DR MARK'S MAGICAL MATHS!

A SET OF FUN & NOVEL 'MATHEMAGICAL' ACTIVITIES & 'ARITHMETRICKS' TO STIMULATE PROBLEM SOLVING, COMMUNICATING AND REASONING SKILLS

BOOK 1

MATHS WITH THE FUN BITS LEFT IN!

THANK YOU!

(ACKNOWLEDGEMENTS)

To the many teachers, especially Colette Smith, who initially encouraged and inspired me to further research and develop the 'MatheMagical' shows, hands-on workshops and teacher training days from my early ideas.

To everyone in the ProEducation team, especially to 'Dr Jasmine' for indulging me while I played around with the 'Magical Maths' approach; to my sister 'Dr Lea' and to 'Dr Julie' for trying out the initial ideas in schools with me, and to the 'newer' members of the team: 'Dr David', 'Dr Sarah', 'Dr Clare' and 'Dr Caitlin', for being mad enough to take on the ideas as well! Thank you all.

Thanks again to Jeff for his usual brilliant graphics work, without which this book would have undoubtedly joined the already swollen ranks of exceedingly dull-looking maths books!

And finally, thanks to Tim and Mel of HANDS ON PUBLISHING of the Commotion Group for yet again agreeing to distribute what I hope to be the first of my crazy maths books.

Oh, and thanks too to the 'Education Department' of the British Government for promoting the idea that the sorts of activities and 'tricks' contained in this book are a great way of stimulating and developing mathematical 'process and thinking skills' in our children.

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1 MAGIC MENTAL MATHS

WHAT YOU NEED:

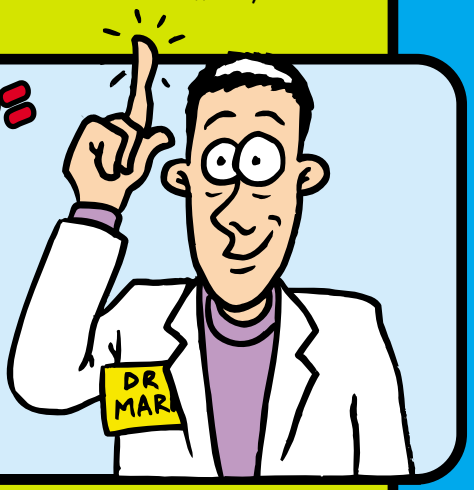
- Your head – because I want you to try to do the following questions in your head!
- Your fingers (and toes too, if you like) – just in case you can't do it all in your head!
- A pencil (or pen) and paper, just in case you get really stuck and also to help with your investigations

WHAT TO DO:

Below are three sets of 'Magic Mental Maths' instructions I want you to try. They all start with asking you to think of a number. I want you to try each set of instructions at least two or three times with different numbers. Notice what answer you get each time.

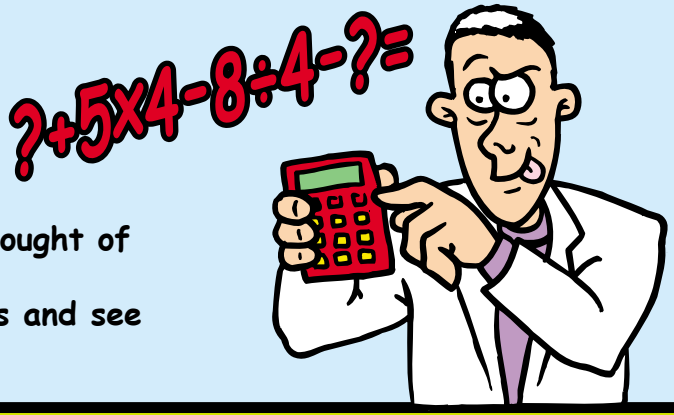
HINT: You'll find them all a little easier to do if you start each with a low number, say, between 2 and 6.

1. Think of a number
2. Add 4 to it
3. Double the result
4. Take away 6
5. Halve the result
6. Take away the number you first thought of
7. WHAT DO YOU GET?
8. Now try again with other numbers and see what you get.



1. Think of a number
2. Add 7 to it
3. Times that answer by 3
4. Take away 9
5. Divide it all by 3
6. Take away the number you first thought of
7. WHAT DO YOU GET?
8. Now try again with other numbers and see what you get.

1. Think of a number
2. Add 5 to it
3. Multiply that answer by 4
4. Subtract 8
5. Divide it all by 4
6. Subtract the number you first thought of
7. WHAT DO YOU GET?
8. Now try again with other numbers and see what you get.



2 A HANDY CALCULATOR!

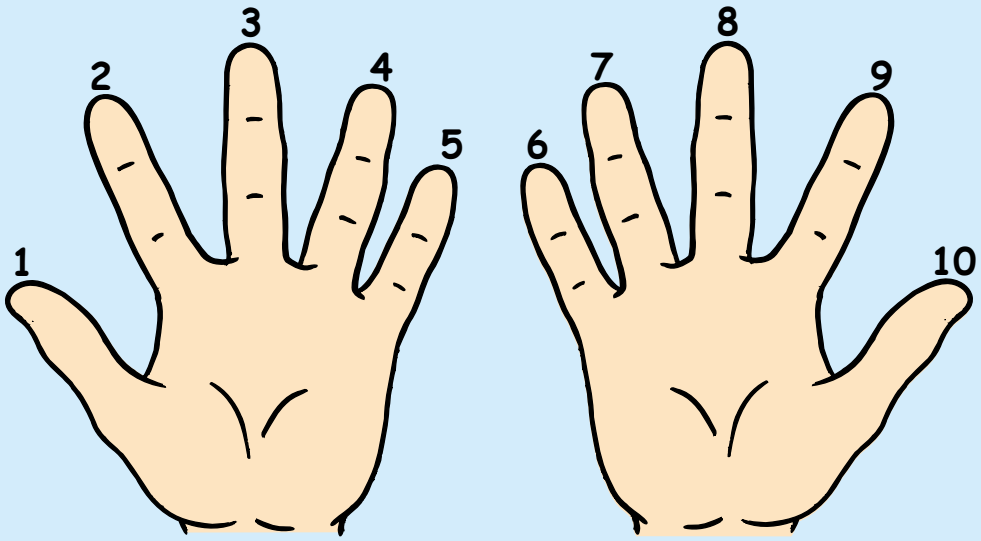
This is a great way of doing the nine-times-table if you have trouble learning and remembering it by heart, as many people do!

WHAT YOU NEED:

- Both your hands with all ten fingers

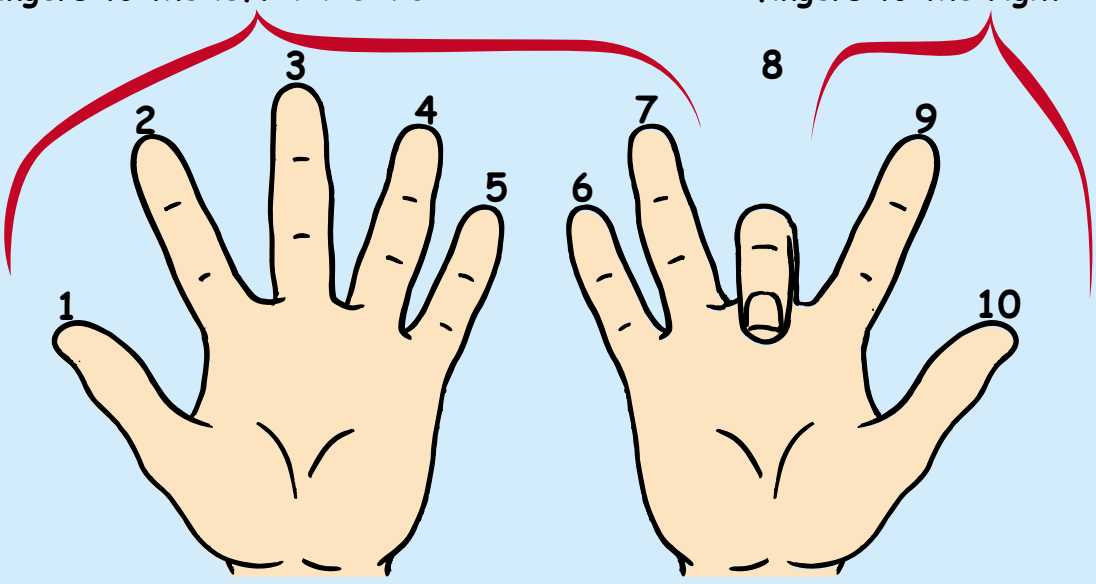
WHAT TO DO:

1. Hold your hands up with palms facing you and with all ten fingers straight and spread a little apart. Mentally number your fingers from 1 to 10, from left to right, with your left thumb numbered '1' and your right thumb numbered '10':



2. First, you bend over the numbered finger that is the same as the number you want to multiply nine by. For example, suppose you want the answer to 8 times 9. First, bend your '8' finger over:

7 fingers to the left=7x10=70 **2 fingers to the right=2x1=2**



3. To get to the answer, count the number of straight fingers to the LEFT of your bent finger as how many 'tens' you have and the number of fingers to the RIGHT of your bent finger as how many 'units' you have. You then add the 'tens' and 'units' together. So, with our 8 times 9 example, you have 7 fingers to the LEFT of your bent 8 finger (fingers 1 to 7) which makes 70, and two fingers to the RIGHT (fingers 9 and 10) which makes 2. And 70 + 2 = 72. So, your handy calculator says that 8 x 9 = 72, which it does!

SOME THINGS YOU COULD INVESTIGATE

Why not try your nine-times-table 'handy calculator' against some of the nine-times-table you may already know to make sure it works? For example, try 2 x 9 = 18, 5 x 9 = 45, 9 x 9 = 81 and 10 x 9 = 90.

