

FLEXOMANIA!

Magical models to make and colour in

by Kjartan Poskitt



**All the templates to make the models in this book
can be downloaded and printed out from**

www.flexomania.com

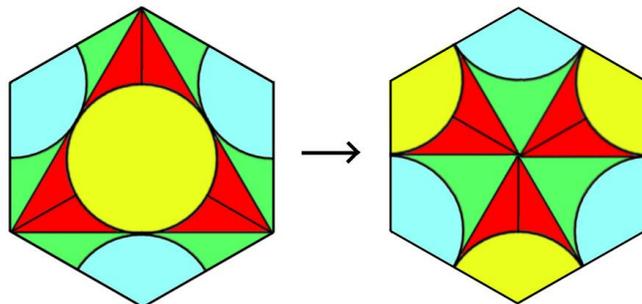
The Magic of Flexagons!

You start with a ring drawn on a piece of folded paper.



You give the paper a quick twist and the ring is now on the back of the paper – but broken up. You give the paper one more twist and the ring has vanished!

This is the first simple trick we're going to make using a *Triflexagon*. (It might sound scary, but we'll explain the name later on.) Once you've seen how it works, we'll go on to make lots of other tricks and puzzles including the Escaping Thief and the Pirates Treasure Chest, plus crazy pictures and patterns that twist and turn themselves inside out!



As you go along, you'll learn more and more of their secrets, and the flexagons will get bigger and better ... *and stranger!*

When you've finished this book, you'll be able to go off and invent your own, so let's get started...

What do you need?

- Scissors
- Coloured pens or pencils
- A glue stick, or a little bit of blu-tak
- The FLEXAGON TEMPLATES.

Printing Out the Templates

The templates for all the flexagons can be downloaded from www.flexomania.com .

Just print out the templates as you need them. The “backs” must be on the reverse of the “fronts”. It’s usually best if you just print out a single page with the front of a template, then put the same paper in the printer the other way round, and print the back. Most reasonable printers can line the images up perfectly, but if you’re having trouble then you’ll need to print fronts and backs on different sheets, paste* them together and cut them out. (* It’s best to use spray mount if you can.)

It’s worth taking your time to cut the templates out as neatly as possible. The better you do it, the better your flexagon will work!

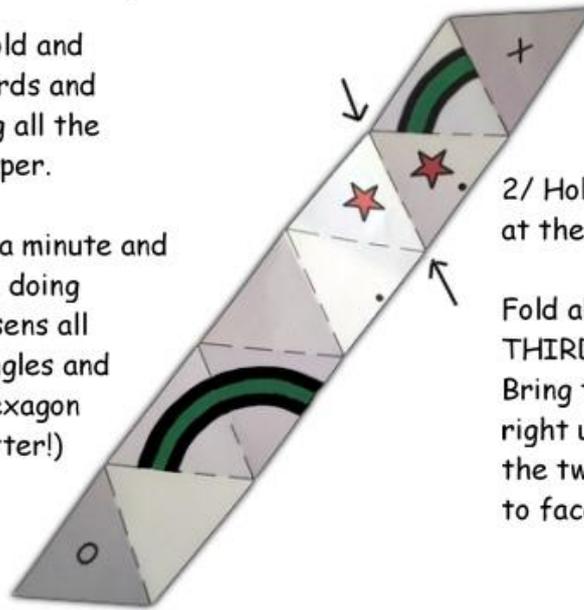
The first template you need is **The Vanishing Rings** . As this is the first flexagon you’ll be making, there are three copies of this one in case you go wrong cutting or folding.

The instructions below describe how to fold The Vanishing Rings, but all trihexagons are folded in exactly the same way. If you practise folding trihexagons until you don’t need the instructions, you’ll find it much easier when we make more complicated flexagons later on!

How to make the perfect TRIFLEXAGON

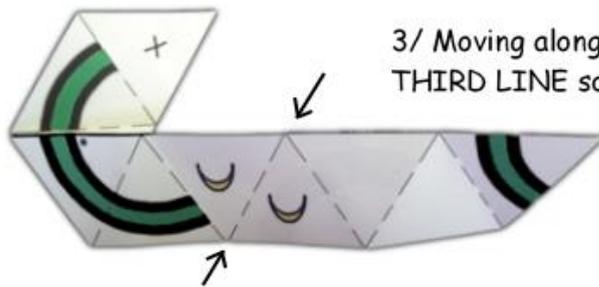
1/ Carefully fold and unfold backwards and forwards along all the lines on the paper.

(It only takes a minute and it's well worth doing because it loosens all the little triangles and makes your flexagon work much better!)



2/ Hold the strip with the X at the top.

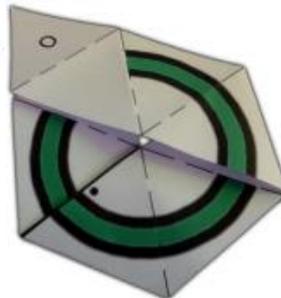
Fold along the THIRD LINE DOWN
Bring the long lower section right up and over so that the two stars meet face to face and you can't see them.



3/ Moving along the strip, fold the THIRD LINE so that the two moons meet face to face and you can't see them.

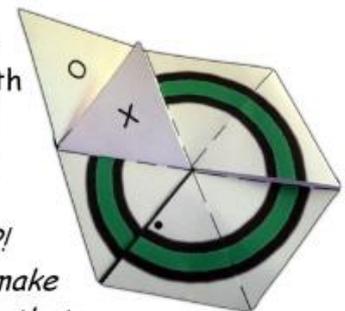
4/ Your flexagon should look like this...

(You're nearly finished!)



5/ Bring the little flap with the X up onto the top.

