

# I Have. . . , Who Has. . .

## Standards Addressed [Boldface added.]

1. A2.A.APR.A.2, M3.A.APR.A.2, B.A.APR.B.2: Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. TN's Scope & Clarification: Tasks include quadratic, cubic, and quartic polynomials and polynomials for which factors are not provided. Note TN's A1.A.APR.B.2 is the same but perhaps limited to quadratics.

Note: This is CCSS.Math.Content.HSA.APR.B.3. Several state standards (GA, CT, . . .) connect this standard to the Rational Zero Theorem, but this can often be avoided with graphical calculators, especially in the context of a multiple choice test.

2. A1.A.REI.B.3, M2.A.REI.B.2, B.A.REI.B.2: Solve quadratic equations and inequalities in one variable.
  - (a) Use the method of completing the square to rewrite any quadratic equation in  $x$  into an equation of the form  $(x - p)^2 = q$  that has the same solutions. Derive the quadratic formula from this form.
  - (b) Solve quadratic equations by inspection (e.g., for  $x^2 = 49$ ), taking square roots, completing the square, knowing and applying the quadratic formula, **and factoring**, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions.
3. A2.A.REI.B.3: Solve quadratic equations and inequalities in one variable.
  - (a) Solve quadratic equations by inspection (e.g., for  $x^2 = 49$ ), taking square roots, completing the square, knowing and applying the quadratic formula, **and factoring**, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as  $a \pm bi$  for real numbers  $a$  and  $b$ .
4. A1.A.SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
  - (a) **Factor a quadratic expression to reveal the zeros of the function it defines.**
  - (b) Complete the square in a quadratic expression in the form  $Ax^2 + Bx + C$  where  $A = 1$  to reveal the maximum or minimum value of the function it defines.
  - (c) Use the properties of exponents to rewrite exponential expressions.

This is simplified from CCSS.MATH.CONTENT.HSA.SSE.B.3.

## Contents of the Document

1. These cover pages about the activity.
2. Instructions Instructions for creating your own deck and a page of blank cards.
3. A deck of forty-eight cards to practice multiplying binomials (labeled 'multiply').
4. A deck of forty-eight cards to practice factoring quadratics with integer zeros (labeled 'factor').

5. One page of answers to the previous two sets of problems.
6. A deck of forty-eight cards to practice factoring cubics with rational zeros (labeled ‘cubics’).
7. The solutions to the cubic deck.

### **Before conducting the activity**

Run off the sets of cards you plan to use or make your own set. Laminate them if you plan on reusing them. Have the answer sheet handy to follow along.

Before using the cubic deck decide and review the method that you expect your students to use. Will they be using the rational zero theorem or their calculators? Will they verify their answers with long division, synthetic division or their calculators?

### **Conducting the Activity**

1. Shuffle the deck of cards.
2. Give each student at least two cards.
3. Do not let students use paper and pencil if this is a review.
4. Use the answer key to follow along.
5. Choose a student to begin by reading one of their cards (or keep a card the process yourself).
6. Remind each student to read the “I have” answer and then the “who has” question from the same card.
7. The activity ends when all cards have been read and it comes back around to the beginning card.

### **Shortening the Deck**

Select a sequence of cards, in order, from the deck to keep. Treat this sequence as one card by using the “I have” answer from the first card and the “who has” question from the last card. (Again these cards must be in order!)

### **Variation**

You could use this technique to teach almost any topic that can be reinforced with short questions and answers.

### **Source**

This activity is based on “I have . . . Who Has . . .” in the *Mathematics Activities Manual for Algebra I and II* prepared by UT Martin in 1990.

## Making your own deck

If making a new set, write a list of unique problems and their answers. No two answer can be the same. This list should be kept to follow along as the class progresses with their activity.

The questions and answers should be as brief as possible because students rarely listen well. You might have students stand up and read each part twice to help with this.

Reproduce the next page as often as needed to have enough card blanks.

On the first card skip the “I have” section and write the question in the ‘who has’ section. On the next car write the answer to the first question along with the next question. Repeat with more cards until you have use all of the questions, this will leave one answer left to write. Place the last question’s answer in the blank spot you left on the first card.

