Print Name _____ Period _____ Date _____

CA1 4.13: A Large Geodesic Dome Activity

Purpose: This activity takes several days, but at the end of it you will have a working planetarium! This set of plans tells you how to build a 5-meter dome suitable for a small high school class or a large elementary class. This activity is focused on building the dome and obtaining a projector; the next set of instructions tells what to do with the dome once you build it.

These instructions are adapted from a web page by the Contra Costa County (CA) Office of Education and the Dean and Margaret Lesher Foundation's CTAG project "A Planetarium for Every School." Other versions are posted at the web site. http://www.cccoe.net/stars/

Materials needed: corrugated cardboard—ten to twenty 4x8 foot sheets, giant binder clips (2 inch or larger), cutting tools (scissors and x-acto knives), rulers and meter sticks, string, paint (flat white, grey, or black, depending on design), brushes, clear plastic bowl or cylinder, 3-6 V light bulb plus battery and wires to make it glow, commercial star projector toy (optional); thin strips of plywood, nuts and bolts (optional).

Getting materials

This dome is a 2v, or two-frequency geodesic dome based on plans posted at www.desertdomes.com (plans used with permission). Plans are not presented here to make this into a sphere, although you could easily do so by adding additional triangles and continuing the pattern (but where would you put it?). Two different triangle sizes are used. An optional base ring lifts the dome off the floor, and even makes it possible to add a door and ventilation system to the dome.

Unlike smaller domes, only corrugated cardboard is strong enough to support the weight of the dome. Even though each individual panel is lightweight, in combination all the cardboard used would be difficult to lift at best. Cutting corrugated cardboard isn't easy and scissors are probably not the best tool to use.

In some cases, if you use box cutters or an X-Acto knife to cut one side of the cardboard following a straightedge, you can fold the cardboard along the cut and just snap it apart. Otherwise, turn the cardboard over and fold it into a V-shape, then cut in the narrow channel that results.

If you have access to a paper manufacturing facility, sometimes cardboard can be purchased with one side already made white for producing white cardboard boxes. Such cardboard typically comes in 4 x 8 foot sheets, and you should take care not to bend it until absolutely necessary in order to retain its strength. It is entirely possible to build the dome

CA1 4.13: A Large Geodesic Dome

out of scrap cardboard from a variety of boxes, and a grocer or warehouse store probably has lots of boxes they would be willing to donate to your project.

If you don't have white cardboard, you should paint one side of the cardboard white with any white flat paint. It is best to note that painting is probably best done before the cardboard is assembled into a dome. The connecting flaps do not need to be painted.

The optional thin strips of plywood and nuts and bolts probably should not be used unless you intend to leave the dome assembled permanently. You will need to cut two strips for each joint, and use 3-4 nuts and bolt sets to create reinforcing strips that hold the cardboard tabs together. Used alone, the nuts and bolts will eventually pull through the cardboard.

Procedure:
This dome uses two different size triangles. To create a dome with a radius of 2.5 meters, construct the following templates for use in tracing triangles on other pieces of cardboard.

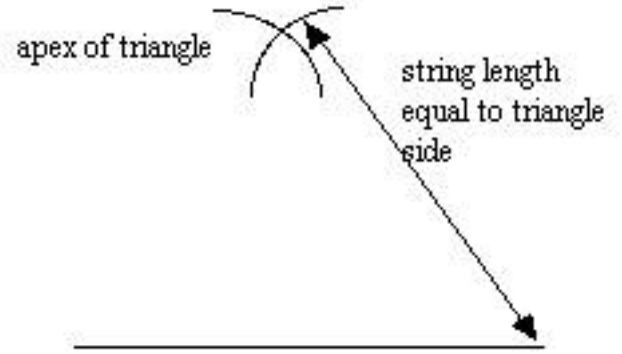

Figure 1. Use string to make a near-perfect isosceles triangle.

One way to make the template accurately for these triangles is to use an old geometry technique. First, draw the base the triangle with a pencil and ruler. Next, measure a length of string equal to one of the remaining sides, and draw an arc centered on one end of the line you drew. Repeat on the other side, and where the arcs cross must be where the top of the triangle is located.

1. The first triangle, called an "A" type in these instructions, is an equilateral triangle with each side equal to 1.545 meters, or 154.5 centimeters. No gap between triangle sides is needed as you lay out this triangle and the next one on the cardboard, because these will be your templates for tracing.

