Cuisenaire Rod Equations

Materials and Prep
Number Rods, number rod fill-in (10 cm) sheet, colored pencils or crayons.

Motivating Question
How many ways can you make a 20cm line with a single color of rod?

Launch
If students have not explored Cuisenaire rods before, give them 5 - 10 minutes to play on their own to start.

Introduce the idea of *mathematizing* the rods. First, run through the following questions with students. These should take roughly 15 minutes.

   a.   If the white (1cm) rod is worth 1, what are the values of the other rods?

You can demonstrate a proof that red (2cm) is worth 2 by putting 2 white rods together and confirming that they are the same length as 1 red rod. In other words, white + white = red, or w + w = r. Students can make similar arguments to confirm the value of each rod. For example, a student might show that blue is worth 9 by lining up 9 whites.
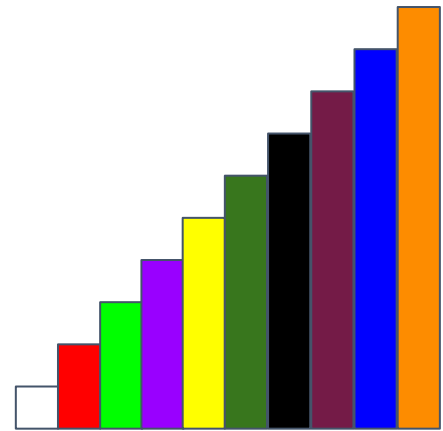
The key point is that if two lines of rods are the same length, the values are the same.

Students will typically find building the staircase a helpful way to see and remember the relatively values of the rods.

   b.   Once students know the values of the rods, ask them to build models of some equations.
       i.   6 + 3 = 9
       ii. 3 + 4 = 1 + 6
   c.   You can also give them a set of rods that line up and ask them to write a corresponding equation.
       i.   Red + dark green = brown.
   d.   For an intermediate challenge, ask students which rods are exactly double of other rods. (Answer: red, purple, dark green, brown, orange).

Once students have worked their way through these questions with you, pose the main question. Hold up two orange rods and ask students how much they are worth together (20). Then ask what other single colors would come out to the same length.
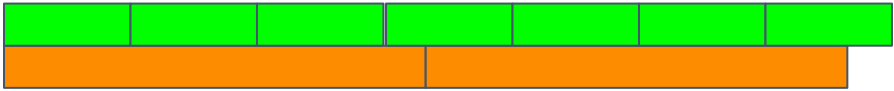
A model of 6 + 3 = 9

A model of 3 + 4 = 1 + 6

Red + dark green = brown becomes 2 + 6 = 8.

For example, demonstrate with light green, and predict that a line of light green rods will come out to match two oranges. When you build the line, it turns out to be one white rod longer than the two oranges.

If light green doesn't work, which colors will work? That's the question students should work out on their own.

Work

Students can work alone or in pairs to try to find all the ways to match two orange rods using other single-color lines. For students who successfully identify all the ways to solve the problem (see next page), you can challenge them to try to solve it for 3 orange rods as well.

Closer

Ask students to share which colors work, and help them to write a mathematical equation for each color. The complete list of solutions is:

2 Orange = 4 Yellow = 5 Purple = 10 Red = 20 White. Translating to numbers, we would have:

$$10 + 10 = 5 + 5 + 5 + 5 = 4 + 4 + 4 + 4 + 4 = 2 + \ldots + 2 \text{ (ten times)}$$
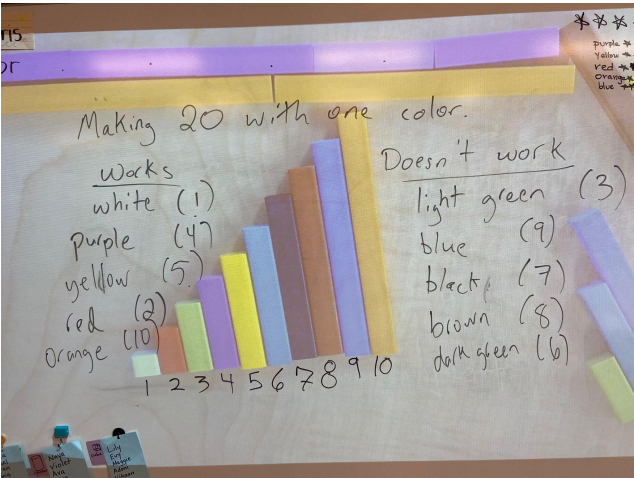$$= 1 + 1 + \ldots + 1 \text{ (twenty times)}.$$

As an additional extension if time permits, ask students if the same colors would work if we were trying to match 3 orange rods instead of 2. Would all the same colors work? Just some of them? None of them? Students can make predictions, and then try it out.

Prompts and Questions

- Which colors have you tried so far?

