Magic Rope and Pencil Trick

How it is performed: A pencil / pen / marker / stick is fixed in position. A long string, centered on and held perpendicular to the stick, has both its ends wrapped around the stick simultaneously. After a specified number of times being wrapped around (say three), a strip of paper is taped across the wrapped string to the stick. Then the string is again wrapped around the same number of times again – this time both paper and stick together. Finally, the ends of the string are quickly pulled tight. The paper is ripped, and the string is no longer around the stick.

What makes the trick work: When the string is wrapped initially, the ends of the string must remain in the same relation to each other with each wrap. Then, once the paper is put in place, the string gets wrapped in the opposite direction, effectively unwrapping the string. *So, if the paper were not in place, this would not be a "trick", the string would just unwind.* When the ends are pulled, the paper that was keeping the opposite twists apart is torn, and the two twists unwind themselves.

To enhance the trick, both ends are wrapped at the same time, creating two mirrored or opposite helices (plural of helix). When we put the paper in place, and then we wrap in the opposite direction we are basically undoing the wrapping we just did. This is so that when the paper is removed - or torn when we pull the string ends - the wrapping and unwrapping undo each other.

Math behind the trick: The helix is a very interesting figure in mathematics that shows up in nature all the time – DNA, squirrels climbing trees, animal horns, etc. They can be either right-handed or left-handed, depending on which way they wind around. We have both in wrapping the string around the pencil, which is sometimes called Transverse Helixes. This is different than the shape of DNA, which is in the shape of a double helix. A double helix is two helixes of same type (usually righthanded) that wind around each other a distance apart.

The idea that makes the trick work is also related to a common theme in mathematics – that of "doing, then undoing" something, or doing an operation, then immediately doing its opposite operation, and getting back exactly where we started.

$8 + 3 - 3 = 8$

Also happens in:

Making common fractions

Algebra - adding same thing to both sides of an equation is essentially doing this.

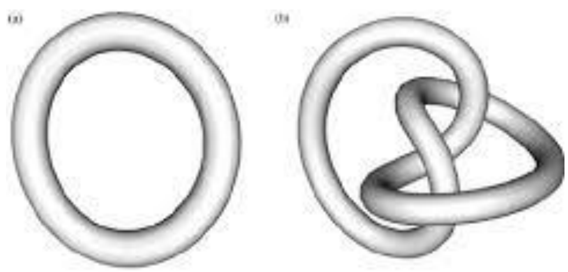
Completing the Square – Add and subtract same number on one side to manipulate an equation.

Many other examples…

<u>“Impossible” Knot Trick</u>:

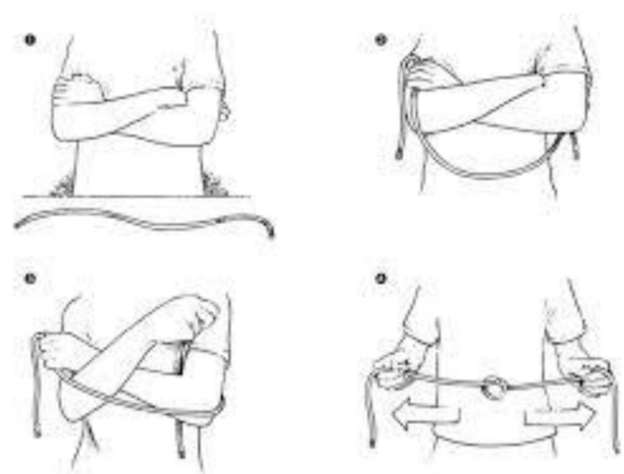
How it is performed: The “magician” hands a piece of string to a participant, and then tells them, without letting go of either end, that they are to tie a knot in the center of the string. They are to think of the string, once held, as “glued” to their hands – so the ends cannot switch hands at any time. The participant will try, unsuccessfully, to make a knot, but when pulled, the knot will always come out. Finally, the “magician” will show how the trick is done. They will cross their arms *before* picking up the ends of the string, and then, uncrossing their arms, a knot will be in the center of the string.

