**A Guided Inquiry For Younger Users** **PART I** **Start from: https://www.playingwithpolygons.com/**

**PART I deals with changing the numbers associated with *n*, *S*, and *P*, and seeing what SCF means**

Even without knowing multiplication and division, you can see many of the ideas used to create String Art.

Click *Toggle Vertices* on. As you do this you will see numbered points (called vertices).

You can turn them off to view images but we will use them often in the discussion below.

**What *n* in an *N-gon* means** ***n*** is the number of vertices and sides of a regular polygon, called an ***n***-gon.

Click on the 4 and as you increase or decrease ***n***, the number of equally-spaced points changes.

Do not worry about why images look like they do, just note that numbered points go from 0 to ***n***-1.

Return ***n*** to 4.

**What *S* in *Subdivisions* means** Make sure to click *Toggle Subdivisions* on. You should see **purple dots, •**.

Click on the 12. Change ***S*** and the number of equally-spaced **dots** between numbered vertices changes.

Return ***S*** to 12.

**What *P* in *Points* means** You use ***P*** to draw lines in the final image.

Click on the 30. Change ***P and*** see what happens as ***P*** changes. The image changes a lot as we move ***P***.

Return ***P*** to 30 to see how ***P*** tells us where to draw lines.

**Drawing lines in the final image:** *Lines are drawn connecting every* ***P*^th^ dot,*** *starting at vertex 0 (the top).*

The image is made by counting out ***P*** = 30 subdivisions starting at the top and going around the **dots**.

There are 12 between vertex 0 and 1, 12 more between 1 and 2, and 6 more halfway between 2 and 3.

If ***P*** = 31, the first line is one **dot** closer to vertex 3, if ***P*** = 29 it is one **dot** closer to vertex 2.

Notice that the center gets larger with ***P*** = 31, and smaller with ***P*** = 29, and smallest with ***P*** = 25 or 23.

Return ***P*** to 30.

**Visualizing SCF**

**SCF** stands for *Subdivision Common Factor*.

In a geometric sense, **SCF means: What portion of the subdivision dots does the final image use?**

The initial setup was ***n*** = 4, ***S*** = 12, and ***P*** = 30, and this produced a star made from 8 lines.

Click *Toggle Subdivisions* on (for the rest of **Visualizing SCF**). Note that only every 6^th^ **dot** is being used.

That is what SCF = 6 means.

Click ***P*** up to 31. Note that there are now 48 lines and ALL subdivision endpoints are being used.

That is what SCF = 1 means.

Click ***P*** up to 32. Now there is a triangle and every 16^th^ subdivision endpoint is being used.

That is what SCF = 16 means.

Click ***P*** down and watch what happens as ***P*** changes

| ***P*** | Lines | SCF | Proportion of subdivisions used |
|---|---|---|---|
| 29 | 48 | 1 | all |
| 28 | 12 | 4 | one fourth |
| 27 | 16 | 3 | one third |
| 26 | 24 | 2 | one half |
| 25 | 48 | 1 | all |
| 24 | 2 | 24 | one twenty-fourth |

This looks like one line but is two because you always have to return to the top.

Note: 24+24 = 48

Put ***P*** back at 30. We know there are 8 lines here since that is where we started.

If we increase ***n*** to 5, it looks like there is 1 line, but the image says 2.

The same thing is happening here as with ***P*** = 24 in the box above.

Notice that 30 = 12+12+6 so 30 **dots** is exactly half way around the pentagon.

Put another way, there are 60 subdivision endpoints possible, but only 2 are used in this image.

One to get to the middle bottom, the other to get back to the top. 30+30 = 60 and SCF = 30.

Next, change ***P*** to 29. Now every subdivision is attached to the image and there are 60 lines total.

You should have a very fun looking pointy image, kind of like a porcupine with needles everywhere.

This is actually called a *Porcupine Polygon* because it as close as you can get to halfway around.

Check other ***P*** between 28 and 24. You will find there are less than 60 lines since SCF > 1 in each instance.