GEODESIC DOME

OBJECTIVE:

You will construct two geodesic domes and will investigate their properties.

INTRODUCTION:

Geodesic domes are constructed of geometrically shaped panels—usually triangles, pentagons, or hexagons—which when fitted together form a sphere or hemisphere. The panels are usually glass or acrylic, held together by a lightweight tubular metal frame.

This major innovation in building design was developed by the American architect R. Buckminster Fuller (1895–1983) for the US Marines. His aim was to provide a lightweight, mobile structure that could be airlifted by helicopter and lowered into position complete. He patented the geodesic dome idea in 1954. Later, he devised a scheme for encapsulating a large area of Manhattan inside a geodesic dome, which would have provided a weatherproof, controlled environment all year round.

The main advantages of geodesic domes are that they are very strong for their weight, they can be constructed quickly, and they are self-supporting. Indeed, they are the largest self-supporting domes in the world—the largest is in Venezuela and is constructed of a framework of aluminum tubes 469 feet across. Geodesic domes are used in a number of structures, including roofing systems, sports arenas, theaters, greenhouses, and exhibition halls. A large geodesic dome was used to house the United States exhibit at the Expo in Montreal in 1967.

TIME NEEDED:

1 hour

MATERIALS:

- 3 pieces of construction paper, 10 in. x 9 in.
- ruler
- 2 pencils, one sharp and one blunt
- scissors
- glue
- protractor
- 3 pieces of tracing paper

Safety Precautions

Please read and copy the safety precautions at the beginning of this book.

PROCEDURE:

1. Use tracing paper and a sharp pencil to trace the outline of figure 1, including all the dotted foldlines. (Use a ruler to get straight lines.)
2. Rub the blunt pencil point over the back of the tracing paper, completely covering the outline of the shape.
3. Lay the tracing paper, outline side up, on a piece of cardboard. With the sharp pencil, carefully trace over the outline, making sure it is transferred to the cardboard below. (Again, use a ruler to get straight lines.)
4. Cut out the shape using the scissors.
5. Lightly score along the dotted foldlines as shown with the blunt edge of the scissors blade, and fold the shape along these lines.
6. Repeat steps 3–5 with the same piece of tracing paper but a clean sheet of cardboard to form a second, identical shape.
7. Tuck in the tabs of both shapes. On each shape, glue the A tab pairs together. Then glue the B tabs of one shape to the matching B tabs on the other. You have now formed a three-dimensional dodecahedron.
8. Repeat steps 1–5 with figure 2, using clean sheets of tracing paper and cardboard.

