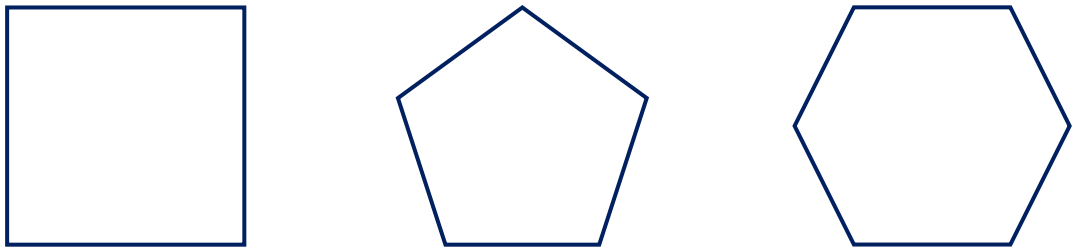
Name: _____ Date: _____ Class: _____

Lesson Worksheet Answer Key

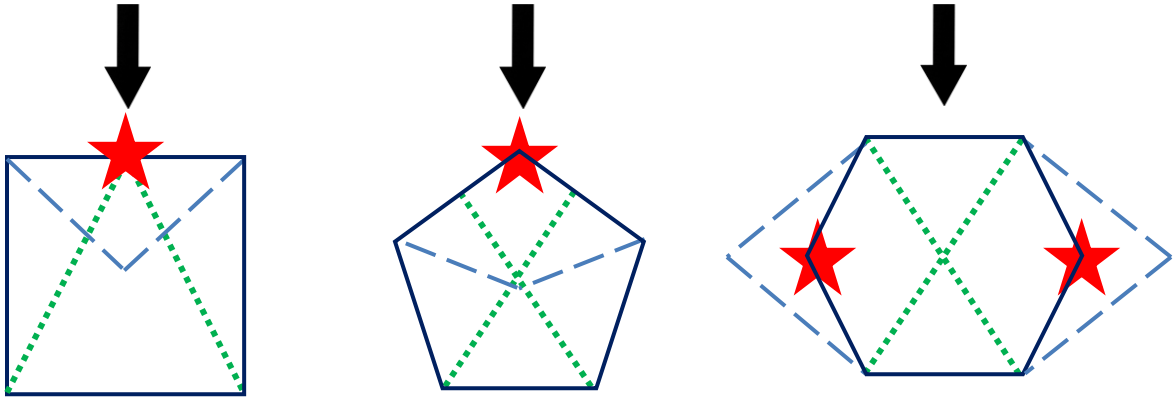
Let's think like civil engineers and apply our knowledge of geometric shapes to the design of trusses.

Two-Dimensional Modeling

1. What polygons are shown below? Square (quadrilateral), pentagon, hexagon



2. Now imagine these polygons are standing upright with weight on them, as shown by the **force arrows** below.



3. Under this load, where would the shapes collapse?
   Place **stars** where the polygons are likely to undergo failure (collapse).
   Draw **dashed lines** to represent the deformed members. Explain your reasoning.

   Square: No supports in the center, so it would deform when a load is place there.
   Pentagon: Nothing to support its center, so like the square, it would deform downwards.
   Hexagon: Due to lack of support, its center would go down, and its sides would go outwards.
   None of the shapes have center supports, so they would collapse under force applied to their centers.

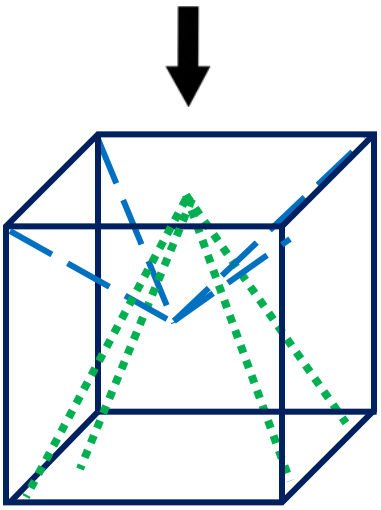
4. If you were going to add support members to these shapes to keep them from collapsing, where would you put those? Draw them as **dotted lines** on the shapes above.