USEFUL TIP!
If ever you make a triflexagon that doesn't work, you probably forgot to do this bit!

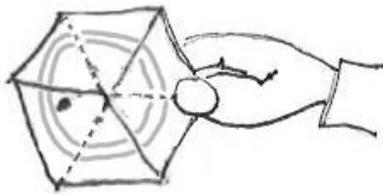


6/ Fold the last flap over and stick the O down onto the X.

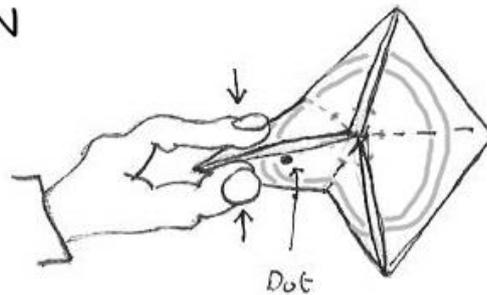


And that's it!

HOW TO FLIP A FLEXAGON

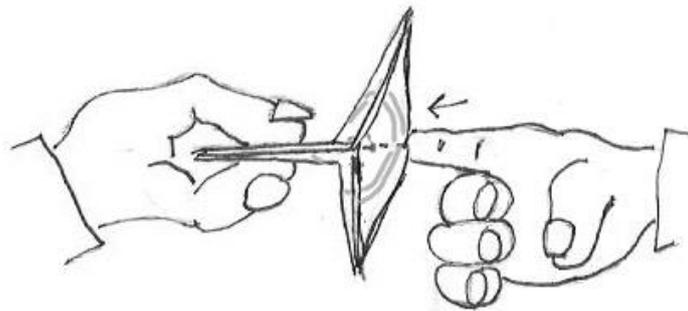


1/ Hold your flexagon like this so you can see the rings and there's a dot on the left hand side.

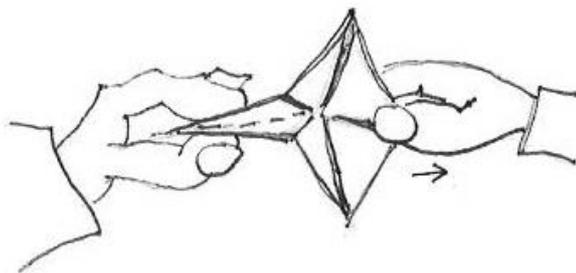


2/ Put your left thumb on the dot, then put your finger above it and pinch the flexagon together.

3/ Use your right index finger to push the opposite corner of the flexagon underneath.



4/ With your right thumb you should now be able to pull the top flap of the flexagon aside and open it up.



5/ That's it!

Now look on the back and see what's happened to the rings!
Another dot will have appeared so you can flip your flexagon again.
Where are the rings now?
Flip it once more to find out...

Have you done it?

Just for fun, flip your flexagon until the blank face is showing. (A *face* is one of the flat sides. A triflexagon has three different faces.) You can draw your own pattern such as a monster or a flower on it, then flip the flexagon and see what happens!

Keep flipping the flexagon to get used to it. Try pinching the other folds that are not next to a dot. You'll find three of the folds will work and three of them won't. This is important later on when we look at bigger flexagons.

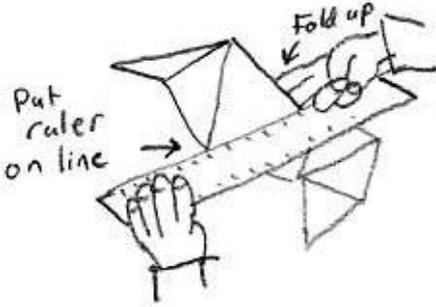
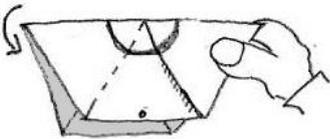
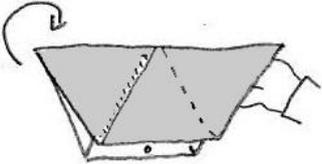
Where does the name come from?

Flexagons get their names from how many different faces they can make, and how many edges they have.

Tri means three, *Tetra* means four, *Penta* means five, *Hexa* means six and *Hepta* means seven. The little flexagon we just made has three faces and six edges, so its full name is a *tri-hexaflexagon*, but we'll just call it a triflexagon for short.

A few tips!

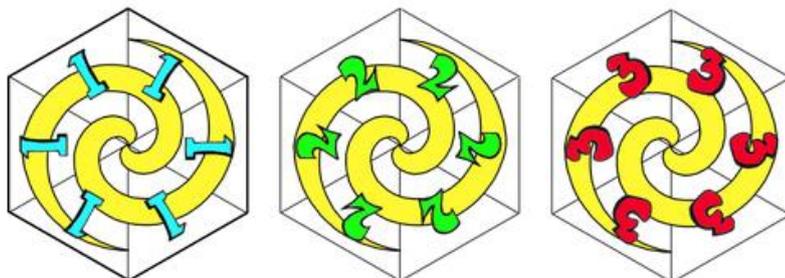
Before we make any more flexagons, here are a few tips to get the best results.

- Always cut the shape out as carefully as you can! Don't leave even the tiniest bit of extra paper poking off the edge.
- Before you put any flexagon together, always fold backwards and forwards along all the little lines. The best way to fold accurately is to put a ruler along the line, then bend the paper against the edge of the ruler.
- When you first put your flexagon together, just stick it with a tiny bit of blu-tak. This means you can test it, and if it doesn't work you can undo it and try again.
- Before you flip your flexagon loosen it up even more. Fold it backwards and forwards along each diagonal, then flatten it out again so the fun can start!
- When you first flip your new flexagon, don't be too rough! If it doesn't want to open up one way, try pinching two different triangles together.

