LADYBUGS

FESTIVAL GUIDE

TABLE OF CONTENTS

Julia Robinson Mathematics Festival

Materials and Setup

Per table (assuming 5 children per table), you will need:

Per Table	Material Preparation	
5 sets of tiles or counters	Each set requires the numbers 1 through 9.	
3 copies of Instructions	1-page sheet	p. 8
5 copies of Tasks	2-page sheet *can be printed double-sided*	p. 9-10
5 x Leaf Mats	2-page sheet *can be printed double-sided*	p. 11-12
1 copy of Table Sign	1-page sheet *print on cardstock for sturdiness*	p. 13
Paper and pencils		

Per Table	Purchasing Materials		
5 sets of counters numbered 1 to 9.	15 sets numbered 1 to 9 for $12.99	Print on cardstock or write on red counters.	
13 plastic sheet protectors	pack of 100 for $7.67	pack of 500 for $26.99	These are recommended in order to protect the documents that children will be handling.

Objective

Place as many numbered ladybugs on a leaf as possible.

Rule:
1. Two ladybugs cannot add up to a third ladybug on a leaf.

Materials

Each Ladybugs table should be prepped for 5 stations.
Each station needs:
1. 1 set of counters numbered 1 to 9.
2. Ladybugs instructions.
3. Ladybugs tasks.
4. Leaf mats.
5. Paper and pencils for challenge questions.

How to Play

We strongly encourage you to explore the activity yourself ahead of time.
You can try our digital version here: jrmf.org/puzzle/ladybugs

Introduce the activity without overexplaining it and without telling what strategies children might want to use. As much as possible, avoid giving away answers. Children should be encouraged to explore, experiment, and learn from their mistakes.

1. Have ready to go the single leaf mat and tiles numbered 1 to 6.
2. Tell the students that each numbered tile represents a ladybug and the number of spots on her shell.
3. Model the rules by laying two tiles on the leaf and asking the child to find the sum of the two ladybugs.
4. Tell the child that more ladybugs want to join, but another ladybug can only land on the leaf if the number on her shell *doesn't equal* the sum of any two ladybugs already there.
5. Ask the child to tell you which ladybug *can't* land there. Encourage them to explain their thinking out loud.
6. Ask if they can think of a ladybug that could land there. Encourage them to explain their thinking out loud.
7. Ask the child which other ladybugs could be placed on the leaf. Encourage the child to move the ladybugs (numbered tiles) onto the leaf image.

8. Starting with Ladybugs 1 to 6, have the child explore which ladybugs can be placed together. Next, have them 9 ladybugs on a single leaf. For a challenge, they can try placing 6 or more ladybugs on *two* leaves.

   For some children, you may need to model this several times using different scenarios, e.g., Can't place Ladybugs #1 and #4 with Ladybug #5, can't place Ladybug #2 with Ladybugs #3 and #5.

Standards

1. Make sense of problems and persevere in solving them. CCSS.MP1
2. Construct viable arguments and critique the reasoning of others. CCSS.MP3
3. Model with mathematics. CCSS.MP4
4. Look for and make use of structure. CCSS.MP7

Answers

General Answers

For a single leaf, you can always place at least half of the ladybugs.

- Start by placing the first two consecutive numbers whose sum is greater than the largest number in the set.
  - For example, using Ladybugs 1 to 6: The largest number in the set is 6. The first two consecutive numbers whose sum is greater than 6 are 3 and 4 so they can be placed on the leaf.
- Then put on the leaf all the remaining ladybugs that are larger than the two already placed.
  - For example, using Ladybugs 1 to 6: After placing Ladybugs 3 and 4, Ladybugs 5 and 6 can also be placed on the leaf.
  - For example, using Ladybugs 1 to 7: The first two consecutive numbers whose sum is greater than 7 are 4 and 5 so Ladybugs 4, 5, 6, and 7 can be placed on a single leaf.

