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Building a GEODESIC DOME

From desktop models to fort sized fun!

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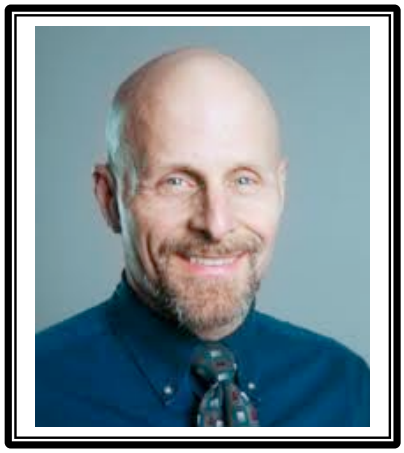

Brad Fulton

Educator of the Year

- ♦ Consultant
- ♦ Educator
- ♦ Author
- ♦ Keynote presenter
- ♦ Teacher trainer
- ♦ Conference speaker

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Known throughout the country for motivating and engaging teachers and students, Brad has co-authored over a dozen books that provide easy-to-teach yet mathematically rich activities for busy teachers while teaching full time for over 30 years. In addition, he has co-authored over 40 teacher training manuals full of activities and ideas that help teachers who believe mathematics must be both meaningful and powerful.

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- ♦ California Math Council and NCTM national featured presenter
- ♦ Lead trainer for summer teacher training institutes
- ♦ Trainer/consultant for district, county, regional, and national workshops

Author and co-author of mathematics curriculum

- ♦ Simply Great Math Activities series: six books covering all major strands
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Brad

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Building Geodesic Domes

From desktop models to fort sized fun!

Overview:

Geodesic domes are intriguing shapes that are fun to build and explore. They are extremely strong yet much simpler to build than they appear. Whether students build the smaller personal version or you opt to build one large enough for them to fit inside, they will be amazed and remember this activity for years to come.

Options are provided for making a semi-permanent structure or one that can be assembled and disassembled in just a few minutes. Best of all, the plans utilize inexpensive materials. A dome big enough for a student to fit inside can be constructed for under ten dollars using appliance boxes.

Required Materials:

Small dome:

- ☒ Paper dome template
- ☒ Tape
- ☒ Scissors

Large dome:

- ☒ Cardboard
- ☒ Rubber bands

Optional Materials:

- ☐ Duct tape
- ☐ Glue

Procedure:

For the large dome, I bought cardboard from a local shipping store. It came in 4' x 8' sheets and cost about $10 each. I used three of them. You can use cardboard from refrigerator and other appliance boxes, and these can often be acquired for free. Though my dome was painted, this isn't absolutely necessary. If you want to build the large dome as inexpensively as possible, you'll probably only need to buy a bag of large rubber bands. Simply make sure that they are capable of easily stretching the length of your longest triangle side.

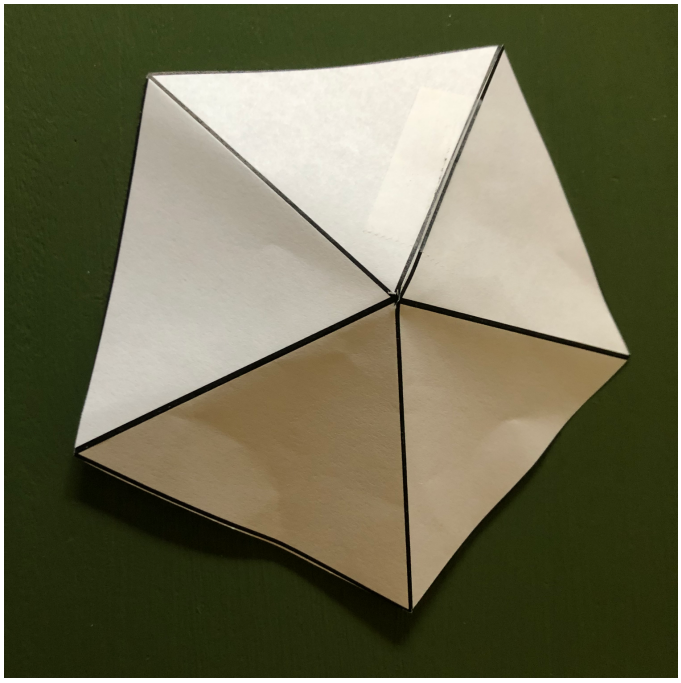
For larger or smaller domes, you can scale the small paper template on a copy machine. You may wish to enlarge it so each of the 5 ABB templates fits on its own page.

A chart is given to allow you to scale the larger habitable dome to any size you desire.

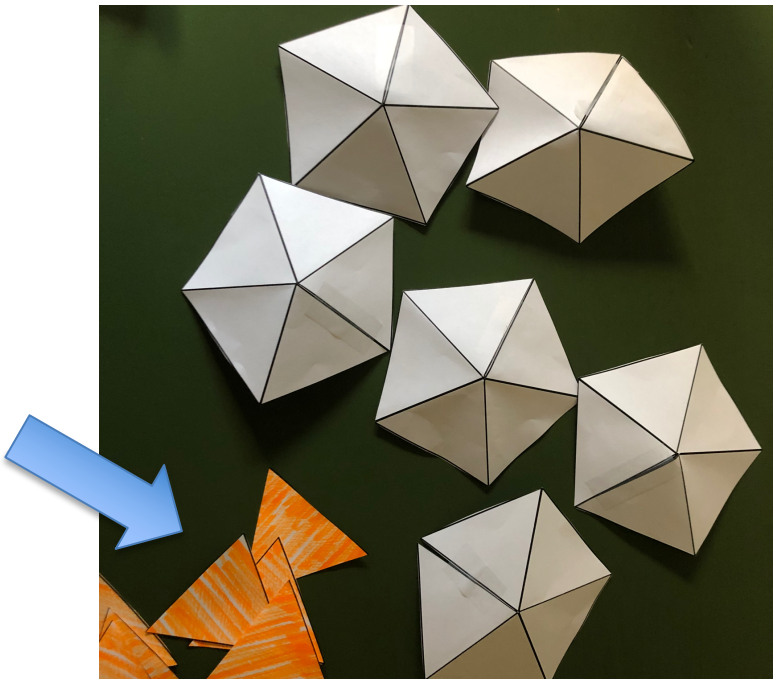
Small Dome

1. Give students the three pages of dome templates. My model was printed on standard copy paper. You may wish to use tagboard for a more robust model. For best results, have them color the ABB (isosceles) triangles in one color and the AAA in an alternating color. This will help keep them organized during the building phase. Here the AAA (equilateral) triangles are colored orange.

2. The ABB triangles must be cut **accurately** along the perimeter and **neatly** folded along the interior lines. The two edges are then taped **neatly** together. **Accuracy is crucial**. This will form a low, five-sided pyramid.