Figure 1 Dodecahedron

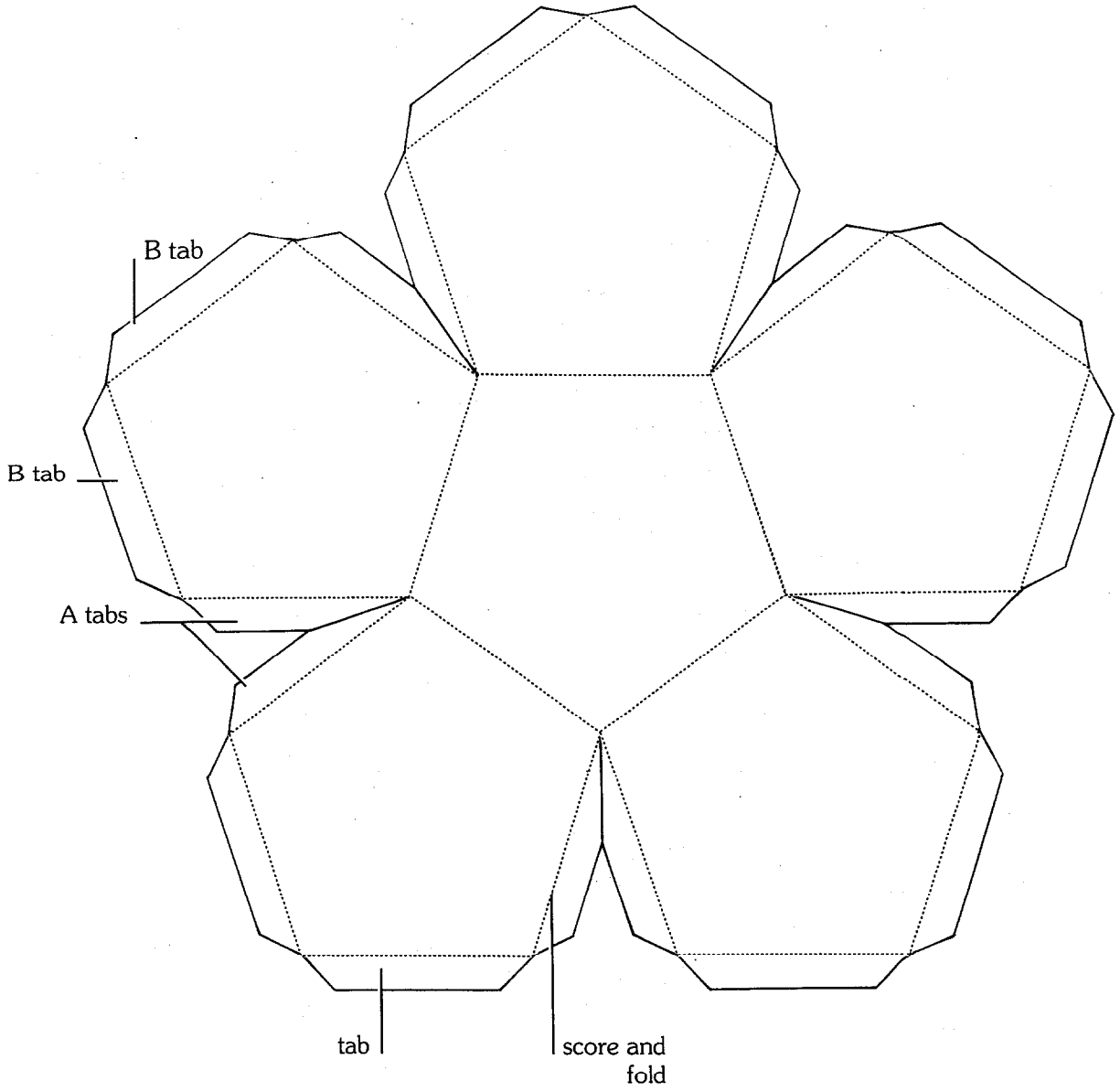