<p>(example)</p> <p><b>I Have:</b></p> <p>last answer</p> <p><b>Who Has:</b></p> <p>question 1</p>	<p>(example)</p> <p><b>I Have:</b></p> <p>answer 1</p> <p><b>Who Has:</b></p> <p>question 2</p>
<p>(example)</p> <p><b>I Have:</b></p> <p>answer 2</p> <p><b>Who Has:</b></p> <p>question 3</p>	<p>(example)</p> <p><b>I Have:</b></p> <p>answer 3</p> <p><b>Who Has:</b></p> <p>question 4</p>
<p>(example)</p> <p><b>I Have:</b></p> <p>answer 4</p> <p><b>Who Has:</b></p> <p>question 5...</p>	<p>(example)</p> <p><b>I Have:</b></p> <p>continue as needed</p> <p><b>Who Has:</b></p> <p>last question</p>

<p style="text-align: right;">(      )</p> <p><b>I Have:</b></p>  <p><b>Who Has:</b></p>	<p style="text-align: right;">(      )</p> <p><b>I Have:</b></p>  <p><b>Who Has:</b></p>
<p style="text-align: right;">(      )</p> <p><b>I Have:</b></p>  <p><b>Who Has:</b></p>	<p style="text-align: right;">(      )</p> <p><b>I Have:</b></p>  <p><b>Who Has:</b></p>
<p style="text-align: right;">(      )</p> <p><b>I Have:</b></p>  <p><b>Who Has:</b></p>	<p style="text-align: right;">(      )</p> <p><b>I Have:</b></p>  <p><b>Who Has:</b></p>
<p style="text-align: right;">(      )</p> <p><b>I Have:</b></p>  <p><b>Who Has:</b></p>	<p style="text-align: right;">(      )</p> <p><b>I Have:</b></p>  <p><b>Who Has:</b></p>

(multiply)	<p><b>I Have:</b></p> $x^2 - 18x + 81$ <p><b>Who Has:</b></p> $(x - 10)(x + 1)$	(multiply)	<p><b>I Have:</b></p> $x^2 - 9x - 10$ <p><b>Who Has:</b></p> $(x + 12)(x - 3)$
(multiply)	<p><b>I Have:</b></p> $x^2 + 9x - 36$ <p><b>Who Has:</b></p> $(x + 7)(x + 7)$	(multiply)	<p><b>I Have:</b></p> $x^2 + 14x + 49$ <p><b>Who Has:</b></p> $(x + 2)(x - 6)$
(multiply)	<p><b>I Have:</b></p> $x^2 - 4x - 12$ <p><b>Who Has:</b></p> $(x + 11)(x - 3)$	(multiply)	<p><b>I Have:</b></p> $x^2 + 8x - 33$ <p><b>Who Has:</b></p> $(x + 8)(x + 4)$
(multiply)	<p><b>I Have:</b></p> $x^2 + 12x + 32$ <p><b>Who Has:</b></p> $(x - 15)(x - 4)$	(multiply)	<p><b>I Have:</b></p> $x^2 - 19x + 60$ <p><b>Who Has:</b></p> $(x - 6)(x + 6)$

(multiply)	<p><b>I Have:</b></p> $x^2 - 36$ <p><b>Who Has:</b></p> $(x + 2)(x + 7)$	(multiply)	<p><b>I Have:</b></p> $x^2 + 9x + 14$ <p><b>Who Has:</b></p> $(x + 9)(x - 5)$
(multiply)	<p><b>I Have:</b></p> $x^2 + 4x - 45$ <p><b>Who Has:</b></p> $(x + 1)(x + 1)$	(multiply)	<p><b>I Have:</b></p> $x^2 + 2x + 1$ <p><b>Who Has:</b></p> $(x + 9)(x + 9)$
(multiply)	<p><b>I Have:</b></p> $x^2 + 18x + 81$ <p><b>Who Has:</b></p> $(x + 6)(x - 10)$	(multiply)	<p><b>I Have:</b></p> $x^2 - 4x - 60$ <p><b>Who Has:</b></p> $(x - 6)(x - 6)$
(multiply)	<p><b>I Have:</b></p> $x^2 - 12x + 36$ <p><b>Who Has:</b></p> $(x - 15)(x + 4)$	(multiply)	<p><b>I Have:</b></p> $x^2 - 11x - 60$ <p><b>Who Has:</b></p> $(x + 1)(x + 10)$

