



Dome Home

Content Focus: Math

- Geometric Shapes and Relationships
- Measurement: Angles and Distance
- Modeling: Shapes and Patterns
- Scale

Content Focus: Technology

- Engineering Design







Content Focus: Built Environment

- Form
- Measuring/Estimating
- Model-Making / 3D
- Scale/Proportion
- Space
- Trusses

Performance Outcome(s)

- Design and build an outdoor cardboard geodesic dome large enough to hold the entire class.

Standards/Interdisciplinary Connections

					
S	S	L	A	M	T
Science	Social Studies	Language Arts	Art	Math	Technology

How To Read The Symbols: The symbols in **bold** indicate the subject standards that this lesson satisfies.

Lesson Outline (multiple-lesson project)

1. Motivation
2. The Challenge
3. Learn About Domes



4. Learn About Geodesic Domes
5. Design A Geodesic Dome For Your Class
6. Build A Scale-Model Geodesic Dome For Your Class
7. Build A Full-Scale Geodesic Dome For Your Class
8. Reflect
9. Extensions And Variations
10. Middle School Standards

Salvadori Prerequisites

- FOUNDATION - BASIC SKILLS: Measuring/Estimating (Activity #3); Scale (Activity #3); Model-Making (Activity #1)
- FOUNDATION - ARCHITECTURE 101: Form (Activity #2, Activity #3); Space (Activity #1, Activity #2)
- FOUNDATION - STRUCTURES 101: Trusses
- LESSON(S): "Cut To Fit" (School / Math / Go Beyond)

CONCEPTS

- Because geodesic domes employ a network of triangles to form the approximation of a sphere, they are one of the most inherently stable volume-enclosing geometric forms available to architects and engineers.
- Their strength-to-weight ratio and their surface area-to-volume ratio make geodesic domes highly efficient structures.
- Constructing a full-scale geodesic dome demonstrates how the repeated use of a two-dimensional form (in this case, a triangle) can result in an enclosed volume and fosters an appreciation of the precision necessary for the construction process.

RESOURCES

On-Line

- <http://www.bfi.org> - A link to the Buckminster Fuller Institute's site on geodesic domes
- http://en.wikipedia.org/wiki/Geodesic_dome - An excellent overview of dome facts and vocabulary
- <http://www.monkeyc.org/dome/index.html> - A complete guide to building a more durable cardboard dome
- <http://sci-toys.com/scitoys/scitoys/mathematics/dome/dome.html> - Simon Quellen Field's site on building domes



- <http://www.hilaroad.com/camp/projects/dome/domemath.html> - Hila Science Camp: Dome Math
- <http://www.netaxs.com/people/cjf/fuller-faq-4.html> - A site with chord factor tables for geodesic domes

MATERIALS

Facilitator

- ●: Q&A/Teacher Tips
- Hardboiled egg, egg cup, small rigid board, etc.

Students

- ●: Fact Sheet: Geodesic Domes
- Paper, pencils, rulers, protractors, scissors, scotch tape, yardsticks, masking tape, large sheets of cardboard, utility knives, cutting mats, permanent markers, translucent plastic sheeting, duct tape, ¼" bolts, nuts, and washers, primer, water-based enamel paint, brushes.

MOTIVATION - TESTING A COMMON EVERYDAY DOME: THE EGG

- *How do you think we could test the strength of an egg?* ●: Q&A/Teacher Tips

Test the strength of the egg.

- *How much weight did the egg hold before it broke?*
- *What do you think makes eggs strong?* ●: Q&A/Teacher Tips
- *Which side of the egg do you think would hold the most weight, the pointy end, the rounded end, or the side? Why?* ●: Q&A/Teacher Tips
- *Why do you think eggs are shaped the way they are?* ●: Q&A/Teacher Tips

THE CHALLENGE

In building a geodesic dome for the class, we will go through three steps: 1) create the design of the geodesic dome, 2) build a scale model based on that design, and 3) using that model, build a geodesic dome large enough to hold the entire class!