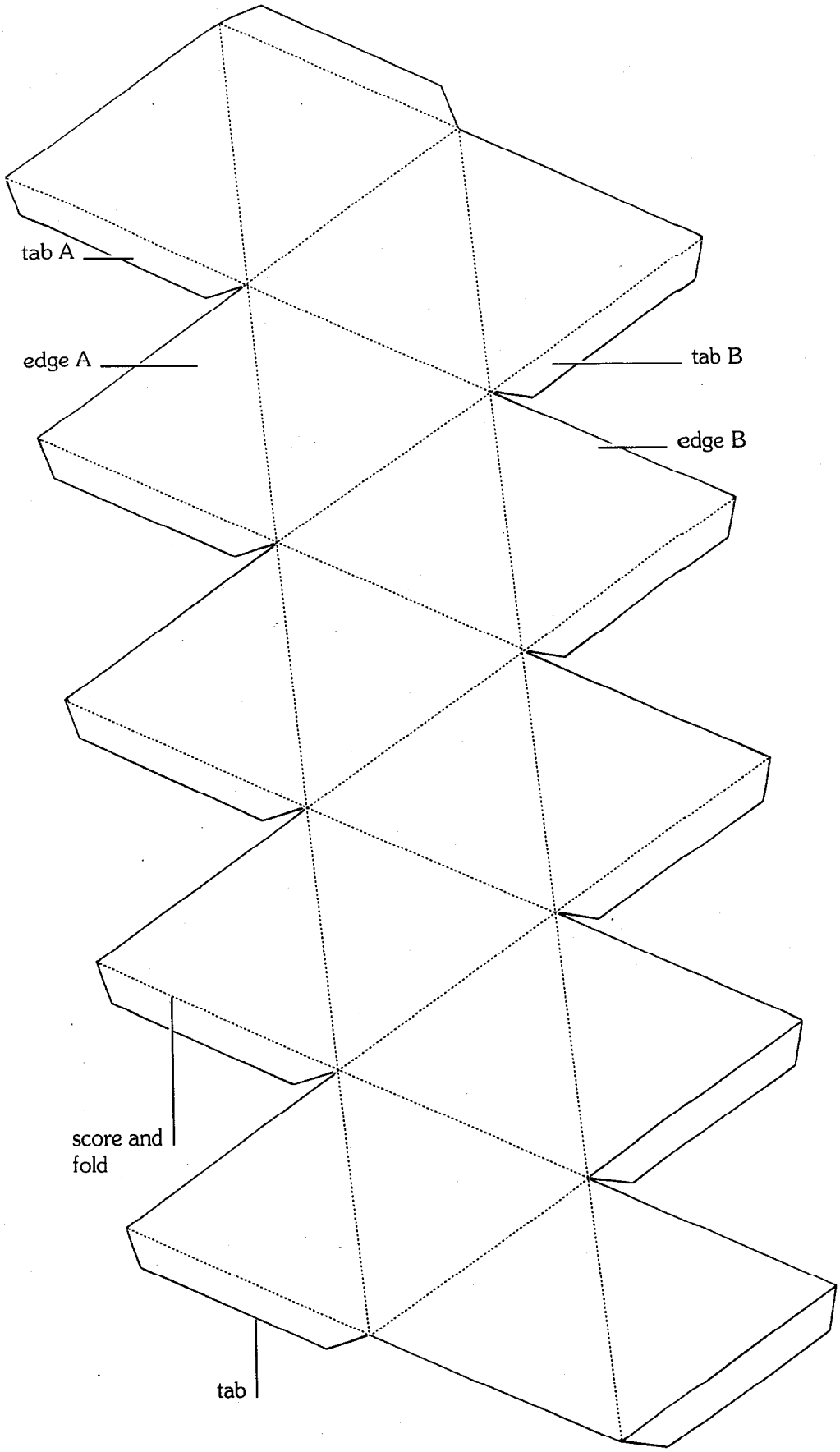
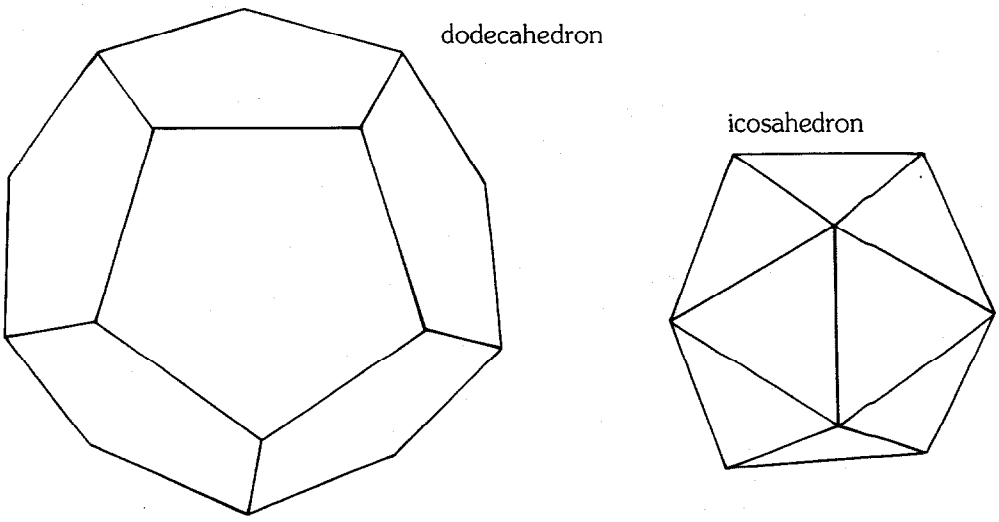