(multiply)	<p><b>I Have:</b></p> $x^2 + 11x + 10$ <p><b>Who Has:</b></p> $(x - 9)(x - 3)$	(multiply)	<p><b>I Have:</b></p> $x^2 - 12x + 27$ <p><b>Who Has:</b></p> $(x - 6)(x + 4)$
(multiply)	<p><b>I Have:</b></p> $x^2 - 2x - 24$ <p><b>Who Has:</b></p> $(x - 8)(x - 4)$	(multiply)	<p><b>I Have:</b></p> $x^2 - 12x + 32$ <p><b>Who Has:</b></p> $(x - 9)(x + 6)$
(multiply)	<p><b>I Have:</b></p> $x^2 - 3x - 54$ <p><b>Who Has:</b></p> $(x + 15)(x + 4)$	(multiply)	<p><b>I Have:</b></p> $x^2 + 19x + 60$ <p><b>Who Has:</b></p> $(x + 7)(x + 3)$
(multiply)	<p><b>I Have:</b></p> $x^2 + 10x + 21$ <p><b>Who Has:</b></p> $(x - 8)(x - 3)$	(multiply)	<p><b>I Have:</b></p> $x^2 - 11x + 24$ <p><b>Who Has:</b></p> $(x + 5)(x + 9)$

(multiply)	<p><b>I Have:</b></p> $x^2 + 14x + 45$ <p><b>Who Has:</b></p> $(x - 2)(x - 10)$	(multiply)	<p><b>I Have:</b></p> $x^2 - 12x + 20$ <p><b>Who Has:</b></p> $(x + 7)(x - 3)$
(multiply)	<p><b>I Have:</b></p> $x^2 + 4x - 21$ <p><b>Who Has:</b></p> $(x + 9)(x + 6)$	(multiply)	<p><b>I Have:</b></p> $x^2 + 15x + 54$ <p><b>Who Has:</b></p> $(x - 8)(x - 7)$
(multiply)	<p><b>I Have:</b></p> $x^2 - 15x + 56$ <p><b>Who Has:</b></p> $(x + 8)(x + 5)$	(multiply)	<p><b>I Have:</b></p> $x^2 + 13x + 40$ <p><b>Who Has:</b></p> $(x - 6)(x - 10)$
(multiply)	<p><b>I Have:</b></p> $x^2 - 16x + 60$ <p><b>Who Has:</b></p> $(x + 6)(x + 5)$	(multiply)	<p><b>I Have:</b></p> $x^2 + 11x + 30$ <p><b>Who Has:</b></p> $(x - 12)(x + 3)$



(multiply)	<p><b>I Have:</b></p> $x^2 - 9x - 36$ <p><b>Who Has:</b></p> $(x - 1)(x - 1)$	(multiply)	<p><b>I Have:</b></p> $x^2 - 2x + 1$ <p><b>Who Has:</b></p> $(x + 3)(x + 3)$
(multiply)	<p><b>I Have:</b></p> $x^2 + 6x + 9$ <p><b>Who Has:</b></p> $(x - 9)(x + 3)$	(multiply)	<p><b>I Have:</b></p> $x^2 - 6x - 27$ <p><b>Who Has:</b></p> $(x - 7)(x + 3)$
(multiply)	<p><b>I Have:</b></p> $x^2 - 4x - 21$ <p><b>Who Has:</b></p> $(x - 1)(x + 10)$	(multiply)	<p><b>I Have:</b></p> $x^2 + 9x - 10$ <p><b>Who Has:</b></p> $(x - 6)(x - 5)$
(multiply)	<p><b>I Have:</b></p> $x^2 - 11x + 30$ <p><b>Who Has:</b></p> $(x - 3)(x - 3)$	(multiply)	<p><b>I Have:</b></p> $x^2 - 6x + 9$ <p><b>Who Has:</b></p> $(x + 15)(x - 4)$

(multiply)	<p><b>I Have:</b></p> $x^2 + 11x - 60$ <p><b>Who Has:</b></p> $(x + 5)(x + 7)$	(multiply)	<p><b>I Have:</b></p> $x^2 + 12x + 35$ <p><b>Who Has:</b></p> $(x + 9)(x - 3)$
(multiply)	<p><b>I Have:</b></p> $x^2 + 6x - 27$ <p><b>Who Has:</b></p> $(x + 6)(x + 10)$	(multiply)	<p><b>I Have:</b></p> $x^2 + 16x + 60$ <p><b>Who Has:</b></p> $(x - 11)(x + 2)$
(multiply)	<p><b>I Have:</b></p> $x^2 - 9x - 22$ <p><b>Who Has:</b></p> $(x - 2)(x - 7)$	(multiply)	<p><b>I Have:</b></p> $x^2 - 9x + 14$ <p><b>Who Has:</b></p> $(x + 5)(x - 9)$
(multiply)	<p><b>I Have:</b></p> $x^2 - 4x - 45$ <p><b>Who Has:</b></p> $(x + 9)(x + 3)$	(multiply)	<p><b>I Have:</b></p> $x^2 + 12x + 27$ <p><b>Who Has:</b></p> $(x - 9)(x - 9)$

## Quadratic Answers — do not put on cards!

The ‘factor’ and ‘multiply’ cards have the same set of problems below. When the first student read the ‘who has’ from their card, find it in the list below. The corresponding entry in the other row is the answer, the ‘I have,’ that the next student should read.