3. Next cut out the AAA triangles so they are all separate.



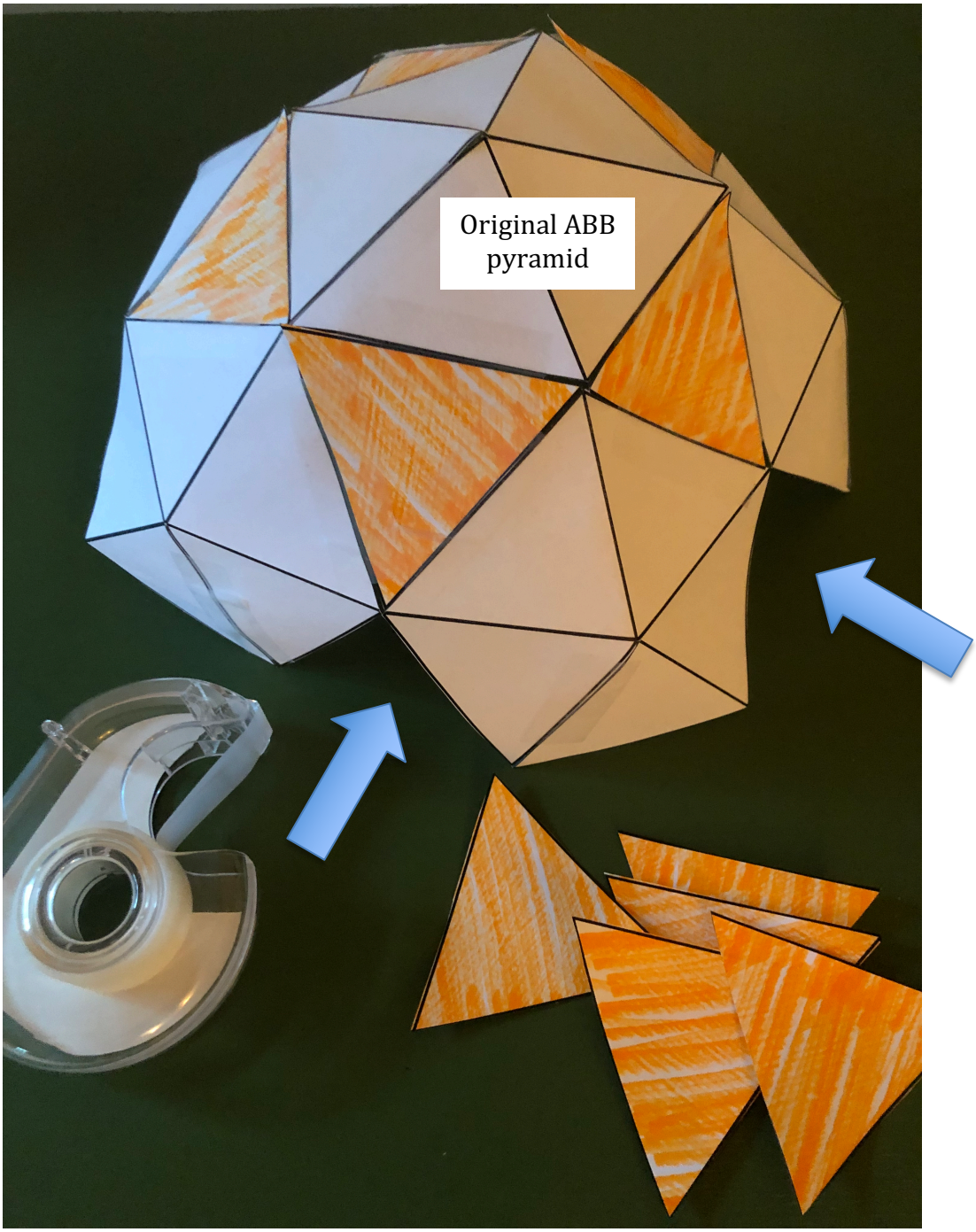
Assembly — simple as a, b, c!

a. Begin assembly by taking one of the ABB pyramids and attaching five AAA triangles along each outside edge. Again, make sure edges are taped accurately.

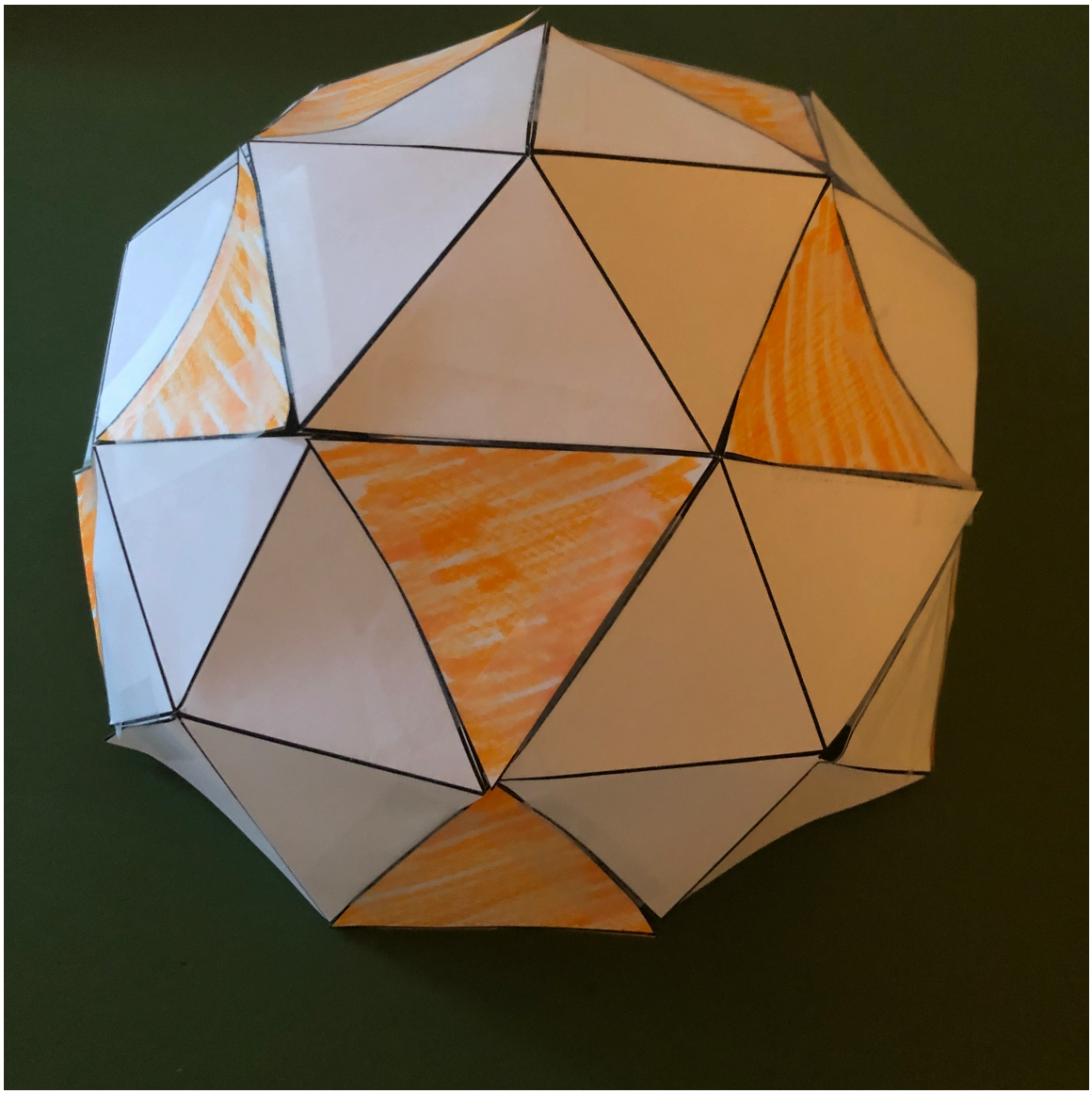
b. Then insert another ABB pyramid in between two of the AAA triangles as shown.

c. Once all of the remaining ABB pyramids are taped between the AAA triangles, there will be openings between them at the base. (Shown here.)