LEARN ABOUT DOMES

- *What is a dome?* ●: Q&A/Teacher Tips
- *What does the egg experiment have to do with domes?* ●: Q&A/Teacher Tips
- *Can you think of ways that people use domes?* ●: Q&A/Teacher Tips
- *Why might you want to design a house in a way that minimizes its surface area?* ●: Q&A/Teacher Tips
- *What might be some other advantages of having a dome house? What might be some disadvantages?* ●: Q&A/Teacher Tips

LEARN ABOUT GEODESIC DOMES

- *How can we use triangles to build a dome if we are not going to use concrete or some similar material which can easily assume a smooth (dome-like) shape?*

Attach four folded strips of paper, drilled popsicle sticks, or straws together using bendable paper fasteners to form a square. If you have enough materials, have students try the exercise individually or in groups.

- *What happens when you apply pressure to one side of the square?*



- *How can you make the square more stable?*

Add a cross brace between two of the corners to create a parallelogram made of two equilateral triangles.

Push and pull on it to demonstrate its rigidity.

- *What does this exercise tell us about triangles?*
- *How we can combine the rigidity of a triangle with the strength of a dome? Have you seen anything like that?*



DESIGN A GEODESIC DOME FOR YOUR CLASS

Our dome will be made out of paper triangles and will be at a scale of $1' = 2''$.

- *How big do you think a dome would need to be to hold the entire class?*
- *How can we find out?*

Have the entire class crowd together in a circle so that the students are standing tightly packed but not uncomfortably close. One student traces the circumference of the rough circle with masking tape or a pencil.

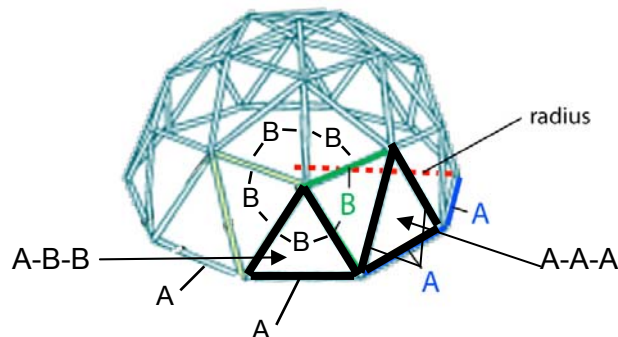
Using a tape measure, students measure the diameter of this rough circle.

- *Remember that the dome is roughly the shape of a hemisphere. If we use the dimensions of the circle we just calculated, how high will the center of the dome be?*
- *Is that high enough for the tallest members of our class to be able to stand? What are the adjustments we need to make to the size of the circle?*

Now that we know the approximate diameter of the footprint we would like our dome to have, we can start calculating the dimensions of the individual triangular pieces using a scale of $1' = 2''$.

Distribute the Fact Sheet. ●: Fact Sheet: Geodesic Domes

As it turns out, all of the triangles needed to make a “2-frequency icosahedron” dome (as described in the student Fact Sheet) are either equilateral or isosceles triangles. Therefore, we have to calculate 2 dimensions. Referring to the model below, we will call the equilateral triangles the “A-A-A triangles” and the isosceles triangles as the “A-B-B triangles.”



We will calculate these two dimensions *A* and *B* with the help of two constants called the **chord factors**. The chord factors are constants of proportionality which quantify the relationship between the radius of the dome and the dimensions of the triangles. The formula for this relationship is $r \times cf = l$, where r = the radius of the dome, cf = the chord factor, and l is the length of the side of the triangle. The chord factor for the *A* length is 0.618 and the chord factor for the *B* length is 0.547. ●: Q&A/Teacher Tips



Students use the formula $r \times cf = l$ to calculate the dimensions of the triangles they will be using.