If you are using the ‘multiply’ deck, you will progress down the list. If you are using the ‘factor’ deck, you will progress up the list. (Or just follow along on a set of the cards that have not been cut from the pages yet!)

factored	expanded	factored	expanded
$(x - 9)(x - 9)$	$x^2 - 18x + 81$	$(x + 5)(x + 9)$	$x^2 + 14x + 45$
$(x - 10)(x + 1)$	$x^2 - 9x - 10$	$(x - 2)(x - 10)$	$x^2 - 12x + 20$
$(x + 12)(x - 3)$	$x^2 + 9x - 36$	$(x + 7)(x - 3)$	$x^2 + 4x - 21$
$(x + 7)(x + 7)$	$x^2 + 14x + 49$	$(x + 9)(x + 6)$	$x^2 + 15x + 54$
$(x + 2)(x - 6)$	$x^2 - 4x - 12$	$(x - 8)(x - 7)$	$x^2 - 15x + 56$
$(x + 11)(x - 3)$	$x^2 + 8x - 33$	$(x + 8)(x + 5)$	$x^2 + 13x + 40$
$(x + 8)(x + 4)$	$x^2 + 12x + 32$	$(x - 6)(x - 10)$	$x^2 - 16x + 60$
$(x - 15)(x - 4)$	$x^2 - 19x + 60$	$(x + 6)(x + 5)$	$x^2 + 11x + 30$
$(x - 6)(x + 6)$	$x^2 - 36$	$(x - 12)(x + 3)$	$x^2 - 9x - 36$
$(x + 2)(x + 7)$	$x^2 + 9x + 14$	$(x - 1)(x - 1)$	$x^2 - 2x + 1$
$(x + 9)(x - 5)$	$x^2 + 4x - 45$	$(x + 3)(x + 3)$	$x^2 + 6x + 9$
$(x + 1)(x + 1)$	$x^2 + 2x + 1$	$(x - 9)(x + 3)$	$x^2 - 6x - 27$
$(x + 9)(x + 9)$	$x^2 + 18x + 81$	$(x - 7)(x + 3)$	$x^2 - 4x - 21$
$(x + 6)(x - 10)$	$x^2 - 4x - 60$	$(x - 1)(x + 10)$	$x^2 + 9x - 10$
$(x - 6)(x - 6)$	$x^2 - 12x + 36$	$(x - 6)(x - 5)$	$x^2 - 11x + 30$
$(x - 15)(x + 4)$	$x^2 - 11x - 60$	$(x - 3)(x - 3)$	$x^2 - 6x + 9$
$(x + 1)(x + 10)$	$x^2 + 11x + 10$	$(x + 15)(x - 4)$	$x^2 + 11x - 60$
$(x - 9)(x - 3)$	$x^2 - 12x + 27$	$(x + 5)(x + 7)$	$x^2 + 12x + 35$
$(x - 6)(x + 4)$	$x^2 - 2x - 24$	$(x + 9)(x - 3)$	$x^2 + 6x - 27$
$(x - 8)(x - 4)$	$x^2 - 12x + 32$	$(x + 6)(x + 10)$	$x^2 + 16x + 60$
$(x - 9)(x + 6)$	$x^2 - 3x - 54$	$(x - 11)(x + 2)$	$x^2 - 9x - 22$
$(x + 15)(x + 4)$	$x^2 + 19x + 60$	$(x - 2)(x - 7)$	$x^2 - 9x + 14$
$(x + 7)(x + 3)$	$x^2 + 10x + 21$	$(x + 5)(x - 9)$	$x^2 - 4x - 45$
$(x - 8)(x - 3)$	$x^2 - 11x + 24$	$(x + 9)(x + 3)$	$x^2 + 12x + 27$

Notice the bottom row of the left table connects to the top row of the right (and visa versa).

