Professor Brainstorm's
Pringles Floor Walker

Safety First

Several of the items used to assemble the Floor Walker are small and pose a potential choking hazard.

Once the elastic band has been wound up, the Floor Walker should only be used on the floor. Do not hold the crisp tube and allow the pencil to spin round.

Care should be taken when assembling the Floor Walker with the use of scissors and other sharp tools.

About this Activity

(Information for Parents and Teachers)

In this activity we are going to use the energy stored in a wound elastic band to push a crisp tube across the floor. Topics covered include:

- Storing energy;
- Converting stored energy into a force;
- and Friction.

What you Need

- A crisp tube - Pringles or similar
- A long elastic band - when it is stretched it needs to be slightly longer than the crisp tube
- A pencil
- A paperclip
- Something to make a hole in the metal base of the crisp tube - a hammer and a large nail works well
- And a small bead (optional) - if you decide to use the bead, the hole in the middle of the bead must be large enough to fit the elastic bands through.

How to make your Pringles Floor Walker

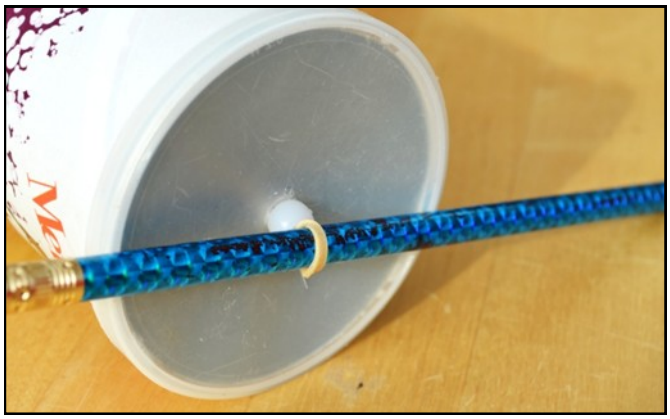
(You can watch a video of how to do this experiment on Professor Brainstorm's YouTube channel - search for 'Professor Brainstorm Science')

Assembly of the Floor Walker takes about 10 minutes, a few tools – and a bit of patience!

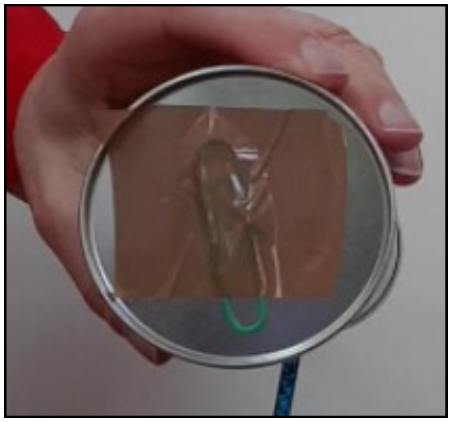
- First make a hole in the centre of the metal base of the crisp tube. (This is a job for an adult!) I have found that the best way to do this is with a hammer and nail. (If you use a drill, be aware that you may end up with sharp edges around the edge of the hole.) The hole needs to be wide enough to allow the elastic band to fit through, so once you have made a small hole with the nail you may need to enlarge it by pushing a screwdriver through. (See photo top left.)
- Make a similar sized hole in the centre of the plastic lid. (This is much easier!)
- Loop the elastic band through the paperclip - and then feed the elastic band through the hole in the base of the crisp tube - so the elastic band is on the inside of the crisp tube - and the paperclip is on the outside of the base. (See photo bottom left.)

How to make your Pringles Floor Walker (continued)

Now we get to the fiddly bit:



- Reach in to the tube and pull the elastic band, feeding it through the hole in the plastic lid. (You can place the lid on the crisp tube once you have threaded the elastic band through it - but keep holding the end of the elastic band.)
- Next push the end of the elastic band through the bead*, and then push the pencil through the end of the elastic band. (The end of your floor walker should now look like the photo at top right.)



- Adjust the position of the pencil so that about 1/3 of the pencil is on one side of the elastic band - and obviously 2/3 on the other side. (If the elastic band is near the middle of the pencil, the pencil tends to rock backwards and forwards - which hinders the movement of the floor walker.)
- Finally, put some sticky tape over the paperclip at the other end of the tube. (This is to stop the paperclip turning when we wind up the elastic band.)