More Triflexagons

Now that you've got your first triflexagon to work, look at the other triflexagon templates.

Start by making the **123 Flexagon**.



- Keep the X at the top, then fold along the third line down. You'll find a pair of 3's should go face to face.
- Move three lines further along, and fold the next pair of 3's together.
- Don't forget to bring the X triangle to the top before folding the O triangle over and gluing it down!

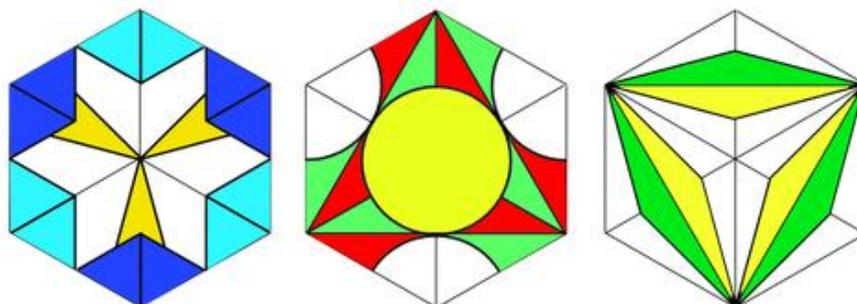
If you're not sure, check with the diagrams on page 4.

Now make **The Escape**.



When you've finished, flip it until the robber is inside the prison wall. Now flip it one more time so that the footprints are showing. Look on the back! Who's inside the prison now?

The Twisters is a pattern flexagon. When you've made it, flip it and see how the patterns change on the front and the back.



Now you've seen what triflexagons can do, try making your own! Make and fold some of the blank templates, then draw your own patterns on them.

When you get really good at this, you can make your own triflexagon templates on much bigger pieces of paper with even bigger patterns and pictures!

The *four-faced* Tetrahexaflexagon

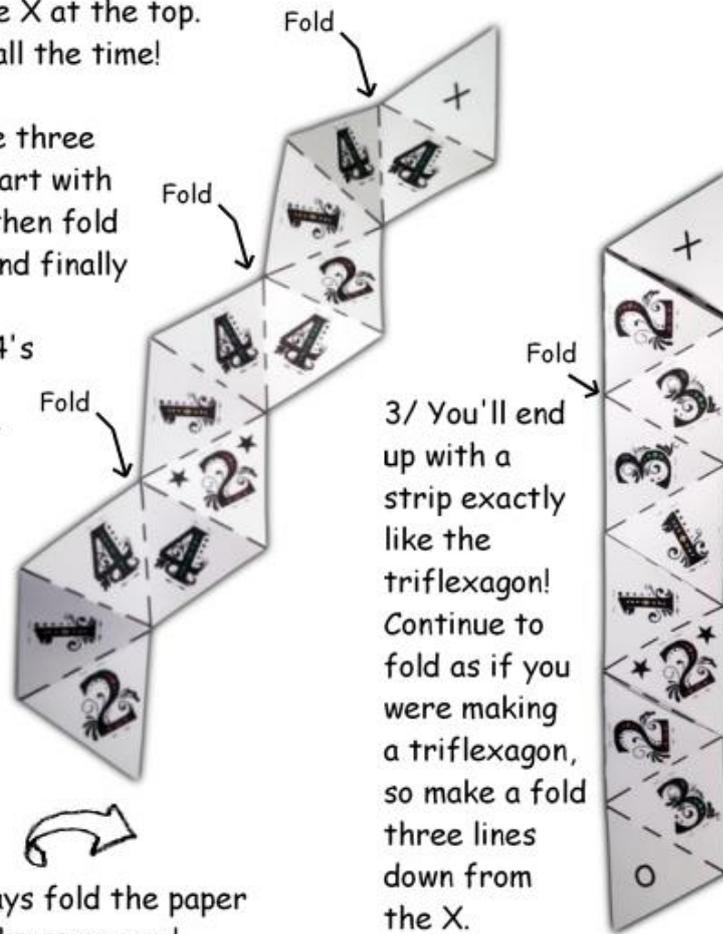
We're going to make things a bit more exciting now. The tetraflexagon has got four faces, and once you've made it, the challenge is to find them all!

Print and cut out the **1234 Tetraflexagon** template. Remember, before you do anything else, fold all the lines on the paper backwards and forwards so all the little triangles bend in the right places.

How to fold a TETRAFLEXAGON

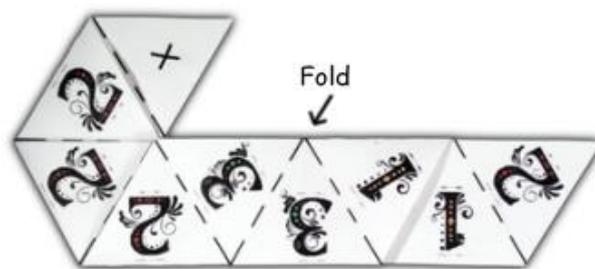
1/ Start with the X at the top.
Keep it showing all the time!

2/ Fold along the three
vertical lines. Start with
the lowest one, then fold
the middle one and finally
the highest.
All the pairs of 4's
should come
together so that
none of them
are showing.



* Always fold the paper
over the same way!

4/ Now fold three
lines further along...



5/ Bring the
X flap to
the top.



6/ Fold the
O flap over
and stick
down onto
the X.



How to flip a Tetraflexagon

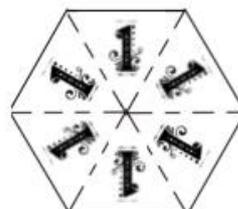
You flip the tetraflexagon in the same way as the triflexagon, but there's an extra little trick.