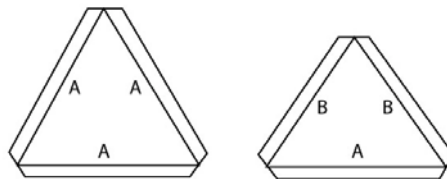
- *What are the dimensions of the A-A-A triangles?*
- *What are the dimensions of the A-B-B triangles?*
- *What is the area of the footprint of the dome?*
- *Will this result in a “comfortable” number of square feet per person?*
- *How does that number compare to the number of square feet per person in the classroom?* ●: Q&A/Teacher Tips
- *Are there any other factors we need to take into consideration in deciding upon the size of our dome?* ●: Q&A/Teacher Tips

BUILD A SCALE-MODEL GEODESIC DOME FOR YOUR CLASS

Students calculate the dimensions of their triangles at a scale of 1'=2", converting all feet measurements to inches and calculating to the nearest 1/16". Ensure that the entire class is working with the same measurements.

Assign some students to make the 10 A-A-A triangles and the rest to make the 30 A-B-B triangles.

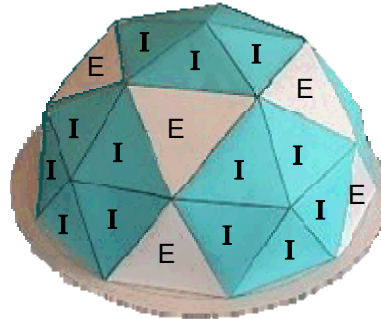
Using a protractor and a ruler, students draw their triangles on paper. They then draw 1/4" tabs on each side of the triangle and mark each tab with an A or a B to indicate its length. ●: Q&A/Teacher Tips



The two types of triangles with connection tabs

Students cut out their triangles and fold all tabs down.

Using scotch tape, students attach sets of 5 A-B-B triangles along the B edges to form 6 pentagons, then attach 5 of the pentagons together at the base with the 5 of the A-A-A triangles to form the base of the dome. Then they tape the remaining 5 A-A-A triangles to the edges of the last pentagon, and attach that to the base to form the completed dome. [See the figure below.]



Legend

E = ▲ A-A-A

I = ▲ A-B-B

For an illustrated description of this process, see
<http://www.hilaroad.com/camp/projects/dome/dome.html>

- *How will we get into our full-sized dome -- in other words, where is the door?*
- *Where should the windows be?*

Students decide upon the locations of the doors and windows and mark the window-triangles with a "W" and the door-triangle(s) with a "D." These triangles will not be needed in the final construction. From this they can make a tally of the total number of A-A-A and A-A-B triangles they will need for the full-scale dome.

BUILD A FULL-SCALE GEODESIC DOME FOR YOUR CLASS

We are now ready to build a full-scale geodesic dome for the entire class! Were there any problems or mistakes you encountered while constructing the model dome that we can learn from as we make the full-sized version? Where will the completed dome go once we construct it?

- *What factors do we have to consider in building a dome outside?*

As a class, find an appropriate spot on school grounds where the dome can eventually be assembled.

Buy or have students collect the cardboard needed for the construction of the dome you designed. ●: Q&A/Teacher Tips

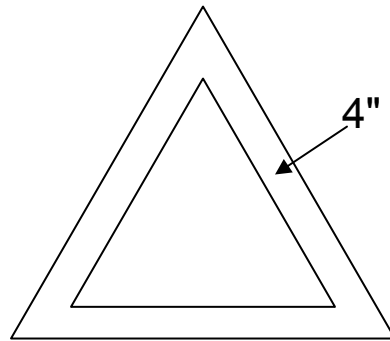
Once enough cardboard is obtained, divide students into groups to start measuring and cutting the triangles. Each triangle should have 2 inch wide tabs. ●: Q&A/Teacher Tips



Students drill or punch holes at even intervals along the tabs. They then score the tabs on one side, cutting only through the surface layer of the cardboard. They then fold the tabs down and apply duct tape to the underside of the fold to reinforce this weak point. ●: Q&A/Teacher Tips