2 ANOTHER HANDY CALCULATOR!

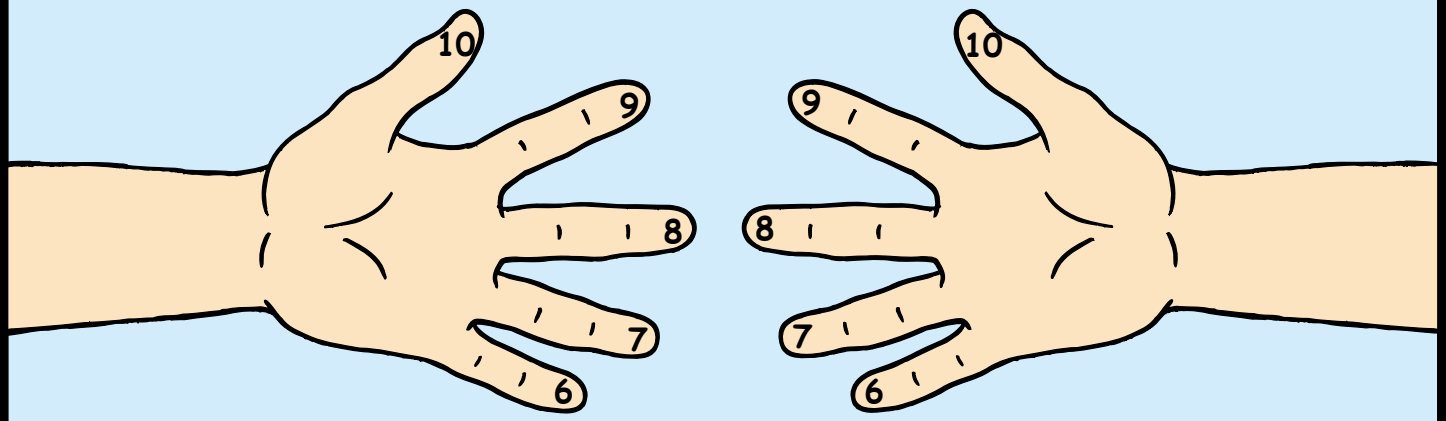
This is a great way of multiplying any two numbers between six and ten.
I heard from somewhere that this method was used by Russian peasants.

WHAT YOU NEED:

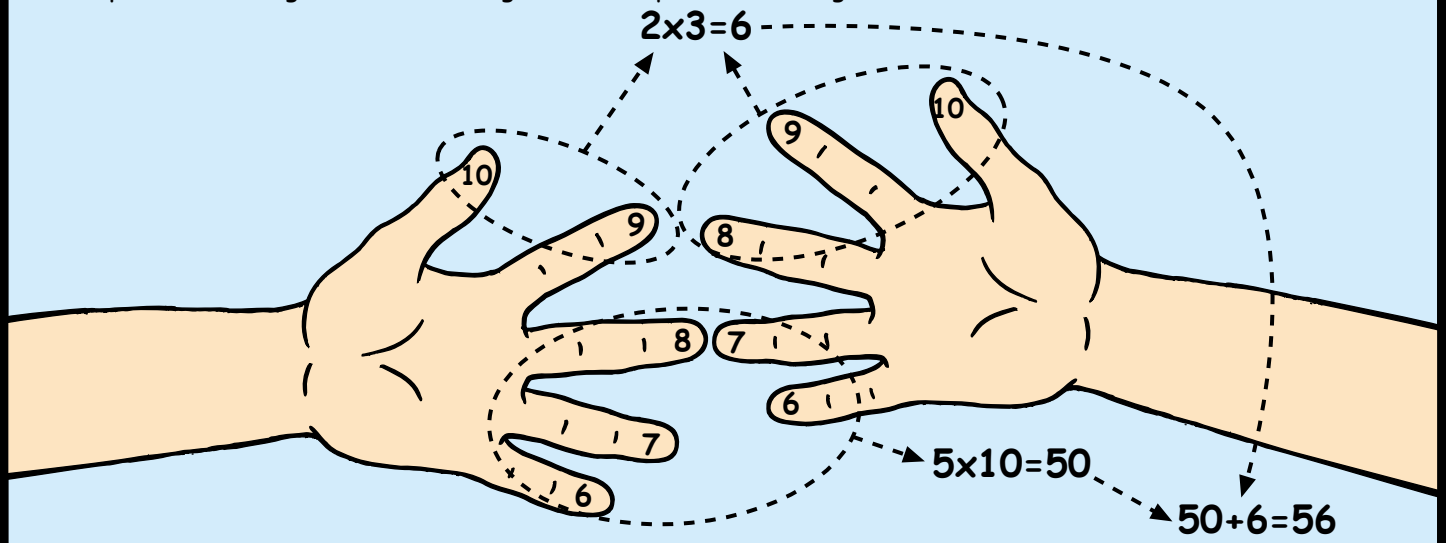
- Both your hands with all ten fingers

WHAT TO DO:

1. Hold your hands up with palms facing you, with all ten fingers straight and spread a little apart, and with the five fingers of one hand pointing towards the five fingers of your other hand. Mentally number the five fingers of each hand from 6 to 10, from bottom to top, with each 'little finger' (or 'pinky') numbered '6' and each thumb numbered '10':



2. First, you touch together the tips of the two numbered fingers that are the same as the two numbers you are multiplying together. For example, suppose you want the answer to 8 times 7. First, touch the tip of the '8' finger of one hand against the tip of the '7' finger of the other hand:



3. Adding the two touching fingers plus all the fingers BELOW them on both hands tells you how many 'tens' you have; that's five fingers in our example above which gives you 5 x 10 = 50. Now multiply the number of remaining fingers on one hand by the number of remaining fingers on the other hand, and finally add this number to how many 'tens' you have. In our example, you have 2 remaining fingers on one hand times the 3 remaining fingers on the other hand, which is 2 x 3 = 6. And adding that to the number of 'tens' you have gives: 50 + 6 = 56. So, your handy calculator says that 8 x 7 = 56, which it does!

SOME THINGS YOU COULD INVESTIGATE

1. Does it matter which way around you touch fingers, such as the '7' finger of your left hand against the '8' finger of your right hand in our 8 times 7 example above?
2. Why not try this 'handy calculator' to multiply other numbers together between 6 and 10 which you may already know to make sure it works? For example, try 8 x 9 = 72, 6 x 6 = 36, 7 x 7 = 49 and 10 x 9 = 90.

3 THE 3X3 MONTHLY MATHS TRICK!

WHAT YOU NEED:

- A sheet from ANY monthly calendar (or copy the unmarked September 2004' sheet I've given you at the end of this section)
- A pencil (or pen) and paper (to write on)
- A friend
- Maybe a calculator to check your answers

WHAT TO DO:

1. Ask your friend to draw a 3x3 square box around ANY group of nine numbers on the calendar, as shown by my example below.
2. Then ask your friend to see how quickly they can add up all the numbers in the square to find the total. You can ask them to add up the numbers 'mentally' in their head, or by writing the sum on paper, or by using a calculator.
3. You should be able to beat them simply by looking at the number in the middle of the square and multiply it by 9. Try it on my example below and see!
   TRICK TIP: To multiply any number by 9 quickly in your head, all you do is multiply the number by 10 (by just adding a '0') and then subtract the number. For the 3x3 square below that's, 16 x 10 = 160, and 160 – 16 = 144. With a bit of practice you should be able to do all this quite quickly in your head.

SEPTEMBER 2004

Mon	Tue	Wed	Thur	Fri	Sat	Sun
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

SOME THINGS YOU COULD INVESTIGATE

1. Can you see any other number patterns inside the 3x3 box? What are they? Can you explain them?
   (A CLUE FOR ONE PATTERN: Look at the pairs of opposite numbers)
2. What happens when you try the same '3x3' trick again, but instead of using a monthly calendar, you use a totally different 'grid' or array of numbers on which you draw your 3x3 box? For example, you could try drawing the 3x3 box on a 10x10 grid of numbers (numbered from 1 to 100 – you'll see that I've drawn such a 10x10 grid for you to copy at the end of this section).

3 THE 4X5 MONTHLY MATHS TRICK!

WHAT YOU NEED:

- A sheet from ANY monthly calendar (or copy the unmarked September 2004' sheet I've given you at the end of this section)
- A pencil (or pen) and paper (to write on)
- A friend
- Maybe a calculator to check your answers

WHAT TO DO:

1. Ask your friend to draw a 4x5 box around ANY group of twenty numbers on the calendar, as shown by my example below (sometimes you won't be able to do this for 'February', so use another month).
2. Then ask your friend to see how quickly they can add up all the numbers in the box to find the total. You can ask them to add up the numbers 'mentally' in their head, or by writing the sum on paper, or by using a calculator.
3. You should be able to beat them simply by adding together the smallest and largest numbers inside the box and multiply the answer by 10. Try it on my example below and see!
   TRICK TIP: To multiply any number by 10 quickly in your head, simply add a '0' to the number.

SEPTEMBER 2004

Mon	Tue	Wed	Thur	Fri	Sat	Sun
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

SOME THINGS YOU COULD INVESTIGATE

1. Can you see any other number patterns inside the 4x5 box? What are they? Can you explain them?
   (**A CLUE FOR ONE PATTERN:** Look at the pairs of opposite numbers)
2. What happens when you try the same '4x5' trick again, but instead of using a monthly calendar, you use a totally different 'grid' or array of numbers on which you draw your 4x5 box? For example, you could try drawing the 4x5 box on a 10x10 grid of numbers (numbered from 1 to 100 – you'll see that I've drawn such a 10x10 grid for you to copy at the end of this section).