Flip the flexagon until all the 2's are facing you, then turn it so that the two little stars are on the top. When you flip it, you will get the 3's. Keep going until you get back to the 2's. Now try holding the flexagon so the two stars are on the bottom edge, then flip it!

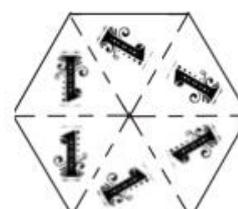
Finding your way round

Flip your tetraflexagon until you find the face with all the 1's neatly sticking out of the middle. We'll call this the FRONT side of the flexagon.

(The numbers *never* stick out of the middle on the back of the flexagon.)



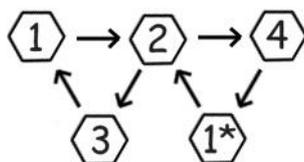
The 1's sticking out from the middle on the front of the flexagon



This is how the 1's will look when they appear on the back of the flexagon.

This little diagram shows what happens next.

The Tetraflexagon Map



There's an arrow going from 1 to 2. This means when you flip your flexagon, the 2's will appear all neatly round the middle. (The 1's will be on the back all jumbled up.)

Now it's time to make your mind up! The diagram has two arrows coming from the 2. You can choose if you want to go to the 3's or the 4's. If you go to the 4's, then after that you'll get the 1's on the front side, but they will all be jumbled up. We've marked this on the diagram as 1*. One more flip brings you back to the 2's.

The Magic Tetraflexagon

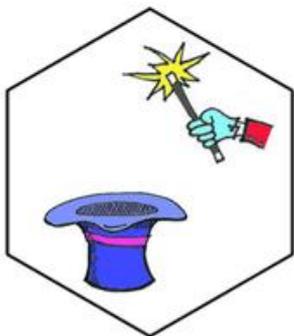
Cut out and fold the magic tetraflexagon. You fold it in exactly the same way as the 1234 tetraflexagon.

- Keep the X showing at the top.
- Fold along the three vertical lines, starting with the lowest one.
- You'll get a straight strip of 10 triangles. Fold it like a triflexagon!

Remember – always keep folding the paper over the same way!

*(*Hint: whenever you make any flexagon, every fold puts two parts of the same image together. With the Magic Flexagon, the first three folds put the pieces of the snake image together, so you can't see them. The next three folds put the rabbit images together.)*

Flip the finished flexagon until you see the wand over the hat. Now when you flip it, the Magic Tetraflexagon makes a cute little trick!



Wave the wand!



What will you get?



Will it be the rabbit ...



... or the snake?

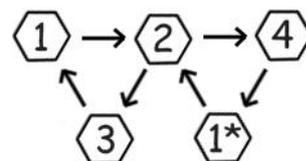
To understand it, have a look at the map.

The wand is image 1.

When you flip it, you get the green cloud (image 2).

When you flip again you might get the rabbit (image 3) or you might get the snake (image 4).

The Tetraflexagon Map



If you get to the snake, when you flip again, the wand and hat will appear jumbled up! That's because you've reached the 1* position on the

map. You need to flip again to get the green cloud (image 2), then the rabbit (image 3) and then the wand and hat will return properly (image 1).

Feeling brave? Then use the blank templates to design your own tricky tetraflexagons!

The *five-faced* Pentaflexagon

Things are about to get even stranger!

Print and cut out the **12345 Pentaflexagon** template.

For the 12345 pentaflexagon, you can start by folding all the pairs of 5's together, and that gives you the *tetraflexagon* shape! Next, you fold the 4's together which makes the triflexagon strip, and then you just fold that in the usual way. Easy!

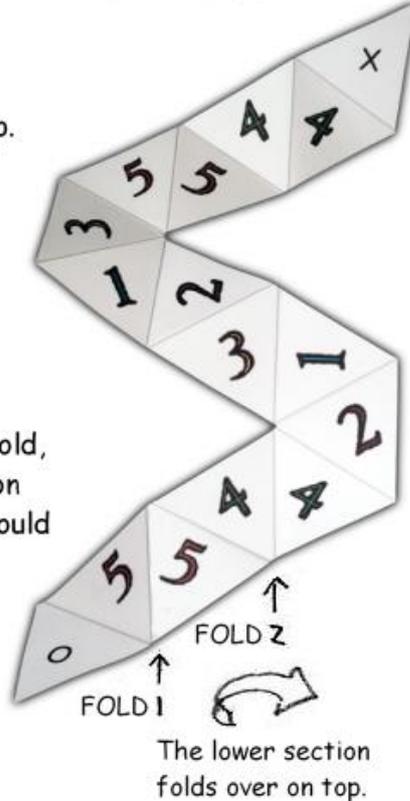
However if you're folding a pentaflexagon without the numbers on, it can be a bit confusing. The best way to practise is to use your 12345 strip and follow these instructions.

How to fold a PENTAFLEXAGON

1/ Start with the X at the top.

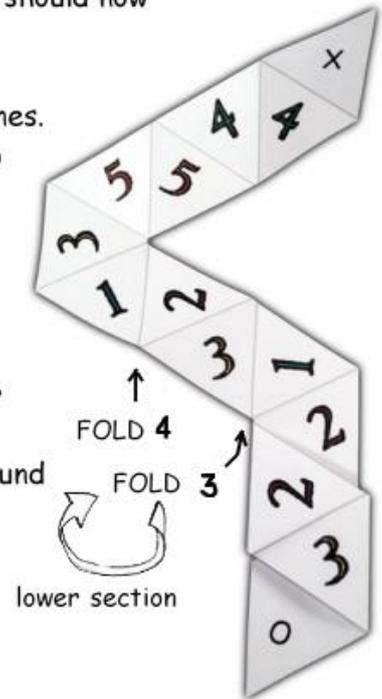
Fold along the lowest vertical line, and then fold the next vertical line.