Tape the remaining five AAA triangles into these gaps. (Shown on the next page.)



Final geodesic dome:



4. If you wish, students can tape two geodesic domes together to form a geodesic globe! You can also leave one edge of one of the ABB triangles without tape to make a door.

5. Students can research geodesic domes online to learn more. This model is called a 2v dome. There are also 1v domes, 3v, 4v, 5v and others. What is the difference in these other domes? (The *v* refers to the frequency of the dome. Although complicated, a simplified explanation is that it refers to how many vertices you encounter in running from the top of the dome to the base. More technically, geodesic domes are based on the icosahedron, a 20-sided shape of equilateral triangles. As each AAA triangle is subdivided through tessellations into smaller subsets of ABB triangles, you add frequencies to the shape and it begins to take on a more spherical form. The second link below can explain this more fully.)

   a. Geodesic domes: https://en.wikipedia.org/wiki/Geodesic_dome

   b. http://geo-dome.co.uk/article.asp?uname=domefreq

   c. Montreal biosphere: https://en.wikipedia.org/wiki/Montreal_Biosphere

   d. Who invented the geodesic dome? (Walther Bauersfeld, though Buckminster Fuller researched it and received the American patent.)

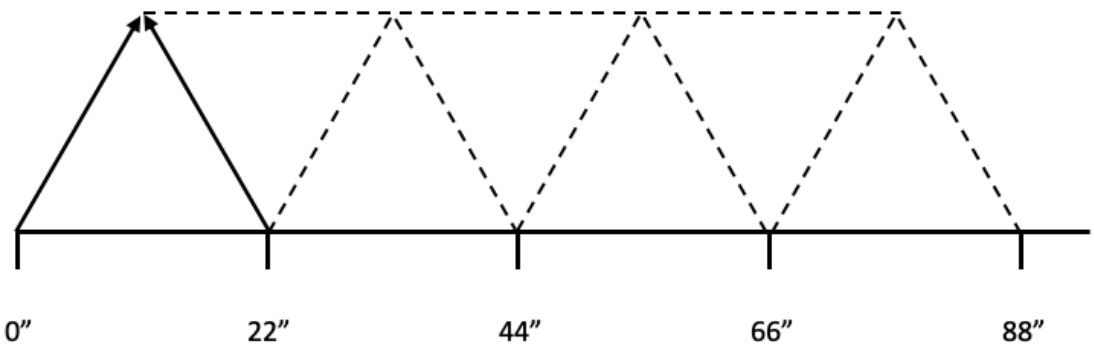
   e. What are its advantages? (It is very strong and requires no internal support. As it approximates a sphere, it encompasses the maximum volume for the materials used. This makes it very energy efficient as well. It can withstand strong winds and loads and can be easily transported and constructed from a kit.)

   f. What are the disadvantages in housing construction? (Most furniture and cabinetry are designed for rectangular shapes. Design and measurements require unique skills.)

Large Dome

1. You will need to cut thirty ABB (isosceles) triangles. You will also need ten AAA (equilateral) triangles. The fort that you see on the cover is 64" in diameter and 32" tall. It requires about 3 refrigerator boxes. In my model, I made A=22" in my model. Once the flaps were cut and folded, this resulted in A=20". **Don't forget to add these two inches**.

2. To make the layout of the triangles consistent, I began by creating a baseline along which to draw the triangles. I then carefully made the first AAA triangle. I marked the baseline at 22", 44", 66", and 88". Then I created a compass by tying a loop in a string and measuring **exactly** 22" along it. This allowed me to place the end of the string at the two endpoints of the base and swing two 22" arcs that intersected above it:



3. I repeated this process for the next three triangles along the baseline. Then I connected the tops to create three inverted triangles. (Shown by the dotted lines above.) This gave me seven of the ten AAA triangles that I needed. I then made three more AAA triangles the same way for a total of 10.

4. To make the ABB triangles, I began the same way, but the string compass was shortened to the desired length for the shorter sides. In my example, this was 19.45" for side B, but remember that I lost two inches for the flaps. You will need 30 ABB triangles.

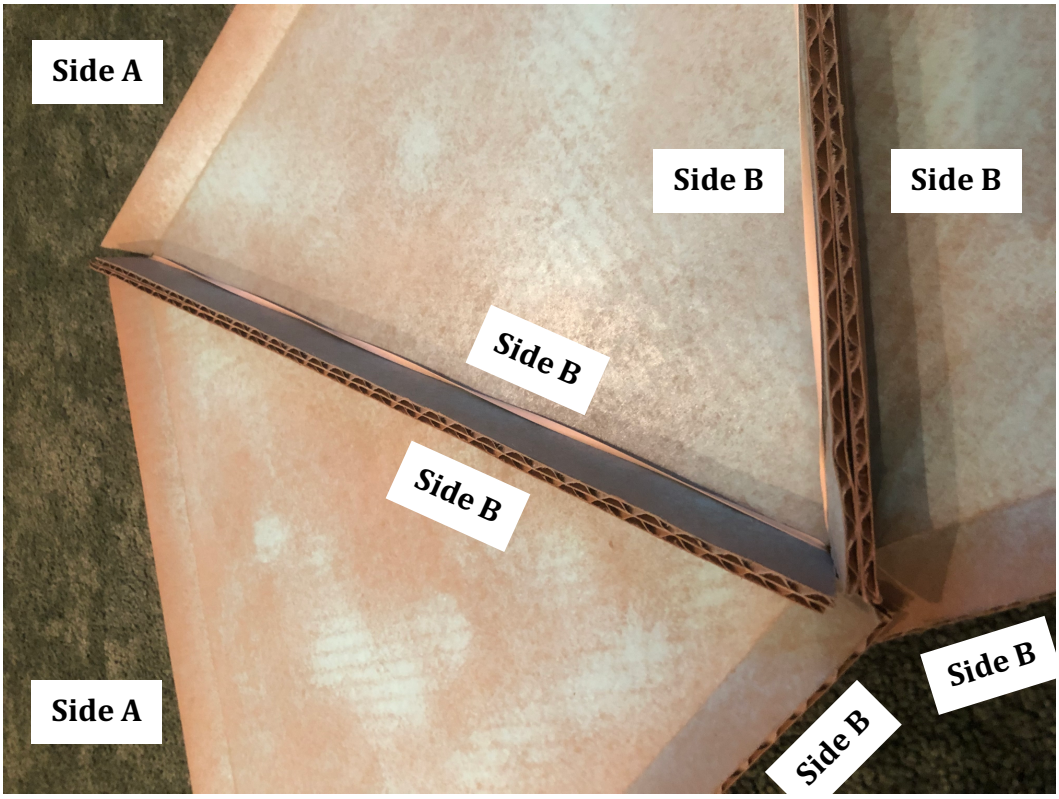
Good Tip:
To build a permanent and stronger dome, you can avoid making the flaps and simply tape the seams together. I'd suggest a strong tape such as duct tape.