3 MORE MONTHLY MATHS TRICKS!

WHAT YOU NEED:

- A sheet from ANY monthly calendar (or copy the unmarked September 2004' sheet I've given you at the end of this section)
- A pencil (or pen) and paper (to write on)
- A friend
- Maybe a calculator to check your answers

WHAT TO DO:

1. Look at the four numbers inside the smaller 2x2 shaded box I've drawn on the calendar below around the numbers, 6, 7, 13 & 14..
2. Can you see any number patterns inside the box? What are they? Can you explain them? **(A CLUE FOR ONE PATTERN:** Look at the diagonally opposite numbers.)
3. Imagine or draw the same 2x2 box around a different group of four numbers on the same calendar. Are there still similar number patterns?
4. Repeat steps 1, 2 and 3 for the larger 2x3 and 2x5 shaded boxes.

SEPTEMBER 2004

Mon	Tue	Wed	Thur	Fri	Sat	Sun
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

SOME THINGS YOU COULD INVESTIGATE

1. Repeat steps 1, 2 and 3 above for different sized and different shaped boxes of numbers, such as 2x7, 4x4, 3x5 and 3x7 boxes, as well as 'T', 'L', 'E', 'F', 'H' and '+'-shaped boxes. Also, see what happens when you draw all the same boxes another way around, for example, as if you'd drawn them back-to-front, upside-down or turned through 90 degrees.
2. What happens when you repeat everything you've tried so far but using a monthly calendar where the dates are on different days of the week, such as the 1st of the month falling on a Monday or a Friday?
3. What happens when you repeat everything you've tried so far but instead of using a monthly calendar, you use a totally different 'grid' or array of numbers on which you draw your various boxes? For example, you could try drawing your boxes on a 10x10 grid of numbers (numbered from 1 to 100 – you'll see that I've drawn such a 10x10 grid for you to copy at the end of this section).

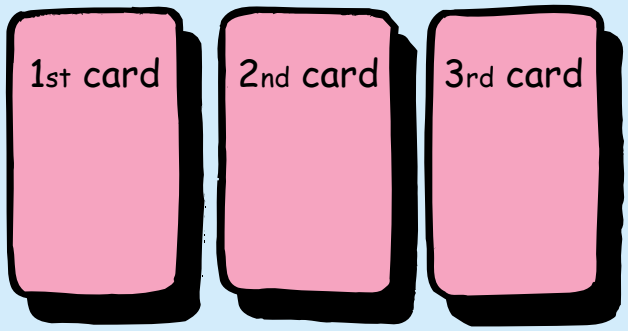
4 CUNNING CARD TRICK

WHAT YOU NEED:

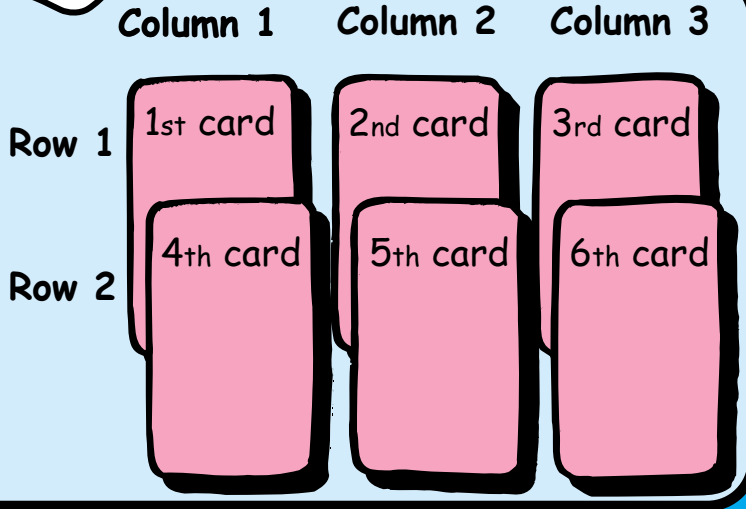
- A pack of Playing Cards – you only need 15 cards for the first part of the card trick.
  (or any set of cards which each ALL LOOK different, such as collectors' swap or trading cards, or even pieces of card or paper with a different number written on each of them)
- A friend

WHAT TO DO:

1. Take **15 playing cards** and deal three of them out **FACE-UP** in a row onto a table – starting on the left (They need to be **FACE-UP** so that you can clearly see what each card is).



2. Then deal another (4th) card beneath (and slightly overlapping) the 1st card on the left, another (5th) card beneath the 2nd card and another (6th) card beneath the 3rd card. You should see so far that your cards are in three columns and two rows. Overlapping the lower row of cards onto the row of cards above makes the column of cards easier to pick up in the right way, as described in a minute

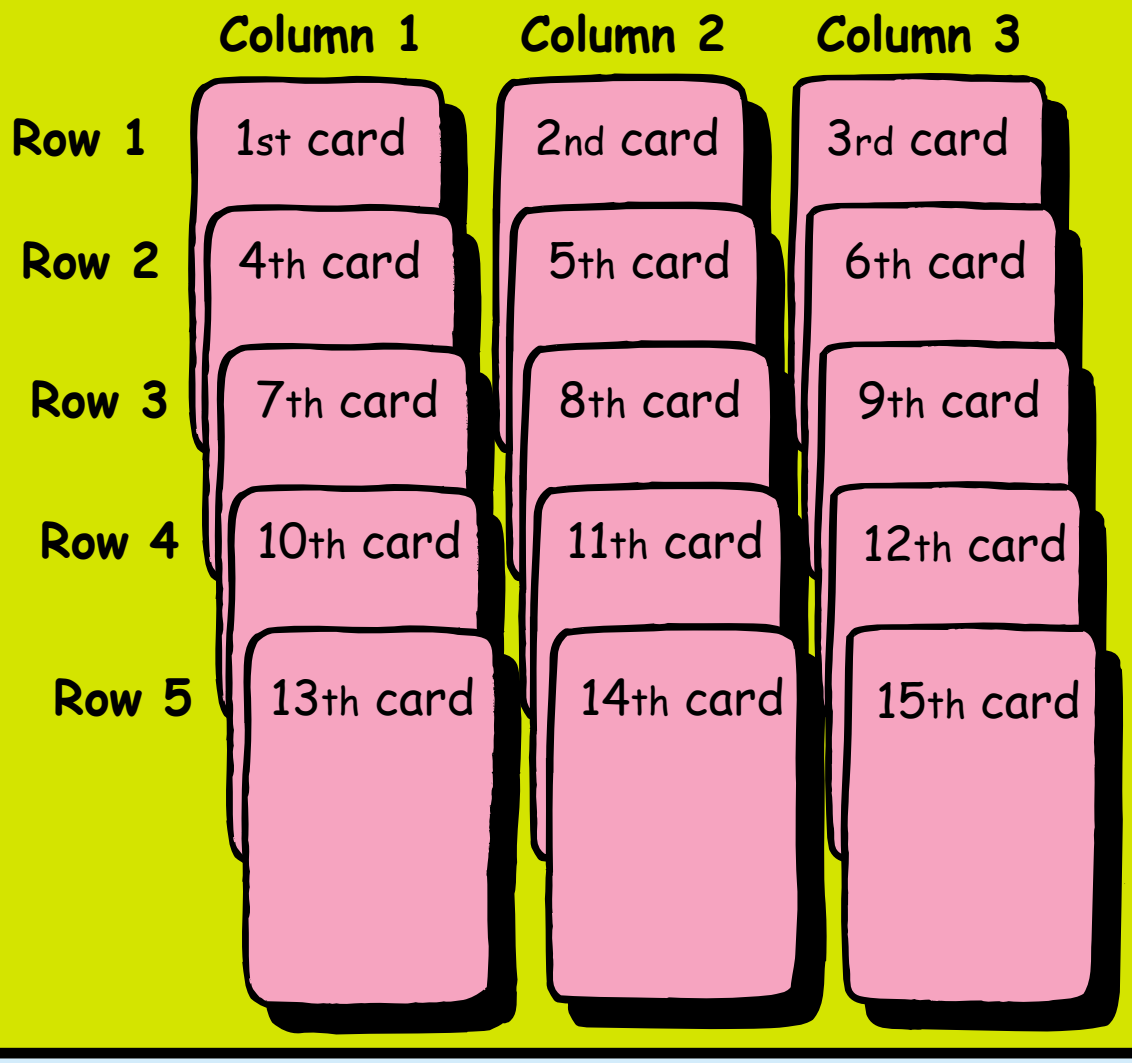


WHAT TO DO: CONTINUED

3. Carry on dealing out the cards in the three columns in this same pattern, starting each new row of cards on the left in column 1. You should end up with all fifteen cards laid out **FACE-UP** in three columns and five rows

4. Ask a friend to choose one card and remember it. They **MUST NOT** tell you what the card is. Just ask them to tell you which **COLUMN** their chosen card is in - 1, 2 or 3?

5. Carefully slide together each column of cards into three neat piles. It's **REALLY IMPORTANT** that you slide your friend's chosen column of cards together keeping the cards in the same order or sequence – you'll find that overlapping the cards as you laid them down makes this much easier and quicker to do. And don't forget which pile your friend's card is in!



6. Pick up the three piles of cards one at a time, placing your friend's chosen pile of cards in between the other two (like a sandwich) – you should now be holding all fifteen cards piled in your hand;

7. Repeat steps 1 to 6 again **2 MORE TIMES**, but stay with the same chosen card – just ask your friend to tell you which column their same card is in each time you lay out all the cards the second and third time.