(factor)	<p><b>I Have:</b></p> $(x - 10)(x + 1)$ <p><b>Who Has:</b></p> $x^2 - 18x + 81$	(factor)	<p><b>I Have:</b></p> $(x + 12)(x - 3)$ <p><b>Who Has:</b></p> $x^2 - 9x - 10$
(factor)	<p><b>I Have:</b></p> $(x + 7)(x + 7)$ <p><b>Who Has:</b></p> $x^2 + 9x - 36$	(factor)	<p><b>I Have:</b></p> $(x + 2)(x - 6)$ <p><b>Who Has:</b></p> $x^2 + 14x + 49$
(factor)	<p><b>I Have:</b></p> $(x + 11)(x - 3)$ <p><b>Who Has:</b></p> $x^2 - 4x - 12$	(factor)	<p><b>I Have:</b></p> $(x + 8)(x + 4)$ <p><b>Who Has:</b></p> $x^2 + 8x - 33$
(factor)	<p><b>I Have:</b></p> $(x - 15)(x - 4)$ <p><b>Who Has:</b></p> $x^2 + 12x + 32$	(factor)	<p><b>I Have:</b></p> $(x - 6)(x + 6)$ <p><b>Who Has:</b></p> $x^2 - 19x + 60$

(factor)	<p><b>I Have:</b></p> $(x + 2)(x + 7)$ <p><b>Who Has:</b></p> $x^2 - 36$	(factor)	<p><b>I Have:</b></p> $(x + 9)(x - 5)$ <p><b>Who Has:</b></p> $x^2 + 9x + 14$
(factor)	<p><b>I Have:</b></p> $(x + 1)(x + 1)$ <p><b>Who Has:</b></p> $x^2 + 4x - 45$	(factor)	<p><b>I Have:</b></p> $(x + 9)(x + 9)$ <p><b>Who Has:</b></p> $x^2 + 2x + 1$
(factor)	<p><b>I Have:</b></p> $(x + 6)(x - 10)$ <p><b>Who Has:</b></p> $x^2 + 18x + 81$	(factor)	<p><b>I Have:</b></p> $(x - 6)(x - 6)$ <p><b>Who Has:</b></p> $x^2 - 4x - 60$
(factor)	<p><b>I Have:</b></p> $(x - 15)(x + 4)$ <p><b>Who Has:</b></p> $x^2 - 12x + 36$	(factor)	<p><b>I Have:</b></p> $(x + 1)(x + 10)$ <p><b>Who Has:</b></p> $x^2 - 11x - 60$

(factor)	<p><b>I Have:</b></p> $(x - 9)(x - 3)$ <p><b>Who Has:</b></p> $x^2 + 11x + 10$	(factor)	<p><b>I Have:</b></p> $(x - 6)(x + 4)$ <p><b>Who Has:</b></p> $x^2 - 12x + 27$
(factor)	<p><b>I Have:</b></p> $(x - 8)(x - 4)$ <p><b>Who Has:</b></p> $x^2 - 2x - 24$	(factor)	<p><b>I Have:</b></p> $(x - 9)(x + 6)$ <p><b>Who Has:</b></p> $x^2 - 12x + 32$
(factor)	<p><b>I Have:</b></p> $(x + 15)(x + 4)$ <p><b>Who Has:</b></p> $x^2 - 3x - 54$	(factor)	<p><b>I Have:</b></p> $(x + 7)(x + 3)$ <p><b>Who Has:</b></p> $x^2 + 19x + 60$
(factor)	<p><b>I Have:</b></p> $(x - 8)(x - 3)$ <p><b>Who Has:</b></p> $x^2 + 10x + 21$	(factor)	<p><b>I Have:</b></p> $(x + 5)(x + 9)$ <p><b>Who Has:</b></p> $x^2 - 11x + 24$

(factor)	<p><b>I Have:</b></p> $(x - 2)(x - 10)$ <p><b>Who Has:</b></p> $x^2 + 14x + 45$	(factor)	<p><b>I Have:</b></p> $(x + 7)(x - 3)$ <p><b>Who Has:</b></p> $x^2 - 12x + 20$
(factor)	<p><b>I Have:</b></p> $(x + 9)(x + 6)$ <p><b>Who Has:</b></p> $x^2 + 4x - 21$	(factor)	<p><b>I Have:</b></p> $(x - 8)(x - 7)$ <p><b>Who Has:</b></p> $x^2 + 15x + 54$
(factor)	<p><b>I Have:</b></p> $(x + 8)(x + 5)$ <p><b>Who Has:</b></p> $x^2 - 15x + 56$	(factor)	<p><b>I Have:</b></p> $(x - 6)(x - 10)$ <p><b>Who Has:</b></p> $x^2 + 13x + 40$
(factor)	<p><b>I Have:</b></p> $(x + 6)(x + 5)$ <p><b>Who Has:</b></p> $x^2 - 16x + 60$	(factor)	<p><b>I Have:</b></p> $(x - 12)(x + 3)$ <p><b>Who Has:</b></p> $x^2 + 11x + 30$