Student Answers to Questions 1 to 3:

1. Ladybugs 1 to 6 on one leaf.
   - The most you can put on is 4.
   - Actual answers will vary, e.g., {1, 2, 4}; {1, 3, 5}; {1, 4, 6}; {3, 4, 5, 6}

2. Ladybugs 1 to 9 on one leaf.
   - The most you can put on is 5.
   - Actual answers will vary, e.g., {1, 2, 4, 7}; {1, 3, 5, 7, 9}; {3, 4, 6, 8}; {5, 6, 7, 8, 9}

3. Ladybugs 1 to 9 on two leaves.
   a. You can place 6:
      - Answers will vary, e.g., {Ladybugs 1 & 2 on leaf 1; Ladybugs 3, 4, 5, & 6 on leaf 2}
   b. You can place 7:
      - Answers will vary, e.g., {Ladybugs 1, 2, & 7 on leaf 1; Ladybugs 3, 4, 5, & 6 on leaf 2}
   c. You can place 8:
      - {Ladybugs 1, 2, 4,and 8 on leaf 1. Ladybugs 3, 5, 6, and 7 on leaf 2}.
   d. It is impossible to place 9.

Possible Student Answers to Challenge Questions 4 to 8:

4. Odd-numbered Ladybugs 1, 3, 5, 7, and 9 on two leaves.
   - All can land on the same leaf or in any order on two leaves.

5. Odd-numbered Ladybugs 1, 3, 5, 7, 9, and 11... on two leaves.
   - Infinite. They can all be on the same leaf or in any order on two leaves.
   - Any number of odd ladybugs can be placed on a single leaf because two odd numbers will always equal an even number: $(2a+1)+(2b+1) = 2a+2b+2 = 2(a+b+1)$.

6. Ladybugs with non-multiples of 3 on two leaves.
    - Infinite. Place the ladybugs in alternating order on the leaves.
    - For non-multiples of 3, a similar odd-even principle holds. We alternate by leaf, all numbers on the left leaf have the form 3n+1 and on the right have the form 3n+2. But (3a+1)+(3b+1) = 3(a+b)+2 and (3a+2)+(3b+2) = 3(a+b+1)+1, so the sum of any two left-leaf numbers could only go on the right leaf and vice versa.

7. Ladybugs with non-multiples of 4 on two leaves.
    - Infinite. This is reduced to odds and evens as any number that leaves a remainder of 1 or 3 when divided by 4 goes on one leaf. Numbers that have a remainder of 2 go on the other leaf.
      e.g., Leaf 1 will have 1, 3, 5, 7, 9, 11... and Leaf 2 will have 2, 6, 10, 14...

8. Ladybugs with non-multiples of 5 on two leaves.
    - Infinite. Numbers that leave a remainder of 1 or 4 when divided by 5 go on one leaf. Numbers that have a remainder of 2 or 3 go on the other leaf.
      e.g., Leaf 1 will have 1, 4, 6, 9... and Leaf 2 will have 2, 3, 7, 8...

Asking Good Questions

1. Ask questions about confidence.
    a. When a student asks you “Is this right?”, instead of saying “yes” or “no” right away, ask them how confident they are in their answer. Here are some examples:
        i. “Maybe. What do you think? How confident are you?”
        ii. “On a scale of 1-5, how confident are you in your answer?”
    b. If a student is not confident in their answer, follow up by asking “What would help you feel more confident in your answer?” or “Why do you not feel confident?” This helps you determine how best to help the student through their explorations.

2. Ask students about choices.
    a. When a student is stuck or shows you a wrong answer, instead of jumping in and showing the student the correct answer, start by asking about the choices that the student made along the way. Here are some suggested steps to follow:
        i. Start from the beginning.
        ii. Ask students to show you what they’ve tried so far.
        iii. When the student gets to a point where they have different choices, ask the student “What other choices can you make here?”
        iv. Have the student make a different choice and try to solve the puzzle. This helps the student see that they have the power to make different choices during an activity, and they’ll start to do this on their own in the future.
        v. If you’re familiar with the puzzle or a particular solution, stop the student only when a different choice will help them get to the solution. This will help them feel successful faster without you giving away too much of the answer.

