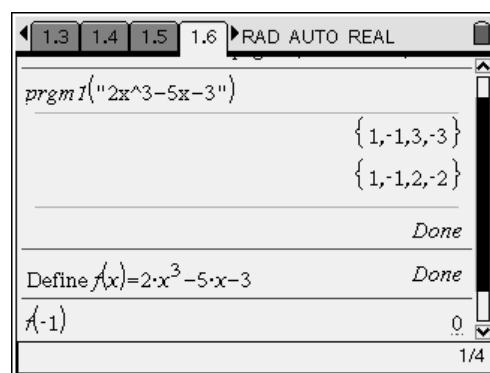


With CAS:
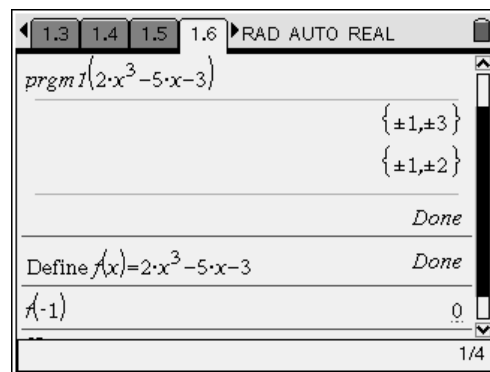
Students will need to work through all three functions. After answering the questions on pages 1.7 and 1.8, they will investigate the next three functions. Students should discover that the two sets will not produce a zero because the zeros of the functions are not rational.

Discuss with students the Rational Root Theorem given below.

**Rational Root Theorem**

Let $f(x) = a_n x^n + a_{n-1} x^{n-1} + \ldots + a_1 x + a_0$ ($a_0 \neq 0$) be an $n$th-degree polynomial with integer coefficients. If $\dfrac{p}{q}$ is a rational root of $f(x) = 0$, where $\dfrac{p}{q}$ is in lowest terms, then **p** is a factor of $a_0$ and **q** is a factor of $a_n$.

**Practice**

Have students work through the problems either in their textbook or from a worksheet to apply the theorem.