ENGINEERING WITH GEOMETRY

Next Generation Science Standards: **MS-PS2-3, MS-PS2-4, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4, HS-PS2-2, HS-PS3-2**

Objective:

Students will apply scientific and engineering ideas to design, evaluate and refine three different shaped paper structures (triangle, circle and square) that minimize the force on a large scale object in order to discover which shape is the strongest.

Vocabulary:

Engineering – branch of science and technology concerned with design, building and structure

Hypothesis – proposed question based on limited evidence used as a starting point before experimentation

Load – Weight carried or supported by the engineered structure

Load Capacity – total amount of load a structure can handle before the structure possibly breaks

Supplies:

- 8.5” x 11” single piece of colored paper, folded and cut into thirds.
- Scissors
- Clear office tape
- Books or flat weighted materials to test load capacity

Directions:

1. Have each student fold the colored paper as if it were a letter so that there are three equal folds. [See Figure 1] This can either be done where the paper is folded long or folded short.
2. Using scissors, cut the three pieces out along the creases.
3. Take one of the three pieces of paper, and roll it into an open circle tube. Tape on each end to secure, and set aside. [See Figure 2]
4. Take a second piece of paper, and fold to crease three times [as with original paper – see Figure 1] and fold into a triangle tube. Tape on each end, and set aside. [See Figure 2]
5. Take the third piece of paper, and fold it into quarters (four folds) then fold into a square tube. Tape on each end, and set aside. [See Figure 2]
6. Observe each shaped tube. Make a hypothesis as to which shaped tube will support the most weight.
7. Set each tube on a flat surface, and carefully add weight, a little at a time, and observe the results. [See Figure 3]
8. Once the tube has reached its load capacity, it will collapse in on itself. When this happens, record the number of items it held. Once recorded, move to the next shape.
    a. Circle: _____
    b. Square: _____
    c. Triangle: _____
9. Once all three shaped tubes (circle, square and triangle) have been tested, you now have collected enough data to show which shape is the strongest and most structurally stable.

Figure 1

Figure 2

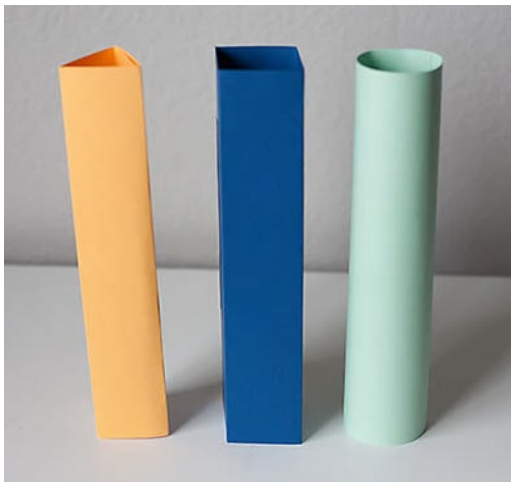
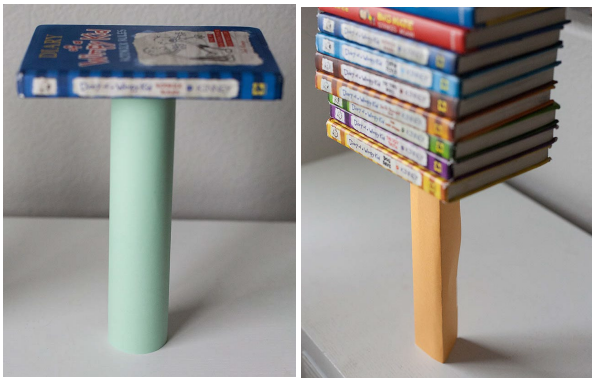


Figure 3



Answer:

Triangle, and here's why:

Triangles are strong because of their inherent structural characteristics. The corner angles of a triangle cannot change without an accompanying change in the length of the edge. Therefore, in order to change a triangle's shape, an edge must collapse.

Edges can be made much stronger than connections. Triangles hold large loads without collapsing or having their structure altered. Triangles are the only polygons that have this characteristic. For instance, triangles have three connections, while squares have four. When forces are applied to a square, a square is more prone to lose its shape. Engineers often add a diagonal through the middle of a square, effectively turning it into two triangles and making it stronger. Triangles are the fundamental building blocks of many contemporary structures. Their strong, inflexible structure makes them perfect for contemporary designs. They are used in architecture and construction to create structures that will bear a certain amount of weight but still have material strength limits. For example, bridge and trusses are often constructed from triangles.

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