5. Next I cut the flaps on the backs of the triangles. (Either side can be the back at this point, but if you have used appliances, cut the flaps on the side that has printing on it so that the finished side will be blank.) To cut the flaps, I scored a line one inch in from all three edges of each triangle as shown here.

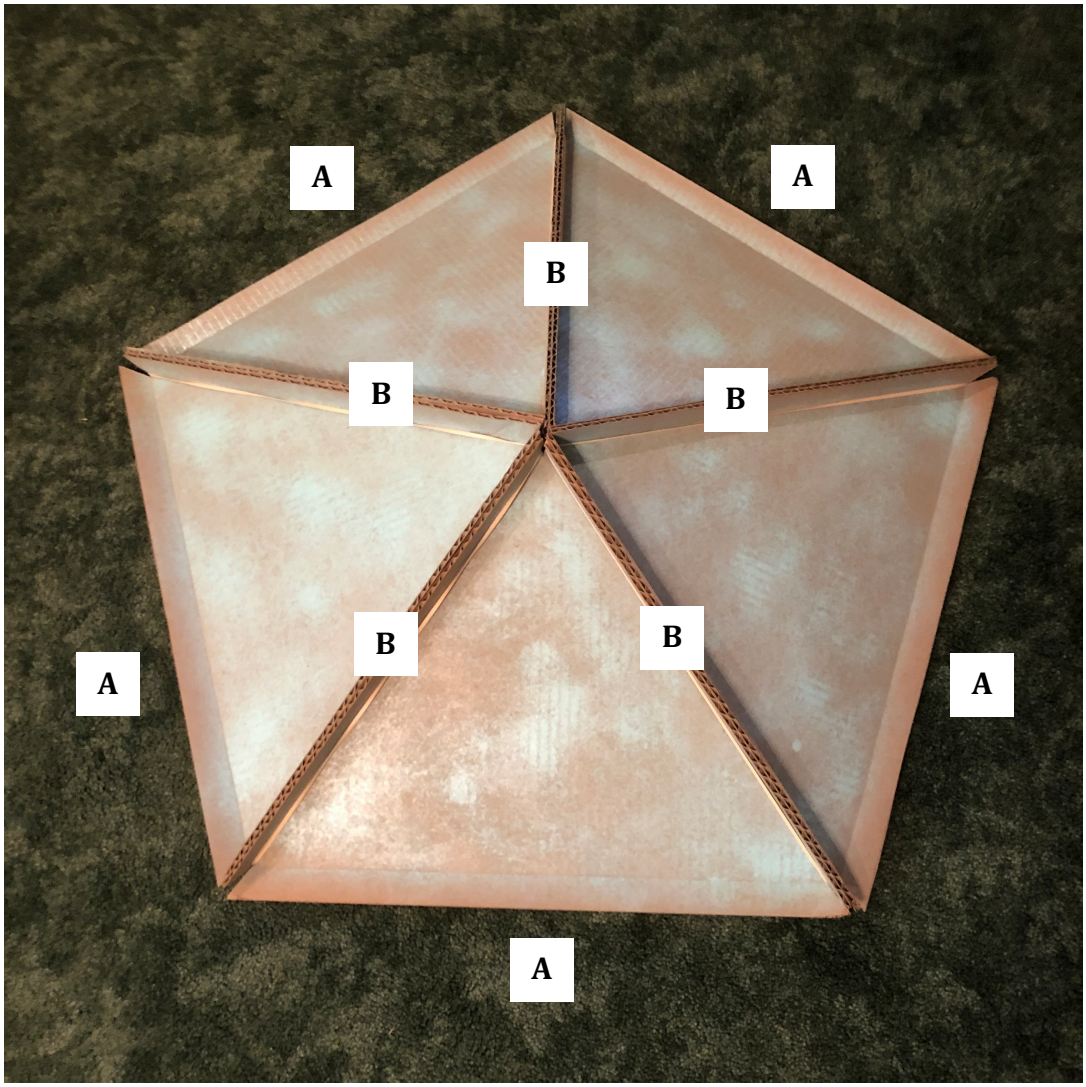
6. I removed the small rhombus at all three corners of each of the 40 triangles.

7. Now fold up these flaps along every side. I painted my two types of triangles different colors to help keep them straight during the assembly. **The ABB triangles are a bluish silver in the illustrations, and the AAA triangles are pink**.

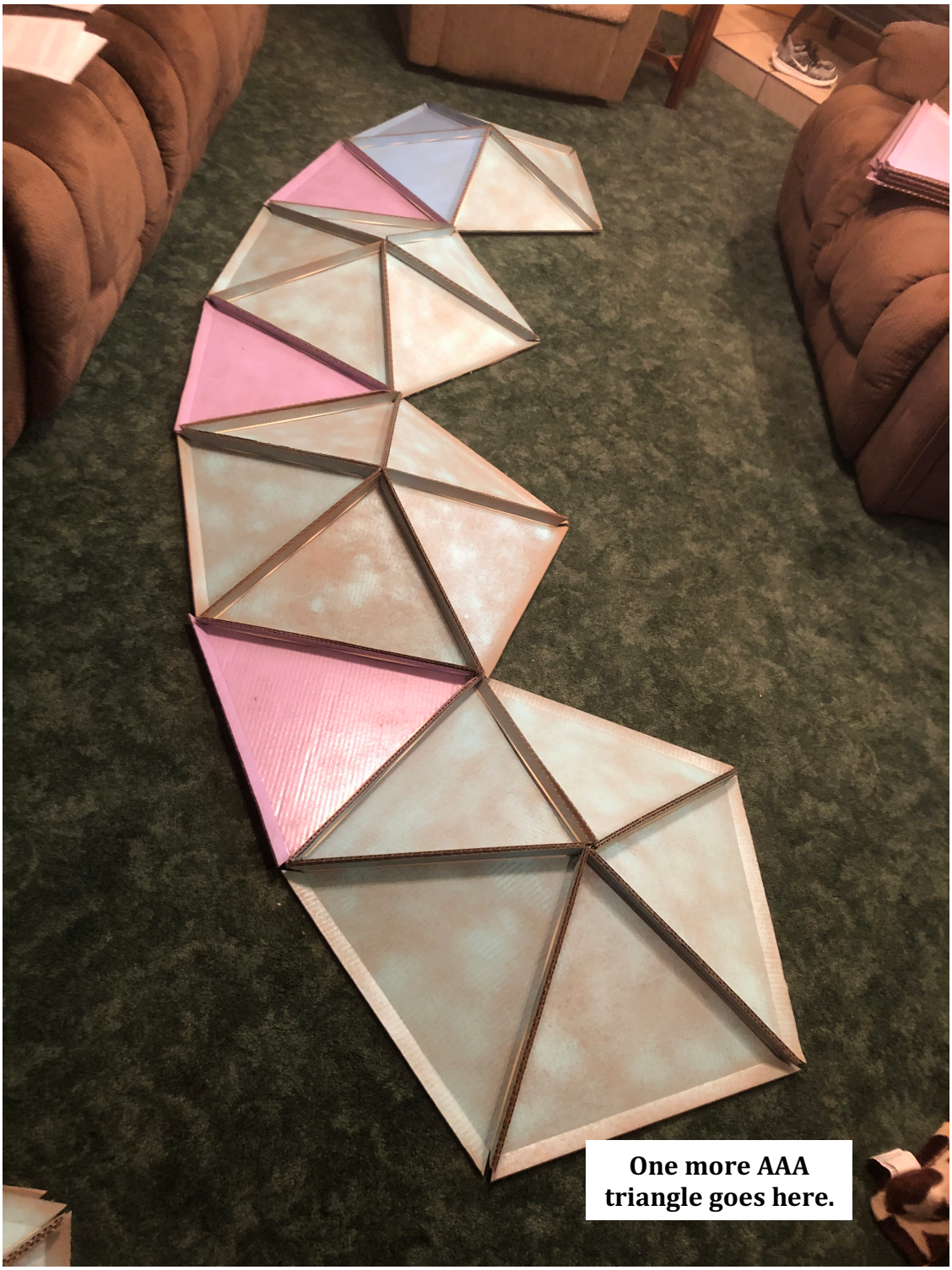
8. Take two of the ABB triangles and align them along their **B side** so the flaps are together. Stretch a rubber band around these to hold them. Here you can see three of these ABB panels hooked together. Notice the triangles are secured along edge B.