Figure 2 Icosahedron



9. Tuck in the tabs and glue each tab to its opposite edge (e.g., glue tab A to edge A). You have now formed a three-dimensional icosahedron.
10. Your final three-dimensional shapes should look like those shown in figure 3.

Figure 3



ANALYSIS:

1. The sides of the shapes are called faces; the points or corners where edges meet are called vertices (singular: vertex). Count each face, edge, vertex, and the number of faces meeting at each vertex for both shapes. Enter your findings in the Data Table.

DATA TABLE

Structure	Number of faces (F)	Number of vertices (V)	Number of edges (E)	Number of faces at a vertex
Dodecahedron				
Icosahedron				

You should find that the relationship between the number of faces (F), vertices (V), and edges (E) follows Euler's formula, below:

$$F + V - E = 2$$

This formula is useful because it enables architects and engineers to calculate the amount of metal required to make the supporting frameworks of geodesic structures. Metal vertices and edges are used to support faces, which are usually made of plastic.

2. Imagine the edges of your domes are constructed of tubular aluminum. Do the frames use the same amount of aluminum? Which of the two domes encloses a larger volume of space? What does this tell you about the effectiveness of the two shapes?
3. Which of the two domes do you think is strongest, and why? How could you verify this?

OUR FINDINGS:

Click on above link to see what we found.

SPECIAL SAFETY NOTE TO INVESTIGATORS

Each invention includes any special safety precautions that are relevant to that particular project. These do not include all of the basic safety precautions that are necessary whenever you are working on a scientific investigation. For this reason, it is absolutely necessary that you read, copy, and remain mindful of the General Safety Precautions that follow this note.

Experimental science can be dangerous, and good laboratory procedure always includes carefully following basic safety rules. Things can happen very quickly when you are constructing or demonstrating a model invention. Things can spill, break, even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following basic safety guidelines the *entire* time you are carrying out the project, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual projects. We made this choice for one reason: We want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical to your safety.

One further note: The book assumes that you will read the safety precautions that follow, as well as those in the box within each project you are preparing to perform, and that you will *remember* them. Except in rare instances, these precautions will not be repeated in the procedure itself. It is up to you to use your good judgment and pay attention when performing potentially dangerous parts of the procedure. Just because the book does not say BE CAREFUL WITH HOT LIQUIDS or DON'T CUT YOURSELF WITH THE KNIFE does not mean that you should be careless when simmering water or stripping an electrical wire. It does mean that when you see a special note to be careful, it is extremely important that you pay attention to it.

If you ever have a question about whether a procedure or material is dangerous, wait to perform it until you find out for sure that it is safe.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking unnecessary risks can be avoided by practicing safety procedures and being alert while carrying out these projects. Be sure to check the individual projects in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone.

PREPARING:
—Clear all surfaces before beginning projects
—Read the instructions before you start
—Know the hazards of the procedures and anticipate dangers

PROTECTING YOURSELF:
—Follow the directions step-by-step; do only one project at a time
—Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eye wash, and first-aid kit
—Make sure there is adequate ventilation
—Do not horseplay
—Wear an apron and goggles
—Do not wear contact lenses, open shoes, loose clothing, or loose hair
—Keep floor and work space neat, clean, and dry
—Clean up spills immediately
—Never eat, drink, or smoke in laboratory or work space
—Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult

USING EQUIPMENT WITH CARE:
—Set up apparatus far from the edge of the desk or bench
—Use knives and other sharp or pointed instruments with caution
—Pull plugs, not cords, when removing electrical plugs
—Clean glassware before and after use
—Check glassware for scratches, cracks, and sharp edges
—Clean up broken glassware immediately
—Do not touch metal conductors
—Use only low voltage and current materials such as lantern batteries
—Be careful when using stepstools, chairs, and ladders
—Never look directly at the sun with your observation devices

USING CHEMICALS:
—Never taste or inhale chemicals
—Label all bottles and apparatus containing chemicals
—Read labels carefully
—Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves)
—Do not touch chemical solutions
—Wash hands before and after using solutions
—Wipe up spills thoroughly

HEATING SUBSTANCES:
—Use goggles, apron, and gloves when boiling water
—Keep your face away from test tubes and beakers
—Never leave apparatus unattended
—Use safety tongs and heat-resistant mittens
—Turn off hot plates, bunsen burners, and gas when you are done
—Keep flammable substances away from heat
—Have fire extinguisher on hand

FINISHING UP:
—Thoroughly clean your work area and glassware
—Be careful not to return chemicals or contaminated reagents to the wrong containers
—Don't dispose of materials in the sink unless instructed to do so
—Wash your hands
—Clean up all residue and put in proper containers for disposal
—Dispose of all chemicals according to all local, state, and federal laws

BE SAFETY CONSCIOUS AT ALL TIMES