* The purpose of the bead is to reduce friction between the pencil and the end of the crisp tube. If you don't have a suitable bead, don't worry - your floor walker should still work.

Using your Pringles Floor Walker

To make the floor walker work you just need to turn the pencil - which winds up the elastic band inside. However, before you do this there is just one more thing to do. Draw an arrow on your crisp tube parallel to the rim of the tube (as shown in the picture below). The arrow tells you which direction to turn the pencil - so that you always wind the elastic band in the same direction. (It is also useful because when you put the floor walker on the floor, the arrow will point in the direction in which the floor walker is going to move.)

The first time you use your floor walker, turn the pencil round about 30 times. (The easiest way to count the number of turns is to rest your index finger gently against the rim of the crisp tube next to the pencil - as shown in the picture on the left. Holding the tube firmly in your other hand, move your finger around the rim of the tube - in the direction of the arrow - and count how many times your finger moves past the starting point.)

Without letting the pencil turn back, place your floor walker on a smooth surface. (A wood, laminate or tiled floor works well. Or just a table top.) The floor walker should now start to roll across the surface. (If it doesn't work, turn the pencil 10 more times - and try again.

Notes for Parents and Teachers

Now that your child has made a floor walker, they may just want to play with it! But we can also use it to do some science experiments. I have divided the experiments in to the following two categories:

- Does it work if ...? - these are qualitative experiments - where you can discuss with your child what happens when you change certain parameters, and
- How far does it roll? - this is a quantitative experiment - where we will try to **measure** the effects of any changes.

There are also a couple of worksheets attached to the end of this document - which you can use if you wish.

How does it work? (This is the science bit)

You can discuss the following questions with the children - and if you wish they can write down their answers on **Worksheet 1**.

Where does the energy come from to power the Floor Walker?

The energy obviously comes from the elastic band - but there are actually two factors at work here:

- Firstly, as we turn the pencil, we are twisting the elastic band, i.e. we are changing its **shape**. Once we let go of the pencil, the elastic band will have a tendency to return to its original shape - so it will tend to rotate back the other way. The same thing would happen if we replaced the elastic band with a piece of string. However, it is doubtful whether this 'restoring force' would be enough to cause the crisp tube to move.
- But as we twist the elastic band, we are also changing its **length**. (The ends of the elastic band are fixed, so the total length of the elastic band – measured along all the curves – must increase as the number of turns increases.) If you stretch an elastic band, and then let go, it will always go back to its original length. So when we put the Floor Walker on the floor, the elastic band unwinds – and becomes shorter.

Has the elastic band unwound completely when the Floor Walker has stopped moving?

No. Once it has stopped rolling, pick the tube up and gently prise open the lid. You will see that the elastic band is still tightly twisted inside. (This is why you have to turn the pencil about 30 times before you use the Floor Walker for the first time.)

Why did we put a bead between the crisp tube lid and the pencil?

The purpose of the bead is to reduce the effects of **friction** between the pencil and the lid of the crisp tube as the pencil rotates. If you make one floor walker with a bead, and one without, you can compare how well they work.

Using your Pringles Floor Walker - Does it work if ...?

What are the effects of different surfaces?

Wind up the floor walker 10 times - and try it on various different floor surfaces. For example, depending on what you have available, you could try it on carpet, wood (or laminate) flooring, lino, or tiled floors. (You could also maybe try different carpets and rugs. Some may work better than others.)

You will probably find that on some surfaces the floor walker travels quite a long way. On other surfaces the floor walker might not move at all. (If it doesn't move, try winding it another 10 turns and see if that makes any difference.)

You can record your findings - which surfaces work best, which ones don't work - on **Worksheet 1.**

You may even be able to go outside and try it on concrete, tarmac or grass. (If you go outside, try to find surfaces which are level, rather than on a slope.)

Why does the floor walker work better on some surfaces than on others?

You will probably find that the floor walker works best on smooth, hard surfaces - such as wood, lino or tiles. But it is probably not very good on carpets and rugs. This is due to **friction**. Smooth, hard surfaces do not produce much friction, so the floor walker is able to roll a long way on these surfaces. Whereas carpets tend to cause a lot of friction - so the floor walker does not work nearly as well. (However, you may find that carpet tiles work quite well.)

