



SUPER POWER: Block and Tackle!

PULLEYS

LAB NOTES...

TO MAKE YOUR PULLEY...

1. Fold your sheet of paper in half widthways. Roll and tape each half around a wooden skewer to make two paper straws then cut out four 8cm straws out.
2. Draw and cut out four identical circles on paper 6 cm in diameter.
3. Cut each in half to make eight semicircles, and roll and tape the ends together to make each into a cone.
4. Snip off the pointy tip of each cone to make a hole large enough to fit the paper straw through.
5. Cut your plastic bottle in half around the middle. Cut a 1cm strip off the top of one of the halves. Cut two small holes opposite each other in each half of the bottle 1cm from the top (you might need to ask an adult to help you with this part).
6. Make washers for your pulley by cutting 4 1cm x 1cm squares from this plastic strip.
7. Place the square on blu-tack and use the end of a pair of scissors to poke a hole through the centre - repeat for all four squares.
8. Make your four pulleys by sliding two cones over opposite ends of each straw with their narrow end facing the centre. Tape in place and use a small sausage of blu-tack inside the cone to secure.
9. Take the pointy end of a skewer and poke a plastic washer through and slide to the blunt end. Next slide a pulley on, then finish with another washer. Leave about 1cm distance between the washers and the end of the pulleys. Secure the washers with blu-tack and repeat to make two long skewer pulley systems.
10. Next make two pulley systems inside your half bottles by pushing a skewer through one hole, sliding it through a pulley then out of the other hole. Trim your skewer and secure to the bottle with blu-tack.
11. Place a blob of blue tack on the end of a skewer which does not have a pulley on it.
12. Stand your box upright on one of its long sides. Draw a horizontal line half way down the front box face and measure and mark five evenly-spaced points along that line. Number them 1 - 5. Repeat on the opposite side of the box so that both sets of marks line up. Use a skewer to poke holes in each mark on each side.
13. Place your box at the end of a table and fill with something heavy to stop it falling off.
14. Start by rigging a simple pulley system. Place one of the pulley skewers into hole 1 and the other into hole 4. Make sure the skewers go through both sides of the box and secure at the back with blu-tack.
15. Measure and cut a piece of string long enough to run from skewer 1, over skewer 4 and down to the ground.
16. Open up two paper clips by unfolding the centre portion out to make a hook at either end.
17. Tie each end of the string onto the hook of each paper clip.
18. Hook each of the free paperclip ends onto each of the bottle pulleys.
19. Place the string over pulleys 1 and 4 so that your bottles are now hanging. Place your small weight into one of the bottles - it should fall towards the ground while the other bottle lifts up.
20. Check your pulleys are running freely by pulling down on the empty bottle and seeing if it pulls the weighted bottle up. Adjust if necessary.
21. Slowly, start pouring water into the empty hopper, until there is just enough that it pulls up the weighted bottle.
22. Pour this volume of water into an empty jug and measure how much water was needed to lift the weight.
23. Change the pulleys to a 'block and tackle' arrangement by adding the blu-tack ended skewer into hole 5.

What's going on?

Pulleys help us to lift heavy weights by changing the direction that a force is applied which makes it easier to lift. To lift something off the floor without a pulley, you would be pulling it upwards. By looping a rope or string from the weight and over a pulley, we change the direction that we need to pull to downwards. Changing the direction of the force we need can make it easier to lift heavy weight. A 'Block and Tackle' is an example of a system which uses more than one pulley. The more pulleys you add which change the direction that the force travels, the easier it should be to move the weight. You should have found that you needed less water to lift the same weight when you used the block-and-tackle arrangement. Try setting up your rig in different arrangements to see which takes the least amount of energy to pull your weight.

YOU WILL NEED

- Card.....
- Scissors
- Pencil
- Ruler.....
- 1 x Paper
- Tape.....
- Cardboard box e.g. shoebox.....
- Blue tack
- 5 x Skewers.....
- Plastic bottle with a lid
- Measuring jug with water
- String.....
- 2 x Paper clip
- Weight like a small stone

24. If your string is long enough, Take the hook off the hopper under pulley 4 and slide the string under that pulley and hook onto skewer 5. If your string isn't long enough, cut off the paperclips and re-attach to a longer piece of string.
25. Repeat the experiment by slowly adding water from the jug into the empty hopper until it falls and the weight lifts. Take a look at the volume of water used - was it more or less than before?

Did you need a different volume of water to lift the weight between the first and second experiments?

Try moving the two pulleys closer together, adding more pulleys or changing the string direction. Does this change the amount of water you need?

What's the heaviest weight your pulley system can lift?