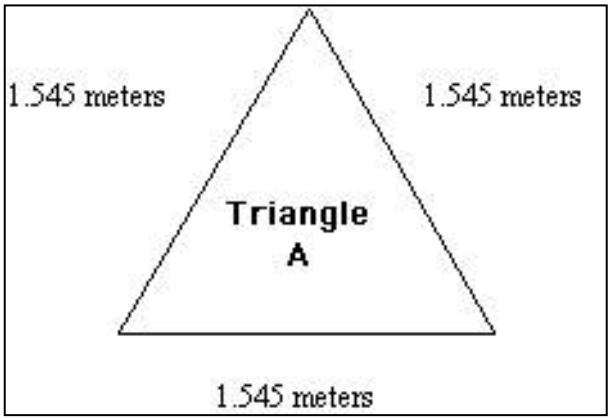

Figure 2. Triangle A.

This will be called triangle A. Make one of these. The measurements of the triangles were determined using an online dome calculator at Desert Domes.

Print Name _____ Period _____ Date _____

CA1 4.13: A Large Geodesic Dome

If you want to make a triangle using some other size, simply multiply these dimensions by the factor you would like to make the dome larger or smaller, or visit www.desertdomes.com and enter the new radius you would like to use. The reference to Desertdomes.com is used with permission.

2. The second triangle template is an isosceles triangle, which means two sides are the same length and the third side is different. In this case, the two identical sides are 1.365 meters long, and the third side is 1.545 meters long (the same as triangle A.) This is called triangle B. Make one of these. Again, leave at least a 4 inch gap between this triangle and the next.

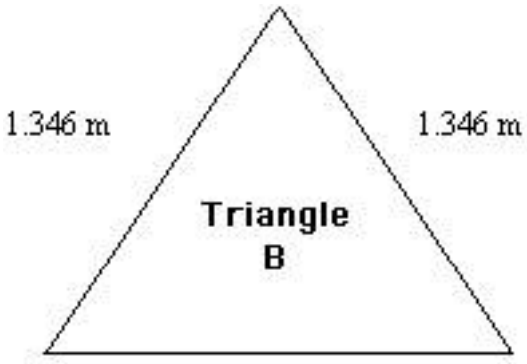

Figure 3. Triangle B.

3. Once you have the templates made, assemble enough cardboard to make the remaining triangles. You will need to make 10 A-type triangles and 30 B-type triangles. Don't put them right next to each other, however; you'll need to leave a 4-inch gap between them (keep reading).

Your teacher may assign you the task of determining how much cardboard is needed prior to the assembly.

Each time you make a triangle, trace the shape from the template so that all the triangles are identical. This will work better than measuring from scratch each time. You need to leave about a 5-cm (2 inch) flap along each edge to use when connecting the triangles together. A single completed triangle will look like this. The flap should not be substantially larger or smaller than the giant triangular binder clips you will use to connect the panels.

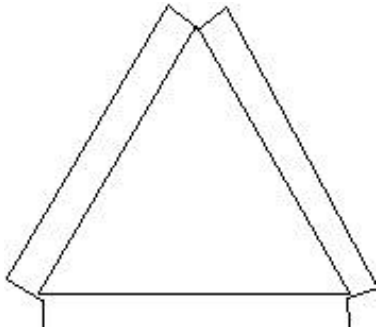

Figure 4. Each triangle edge needs a flap.

The connecting flaps for this dome will need to be folded carefully so they bend straight. In this case score the cardboard by drawing a heavy line with a ball-point pen (not a felt-tip) which will weaken the bending joint.

CA1 4.13: A Large Geodesic Dome

Then bend the cardboard along the line you drew to make a flap or other junction. Don't be afraid to practice on some scrap before committing yourself to a more permanent part.

Another good idea is to label the outside of the triangle with the type, A or B; when you have a stack of triangles it can be difficult to tell which is which. The outside of the triangle is the side the flaps bend toward.

4. At this point you need to obtain binder clips, the large black triangular kind you get from office supply stores. Four per tab should be sufficient, and including the base ring and having some spares, 400 clips will be required. One student who built a larger dome with clips proclaimed, "Rule number one: You can never have too many clips," so consider buying extra for loss and breakage and reinforcing weak spots. The advantages of clips are ease and speed of construction. Their primary disadvantage is they do not take a lot of force to pop loose and slip. This is your best choice if you wish to assemble a temporary dome. When disassembled, the parts fit nicely in a large box or behind a cabinet.

Figure 6. Assemble 5 triangles on the floor.

5. To assemble the dome using your chosen method of attachment, begin by building a pentagon of 5 "B" triangles, with the long sides all on the outside. Leave the last joint unconnected until all the others are done to make the assembly easier.

Connect the last two interior sides together to make a little "cap" or inverted bowl shape. The cap will pucker up and make a little peak.