(factor)	<p><b>I Have:</b></p> $(x - 1)(x - 1)$ <p><b>Who Has:</b></p> $x^2 - 9x - 36$	(factor)	<p><b>I Have:</b></p> $(x + 3)(x + 3)$ <p><b>Who Has:</b></p> $x^2 - 2x + 1$
(factor)	<p><b>I Have:</b></p> $(x - 9)(x + 3)$ <p><b>Who Has:</b></p> $x^2 + 6x + 9$	(factor)	<p><b>I Have:</b></p> $(x - 7)(x + 3)$ <p><b>Who Has:</b></p> $x^2 - 6x - 27$
(factor)	<p><b>I Have:</b></p> $(x - 1)(x + 10)$ <p><b>Who Has:</b></p> $x^2 - 4x - 21$	(factor)	<p><b>I Have:</b></p> $(x - 6)(x - 5)$ <p><b>Who Has:</b></p> $x^2 + 9x - 10$
(factor)	<p><b>I Have:</b></p> $(x - 3)(x - 3)$ <p><b>Who Has:</b></p> $x^2 - 11x + 30$	(factor)	<p><b>I Have:</b></p> $(x + 15)(x - 4)$ <p><b>Who Has:</b></p> $x^2 - 6x + 9$



(factor)	<p><b>I Have:</b></p> $(x + 5)(x + 7)$ <p><b>Who Has:</b></p> $x^2 + 11x - 60$	(factor)	<p><b>I Have:</b></p> $(x + 9)(x - 3)$ <p><b>Who Has:</b></p> $x^2 + 12x + 35$
(factor)	<p><b>I Have:</b></p> $(x + 6)(x + 10)$ <p><b>Who Has:</b></p> $x^2 + 6x - 27$	(factor)	<p><b>I Have:</b></p> $(x - 11)(x + 2)$ <p><b>Who Has:</b></p> $x^2 + 16x + 60$
(factor)	<p><b>I Have:</b></p> $(x - 2)(x - 7)$ <p><b>Who Has:</b></p> $x^2 - 9x - 22$	(factor)	<p><b>I Have:</b></p> $(x + 5)(x - 9)$ <p><b>Who Has:</b></p> $x^2 - 9x + 14$
(factor)	<p><b>I Have:</b></p> $(x + 9)(x + 3)$ <p><b>Who Has:</b></p> $x^2 - 4x - 45$	(factor)	<p><b>I Have:</b></p> $(x - 9)(x - 9)$ <p><b>Who Has:</b></p> $x^2 + 12x + 27$

(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>-1, -1</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>x^3 - 4x^2 + 5x - 2</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, 1</math> and <math>2</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>3x^3 - 7x^2 + 5x - 1</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, 1</math> and <math>\frac{1}{3}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>2x^3 - 5x^2 + 4x - 1</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, 1</math> and <math>\frac{1}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>5x^3 - 7x^2 - x + 3</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, 1</math> and <math>-\frac{3}{5}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>2x^3 - x^2 - 4x + 3</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, 1</math> and <math>-\frac{3}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>x^3 - x^2 - x + 1</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, 1</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>x^3 - 5x^2 + 8x - 4</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, 2</math> and <math>2</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>3x^3 - 10x^2 + 9x - 2</math></p>

(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 1, 2 and <math>\frac{1}{3}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>2x^3 - 7x^2 + 7x - 2</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 1, 2 and <math>\frac{1}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>5x^3 - 12x^2 + x + 6</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 1, 2 and <math>-\frac{3}{5}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>2x^3 - 3x^2 - 5x + 6</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 1, 2 and <math>-\frac{3}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>x^3 - 2x^2 - x + 2</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 1, 2 and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>6x^3 - 11x^2 + 6x - 1</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 1, <math>\frac{1}{3}</math> and <math>\frac{1}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>15x^3 - 11x^2 - 7x + 3</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 1, <math>\frac{1}{3}</math> and <math>-\frac{3}{5}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>6x^3 + x^2 - 10x + 3</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 1, <math>\frac{1}{3}</math> and <math>-\frac{3}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>3x^3 - x^2 - 3x + 1</math></p>