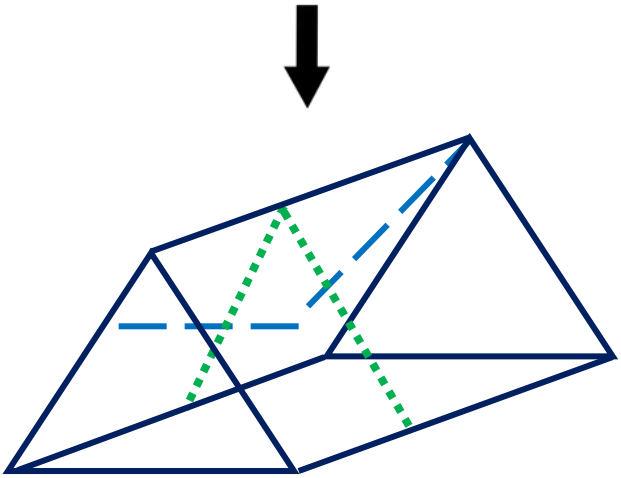
Name: _____ Date: _____ Class: _____

Three-Dimensional Modeling

Now let's test how two prisms would change under a compressive load in a three-dimensional space instead of a two-dimensional space. You are given a cube and a triangular prism, below, to test.

1. How would these square and triangular prisms deform under loads?
   Draw **dashed lines** to represent the deformed shapes.

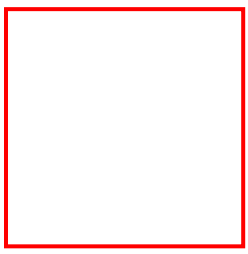




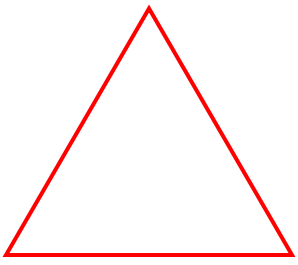
2. If you were to add structural members to strengthen the shapes, where would you add them?
   Draw them as **dotted lines** on your shapes above.

   Add members in places that directly support the location where the objects would collapse.
   Cube: Add an inner triangle to prevent deformation through its center.
   Triangular prism: Add members to its center to support its middle area.

3. Use a ruler to draw a square and an equilateral triangle. Measure all the angles in both shapes. Find the sum of the interior angles in the square and triangle. Write your answers below the shapes.



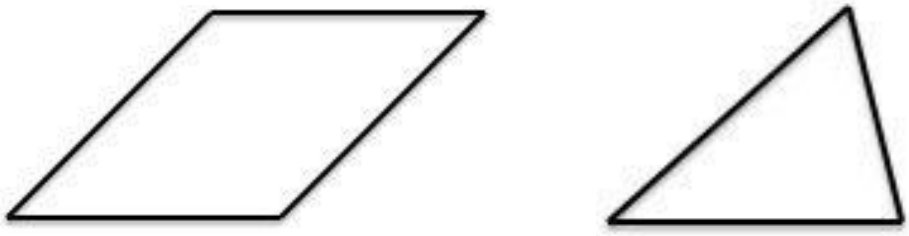
The 4 interior angles of the square are all 90°; the sum is 360°.



The 3 interior angles of the triangle are all 60°; the sum is 180°.

Name: _____ Date: _____ Class: _____

4. Consider the front shapes of the deformed square and triangle (below). Measure all their interior angles.

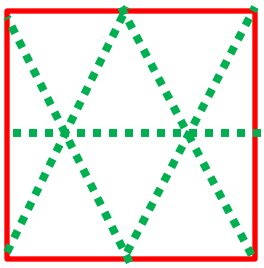


Deformed square: acute angles are 45°, obtuse angles are 135°.
Deformed triangle: from bottom left clockwise: 40°, 60° and 80°.

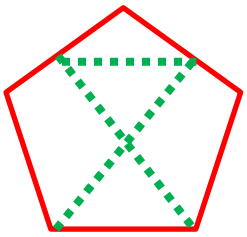
5. How did each of the angles change in the deformed square and triangle?
What is the sum of the interior angles in the deformed square and triangle?

Deformed square: Two angles decreased and two angles increased; the sum is still 360°.
Deformed triangle: One angle stayed the same, one decreased, and one increased; the sum is still 180°.

6. Now draw the square in a way that will keep it from collapsing. You may add up to six members.



7. Draw another polygon and add members in such a way that will keep it from collapsing.



8. Why would engineers choose to design trusses from triangles rather than squares?

A triangle is a stronger shape than a square. It deforms less when weight is put on it, which is important for safety purposes when trusses are used in bridges, house structures, towers, etc.