Once all of the triangles have been made, groups can paint them. The class can decide to have the dome all one color, paint triangles in alternating colors, or have each group decide independently how to paint their triangles. ●: Q&A/Teacher Tips

As the panels dry (for water-based paints this can take up to a week – read the instructions on the can), students make the windows from heavy-strength plastic sheeting, such as the kind used for thicker paint drop-cloths. Have them trace the appropriate triangles onto the plastic with a permanent marker including the tabs, but connect the edges of the tabs so there is no notch at the corners (in other words, so that it forms a complete triangle that is 4" wider than the original triangle on all sides. ●: Q&A/Teacher Tips



Once the triangles have all dried, the class is ready to assemble the dome. Have students carry all of the triangles and windows to the site you established.

Using 1" long $\frac{1}{4}$ " bolts and $\frac{1}{4}$ " washers and nuts, students assemble the dome by bolting the flaps of the triangles together through the existing holes. ●: Q&A/Teacher Tips

Students tape the plastic windows to the outsides of the openings.

As a final step, duct tape all of the seams to seal them.

Now enjoy your dome home!

PRESENT

- Students present their creations.



REFLECT

- *What were some of the challenges you faced as you designed and constructed the dome?*
- *What do you think are the advantages and disadvantages of using solid triangular faces instead of struts to construct your geodesic dome?*
- *Do you think the dome you constructed will stand up well to the elements? How could you make it more durable?*
- *Would you like to live in a dome home? Why or why not? How would you design your dome home?*
- *What would you do differently next time?*

EXTENSIONS AND VARIATIONS

- Students research the life and ideas of Buckminster Fuller and find out how he developed the geodesic dome and the role it played in his philosophy of technology and human societies.
- Students design a livable dome home and draw plans and sections showing the structural system and interior spatial arrangements.
- Students research existing domes from around the world and compare and contrast their structural systems.
- Students design alternative domes to the geodesics by researching spherical polyhedra such as rhombicuboctahedra and compare them to geodesics for strength.

MIDDLE SCHOOL STANDARDS

Social Studies

- Science, Technology, and Society
- Global Connections

Language Arts

- Speaking, Listening, and Viewing (E3b, c)

Art - Visual

- Structures and Functions



Lessons from the Salvadori Classrooms
LESSON TITLE: Dome Home
PREPARED BY: Kubi Ackerman (revised by Michael Bettencourt)
TOPIC: Home
SSLAM: Home / Math / Go Beyond
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Math

- Geometry
- Measurement
- Communication
- Connections
- Representation

Technology

- Technology and Society (5)
- Design (9)
- The Designed World (19, 20)

MOTIVATION - TESTING A COMMON EVERYDAY DOME: THE EGG

- How do you think we could test the strength of an egg?

Q&A: We could place small books or other weights on top of a cardboard “testing apparatus (diagram pending!) that is resting on top of the egg (as in the arrangement below) until the egg cracks “dramatically.” The broken egg and the board are then removed and the weight of the books or weights, minus the final addition that broke the egg, equals the amount of weight that the egg withstood. A more accurate determination of “strength” would be to take into account the thickness of the shell and the surface area of the egg in relationship to the amount of weight it held, but that is beyond the scope of this exercise.

Teacher Tip: While it is surely more exciting for students to test the strength of a *raw* egg and easier to decide when the egg has cracked “dramatically,” a hardboiled egg may be substituted in the name of expediency!

- What do you think makes eggs so strong?

Q&A: As students know, egg shells are relatively fragile. It is their form that makes them strong. That form approximates a sphere, which is the strongest three-dimensional form because weight applied to the surface of a sphere gets distributed evenly on its surface. Stress tends to gather at corners, folds, and seams, which are the weakest elements of three-dimensional forms. Generally it follows that the fewer corners a form has, the stronger it is.

- Which side of the egg do you think would hold the most weight, the pointy end, the rounded end, or the side? Why?

