

# Headframe Engineering Challenge

## Headframes

A headframe is the structural construction above an underground mine shaft. A mine shaft transports workers, materials, mobile equipment, ore, and is used for ventilation. The shaft contains spaces for cages and skips. Cages are used to transport people and materials; similar to an elevator.

Skips are used to transport ore. Headframes provide height in order to lift the skip out of the ground completely to access the mined ore. Headframes are commonly made out of steel, concrete or both. Historically, they were made of wood.

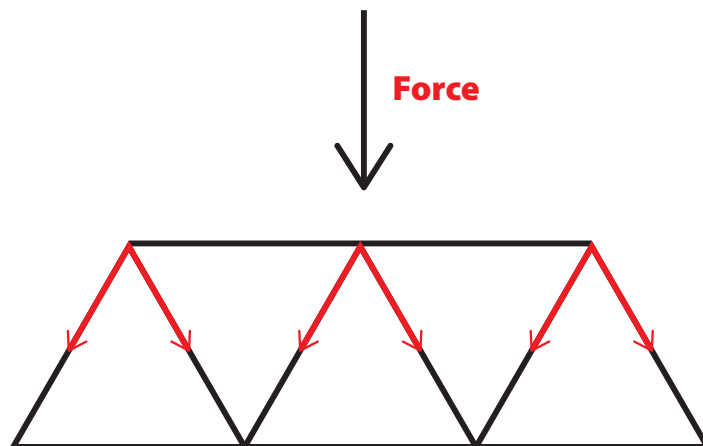
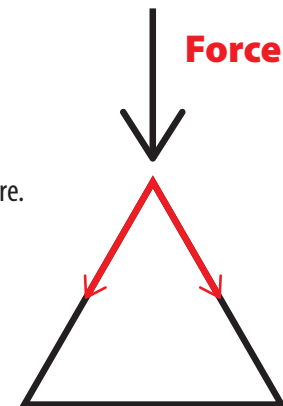


## Trusses

What makes a headframe strong enough to lift many tonnes of ore in the skip? The answer is the structure. Headframes have truss designs which maximize the load that can be applied without failure.

Trusses are triangular rigid structures. Triangles allow for even weight distribution to the base. The weight applied to the top of the triangle is on its point, and is allowed to be distributed to its much larger base, creating a stronger structure.

And when you combine many triangles...



The forces are distributed further and therefore less stress is on each beam!

### Activity Purpose

In this activity you will explore hands on forces associated with lifting via pulleys. You will also learn and understand the nature and use of a headframe.

To complete this activity, you may require the support and assistance of an adult.



## Supplies

- 50 straws
- 30 cm Ruler
- Scissors
- 2m string
- 1 piece of construction paper
- Marbles (Substitution ideas: pebbles, coins, nuts and bolts, etc.)
- Tape

## Goal

The objective of the activity is to hoist as many marbles as possible 15 cm above the ground (two chairs) from below ground (under the chairs) without the Headframe or skip failing. The skip must complete the 15 cm raise without failure, either one straw failing or losing ore, in order to count as a success.

## Instructions

1. Gather your building materials (straws, string, construction paper, and tape).
2. Gather your building equipment (scissors and ruler)
3. Survey your building site, find two chairs (ask permission first) that have seats the same height. Place them side by side with about 10 to 15 cm apart, as in the picture on the right (this distance can be adjusted as you build)
4. Construct a headframe over the gap between the chairs and a skip that can be lifted between the chairs using only the construction materials. Restrictions:
  - a. When testing only the string can be touched
  - b. To lift the skip, the string must be pulled downwards from the top of the headframe at 45° angle (think pulleys)
  - c. The skip must fit between the chairs
  - d. Rulers and scissors are not building materials and cannot be used in the structure, nor can the roll of tape, only the tape itself.
5. Test your headframe until it fails. Try recording your tests and post it on Instagram with the number of marbles you were able to lift. #headframechallenge

### Hint

Tape does not help add support and that the construction paper is best used to make the skip.

### A Greener Straw

Don't have straws? Want to be better for the environment? Try reusing paper, junk mail, newspaper, etc. to make your own straws! National Geographic has instructions to make your own paper straws [here](#). (For this activity you can skip steps six and seven.)