6. Make 5 more of these pentagon shapes. Set one of the pentagons aside.

Print Name _____ Period _____ Date _____

CA1 4.13: A Large Geodesic Dome

7. Set 5 pentagons into a circular pattern on the floor as shown in Figure 7.

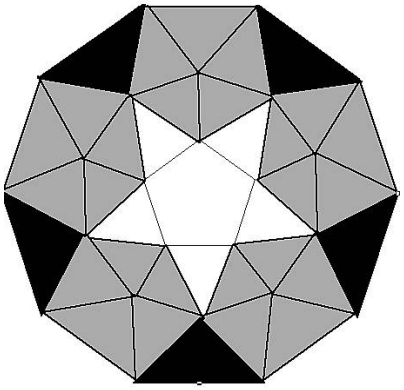

Figure 7. Arrange five pentagon-caps as shown.

Next insert an "A" triangle between them. In the diagram, the "A" triangles are black. The view is looking down from above.

If you are working alone, having lots of chairs around to brace things is helpful. Helpful tip: Don't try this alone.

Stand the pentagons up on one edge and attach the "A" triangles. It's easier if you do two pentagons at a time.

Figure 8. Stand the pentagons up on their sides and connect the adjacent "A" triangles with clips.

8. Insert another "A" triangle into the gaps at the tops of the pentagons, this time with the point of the "A" pointing downward. This will make a "ring" of pentagons leaving a hole in the top.

9. Set the remaining "B" triangle pentagon into the remaining hole and attach with clips. Again, two people working at once is much easier, especially on the larger domes.

9. You should next construct a base ring. Make ten panels 1.545 meters wide, and as tall as you would like the dome to be off the floor (probably not more than a meter would be best.) Don't forget to leave extra flaps on the edges and top to attach the panels to each other and the dome. Before you put the dome on the base ring, however, you need to add the lid to the top of the dome.

Figure 9. Build a base ring to support the dome.

Print Name _____ Period _____ Date _____

CA1 4.13: A Large Geodesic Dome

Figure 10. A completed dome with base ring.

This is what the finished dome will look like.

10. Ventilation.
Would you like to be closed into a cardboard box with 30 people for half an hour with no ventilation? Neither would we. You can easily build a simple ventilator with a floor fan and a large cardboard box. Simply put the fan at one end of the box, add two or three interior baffles (painted black if possible) to help stop the light leaks, and set the other end of the box in a hole in a base ring panel.

11. Add a Door.
Make a light-tight door by cutting a "clubhouse" door in a base ring panel (probably not adjacent to the ventilation system for strength). If you glue a piece of cardboard on the door slightly larger than the size of the door, the extra cardboard will serve as a light-blocking seal. A loop of string or a wooden knob can serve as a doorknob.

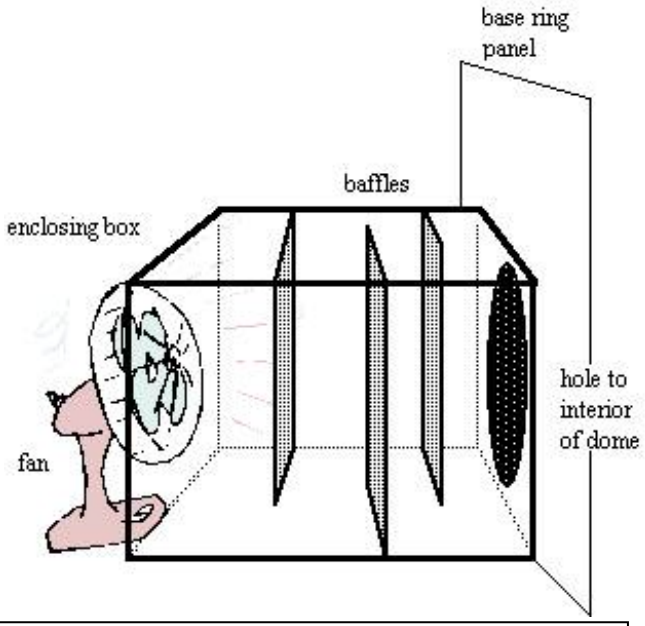

Figure 11. A ventilation system for your dome.

12. Plugging light leaks
If the room you are using cannot be completely darkened, light may leak at the joints where the triangle corners meet.

If you discover this is a problem, you can either drape sheets over the entire assembly or use poster board or aluminum foil to cover each individual junction to prevent light leaks. Darker works better. You might even consider taping the interior joints with white tape if you intend to leave the dome assembled for a while.