Q&A: This is an extension to the experiment that you can conduct with your students. The sides of the egg are the weakest (newborn hatchlings seem to know this – they almost always break out of the side, not the ends), because pressure is distributed towards the ends, which are sharper and therefore the pressure cannot distribute itself evenly. Of the two ends, the dull end is stronger because pressure placed on that end is distributed over a larger surface area. The difference in strength between the dull and the sharp end may be too small to measure with a simple classroom postal scale.

- Why do you think eggs are shaped the way they are?

Q&A: As we have seen, the shape of an egg approximates a sphere, making it strong and protecting it from breakage. Also, the ovoid form makes it much more comfortable to hatch than, say, a cube! But why aren't chicken eggs simply spherical (some other species of bird have almost spherical eggs)? Biologists believe the reason is that spherical eggs will roll down a slope (and possibly break) if they fall out of a nest, whereas ellipsoid shaped eggs roll back around in a circle, with the sharp end pointing up. Also, the egg shape allows multiple eggs to fit in a nest in a more efficient way (sharp end to dull end) than spheres,

with less air space between them and therefore less loss of heat from the eggs as the embryos develop.

LEARN ABOUT DOMES

- What is a dome?

Q&A: A dome is a generally hemispherical form in which the concave side is facing down. A dome can consist of more or less than half a sphere; It can also be a flattened hemisphere.

- What does the egg experiment have to do with domes?

Q&A: Because an egg can be thought of as two opposing domes, the experiment shows us that domes are likely to be strong (relative to their thickness).

- Can you think of ways that people use domes?

Q&A: Domes are most often used by people as a way of covering and enclosing large spaces in buildings. Examples of famous domes include St. Peter's Basilica, the Pantheon in Rome, the Millennium Dome in London, the Hagia Sophia in Istanbul, the Astro Dome in Houston, the Capitol Building in Washington, D.C., the Epcot Center in Orlando, the Taj Mahal in India, and the Dome of the Rock in Jerusalem.

- Why might you want to design a house in a way that minimizes its surface area?


Q&A: The main advantage of minimizing the surface area of the house is that less material is needed in its construction, which generally minimizes both cost and weight (less material used for the construction means that the structure weighs less, requiring a less substantial foundation and mitigating soil settling issues). Also, the surface of a house is where much of the heat transfer to and from the surrounding environment takes place; the smaller the surface area, the easier it is to maintain the interior of the house at a comfortable temperature.

- What might be some other advantages of having a dome house? What might be some disadvantages?

Q&A: Other advantages of a dome house include the fact that the dome shape encourages the free circulation of air (and people) in the interior and that the concave interior reflects heat back toward the center, two characteristics that make domes very efficient to heat. The dome shape is also more aerodynamic than rectilinear forms, minimizing wind pressure on the structure. There are many disadvantages to dome houses, the primary ones being that they are difficult to subdivide into separate spaces, are impossible to subdivide into practical regular spaces, and almost all furniture, cabinetry, and closets are designed for rectilinear spaces, requiring either complicated, inefficient custom designs or large amounts of resultant dead space. The amount of usable volume relative to the total amount of enclosed

space in a dome is small compared to a box, because it is more difficult to create multiple levels. Dome house owners have also complained that noise gets reflected back into the interior and amplified.

LEARN ABOUT GEODESIC DOMES

- Distribute the : Fact Sheet: Geodesic Domes

Teacher Tip: This guide describes the process of creating a 2-frequency icosahedron dome with a total of 40 sides (minus what students leave out for the door and windows).

DESIGN A GEODESIC DOME FOR YOUR CLASS

- As it turns out, all of the triangles needed to make a 2-frequency icosahedron dome are either equilateral or isosceles triangles. We therefore have to calculate 2 dimensions. We will call the equilateral triangles A-A-A triangles (designated by the letter "E" on the figure), and the isosceles triangles A-B-B triangles (designated by the letter "I"). For this type of dome, the chord factor for the A length is 0.618 and the chord factor for the B length is 0.547.

Teacher Tip: It may be helpful to have students create a table outlining the chord factor relationship, with one column for whole dome radii and two columns for the resultant A and B dimensions.