3. Ask students about strategies.
    a. If a student is getting into the activity and has been doing it for a while, ask the student if there are any strategies they’ve come up with to help them solve the puzzle or win the game.
    b. Follow up by asking if they think their strategies will work for all puzzles and/or larger puzzles, more complex puzzles, etc. Have the student explore more complex puzzles to test out their strategies.
    c. This is a great way to encourage a student to dive deeper into an activity and to start looking for patterns, structure, and proofs.

4. Activity specific questions.
    a. What combinations does Ladybug 6 need to watch out for? Ladybug 7? 8? 9?
    b. What do you notice about placing odd ladybugs?
    c. What do we know about the sum of two odd ladybugs?

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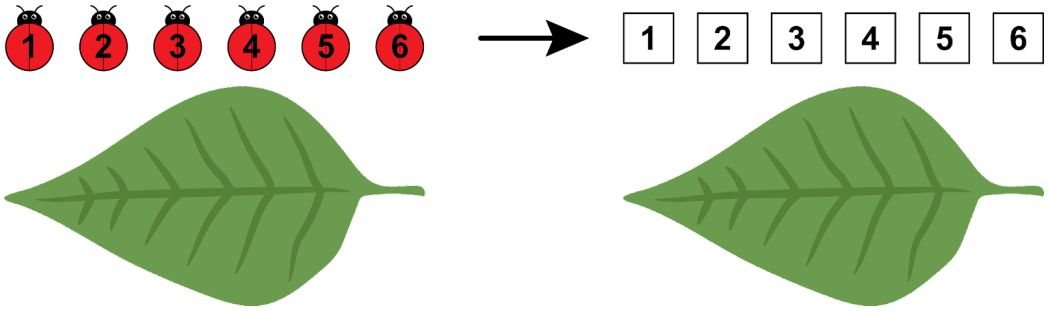
Ladybugs Instructions

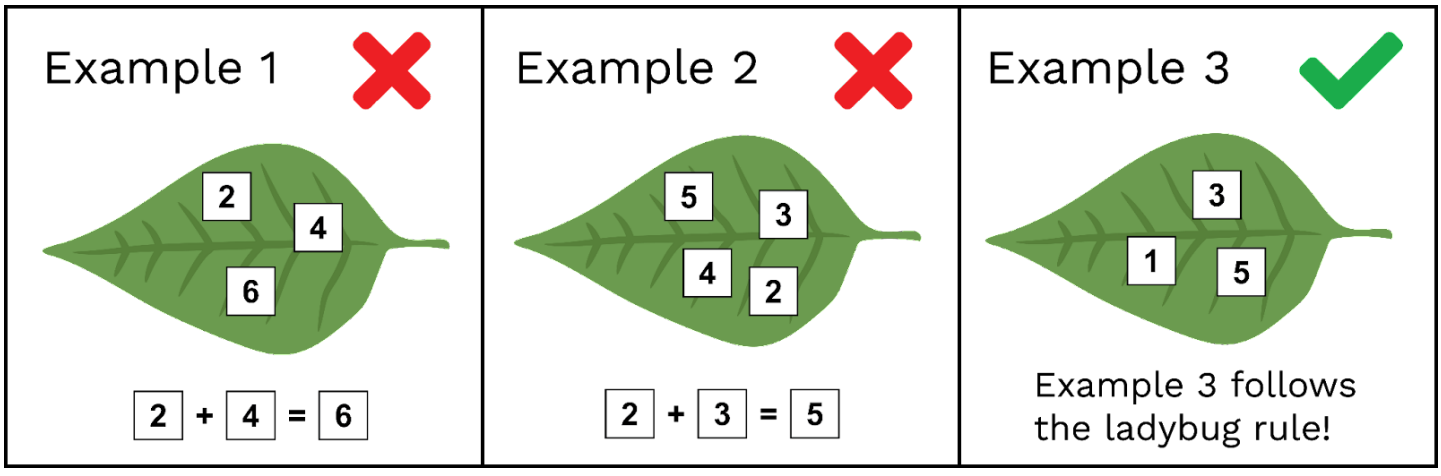
How many ladybugs can you place on the leaf without breaking the ladybug rule?