Each time you fold, the lower section of the paper should come over the top.



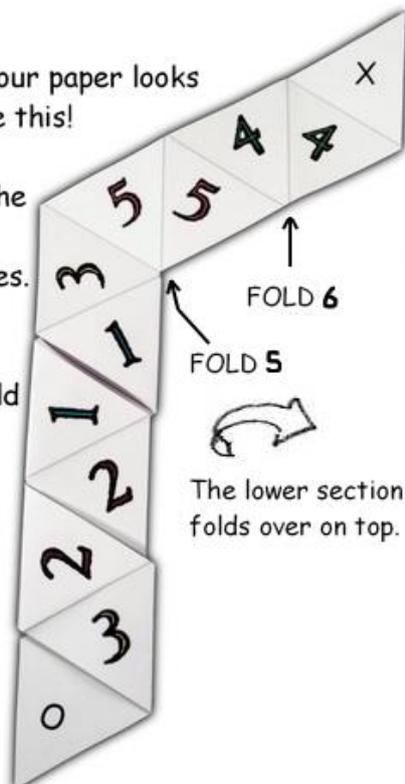
2/ Your paper should now look like this.

Fold the next two vertical lines. You must keep turning the paper in the same direction! You'll find that the lower section of the paper folds round underneath.



3/ Check your paper looks exactly like this!

Now fold the last two vertical lines. The lower section of paper should come over the top.



4/ You should now have the 10 triangle Triflexagon strip!

(If you're folding the 12345 pentaflexagon, there should be no 4's or 5's showing on the front or back.)

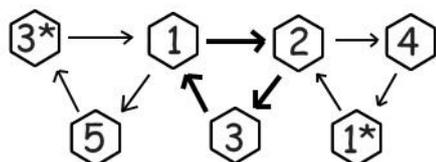
To check you've folded it correctly, hold the X triangle and the O triangle and very gently try to pull them apart. If the paper starts to unwrap then undo it and try again.

5/ Finish off by folding the strip as if it was a Triflexagon!



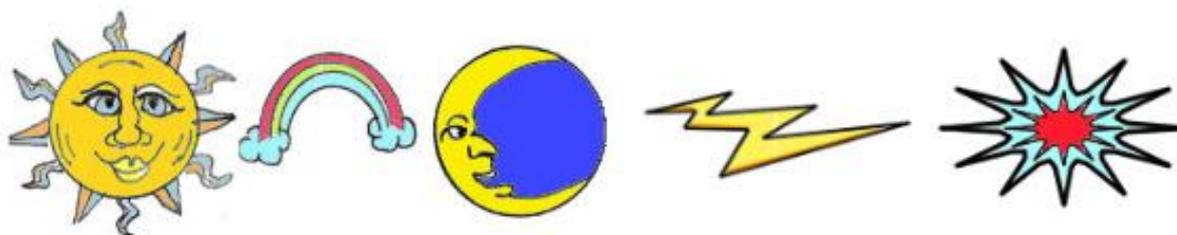
The Pentaflexagon Map

There are five faces to find on a Pentaflexagon. Can you find them all? If you get stuck, you can use the map!



The thick lines show how the three main faces are connected. The thinner lines show how to find the extra faces.

Now print and cut out the **Sky Pentaflexagon** template. When you do your first folds, the lightning bolts go together and so do the thunder flashes. You'll end up with a triflexagon strip, so you just fold that as normal. When you start flipping it, the sun and moon give you two choices of what you get next!



The *six-faced* Hexaflexagon

There are three ways to make a hexaflexagon. The simplest way starts with a long straight strip.

Print and cut out out the long thin **123456 Hexaflexagon**.

How to fold a Strip Hexaflexagon.

The 123456 strip hexaflexagon is really easy! Just fold all the pairs of 4's 5's and 6's together so that none of them are showing. You will end up with the triflexagon strip we've seen before, so just fold that in the usual way.

If your hexaflexagon hasn't got numbers, or you just want to make dead sure you've got it right, follow these instructions:

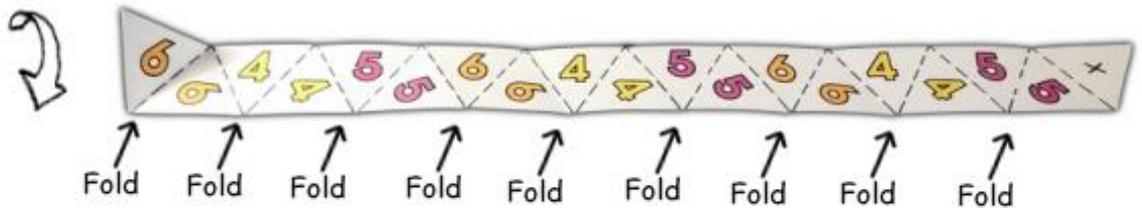
How to fold a HEXAFLEXAGON

1/ Lie the strip with the X facing upwards.

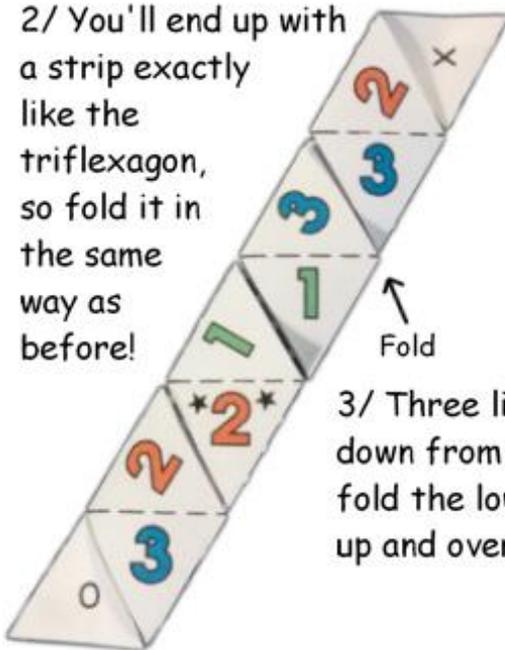
At the other end of the strip fold along the first line.