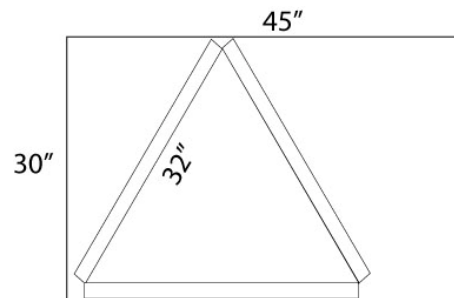
dome radius (r)	A (r * 0.618)	B (r * 0.547)
2'	1.236'	1.094'
4'	2.472'	2.188'
6'	3.708'	3.282'
8'	4.944'	4.376'

If the chord factor concept is beyond the math aptitude of your students, you can make the calculations for them and give them the dimensions of the triangles.

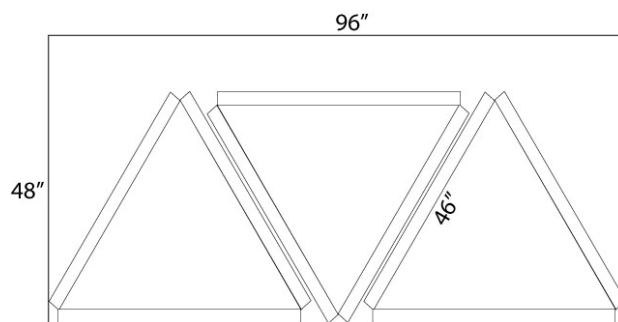
- How does that number compare to the number of square feet per person in the classroom?
Q&A: If students have not already calculated the number of square feet per person in their classroom, have them measure or estimate the dimensions of the classroom and divide the area by the number of students.

- Are there any other factors we need to take into consideration in deciding upon the size of our dome?

Q&A: The primary other consideration in determining the size of the dome will be the size of the cardboard pieces that you will be using. The design requires large sheets of seamless cardboard for the triangles, and regular cardboard boxes will not be big enough. You can sometimes obtain used bicycle shipping boxes from bicycle stores, which have two 30" x 45" sides, in which case the largest equilateral triangle (with connection tabs) you can fit on each side will have 32" sides. Using the chord factors for A, the larger of the two dimensions, we can use the formula $r \times cf = l$, which gives us $r \times 0.618 = 32$ ". We can then calculate that this allows for a maximum dome radius of about 52".



An easier solution is to buy 4' x 8' sheets of cardboard, available online. These allow for a maximum dome radius of 85", although a much more efficient use of material would be to tessellate three triangles of 46" sides (with 2" connection tabs) or smaller on each piece of cardboard, yielding a maximum dome radius of 74".



The other factor in determining the size of the dome is that the sides of the dome slope inward and that therefore no one will be able to stand right at the inner edge of the circumference. It is therefore recommended that 1' to 2' be added to the radius of the dome, though it is possible that the limitations imposed by material size may prevent this.

BUILD A SCALE-MODEL GEODESIC DOME FOR YOUR CLASS

- Using a protractor and a ruler, students draw their triangles on a piece of paper. They then draw $\frac{1}{4}$ " tabs on each side of the triangle and mark each tab with an A or a B to indicate its length.

Teacher Tip: If the class is familiar with trigonometry, they can determine the two equal angles of the isosceles triangles with the formula $\cos \alpha = \frac{1}{2} A / B$. Otherwise, you can tell them that they are 55.6° angles.

BUILD A FULL-SCALE GEODESIC DOME FOR YOUR CLASS

- Buy or have students collect the cardboard needed for the construction of the dome you designed.