You'll be using number tiles for your ladybugs. Place tiles 1 to 6 above your leaf.



Ladybug Rule:

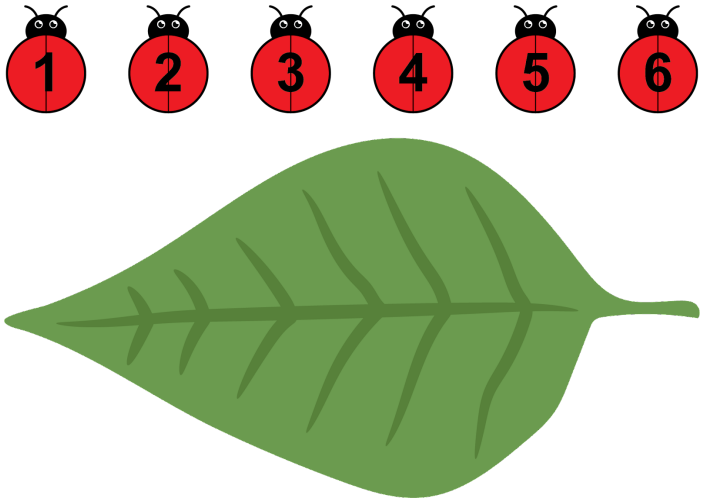
1. **Two ladybugs cannot add up to a third ladybug on the leaf.**



Can you place more than three ladybugs on the leaf without breaking the ladybug rule?

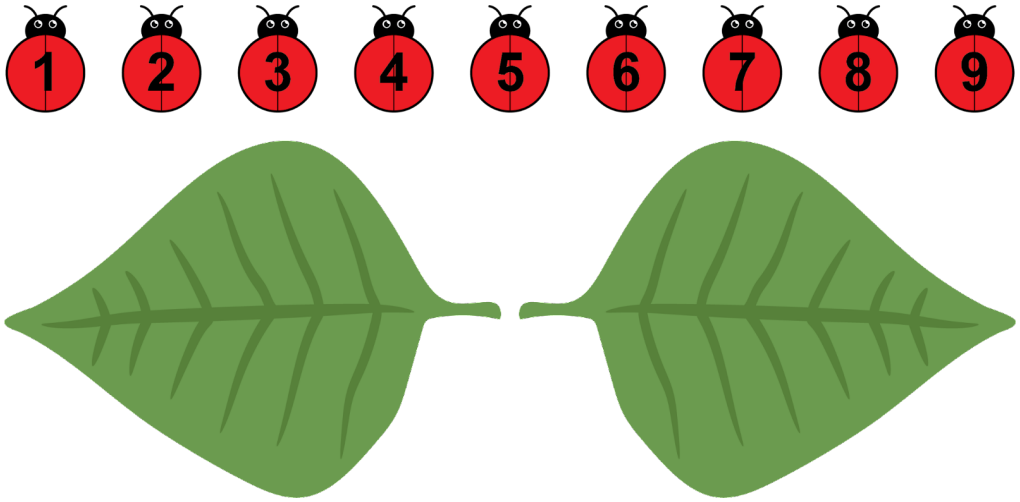
Ladybugs Tasks

1. Now it's your turn. Start with Ladybugs 1 to 6. How many ladybugs can you place on the leaf without breaking the ladybug rule?



