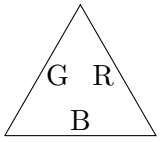
SYMMETRY GROUPS (PART 1)

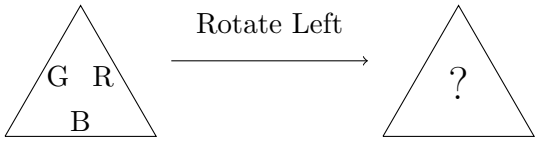
Instructions: You should have an equilateral triangle. With the triangle pointing upwards, color the bottom edge blue, the left edge green, and the right edge red. In your notebook you can draw this position:



Position Zero

Question 1: Draw all the possible positions of the triangle that you can get without flipping the triangle over. Give each of the positions names. They can be more creative names than 'Position Zero'!

Question 2: Starting from Position Zero, any action you take which moves this triangle to another position is called a 'Symmetry'. One example of a symmetry is 'Rotate Left':



Position Zero ???

Copy the above picture into your notebook, filling in the correct picture and name for the question mark.

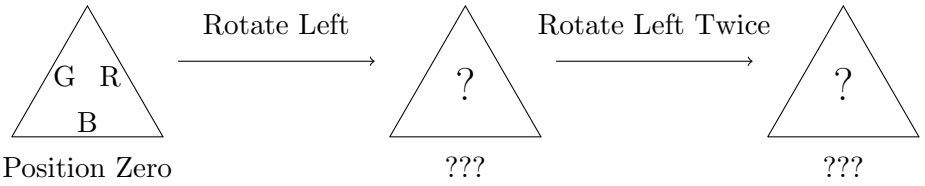
Question 3: Another 'Symmetry' is 'Rotate Left Twice'. What do you think this means? Draw a diagram exactly like the previous one for 'Rotate Left Twice'.

Question 4: Another Symmetry is 'Do Nothing'. Draw a diagram for 'Do Nothing'.

Question 5: Another Symmetry is 'Rotate Right'. Draw a diagram for 'Rotate Right'. Is it the same as any of the previous symmetries?

Question 6: Another Symmetry is 'Rotate Left Three Times'. Draw a diagram for this. Is it the same as any of the previous symmetries?

Question 7: If you do 'Rotate Left' and THEN you do 'Rotate Left Twice', what symmetry do you get? Draw a diagram for this process:



You can write this as a mathematical equation:
Rotate Left + Rotate Left Twice = _____
(Fill in the blank with the correct answer)

Question 8: What is **Rotate Left + Rotate Left**? Use your model triangle.

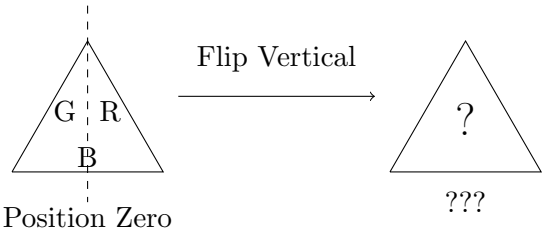
Question 9: What is **Rotate Left Twice + Rotate Left Twice**?

Question 10: In your notebook, draw and fill in a *addition table* for the symmetries of the equilateral triangle. You can use the abbreviations R for 'Rotate Left', $R2$ for 'Rotate Left Twice', and N for 'Do Nothing'.

+	N	R	R2
N			
R			
R2			

Question 11: Now flip over your triangle and color the edges on the opposite side so the colors match. Now there are new positions you can get. Draw all the new positions and give them names.

Question 12: There are new Symmetries where you're allowed to flip over your triangle. One of them is 'Flip Vertical', where you flip over a vertical line:



Complete the diagram in your notebook. What is **Flip Vertical + Flip Vertical**?

Question 11: Another Symmetry is 'Flip Left', where you flip over a line through the bottom left corner. Draw a diagram for 'Flip Left'.

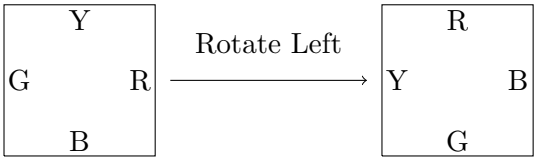
Question 12: Draw a diagram for 'Flip Right'.

Question 13: What is **Flip Left** + **Flip Right**? (Hint: It's the same as a Symmetry you've already seen!).

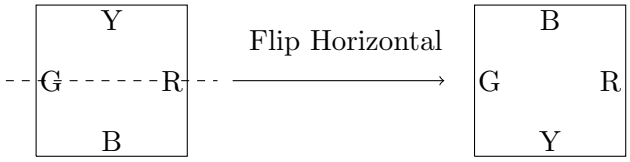
Question 14: What is **Flip Right** + **Flip Left**?

Question 15: Draw an addition table for the symmetries of the equilateral triangle, this time including the three flips.

Question 16: When you finish this, begin exploring the symmetries of a square. You have to use another color, let's use yellow. Here are a few to get you started:



Position Zero Rotated Once



Position Zero Flipped Horizontally