Miss a line, then fold the next line. Miss a line then fold the next line... and keep going until you reach the x.

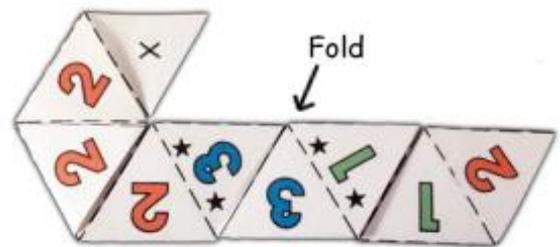
* Always fold the paper over the same way, starting at this end.



2/ You'll end up with a strip exactly like the triflexagon, so fold it in the same way as before!



3/ Three lines down from the X, fold the lower end up and over.



4/ Now move along the strip three more lines and fold the end up and over.

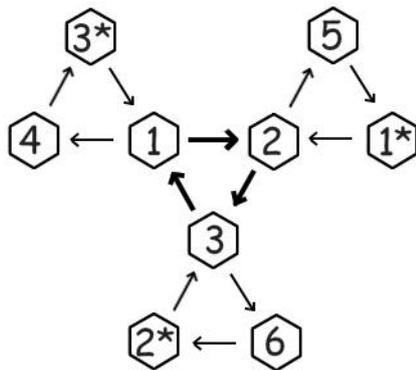
5/ The X flap will be underneath, so bring it to the top.



6/ Stick the O down onto the X.



The Hexaflexagon Map



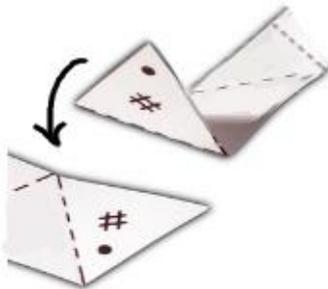
When you flip your 123456 hexaflexagon, work out which face is the front. (The front will usually have all the numbers sticking out from the centre. The numbers on the back are always jumbled.)

Flip the flexagon until the 1's are sticking out of the middle. Turn it so that the two stars are on the top edge, then when you flip you'll get the 2's. If the stars are at the bottom edge, you'll get the 4's.

But don't read this. Play around and find all six faces for yourself!

The Big Hexaflexagon with the dice on it works in almost exactly the same way. Print and cut out both parts, then stick the # flaps together with the dots touching to make one long strip.

Stick the two # flaps together so that the dots are touching.



You can now fold the Big Hexaflexagon in exactly the same way as the small one. When you flip it, watch the dice carefully. On face 1, every dice shows a 1. On face 2, every dice shows a 2 and so on. Of course you can colour the dice in any way you want to if you like.

How to make your own Strip Hexaflexagons

- 1/ Get a strip of paper that is at least 12 times longer than it is wide. (Eg 300mm x 25mm)



- 2/ Divide into equilateral triangles. You can use a 60 degree set square or protractor or just fold them (see below).



- 3/ You need 19 triangles, so chop unused bits off. Finished!

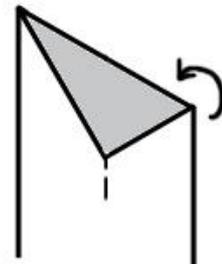


TO FOLD THE TRIANGLES:

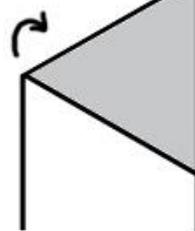
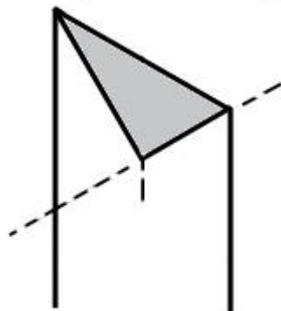
- 1/ Fold the strip in half at one end then open up again.



- 2/ Fold the top over so that the corner touches the fold.

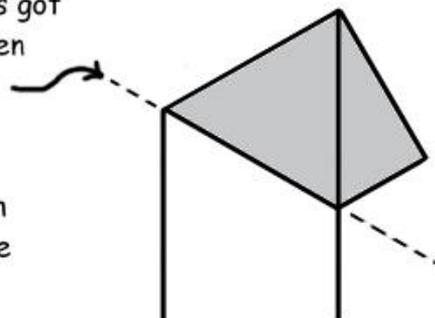


- 3/ Now fold over along the lower edge of the triangular flap.



You should get a perfect equilateral triangle flap!

- 4/ Pull out the little flap that's got sandwiched in the middle then fold along the bottom edge of the new flap...

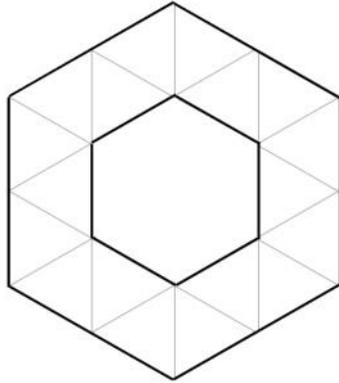


... and keep folding over each new bottom edge until you've folded enough triangles!

The RING Hexaflexagon

The second way to make a hexaflexagon starts with a hexagonal circle shape.