8. Finally, count through the pile of fifteen cards until you reach the **EIGHTH** card – this eighth card should be the card they chose. **AMAZING!**

5 MAGIC NUMBER CARDS

WHAT YOU NEED:

- Four small sheets of paper (or card)

(make them small enough and you'll be able to carry them around in your pocket!)

- A pencil (or pen)
- A friend

WHAT TO DO:

1. Using your sheets of paper (or card) and your pencil (or pen), carefully copy and make the four Magic Number Cards shown below (otherwise just use this page of the book!)

Card A

1	3	5	7
9	11	13	15

Card B

2	3	6	7
10	11	14	15

Card C

4	5	6	7
12	13	14	15

Card D

8	9	10	11
12	13	14	15

2. Ask a friend to look at the Magic Number Cards and choose a number between 1 and 15.
3. Ask them NOT to tell you the number they have chosen.
4. Ask them to tell you ALL the cards where they can see their number (for example, if they choose the number 3, they should tell you that their number is on cards A and B)
5. You then ADD together the first numbers you can see on each of the cards they named.
   (NOTE: the first number on Card A is 1, B is 2, C is 4, and D is 8)

THE ANSWER YOU GET IS THE NUMBER YOUR FRIEND FIRST THOUGHT OF!

SOME THINGS YOU COULD INVESTIGATE:

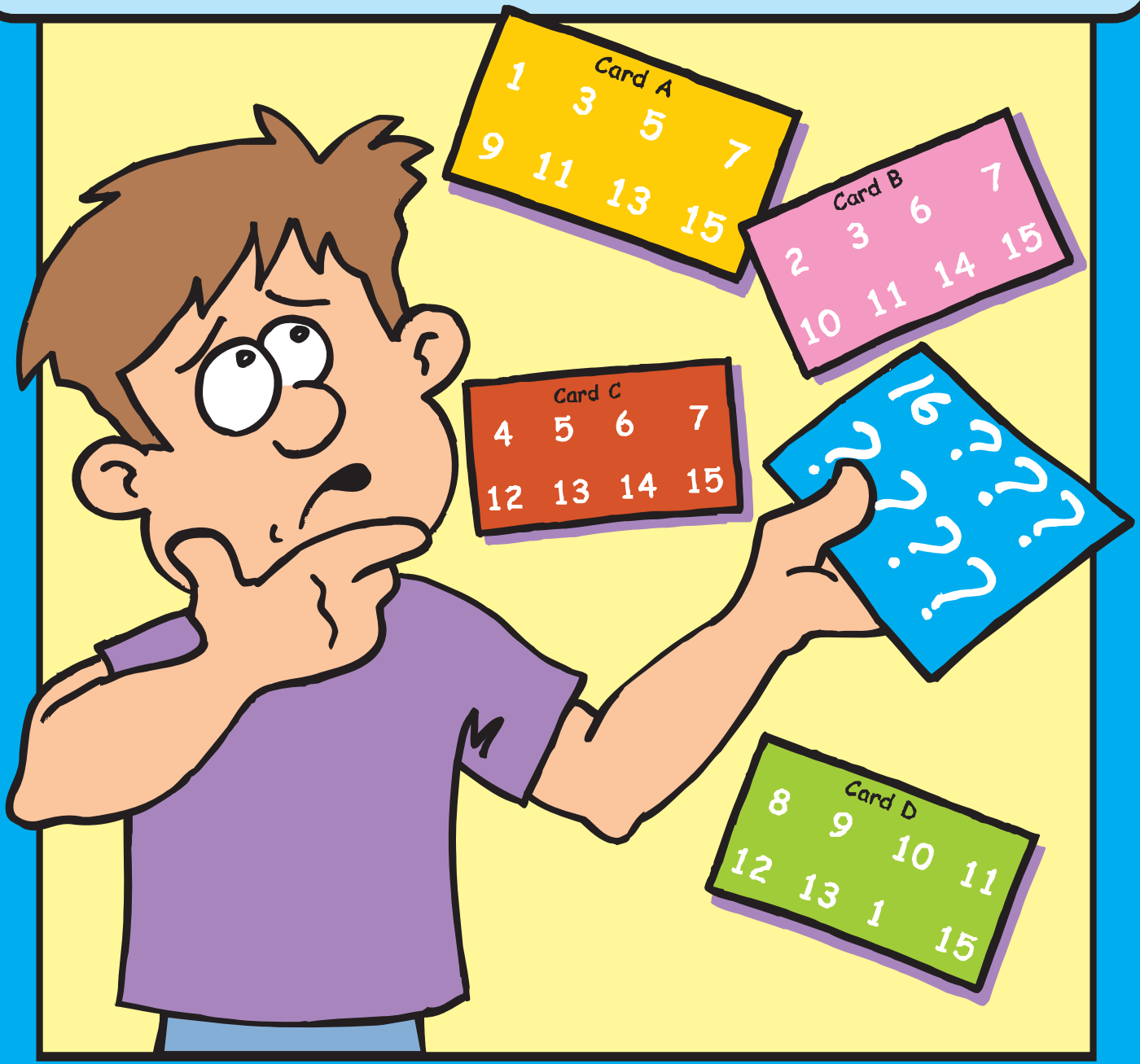
1. What would be the first numbers on the cards E, F, G, H, I, J, K, etc (if you had them)

2. What other number patterns can you see elsewhere on each of the Magic Number Cards?
(**HINT**: When thinking about 'missing numbers', include the digit '0' at the start)

3. What differences in the number patterns can you see between the four Magic Number Cards?

4. This trick can be done with three cards (A, B & C) with the numbers 1 to 7. Try to work out how.

5. What numbers would you need to put on the same trick but using five cards, A to E?



MAGIC NUMBER CARDS : 3 CARD SYSTEM - COPY MASTER

Card A

1 3

5 7

Card B

2 3

6 7

Card C

4 5

6 7

You use the 3-card system in much the same way as the original 4-card system. Give all the cards to someone, ask them to choose a number, and then tell you all the cards they can see their number on. Then you just add up the first numbers you can see on each of the cards they name.

MAGIC NUMBER CARDS : 4 CARD SYSTEM - COPY MASTER

Card A

1 3 5 7

9 11 13 15

Card B

2 3 6 7

10 11 14 15

Card C

4 5 6 7

12 13 14 15

Card D

8 9 10 11

12 13 14 15

MAGIC NUMBER CARDS : 5 CARD SYSTEM - COPY MASTER

Card A

1	3	5	7
9	11	13	15
17	19	21	23
25	27	29	31

Card B

2	3	6	7
10	11	14	15
18	19	22	23
26	27	30	31

Card C

4	5	6	7
12	13	14	15
20	21	22	23
28	29	30	31

Card D

8	9	10	11
12	13	14	15
24	25	26	27
28	29	30	31

Card E

16	17	18	19
20	21	22	23
24	25	26	27
28	29	30	31

You use the 5-card system in much the same way as the original 4-card system. Give all the cards to someone, ask them to choose a number, and then tell you all the cards they can see their number on. Then you just add up the first numbers you can see on each of the cards they name.

MAGIC NUMBER CARDS : 6 CARD SYSTEM - COPY MASTER

You use the 6-card system in much the same way as the original 4-card system. Give all the cards to someone, ask them to choose a number, and then tell you all the cards they can see their number on. Then you just add up the first numbers you can see on each of the cards they name.

Card A

1	3	5	7	9	11	13	15
17	19	21	23	25	27	29	31
33	35	37	39	41	43	45	47
49	51	53	55	57	59	61	63

Card B

2	3	6	7	10	11	14	15
18	19	22	23	26	27	30	31
34	35	38	39	42	43	46	47
50	51	54	55	58	59	62	63

Card C

4	5	6	7	12	13	14	15
20	21	22	23	28	29	30	31
36	37	38	39	44	45	46	47
52	53	54	55	60	61	62	63

Card D

8	9	10	11	12	13	14	15
24	25	26	27	28	29	30	31
40	41	42	43	44	45	46	47
56	57	58	59	60	61	62	63

Card E

16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31
48	49	50	51	52	53	54	55
56	57	58	59	60	61	62	63

Card F

32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55
56	57	58	59	60	61	62	63

6 IMPOSSIBLE PAPER FOLD!
OR HOW MANY TIMES CAN YOU FOLD A SHEET OF PAPER IN HALF?

WHAT YOU NEED:

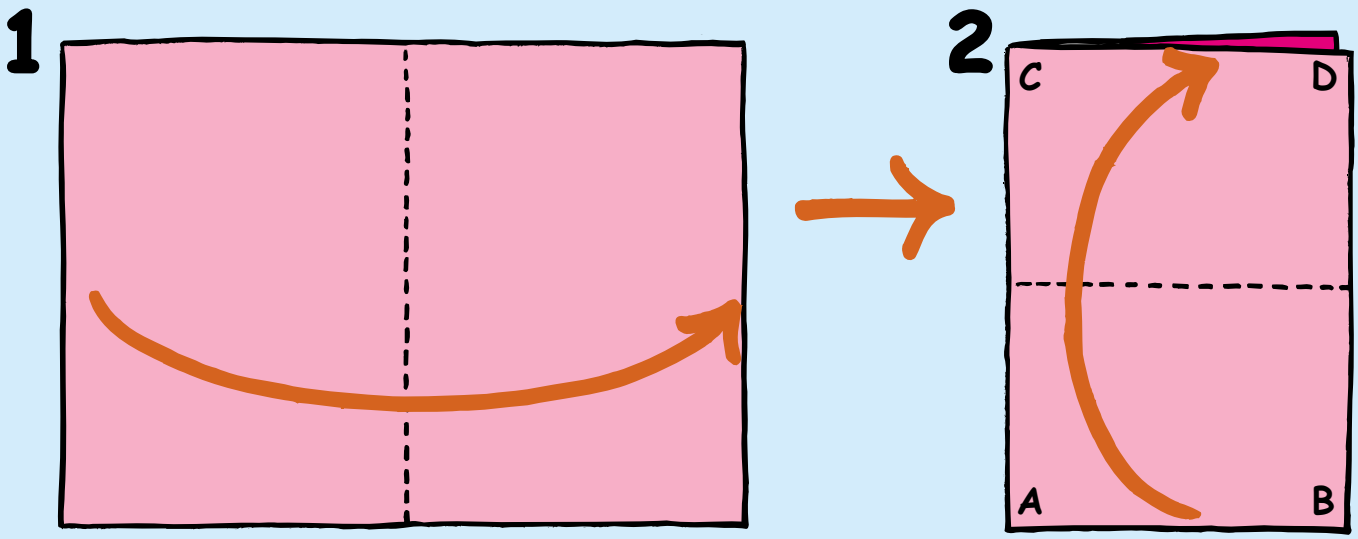
- Two sheets of A4 or similar size paper – say, about 21cm by 30cm
- Carefully tear or cut one of your A4 sheets in half to make two A5 sheets (about 21cm by 15 cm)
- Carefully tear or cut one of your A5 sheets in half to make two A6 sheets (about 15cm by 10.5cm)
- The biggest sheet of paper you can possibly find – a page from an old newspaper is good
- Two or three other sheets of paper of different sizes to those listed already
- A pen (or pencil) and some paper might be useful for making notes

WHAT TO DO

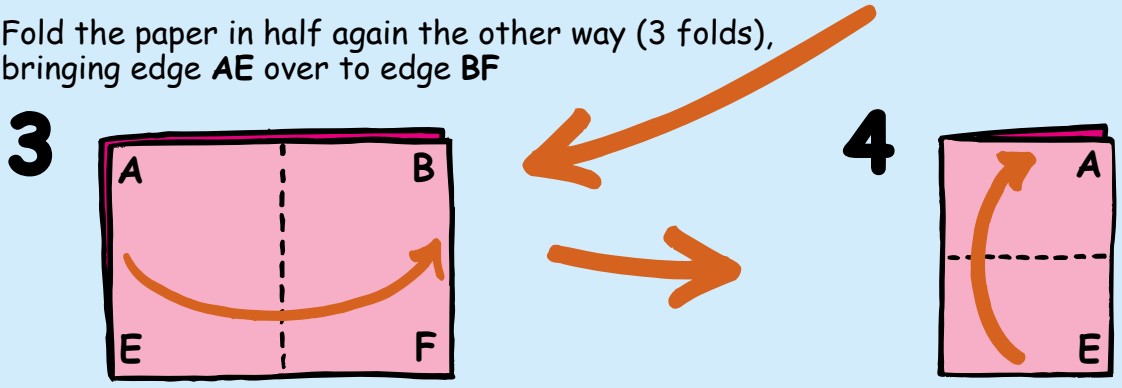
(Read the words & look at the pictures):

1+2+3 : Fold one of the small A6-size sheets of paper in half one way (1 fold) and then in half again the other way (2 folds), bringing edge **AB** up to edge **CD** (see figures **2** & **3**)

(dotted lines show where the folds should appear)



3+4: Fold the paper in half again the other way (3 folds), bringing edge **AE** over to edge **BF**



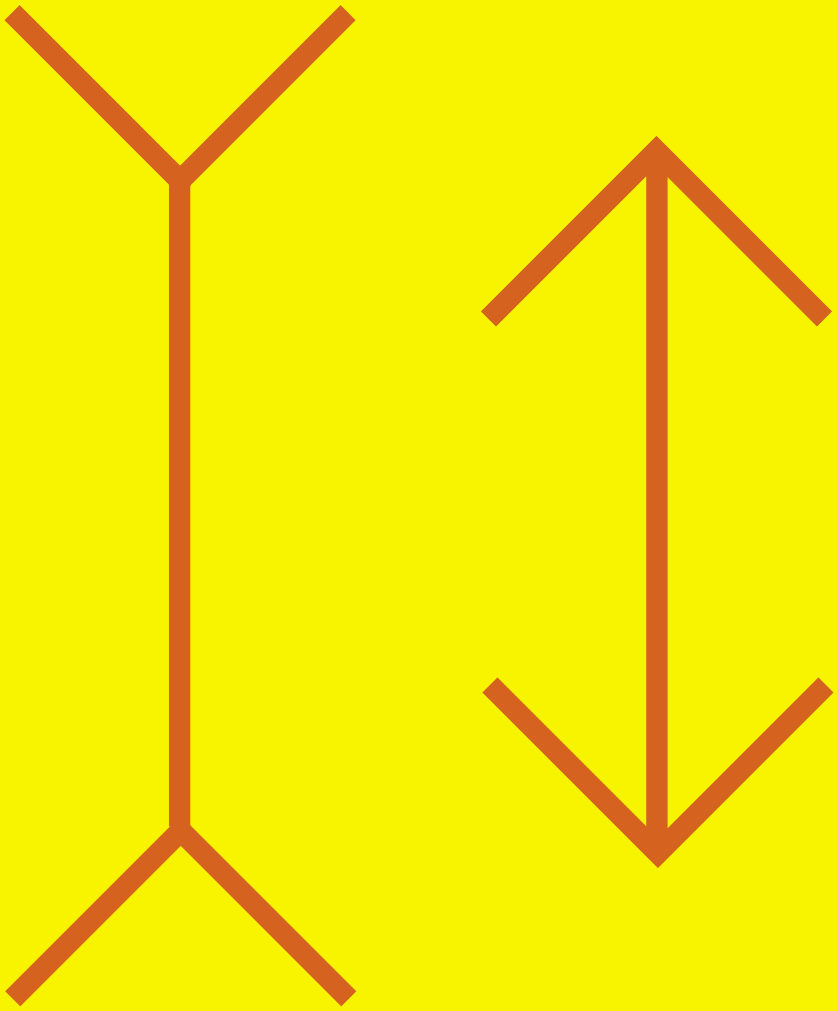
5. Keep on folding the paper in half like this, first one way and then the other, as many times as you can. Make sure you keep a count of how many folds you make.

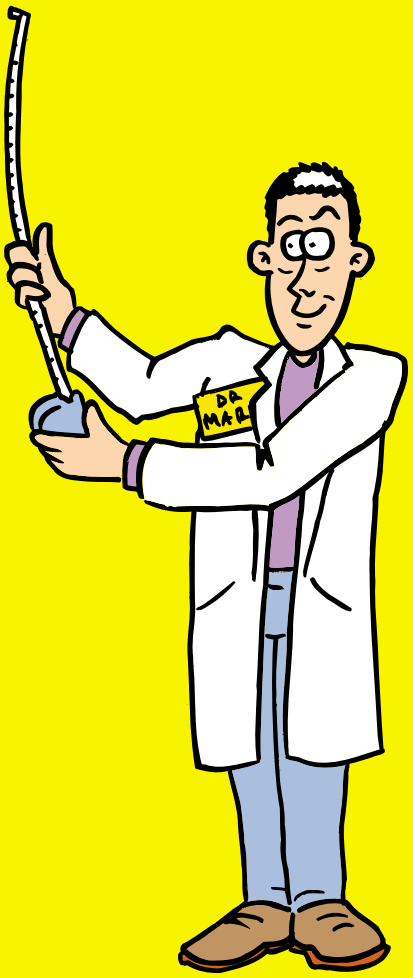
I'd be very surprised if you can fold the small A6 sheet of paper more than 6 times!

7 ILLUSION CONFUSION! - MEASURING LINES -

WHAT TO DO:

1. Look at the line drawings below.
2. Without using a ruler, which long upright or vertical line looks the longest or do they look the same length?