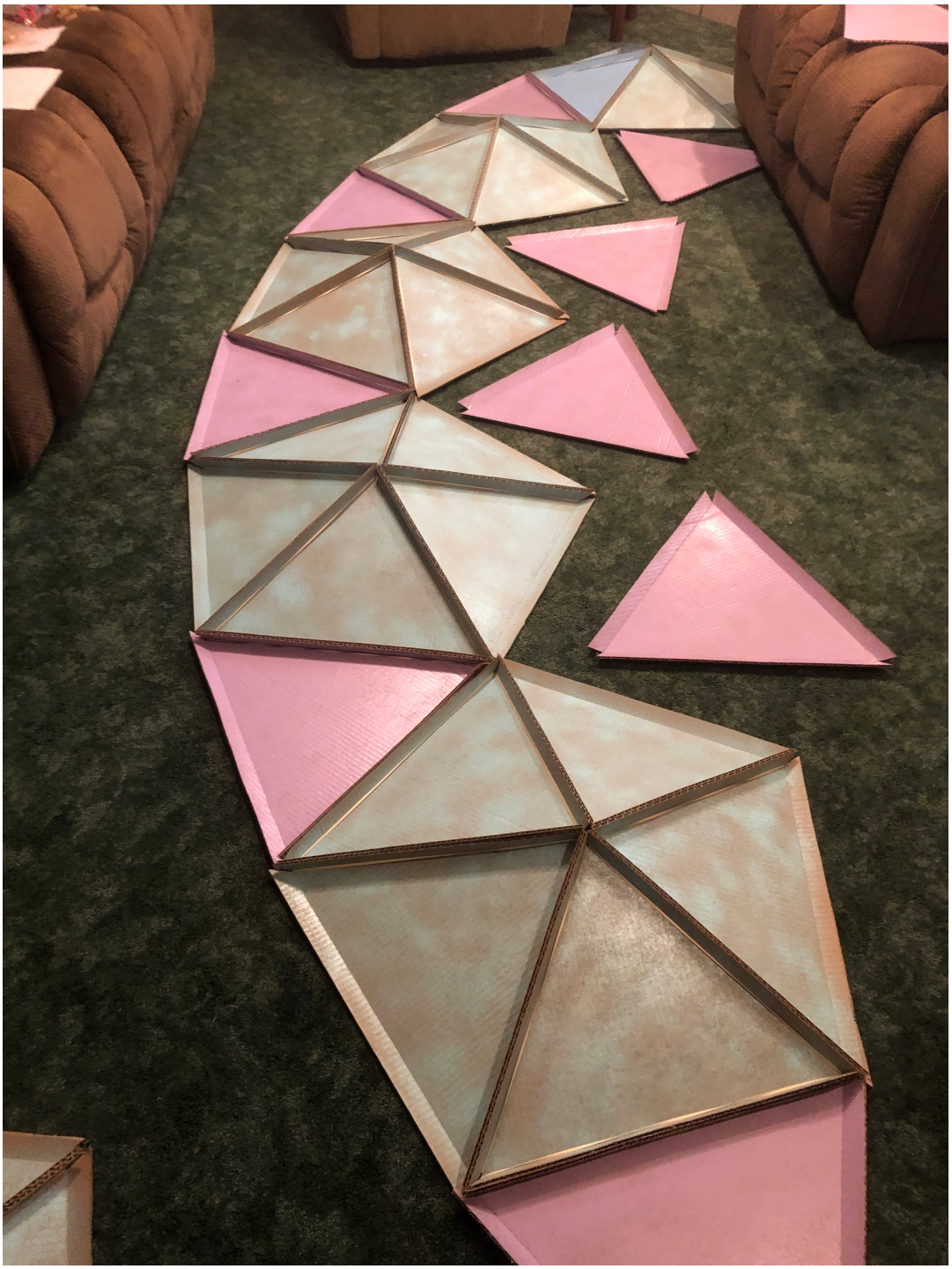
9. Continue to add ABB triangles until you have five. The final two edges are joined to form a low pyramid as we did in the small dome instructions.