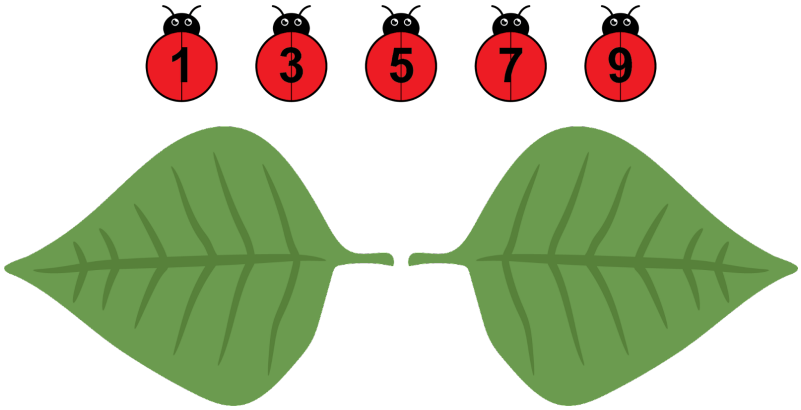
2. What if you have Ladybugs 1 to 9 instead?

3. Now you have **two leaves** and Ladybugs 1 to 9. Each leaf needs to follow the ladybug rule. How many ladybugs can you place on the two leaves without breaking the ladybug rule?



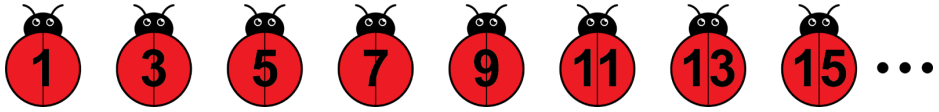
Ladybugs Challenge Tasks

4. You have two leaves and the ladybugs with odd numbers: Ladybugs 1, 3, 5, 7, and 9. How many of these ladybugs can you place on the two leaves without breaking the ladybug rule?



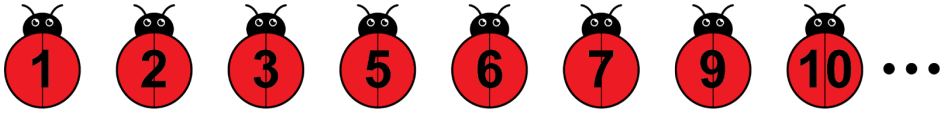
Now you might want to switch to paper and pencil because some ladybugs will be larger than 9!

5. Can you place Ladybugs 1, 3, 5, 7, 9, and 11? What if Ladybug 13 joins them? Ladybug 15? How many ladybugs with odd numbers can you place?