- Which colors have worked so far?

- How do you know they're equal?

- Let's try dark green… do you think it'll match two oranges, or not? Make a prediction, and then let's find out if it works!
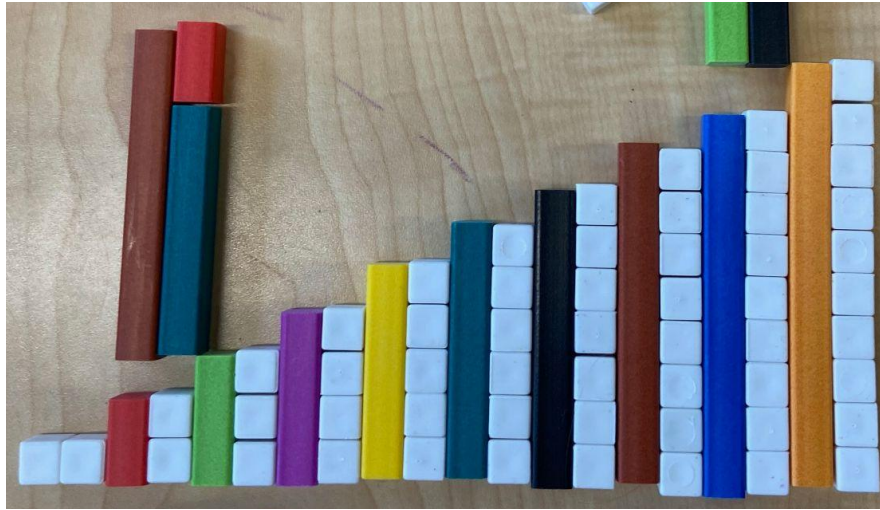
Tips for the Classroom

1. If students haven't played with Cuisenaire rods before, give them time to play. Better yet, make the rods available to play with before you do this lesson.

2. Students may misunderstand the main goal of this lesson, and try to match two orange rods using many different colors. That's not a bad thing for them to do - you can still encourage them to write down their equations. (See next page.)
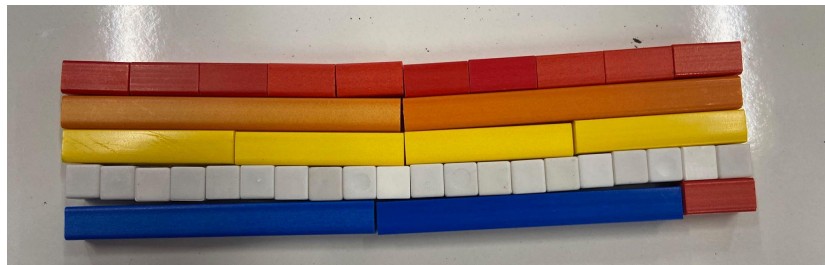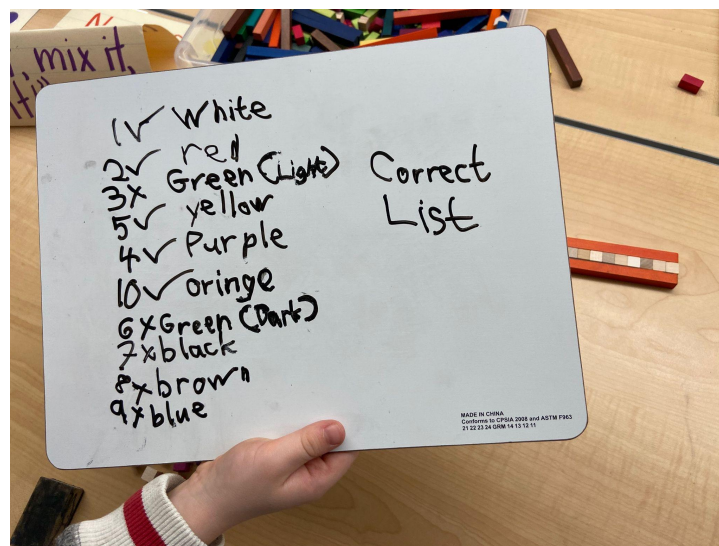
Cuisenaire Rod Equations - Student Work

Here are some examples of student work.

Proof of the value of each of the rods, from 1 to 10.

A student's work showing that red, white, and yellow rods can match two oranges.
Also, blue rods do not match two oranges.

A student's work showing the list of which colors can match 2 orange rods.

Cuisenaire Rod Equations - Student Work

A student's work exploring ways to make lines equal to two orange rods. At first glance, it looks like they've ignored the instruction to use just one color per line, but it may be that they're exploring this question in their own way.

For example, we see two brown rods (2 eights), plus the purple (4) that completes the line of twenty.

We also see three dark green rods (3 sixes) with the red (2) completing the line of twenty.