So you might imagine that friction is a bad thing - because too much of it stops the floor walker from moving. However, if there was no friction at all, the floor walker would turn, but it wouldn't actually go anywhere! (This is like trying to drive a car on an icy road. The wheels can spin around without the car actually moving.) So we need to have some friction to allow the floor walker to move in the first place.

Can your floor walker roll uphill?

Yes it can - although admittedly not much of a hill. You can try this on a table top:

- Put a couple of books under two of the table legs - so that the table top is on a slight incline. Turn the pencil 10 times - and see if your floor walker can go up the slope.
- If it doesn't work, try turning the pencil 10 more times.
- If it does work, try putting another book under the two table legs to make a steeper incline.

Using your Pringles Floor Walker - How far does it roll?

In this experiment we are going to try to measure how far your floor walker travels after it is wound up. You will need to find a long area of floor space which is clear of any furniture. Based on our previous findings it would be best to find somewhere with a hard, smooth floor surface, e.g. laminate, lino or tiles.

You will need a tape measure, and a pen or pencil to record your measurements. (You can write your measurements down on **Worksheet 2**.)

You will also need to choose a 'Starting Line' - so that the floor walker starts from the same place each time. Your Starting Line could be a doorway, or against the skirting board on one side of the room. (If these choices are not suitable, you could mark the position of your Starting Line by putting two books on the floor about 1m apart.)

Before you take any measurements, wind up your floor walker and allow it to roll along the floor until it stops. Now we are ready to start taking measurements:

- Pick up the floor walker carefully, making sure the pencil does not turn.*
- Turn the pencil 10 times (in the same direction as before) and put it on your Starting Line.
- Allow the floor walker to roll across the floor until it stops.**
- Now measure the distance that your floor walker has travelled from the Starting Line.
- Repeat this process another 4 times - so that you have a total of 5 measurements.

*Sometimes you may find that although the elastic band doesn't have enough energy to push the floor walker any further, if you lift up the floor walker the elastic band still has enough energy to turn the pencil a couple more times. Since we want to make sure that we are starting with the same initial conditions each time, it is important to make sure that the elastic band does not unwind when you are holding it in your hand..

** If you run out of space, i.e. the floor walker reaches the other side of the room, you can pick up the floor walker (making sure the pencil doesn't turn) and put it down on the Starting Line again. You then need to add up both of these distances to find the total distance that the floor walker has travelled.

Why do you need to measure the distance 5 times?

When you are doing a science experiment it is always a good idea to repeat the experiment several times. This is particularly true in this case because the floor walker is extremely susceptible to tiny obstacles - such as a small ridge in the floor, a join between two tiles, or a little piece of grit on the floor. You may also have noticed that sometimes your floor walker goes in a fairly straight line, but other times it turns a little to one side.

So if you have taken several measurements you will probably find that not all of your measurements are exactly the same - and there may be quite a bit of difference between the longest and shortest distances that you measure.

Once you have several measurements, you can then find the 'average' distance that it travels. You can work out an 'average' in several ways:

- If you are good at maths, or have a calculator, you can find the mathematical 'mean'. To do this you need to add up all the distances and divide by the number of measurements.
- A much simpler method, which is usually just about as accurate, is to write down all of your measurements in order of size - the shortest one first, and the next shortest, and so on. In this case the 'average' is just the middle number in your sequence.

Want to take some more measurements?

You can find out how far your floor walker goes if you just wind it 5 times. (Is it about half the distance you measured for 10 turns?) Or if you have enough space you can try it with 15 turns, or 20 turns.

Professor Brainstorm's Pringles Floor Walker - Worksheet 1

Where does the energy come from that powers the Floor Walker?

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When it stops rolling, has the elastic band unwound completely?

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Why did we put a bead between the crisp tube lid and the pencil?

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Try using your Pringles Floor Walker on different surfaces. Which surfaces are the best?

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Which surfaces do not work well?

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How far does your Pringles Floor Walker roll?

Follow the instructions on the previous pages to find out how to do this experiment.

How far does the Floor Walker roll when you wind it up 10 times?

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(Remember to write down whether your answer is in millimetres, centimetres or metres)

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Now repeat the experiment 4 more times - and write your readings on the lines below:

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What is the 'average' distance that your floor walker travelled?

(Have a look at the information on the previous pages to find out how to work this out.)

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