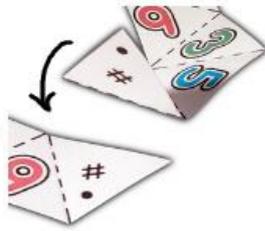
The Ring Hexaflexagon



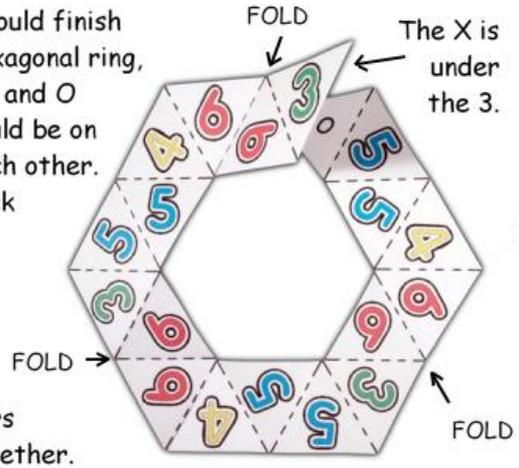
Although it also has six faces, it behaves very differently to the first hexaflexagon. First make sure you know how to fold the pentaflexagon, and then print and cut out both parts of the The Ring Hexaflexagon.

How to fold a RING HEXAFLEXAGON

1/ Stick the two # flaps together so that the dots are touching.



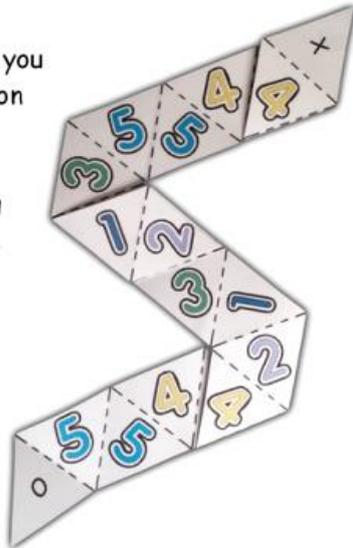
2/ You should finish with a hexagonal ring, and the X and O flaps should be on top of each other. Don't stick them yet!



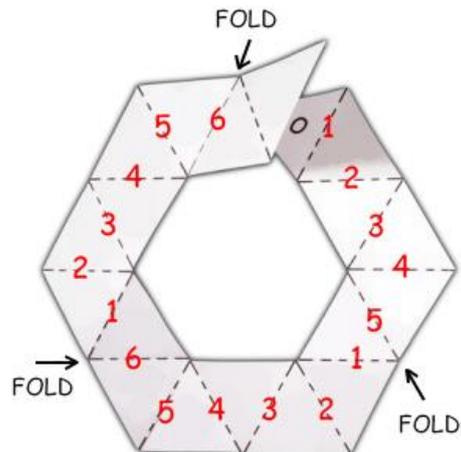
Fold the three pairs of 6's together.

3/ This will give you the Pentaflexagon shape!

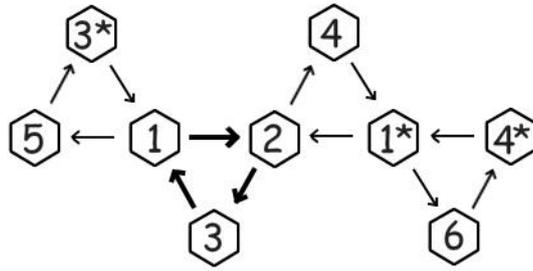
Continue as if you were folding a pentaflexagon. (So fold all the 5's and the 4's together. This makes a Triflexagon strip, so fold that, and you've done it!)



If your ring hexaflexagon doesn't have numbers, lie it down with the 0 showing. Count FIVE lines round from the 0 and fold over. Then count another SIX lines and fold over. Finally count another SIX lines and fold over. This will give you the Pentaflexagon shape.



Now try flipping your Ring Hexaflexagon! Can you find all six faces? If you're having trouble then look at the map:



The Treasure Chest

We've used the Ring Hexaflexagon to make a neat puzzle!

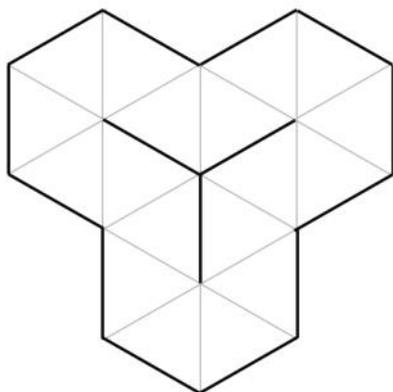
When you first make the flexagon up, you'll see a closed treasure chest. When you flip it, see if you can find the open chest!

Hint: first you must find the keys!

The TREFOIL Hexaflexagon

The third way to make a hexaflexagon starts with a trefoil shape.

The Trefoil Hexaflexagon



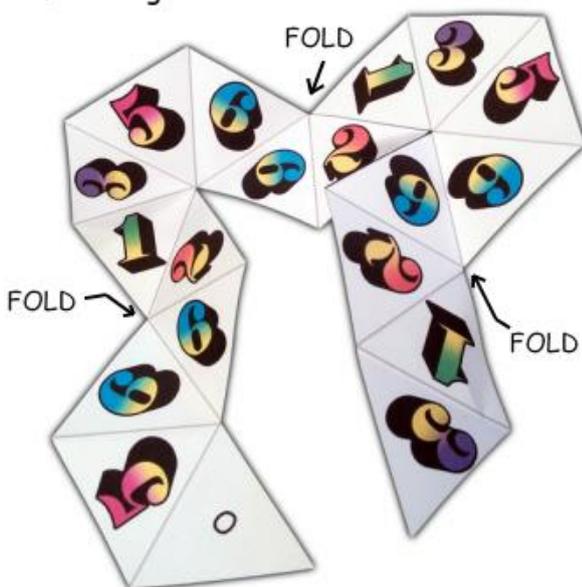
Print and cut out the two pieces of the numbered **Trefoil Hexaflexagon**. Each part has a hexagon shape with one thick black line running to the centre. Carefully cut along this line too.