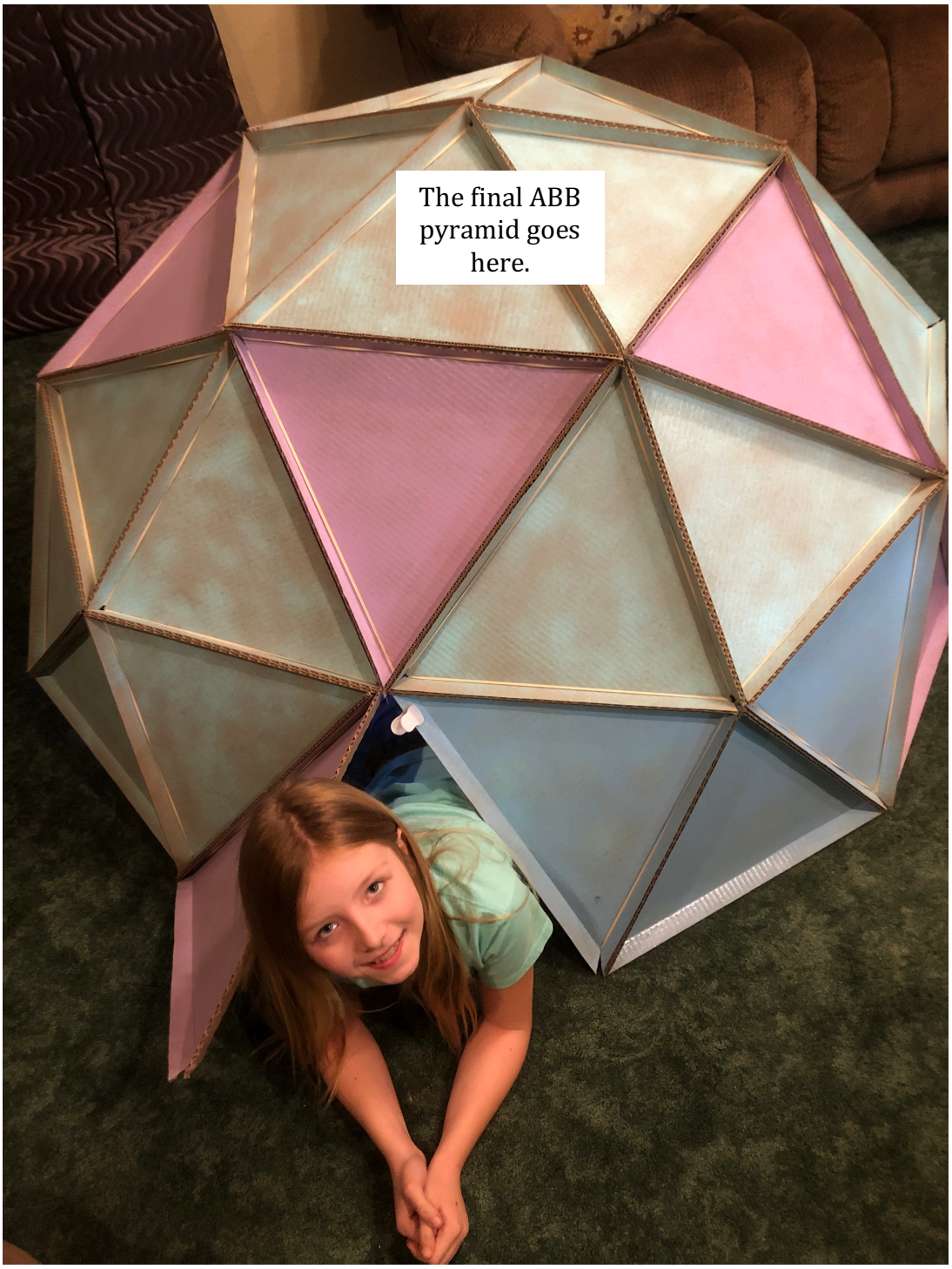
10. Now use AAA triangles to join five of the six ABB pyramids with rubber bands as shown here. (Save one ABB triangle for later.) There are five ABB pyramids joined with alternating AAA triangles. The fifth AAA triangle can be attached at either end of the chain.



11. The remaining AAA triangles are then placed into the gaps as shown and attached with rubber bands. Four of the five are shown here. The dome will now begin to take shape and not lay flat. It will begin to curve more.



12. Bring the ends of the chain together and a pentagonal hole will form in the top of the structure. The remaining ABB pyramid fills this hole and is secured with rubber bands. I left one side of an AAA triangle on the base unattached to use as a door.



Room to lay down inside!

13. This was a bottom-up construction. You could also try a top-down approach as explained in the small dome instructions. At first I used strong rubber bands that barely stretched the 20' length but held it securely. These bands began to cut into the flaps along the scored edges. I then opted for the bigger and more colorful rubber bands shown here. (I got them at an office supply store.) They were not as strong, but they worked fine. They wouldn't support a snow load or meteor impact, but they held up to the grandchildren just fine. This was the only expense I would have had if I'd used free appliance boxes.

14. To dismantle the dome, simply remove the rubber bands. The triangles stack neatly for compact storage. It takes less than 15 minutes to set up or take down the dome.

15. Our fort has been nicknamed the Popcorn Palace. It's a great place to enjoy a good book and a bowl of popcorn. The grandchildren installed battery-operated lights, a flower box, and a mailbox in case anyone wants to deliver some candy! It seems to be working.

ABB isosceles triangles:

Cut these out along the perimeter. Fold along the interior lines. Tape the two remaining edges.