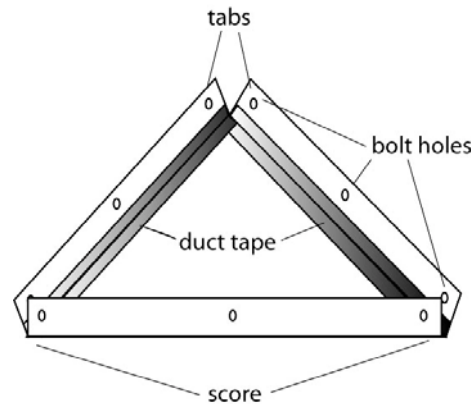
Teacher Tip: As noted in the Q&A, bicycle boxes can be collected from bicycle stores as a source of large sheets of cardboard. Given that it may be difficult to obtain 9 undamaged used bicycle boxes (the approximate number it would take if the class designed a dome with 34 cardboard pieces and each large side of the bicycle box could make 2 pieces), it may be easier to buy 4' x 8' sheets of cardboard (or try to get it donated). Encourage students to try to determine the minimum number of sheets needed given the optimal arrangement of triangles per sheet. It is recommended you get at least one extra sheet in case of mistakes.

- Once enough cardboard is obtained, divide students into groups to start measuring and cutting the triangles. Each triangle should have 2 inch wide tabs.

Teacher Tip: Groups are recommended in this case so that students can check each other's measurements and for safety. It may be helpful to assign roles such that each group has a measurer, a cutter, and a monitor ensuring that the measurements are correct and that the cutting is proceeding safely. The most effective way to make the triangles is to make one A-A-A and one A-B-B triangle (both with tabs), cut them out, and have the rest of the class use these as templates to trace all the other triangles. This will insure uniformity, which is very important for this step. All triangles should have the 2 inch tabs on all sides except where the edges abut windows or the entrance, in which case the tabs are not necessary (though for simplicity and to avoid mistakes it may be easier to make tabs on all sides of all triangles). The cardboard can be cut using utility knives and a metal-edged yardstick.

- Students drill or punch holes at even intervals along the tabs. They then score the tabs on one side, cutting only through the surface layer of the cardboard. They then fold the tabs down and apply duct tape to the underside of the fold to reinforce this weak point.

Teacher Tip: The holes can be drilled using an electric drill, but can also be punched with a sharp pencil or other sharp object. It is recommended that 2 –3 holes be punched in each tab, and their placement must be consistent, such as one hole 3" from each end and possibly one in the middle.



- Once all of the triangles have been made, groups can paint them. The class can decide to have the dome all one color, paint triangles in alternating colors, or have each group decide independently how to paint their triangles.

Teacher Tip: It is recommended that all triangles get painted with a coat of primer and then a coat of high-sheen water-based enamel paint. This will help protect the dome against rain.

- As the panels dry (for water-based paints this can take up to a week – read the instructions on the can), students make the windows from heavy-strength plastic sheeting, such as the kind used for thicker paint drop-cloths. Have them trace the appropriate triangles onto the plastic with a permanent marker including the tabs, but connect the edges of the tabs so there is no notch at the corners (in other words, so that it forms a complete triangle that is 4" wider than the original triangle on all sides).

Teacher Tip: The windows will eventually be taped to the outside of the dome (do not tape them to the inside as this would cause leaks). A more elegant but laborious solution might be to cut cardboard triangles the same size as the plastic ones, then cut a triangle out of the middle of each to form the window. These can then be attached to the outside of the dome on top of the plastic.

- Using 1" long $\frac{1}{4}$ " bolts and $\frac{1}{4}$ " washers and nuts, students assemble the dome by bolting the flaps of the triangles together through the existing holes.

Teacher Tip: The washers are important and should be placed on both sides of the bolt to increase the surface area of the bond and prevent the bolt head or nut from cutting into the cardboard. It is also possible to tape or glue the triangles together, although this is not recommended since the bond may be weaker and it is not possible to take pieces apart in case of mistakes.

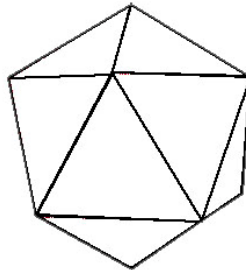
Geodesic Domes

A dome made out of triangles is called a **geodesic dome**. Geodesic domes are usually made with struts, or bars, that connect to form triangular shapes. Each strut is a part of an imaginary circle that goes around the surface of the imaginary sphere (remember that domes are just a section of a sphere). The dome form and the triangular shapes distribute loads evenly around the structure. This design makes a geodesic dome incredibly strong and stable.