How to fold a TREFOIL HEXAFLEXAGON

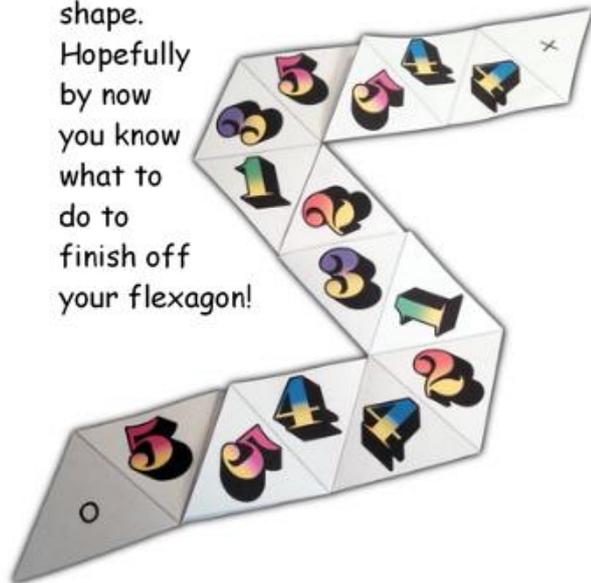
1/ Stick the two # flaps together so that the dots are touching.



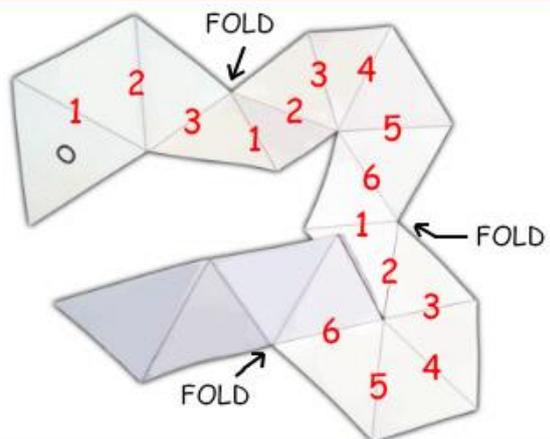
2/ Now fold the three pairs of 6's together.



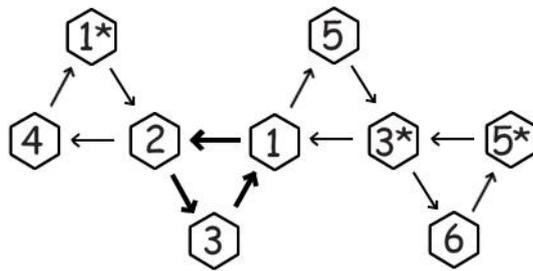
3/ This will give you the Pentaflexagon shape. Hopefully by now you know what to do to finish off your flexagon!



If your trefoil hexaflexagon doesn't have numbers, lie it down with the 0 showing. Count THREE lines round from the 0 and fold over. Then count another SIX lines and fold over. Finally count another SIX lines and fold over. This will give you the Pentaflexagon shape.



The map for the trefoil flexagon is similar to the ring flexagon, but not quite the same!

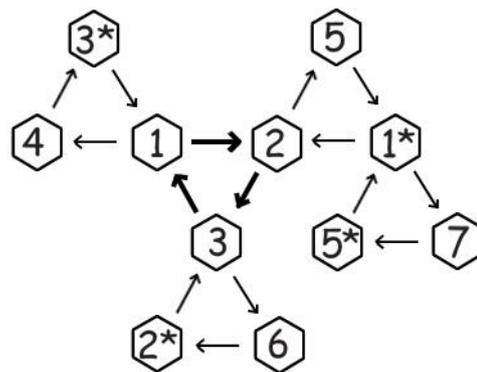


The *seven-faced* Heptaflexagon

You can go on for ever making bigger and bigger flexagons, but for now, we're just going to make one more. Print and cut out **The Heptaflexagon** with the pool balls on it. Although it has seven faces, this one is quite easy to make. Just fold all the black 8-balls together, and you'll be left with a long strip, which you fold as if making the simplest hexaflexagon. It makes into a neat puzzle! Can you find the 8-balls?

Here are the seven faces:

- 1/ random mix (1,4,9,10,6,3)
- 2/ prime numbers (2,3,5,7,11,13)
- 3/ odd numbers
- 4/ spots (numbers under 8)
- 5/ even numbers
- 6/ stripes (numbers over 8)
- 7/ the 8-balls!



Hint If you're stuck, find the prime numbers (face 2). Make sure they read 2,5,7,3,13,11 going round clockwise. If they are going *anti-clockwise* then you're looking at the back of the flexagon. Turn it over and try again!

Design Your Own!

There are blanks for all the flexagons we've seen here, just the X and O ends, plus the # glue points are marked to help you fold and stick them.

A final word...

All the flexagons we've looked at here are hexagon-shaped. There are other sorts including square flexagons, and three-dimensional flexagons! There are a lot of good sites on the internet describing all these, plus you can read about Arthur Stone who accidentally made the first tri-hexaflexagon when he was fiddling with a strip of paper. Other clever people were immediately interested including Richard Feynman who devised the little maps. Then the legendary Martin Gardner made them famous by writing about them in Scientific American magazine in 1956... the year I was born!

I hope you've enjoyed making and playing with these things as much as I do.

Have fun!

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For all publishing/development enquiries,
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