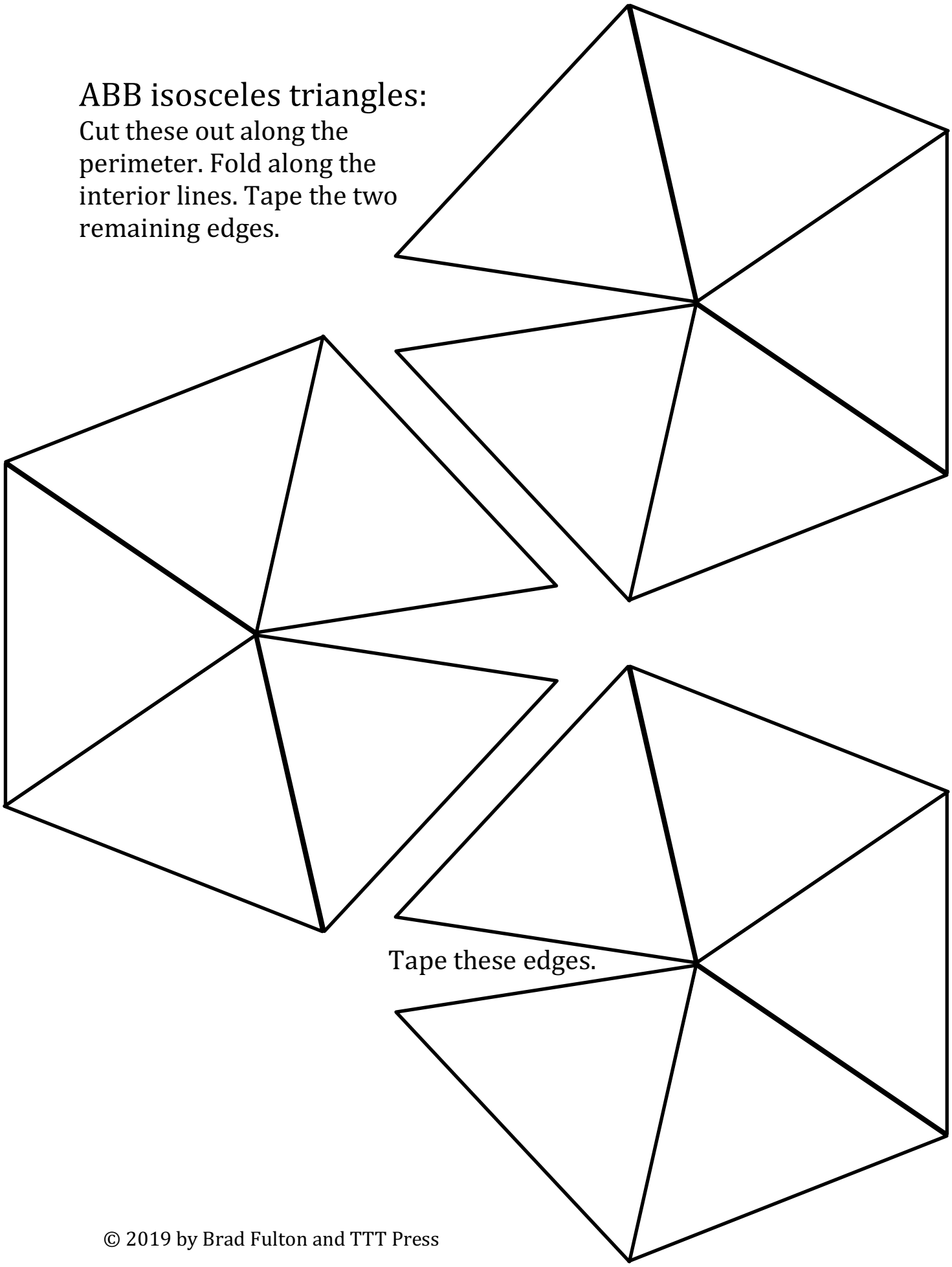
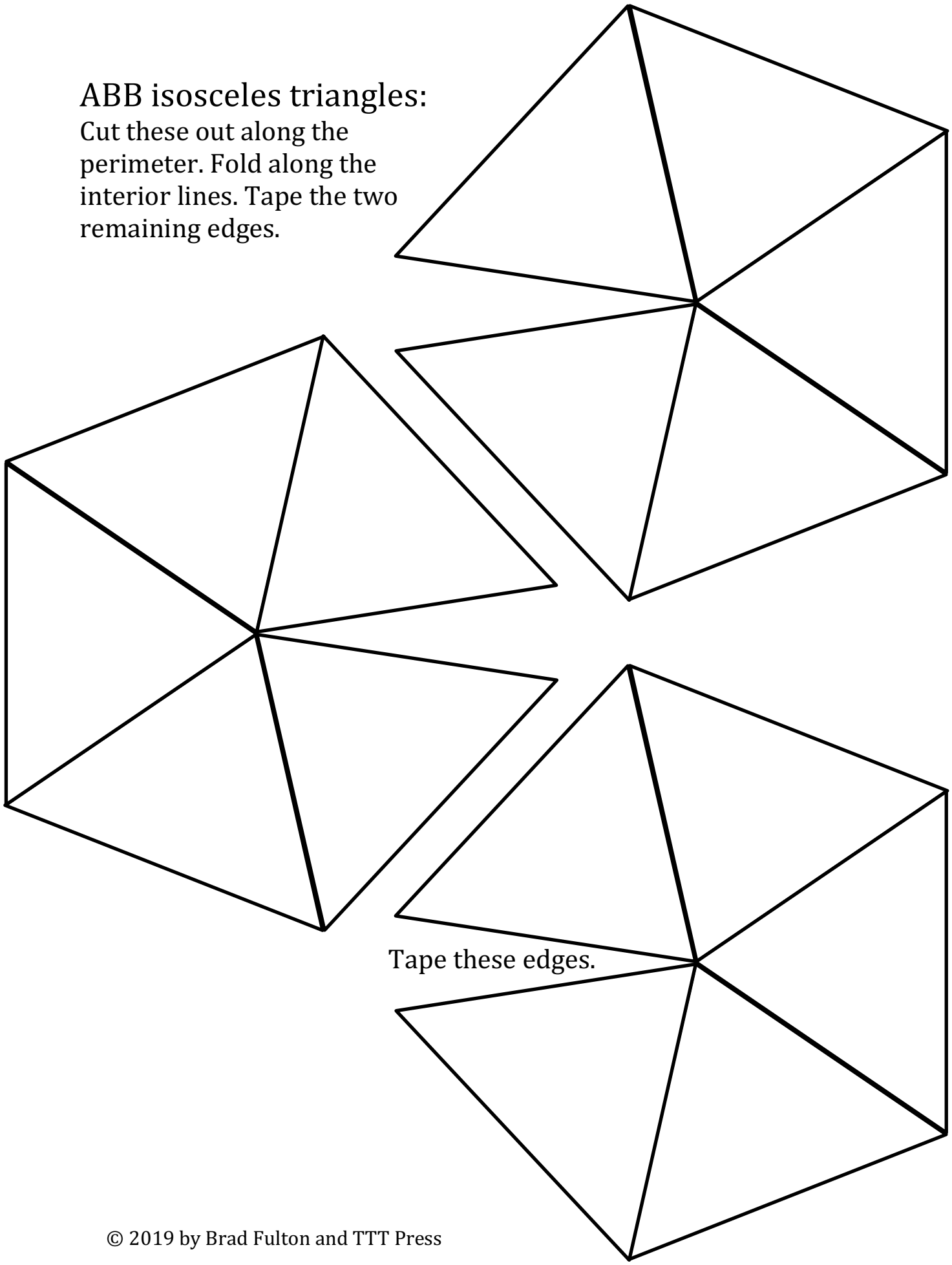
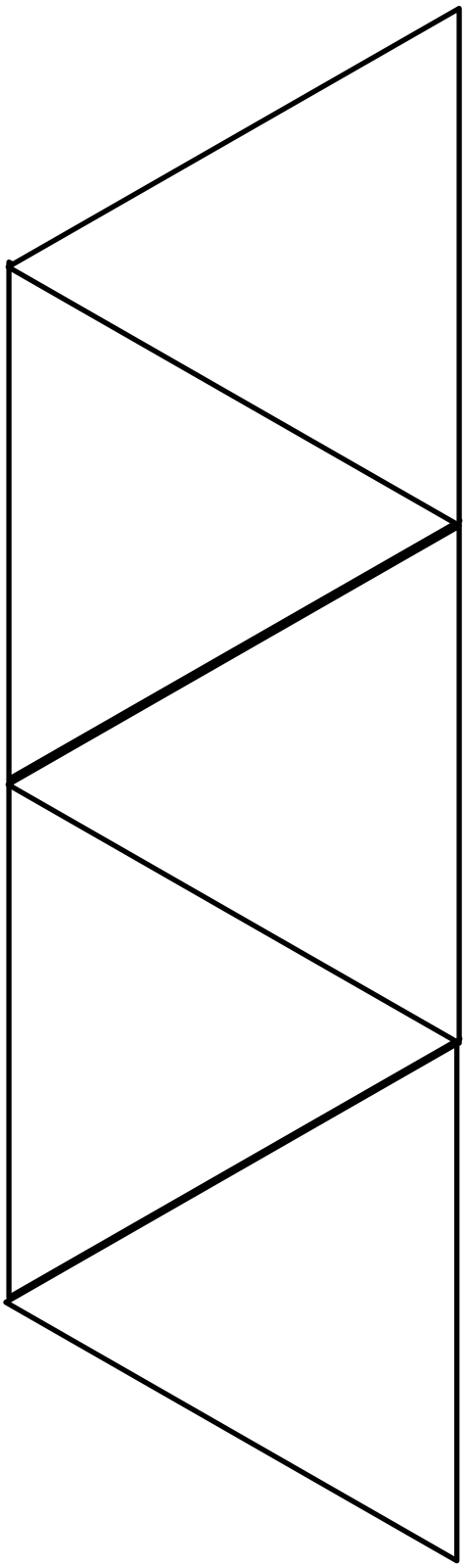


