Stable Structures Stations: Groups of 2-3 students

1. **Structure-Shape Test**
2. Each student may use **one piece of manila paper** each and **an equal portion of tape**.
3. Predict what shape of structure created with these materials will be able to hold the most books on the top before failure, and then build your structure.

***Criteria:***

* Each person should create a different shape (cylinder, triangular prism, rectangular prism (box-like) or other shape).
* Should have minimal overlap of paper.
* A time limit of 5 minutes may be imposed.

1. When finished, test each structure with a set of equally weighted books. Record results in the chart below:

|  |  |  |
| --- | --- | --- |
| **Shape created (& diagram)** | **Predicted number of books:** | **Number of books held:** |
|  |  |  |
|  |  |  |
|  |  |  |

1. As a group, discuss and decide which shape has the most structural strength, and try to explain why.
2. **Stable 2D Shapes**
3. As a group, make a square using **four straws and four straight pins**.
4. Push or pull on the sides of the square and record observations.

Example: Observations when sides pushed / pulled:

1. Add **ONE more straw** to make the *square* more stable, **diagram** your results, and **identify** **the shape** that brought stability to the square.

Diagram: Shape that brought stability:

1. If this shape was a *rectangle* (2 squares together), discuss and decide where a support straw should be placed. Draw a **diagram**, and **identify the shape** that brought stability to the rectangle.

Diagram: Shape that brought stability:

1. **Analyzing Boxes**

**Choose 3 different boxes** from the various types of boxes provided, and as a group discuss and decide:

• which box(es) are the strongest

• what are the characteristics that make some boxes stronger than other boxes

Record your group’s findings the chart below: \*Hint: focus on the *materials used* to create the boxes

|  |  |  |
| --- | --- | --- |
| **Box description** | **Strengths** | **Weaknesses** |
|  |  |  |
|  |  |  |
|  |  |  |

1. **Penny-Paper Bridge**
2. Working in groups, place a piece of paper between two stacks of books to create a beam bridge.
3. Place pennies on the bridge until structural failure occurs, and then discuss why this occurred.
4. Plan and build a paper beam bridge that will hold more pennies than the previous one, following these guidelines:

• The span of the new beam bridge **must be the same length** as that of the previous one.

• The **type of paper** used must be the same, but there is **no limit** on the quantity.

• The paper **can** be folded (e.g., corrugated).

• **Small amounts of tape and glue** may be used to create box beams or I-beams as bridge spans.

1. Record your success in the chart below:

|  |  |
| --- | --- |
| **Bridge description** | **# Pennies held *before* failure** |
| One piece of paper, no modifications |  |
|  |  |
|  |  |
|  |  |
|  |  |

1. **Three-Dimensional (3D) Stability**
2. Work in your groups to build the biggest possible frame, using drinking straws, for a clubhouse. The structure must be relatively stable.

***Note:*** *Square and rectangular structures are* ***not the strongest*** *or most stable structures, but they are easy to make.*

1. When finished your basic frame, read about and discuss what structural supports could be added to make the structure even more stable. Then add the structural supports, testing for stability as you add more.

*Engineers have developed adaptations to strengthen these types of structures, including the addition or use of:* ***pillars, arches, struts, ties, trusses, gussets, and braces.***



The following structures include components that add stability.

pillars arches

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | | | |
|  |  |  |  |  |

struts ties

**Brace**

Provide stability to prevent movement at joints. Place a paperclip into

the end of one straw and connect it with a second paper clip.

Then place the second paper clip into another straw.

**Gusset**

Thick pieces of steel used to reinforce a joint within a structure. Bend one end of a

straw and slide it into the end of a second straw.

**Truss**

Interlocking triangles making up a framework within a structure.

Pin two straws together using a straight pin to make a triangle.

1. When finished constructing their clubhouses, answer the following questions:
2. What main shape did you use to give your clubhouse stability? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Draw a diagram of one wall of your constructed house. Indicate where you added the structural support and explain why.

**Forces Acting on Structures – Mini Quiz Name: \_\_\_\_\_\_\_\_\_\_\_\_\_**

Circle the best answer.

1. A twisting force that acts on structures is called:

a. torsion c. shear

b. tension d. magnitude

2. Forces acting in opposite directions of each other results in:

a. torsion c. shear

b. tension d. magnitude

3. The amount of force applied is called:

a. torsion c. shear

b. tension d. magnitude

4. One spot of paint is to a whole painted wall is point of application is to \_\_\_\_\_\_\_\_of application.

a. magnitude c. plane

b. structural fatigue d. shear

5. A combination of external and internal forces acting on a structure at one time is called:

a. structural fatigue c. structural failure

b. structural stress d. plane failure

6. A structure that allows for the load force to be transferred along its curves instead of one particular point is called:

a. strut c. tie

b. gusset d. arch

7. Trusses rely on this shape to give them stability:

a. circle c. triangle

b. cube d. arch