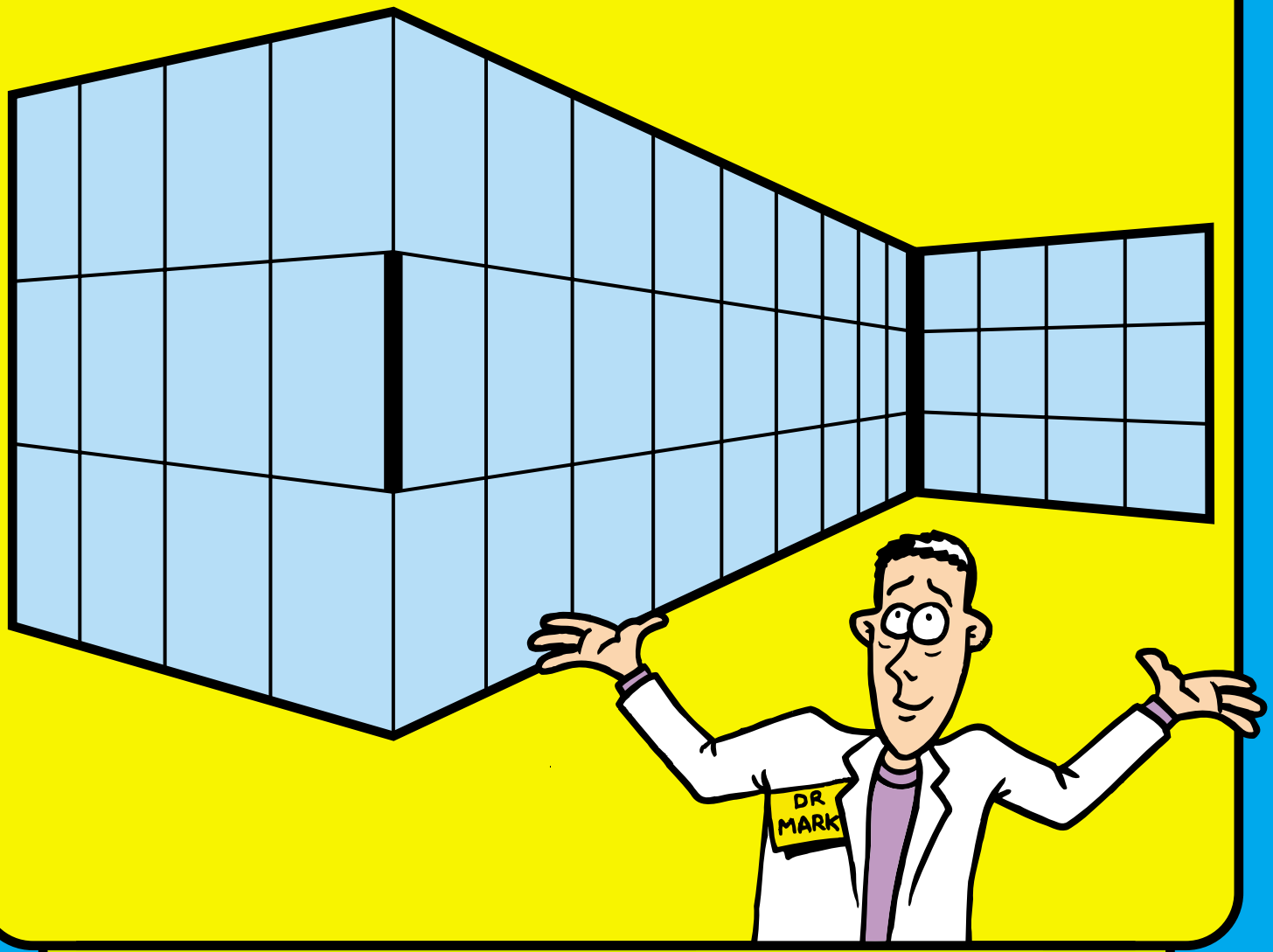
SOME THINGS YOU COULD INVESTIGATE:

1. Use a ruler to measure the actual length of both long vertical lines.
2. Why not try to re-draw the illusion in a different way to see what happens? For example, you could change the length of one or both of the vertical lines; change the size and angles of the 'wings' or 'arrow-fins' at either end of the lines; and change the distance between the two vertical lines. Remember to only change one thing at a time to make it a 'fair test'.
3. What do you think is going on?

7 ILLUSION CONFUSION! - COMPARING CORNERS -

WHAT TO DO:

1. Look at the two thick dark corner lines in the drawing below.
2. Without using a ruler, which thick dark line looks the longest or do they look the same length?



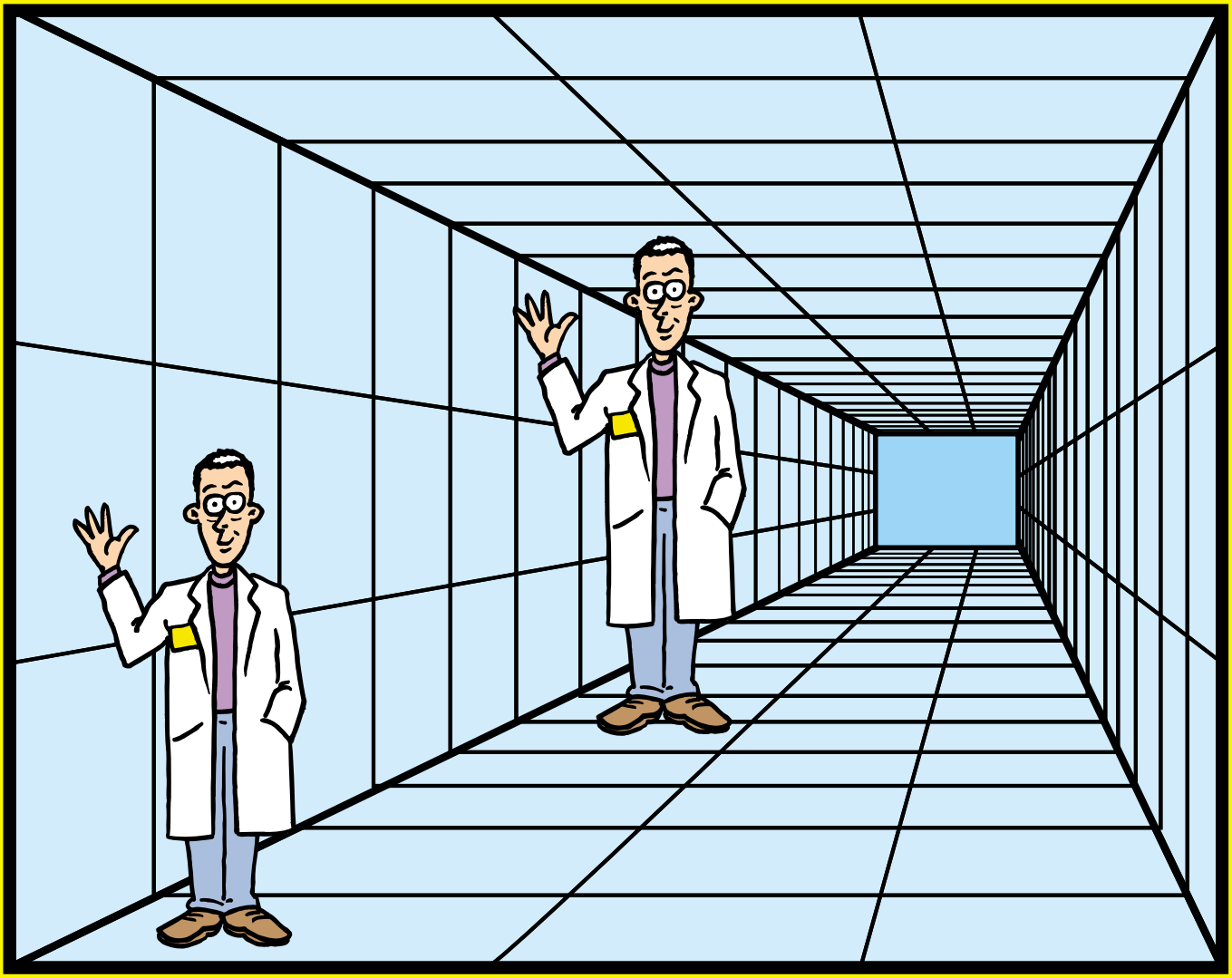
SOME THINGS YOU COULD INVESTIGATE:

1. Use a ruler to measure the actual length of both dark corner lines.
2. Why not try to re-draw the illusion in a different way to see what happens? For example, you could change the length of one or both of the thick dark lines; change the position of one or both of the thick dark lines on the 'grid'; or change the other lines of the grid itself in some way. Remember to only change one thing at a time to make it a 'fair test'.
3. What do you think is going on?

7 ILLUSION CONFUSION! - MEASURING TALLNESS -

WHAT TO DO:

1. Look at the two Dr Mark characters in the drawing below.
2. Without using a ruler, which Dr Mark looks the tallest or do they look the same height?



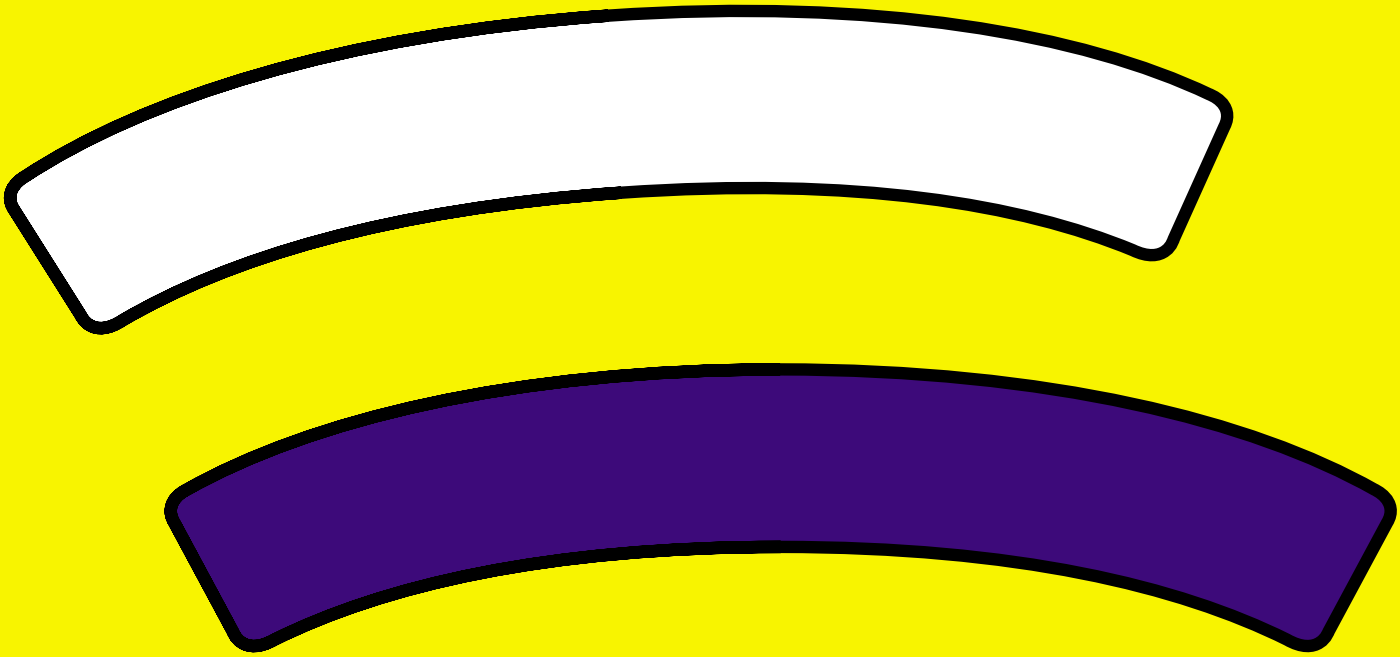
SOME THINGS YOU COULD INVESTIGATE:

1. Use a ruler to measure the actual height of both Dr Mark characters.
2. Why not try to re-draw the illusion in a different way to see what happens? To make this easier, you can draw thinker dark lines in place of the Dr Mark drawings. For example, you could change the length of one or both of your thicker dark lines; change the position of one or both of your thicker dark lines on the 'grid'; or change the other lines of the grid itself in some way. Remember to only change one thing at a time to make it a 'fair test'.
3. What do you think is going on?