(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, \frac{1}{3}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>10x^3 - 9x^2 - 4x + 3</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, \frac{1}{2}</math> and <math>-\frac{3}{5}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>4x^3 - 7x + 3</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, \frac{1}{2}</math> and <math>-\frac{3}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>2x^3 - x^2 - 2x + 1</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, \frac{1}{2}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>10x^3 + 11x^2 - 12x - 9</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, -\frac{3}{5}</math> and <math>-\frac{3}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>5x^3 + 3x^2 - 5x - 3</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, -\frac{3}{5}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>2x^3 + 3x^2 - 2x - 3</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>1, -\frac{3}{2}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>3x^3 - 13x^2 + 16x - 4</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>2, 2</math> and <math>\frac{1}{3}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>2x^3 - 9x^2 + 12x - 4</math></p>

(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 2, 2 and <math>\frac{1}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>5x^3 - 17x^2 + 8x + 12</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 2, 2 and <math>-\frac{3}{5}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>2x^3 - 5x^2 - 4x + 12</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 2, 2 and <math>-\frac{3}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>x^3 - 3x^2 + 4</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 2, 2 and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>6x^3 - 17x^2 + 11x - 2</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 2, <math>\frac{1}{3}</math> and <math>\frac{1}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>15x^3 - 26x^2 - 11x + 6</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 2, <math>\frac{1}{3}</math> and <math>-\frac{3}{5}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>6x^3 - 5x^2 - 17x + 6</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 2, <math>\frac{1}{3}</math> and <math>-\frac{3}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>3x^3 - 4x^2 - 5x + 2</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: 2, <math>\frac{1}{3}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>10x^3 - 19x^2 - 5x + 6</math></p>

(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>2, \frac{1}{2}</math> and <math>-\frac{3}{5}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>4x^3 - 4x^2 - 11x + 6</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>2, \frac{1}{2}</math> and <math>-\frac{3}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>2x^3 - 3x^2 - 3x + 2</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>2, \frac{1}{2}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>10x^3 + x^2 - 33x - 18</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>2, -\frac{3}{5}</math> and <math>-\frac{3}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>5x^3 - 2x^2 - 13x - 6</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>2, -\frac{3}{5}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>2x^3 + x^2 - 7x - 6</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>2, -\frac{3}{2}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>30x^3 - 7x^2 - 10x + 3</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>\frac{1}{3}, \frac{1}{2}</math> and <math>-\frac{3}{5}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>12x^3 + 8x^2 - 13x + 3</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>\frac{1}{3}, \frac{1}{2}</math> and <math>-\frac{3}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>6x^3 + x^2 - 4x + 1</math></p>

(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>\frac{1}{3}, \frac{1}{2}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>30x^3 + 53x^2 + 6x - 9</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>\frac{1}{3}, -\frac{3}{5}</math> and <math>-\frac{3}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>15x^3 + 19x^2 + x - 3</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>\frac{1}{3}, -\frac{3}{5}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>6x^3 + 13x^2 + 4x - 3</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>\frac{1}{3}, -\frac{3}{2}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>20x^3 + 32x^2 - 3x - 9</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>\frac{1}{2}, -\frac{3}{5}</math> and <math>-\frac{3}{2}</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>10x^3 + 11x^2 - 2x - 3</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>\frac{1}{2}, -\frac{3}{5}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>4x^3 + 8x^2 + x - 3</math></p>
(cubics)	(cubics)
<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>\frac{1}{2}, -\frac{3}{2}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>10x^3 + 31x^2 + 30x + 9</math></p>	<p><b>I Have:</b></p> <p style="text-align: center;">zeros: <math>-\frac{3}{5}, -\frac{3}{2}</math> and <math>-1</math></p> <p><b>Who Has:</b></p> <p style="text-align: center;"><math>x^3 + 3x^2 + 3x + 1</math></p>

## Cubic Answers — do not put on cards!

When the first student read the ‘who has’ from their card, find it in the list below. The corresponding entry in the other row is the answer, the ‘I have,’ that the next student should read.