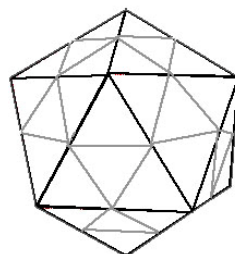


A geodesic sphere with an imaginary circle drawn around it

To make a geodesic dome, we start with a shape called an **icosahedron**, which has 20 triangular sides. You can see that this shape almost looks like a sphere, but it is much more angular.

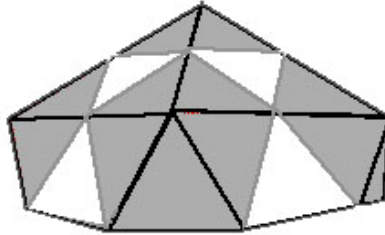


Divide each face of the icosahedron into four triangles—1 equilateral and 3 isosceles triangles—resulting in a total of 80 triangles.

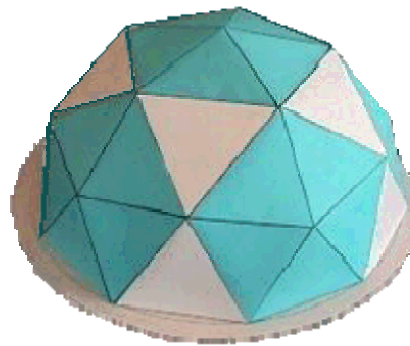


Geodesic Domes

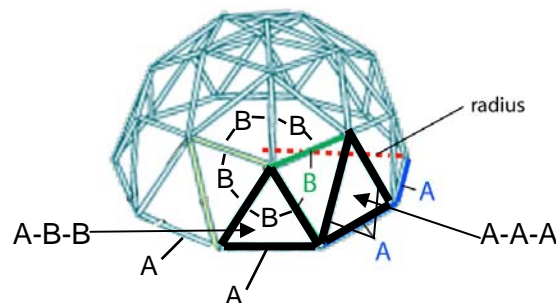
Dividing down the middle results into a dome-shape composed of 40 triangles—10 equilateral and 30 isosceles.



Pull out on each of the edges to make it into a true dome.

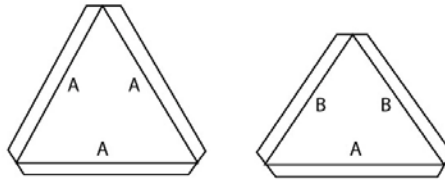


This type of dome is called a **2 frequency** dome because each of the original triangles of the icosahedron was divided so that there are 2 triangles on each side. As it turns out, all of the triangles needed to make a “2-frequency icosahedron” dome (as described in the student Fact Sheet) are either equilateral or isosceles triangles. We therefore have to calculate 2 dimensions. We will call the equilateral triangles A-A-A triangles, and the isosceles triangles A-B-B triangles.



Geodesic Domes

We will calculate these two dimensions A and B with the help of two constants called the **chord factors**. The chord factors are constants of proportionality which quantify the relationship between the radius of the dome and the dimensions of the triangles. The formula for this relationship is $r \times \mathbf{cf} = \mathbf{l}$, where r = the radius of the dome, \mathbf{cf} = the chord factor, and \mathbf{l} is the length of the side of the triangle. The chord factor for the A length is 0.618 and the chord factor for the B length is 0.547.



The two types of triangles with connection tabs

We could also make a 3 frequency dome (each original triangle gets 3 triangles to a side, or 9 triangles total) or a 4 frequency dome (16 triangles total). The more triangles you divide each face into, the closer the resulting form gets to a sphere, and the stronger it gets. Of course, with that many more triangles, its gets that much more complicated.