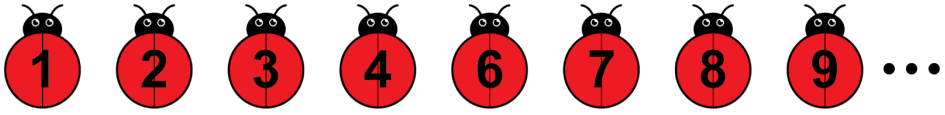


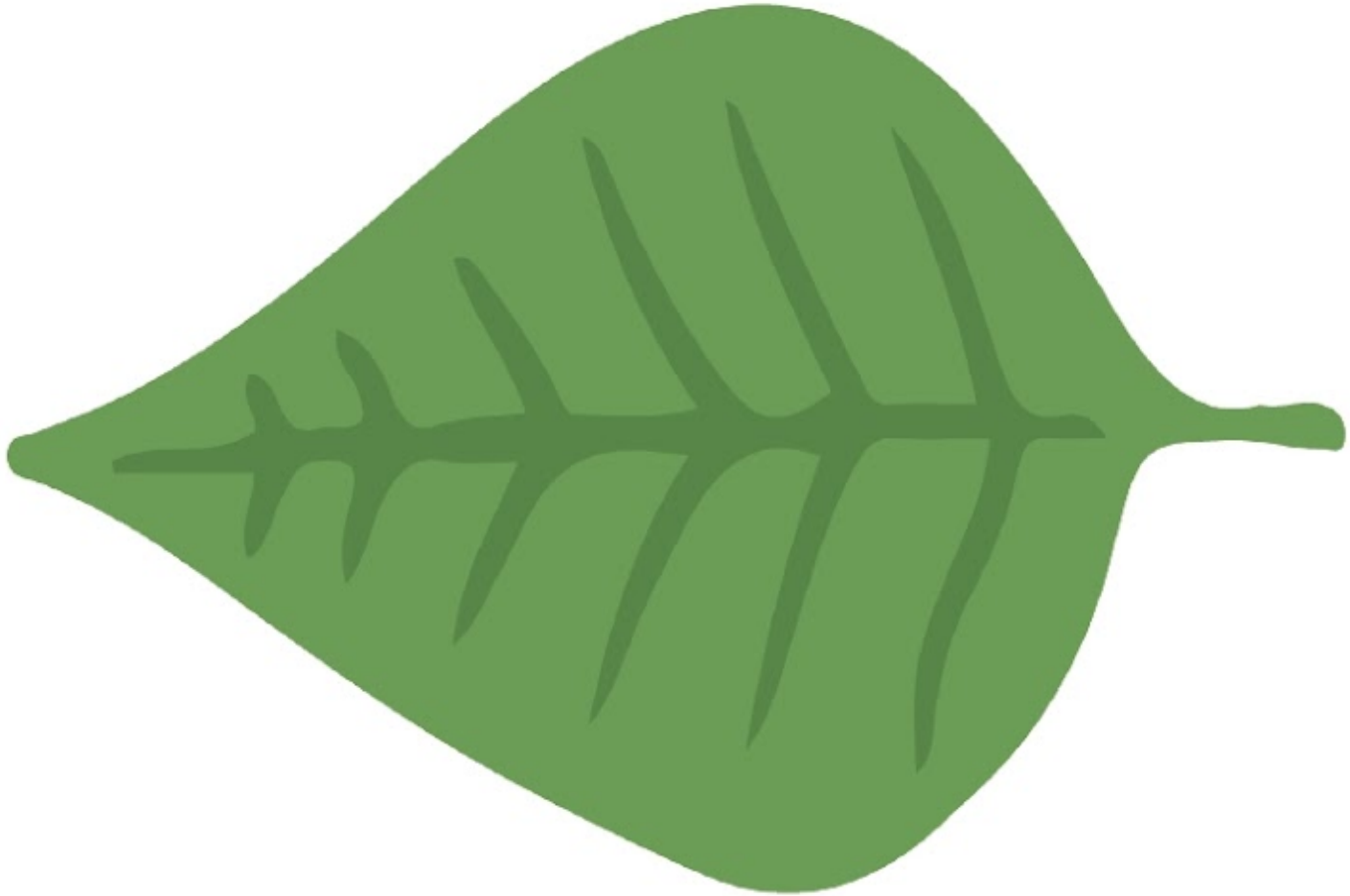
6. How many ladybugs with non-multiples of 3 can you place on two leaves?