factored	expanded	factored	expanded
$x^3 - 4x^2 + 5x - 2$	1, 1, 2	$5x^3 - 17x^2 + 8x + 12$	$2, 2, -\frac{3}{5}$
$3x^3 - 7x^2 + 5x - 1$	$1, 1, \frac{1}{3}$	$2x^3 - 5x^2 - 4x + 12$	$2, 2, -\frac{3}{2}$
$2x^3 - 5x^2 + 4x - 1$	$1, 1, \frac{1}{2}$	$x^3 - 3x^2 + 4$	$2, 2, -1$
$5x^3 - 7x^2 - x + 3$	$1, 1, -\frac{3}{5}$	$6x^3 - 17x^2 + 11x - 2$	$2, \frac{1}{3}, \frac{1}{2}$
$2x^3 - x^2 - 4x + 3$	$1, 1, -\frac{3}{2}$	$15x^3 - 26x^2 - 11x + 6$	$2, \frac{1}{3}, -\frac{3}{5}$
$x^3 - x^2 - x + 1$	1, 1, -1	$6x^3 - 5x^2 - 17x + 6$	$2, \frac{1}{3}, -\frac{3}{2}$
$x^3 - 5x^2 + 8x - 4$	1, 2, 2	$3x^3 - 4x^2 - 5x + 2$	$2, \frac{1}{3}, -1$
$3x^3 - 10x^2 + 9x - 2$	$1, 2, \frac{1}{3}$	$10x^3 - 19x^2 - 5x + 6$	$2, \frac{1}{2}, -\frac{3}{5}$
$2x^3 - 7x^2 + 7x - 2$	$1, 2, \frac{1}{2}$	$4x^3 - 4x^2 - 11x + 6$	$2, \frac{1}{2}, -\frac{3}{2}$
$5x^3 - 12x^2 + x + 6$	$1, 2, -\frac{3}{5}$	$2x^3 - 3x^2 - 3x + 2$	$2, \frac{1}{2}, -1$
$2x^3 - 3x^2 - 5x + 6$	$1, 2, -\frac{3}{2}$	$10x^3 + x^2 - 33x - 18$	$2, -\frac{3}{5}, -\frac{3}{2}$
$x^3 - 2x^2 - x + 2$	1, 2, -1	$5x^3 - 2x^2 - 13x - 6$	$2, -\frac{3}{5}, -1$
$6x^3 - 11x^2 + 6x - 1$	$1, \frac{1}{3}, \frac{1}{2}$	$2x^3 + x^2 - 7x - 6$	$2, -\frac{3}{2}, -1$
$15x^3 - 11x^2 - 7x + 3$	$1, \frac{1}{3}, -\frac{3}{5}$	$30x^3 - 7x^2 - 10x + 3$	$\frac{1}{3}, \frac{1}{2}, -\frac{3}{5}$
$6x^3 + x^2 - 10x + 3$	$1, \frac{1}{3}, -\frac{3}{2}$	$12x^3 + 8x^2 - 13x + 3$	$\frac{1}{3}, \frac{1}{2}, -\frac{3}{2}$
$3x^3 - x^2 - 3x + 1$	$1, \frac{1}{3}, -1$	$6x^3 + x^2 - 4x + 1$	$\frac{1}{3}, \frac{1}{2}, -1$
$10x^3 - 9x^2 - 4x + 3$	$1, \frac{1}{2}, -\frac{3}{5}$	$30x^3 + 53x^2 + 6x - 9$	$\frac{1}{3}, -\frac{3}{5}, -\frac{3}{2}$
$4x^3 - 7x + 3$	$1, \frac{1}{2}, -\frac{3}{2}$	$15x^3 + 19x^2 + x - 3$	$\frac{1}{3}, -\frac{3}{5}, -1$
$2x^3 - x^2 - 2x + 1$	$1, \frac{1}{2}, -1$	$6x^3 + 13x^2 + 4x - 3$	$\frac{1}{3}, -\frac{3}{2}, -1$
$10x^3 + 11x^2 - 12x - 9$	$1, -\frac{3}{5}, -\frac{3}{2}$	$20x^3 + 32x^2 - 3x - 9$	$\frac{1}{2}, -\frac{3}{5}, -\frac{3}{2}$
$5x^3 + 3x^2 - 5x - 3$	$1, -\frac{3}{5}, -1$	$10x^3 + 11x^2 - 2x - 3$	$\frac{1}{2}, -\frac{3}{5}, -1$
$2x^3 + 3x^2 - 2x - 3$	$1, -\frac{3}{2}, -1$	$4x^3 + 8x^2 + x - 3$	$\frac{1}{2}, -\frac{3}{2}, -1$
$3x^3 - 13x^2 + 16x - 4$	$2, 2, \frac{1}{3}$	$10x^3 + 31x^2 + 30x + 9$	$-\frac{3}{5}, -\frac{3}{2}, -1$
$2x^3 - 9x^2 + 12x - 4$	$2, 2, \frac{1}{2}$	$x^3 + 3x^2 + 3x + 1$	-1, -1, -1

Notice the bottom row of the left table connects to the top row of the right (and visa versa).