What makes the trick work/ Mathematics behind the trick: In a branch of mathematics called knot theory, it is a well-known fact that the *unknot*, a circle without a knot in it, is fundamentally different from the *trefoil knot*, a circle with a knot in it. Which means, unless you break the circle to tie it, you can’t turn one into the other.



When you grab the ends of the string, your body creates a circle with the string, and unless you already have a knot in the circle, you will not be able to put one there without letting go of one end.

When you cross your arms before picking up the string, you create a knot in your arms. When you uncross them, the “knot” created by your arms will move onto the string. If the knot is not there to begin with, however, it is impossible to create one without letting go of the ends.



Magic Portal in a piece of Paper:

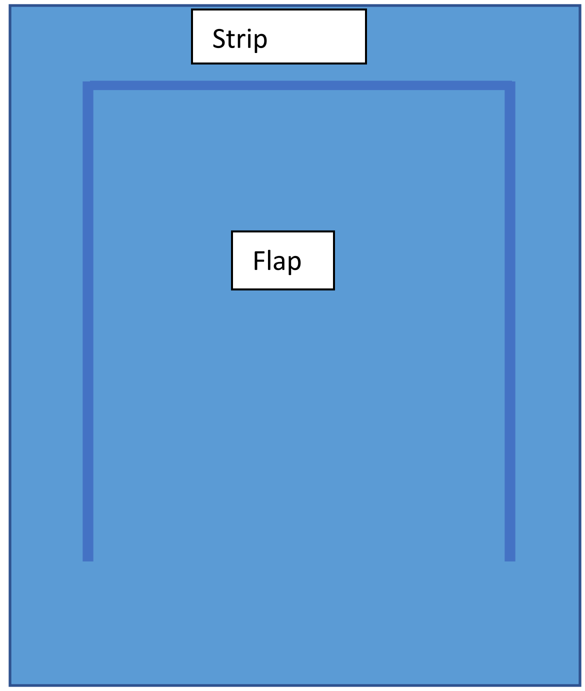
How it is performed: To do the trick, the mathematician asks the audience if anyone thinks they can cut a piece of regular paper with a hole big enough for him to walk through. Let the audience members try – most will just cut the inside area of the paper out, giving a hole just smaller than the piece of paper.

Then the magician snips a piece of paper along the lines on the template (he can either use the template or memorize the snips) and walks through the giant hole that's created!

What makes the trick work/ Mathematics behind the trick: The math behind this trick comes down to the question: What is a hole?

To most people, a hole is empty space. But to a mathematician, holes are defined more by the boundary or edge that makes the hole rather than by the empty space inside. When you cut out the middle of the paper, you throw away paper that could be used as boundary. Cutting it like in the template uses all the paper as boundary. In fact, the thinner or closer together the strips are cut, the larger the hole gets.

Bonus Trick: Flipping Sides



How to do the Trick: The mathematician has a rectangular piece of paper with a cut along the dark lines pictured here. This creates a central flap, with a narrow strip around it. A participant is asked to hold the flap, with the strip "above" their hand, and then tasked with getting the strip below their hand, without letting go. To do it, the participant must roll the strip around to the end of the flap, creating two "hoops" at the end away from the hand. Then flipping the circles inside out will change the orientation of the paper and put the strip below the person's hand.

What makes the trick work/ Mathematics behind the trick: In topology, one property of shapes is called "orientable". A surface is **orientable** if a image on the surface cannot be moved around so that it looks like its own mirror image. A non-orientable surface has any image able to become its own mirror image just by moving it around. Any two-sided surface in space, such as a cylinder or hoop, is an example of an *orientable* surface, While the Möbius band, (which we will talk about in a later seminar) is an example of *non-orientable* surfaces. An **orientable surface** is one where consistent 'orientation' can be assigned over the entire surface; a **non-orientable surface** is one where this cannot be done. Your hands are orientable – you cannot make your right hand exactly the same as your left hand, they are different orientations.

The hoops made by rolling up the strip have an inside and an outside. If we switch the inside and outside of the hoops, but in opposite directions, they "cancel" each other out, but the relation of the strip to the flap will switch as a consequence.