7 ILLUSION CONFUSION!
- CURIOUS CURVES -

WHAT TO DO:

1. Look at the two arcs or curves drawn below.
2. Without using a ruler, which curve looks the longest or do they look the same length?



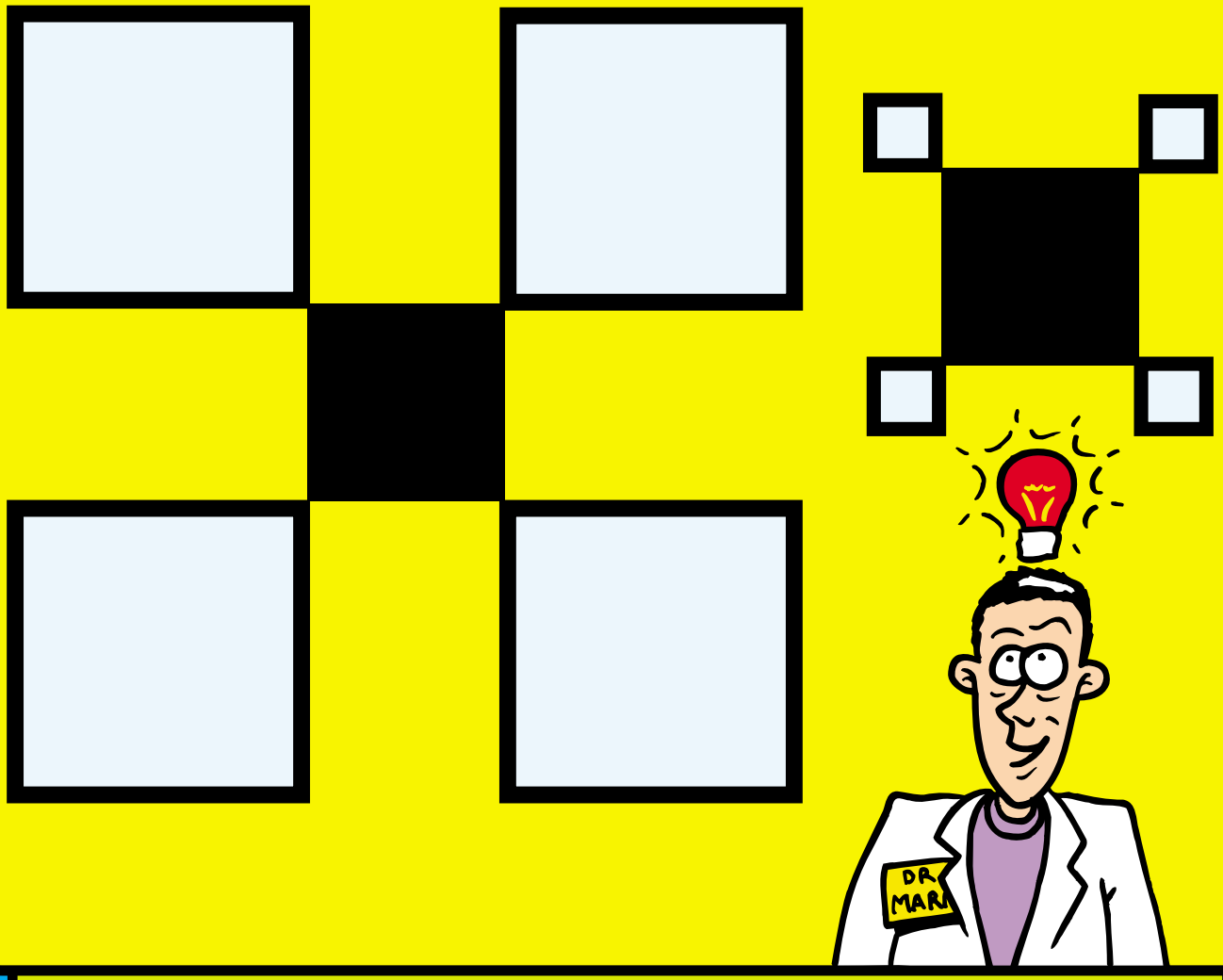
SOME THINGS YOU COULD INVESTIGATE:

1. Use a ruler to measure the actual size of both curves. Better still, why not copy and cut out the two curves and compare them against each other that way?
2. Using cut-out copies of the curves, what is the effect of directly swapping around their positions, with the white curve now beneath the grey curve?
3. Using cut-out copies of the curves, what is the effect of changing the position of one curve to the other in other ways, such as moving the curves further apart or have one curve bending one way and the other the opposite way back to back?
4. Why not try to re-draw one or both curves a different size or with a different 'bend' to see the effect?
5. What do you think is going on?

7 ILLUSION CONFUSION! - MEASURING SQUARES -

WHAT TO DO:

1. Look at the square patterns below.
2. Without using a ruler, which black square looks the largest or do they look the same size?



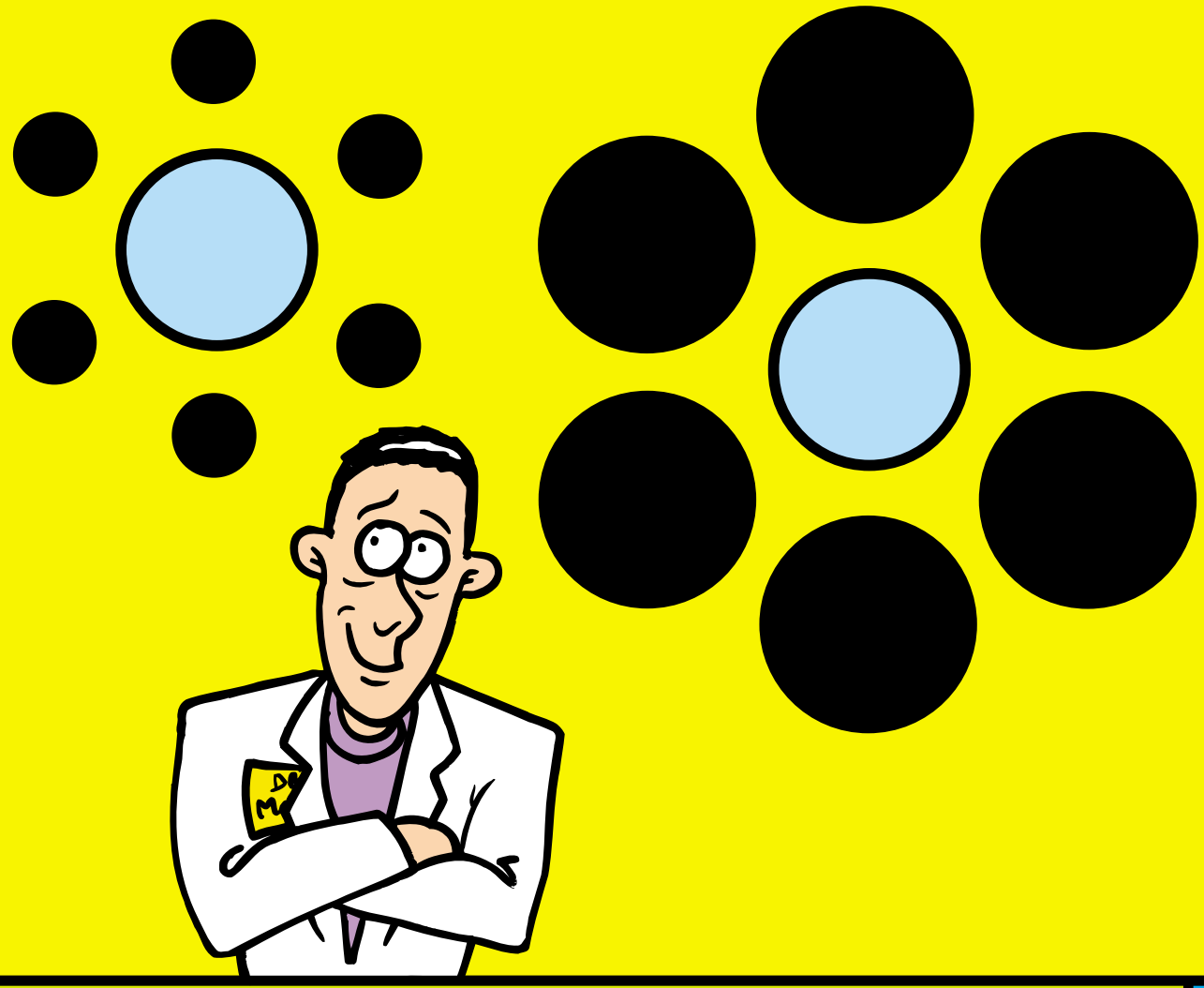
SOME THINGS YOU COULD INVESTIGATE:

1. Use a ruler to measure the actual size of both black squares.
2. Why not try to re-draw the illusion in a different way to see what happens? For example, you could change the size of one or both of the black squares; change the size of one or both sets of the white squares; draw the white squares not touching the black squares; change the distance between the two groups of squares; and change the squares to other shapes. Remember to only change one thing at a time to make it a 'fair test'.
3. What do you think is going on?