7. How many ladybugs with non-multiples of 4 can you place on two leaves?



8. How many ladybugs with non-multiples of 5 can you place on two leaves?





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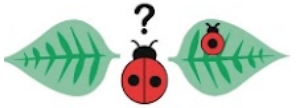
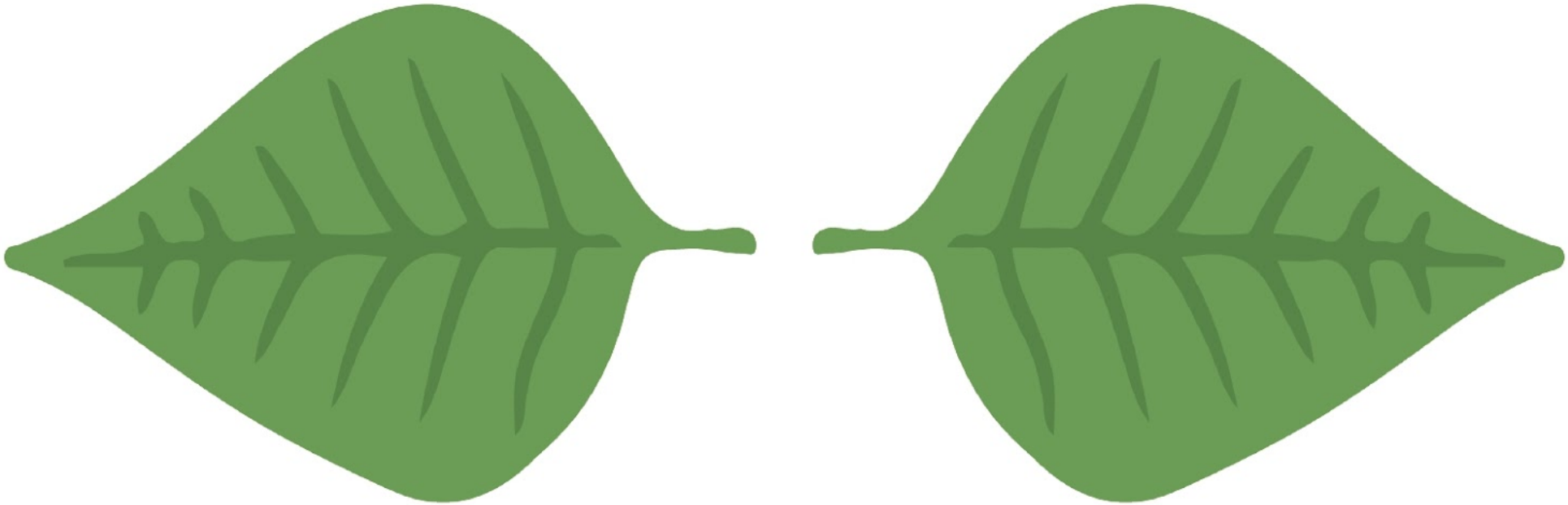
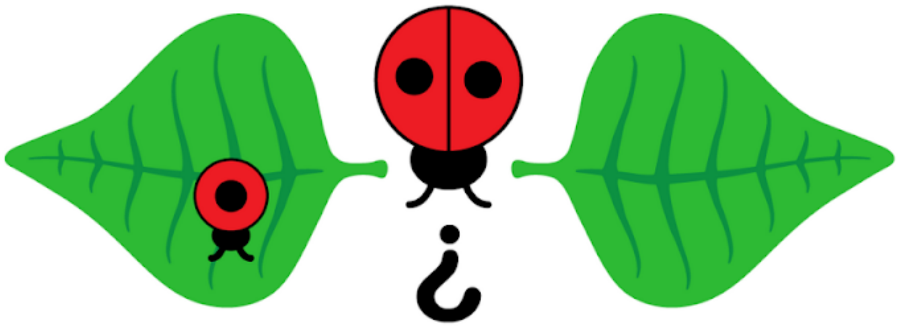




Play for free at
jrmf.org/puzzle/ladybugs



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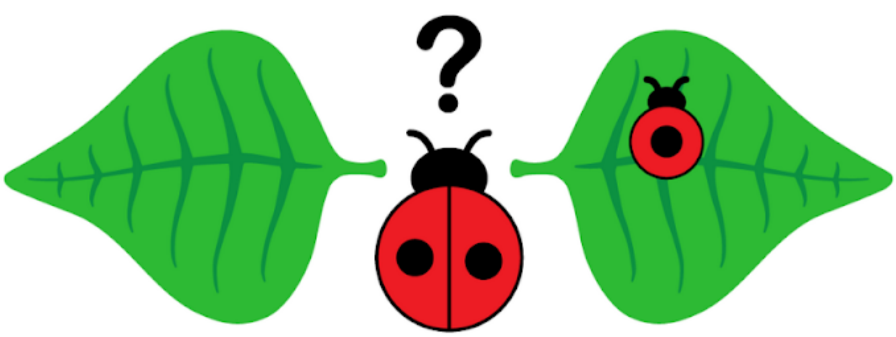

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