ABB isosceles triangles:

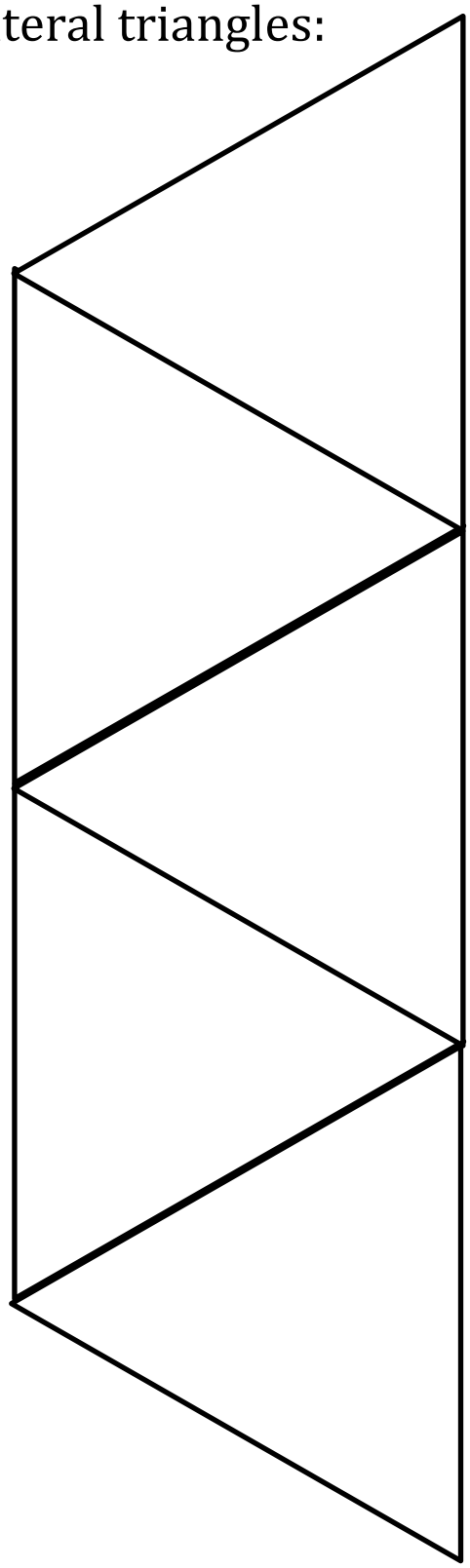
Cut these out along the perimeter. Fold along the interior lines. Tape the two remaining edges.



AAA equilateral triangles:

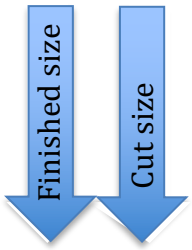


Cut out each one of these triangles.



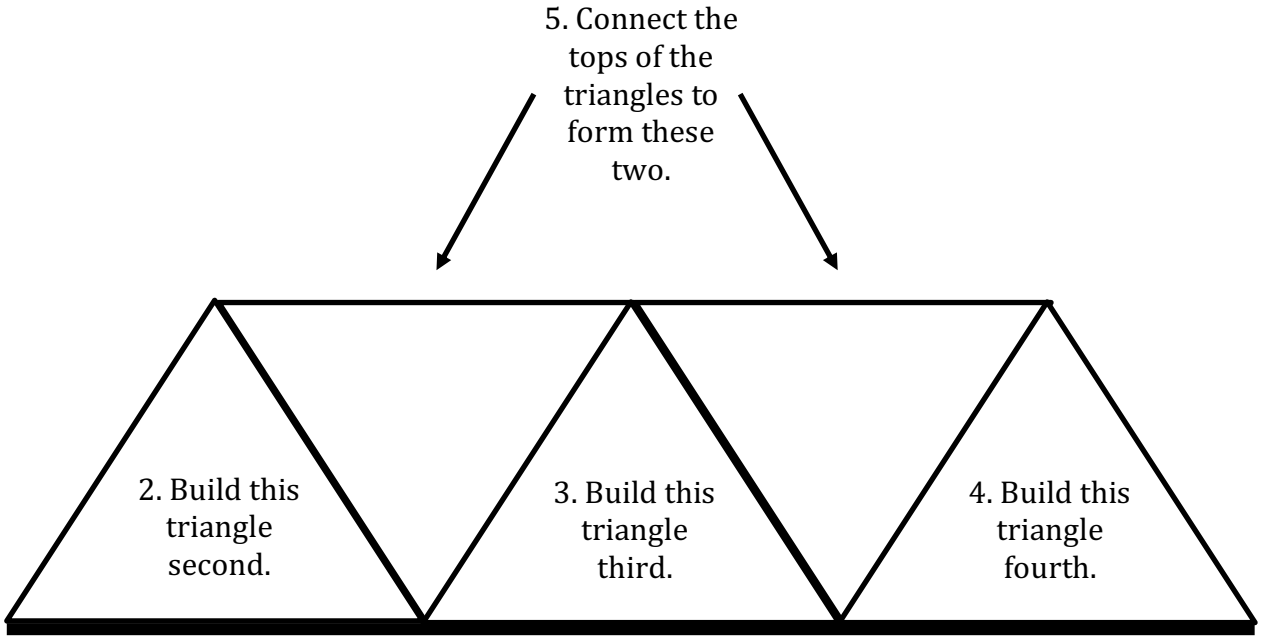
All measurements are in inches, but centimeters will work as well. To get other dimensions, simply multiply all the number in a column by a scaling factor of your choice.

For my dome I used 22" lengths for side A. By the time the flaps were cut and folded, Side A was 20" resulting in a diameter of about 64". **Don't forget to add two inches to A and to B to allow for the flaps.** If you are using tape instead of flaps, you do not need to add the extra two inches.



Side A	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00	26.00	28.00	30.00
Side B	8.84	10.61	12.38	14.15	15.92	17.69	19.45	21.22	22.99	24.76	26.53
Diameter	32.36	38.83	45.31	51.78	58.25	64.72	71.19	77.67	84.14	90.61	97.08
Height	16.18	19.42	22.65	25.89	29.12	32.36	35.60	38.83	42.07	45.31	48.54

You will need 30 ABB (isosceles) triangles and 10 AAA (equilateral) triangles. I found that the easiest way to lay these out on the cardboard was to draw one along a baseline and then lay out the others alongside it as shown here.



1. Draw this baseline first.

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Feel free to contact me if you have questions or comments or would like to discuss a staff development training or keynote address at your site.

Happy teaching,

Brad