7 ILLUSION CONFUSION! - MEASURING CIRCLES -

WHAT TO DO:

1. Look at the circle patterns below.
2. Without using a ruler, which white circle looks the largest or do they look the same size?



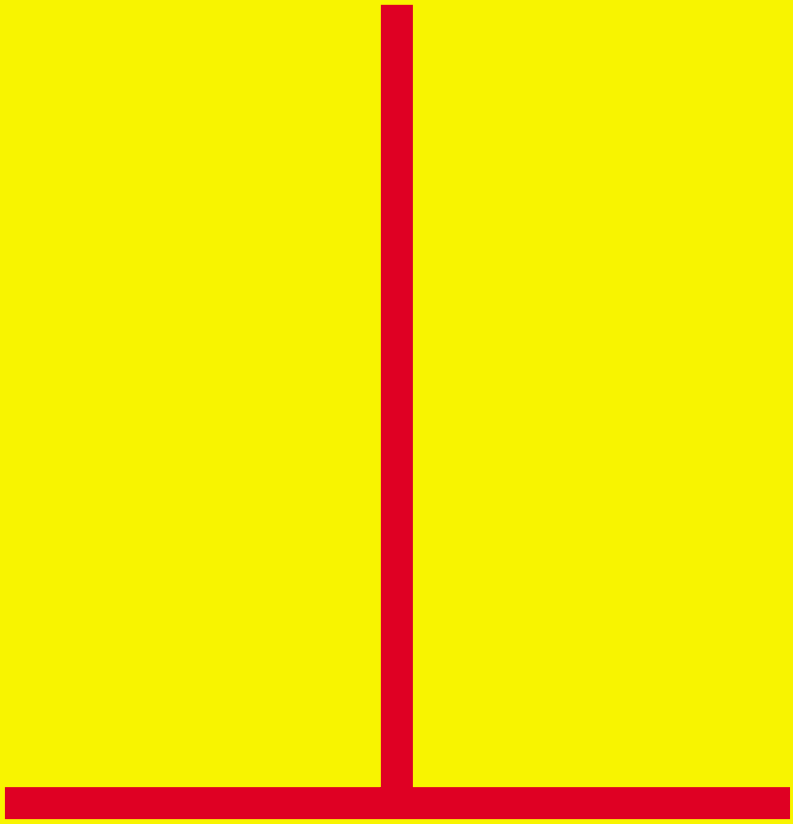
SOME THINGS YOU COULD INVESTIGATE:

1. Use a ruler to measure the actual size of both white circles.
2. Why not try to re-draw the illusion in a different way to see what happens? For example, you could change the size of one or both of the white circles; change the size of one or both sets of the black circles; draw the white circles at a different distance from the black circles; change the distance between the two groups of circles; and change the circles to other shapes. Remember to only change one thing at a time to make it a 'fair test'.
3. What do you think is going on?

7 ILLUSION CONFUSION! - MEASURING LINES -

WHAT TO DO:

1. Look at the two lines drawn together below as an upside-down capital 'T'.
2. Without using a ruler, which line looks the longest, the flat horizontal line or the up-right vertical line, or do they look the same length?



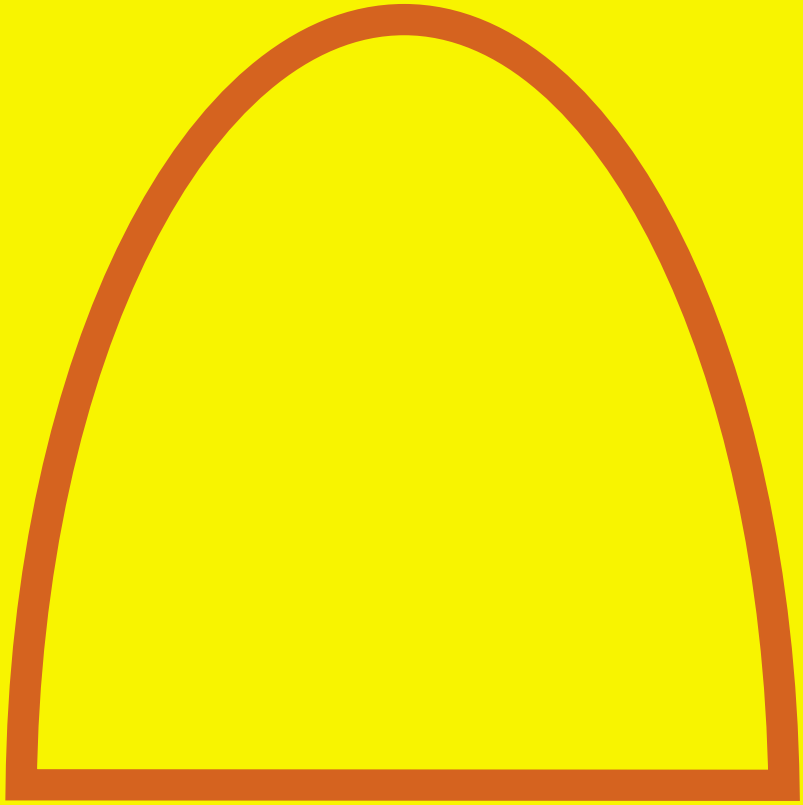
SOME THINGS YOU COULD INVESTIGATE:

1. Use a ruler to measure the actual length of each line.
2. Maybe try to draw a similar illusion for yourself, without actually measuring the lines. First draw the flat horizontal line and then the upright vertical line. Draw the vertical line to look the same length as the horizontal line but remember not to measure your lines as you draw them. Once you've drawn the two lines, only then use a ruler to measure whether you drew them the same length or not.
3. Why not try to re-draw the lines in a different way to see what happens? For example, you could re-draw the lines to look like an up-right capital 'T' or like a capital 'L'; or you could change the length of one or both of the lines; or change the position of one or both of the lines next to each other. Remember to only change one thing at a time to make it a 'fair test'.
4. What do you think is going on?

7 ILLUSION CONFUSION! - MEASURING ARCHES -

WHAT TO DO:

1. Look at the drawing of an arched doorway below.
2. Without using a ruler, which distance looks more: the height of the doorway, the width of the doorway at the floor, or do they both look the same?



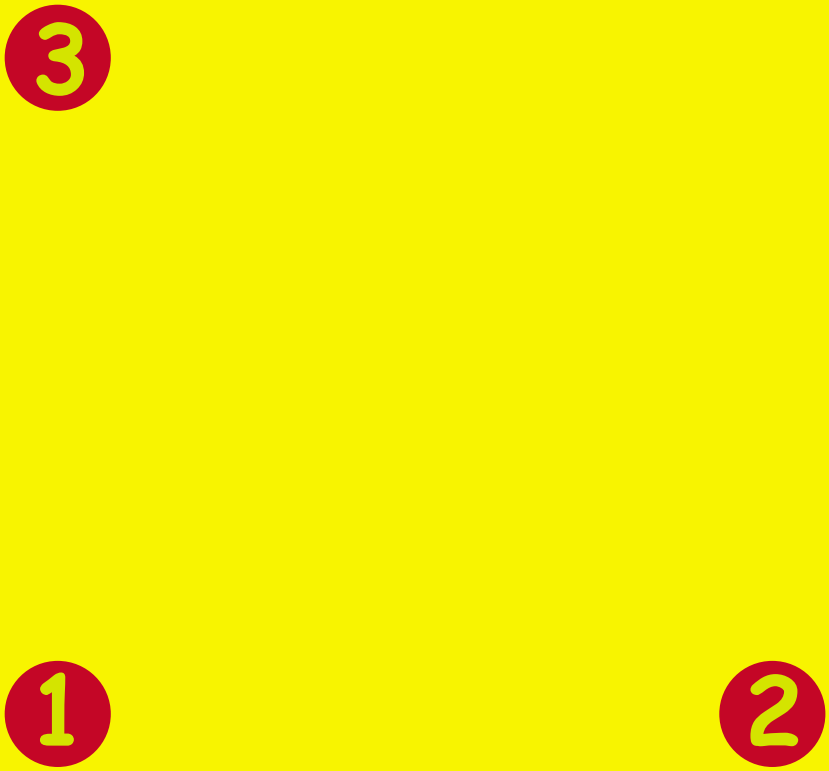
SOME THINGS YOU COULD INVESTIGATE:

1. Use a ruler to measure the actual distances described.
2. Maybe try to draw a similar illusion for yourself, without actually measuring the distances. First draw the straight horizontal line at the bottom of the door. Then draw the archway so that it looks the same height as the bottom width. Remember not to measure the distances as you draw the whole doorway. Once you've drawn the doorway, only then use a ruler to measure whether you drew the measurements of the height and bottom width the same or not.
3. Why not try to re-draw the shape of the arched doorway in a different way to see what happens? For example, you could draw the shape of the top of the doorway to look more like a rounded triangle or maybe draw a more squared door. Remember to only change one thing at a time to make it a 'fair test'.
4. What do you think is going on?

7 ILLUSION CONFUSION! - MEASURING DOTS -

WHAT TO DO:

1. Look at the three dots below, arranged to outline a capital 'L'
2. Without using a ruler, which measurement looks the longest: the horizontal distance between dot 1 and dot 2, the vertical distance between dot 1 and 3 or do they look the same distance apart?



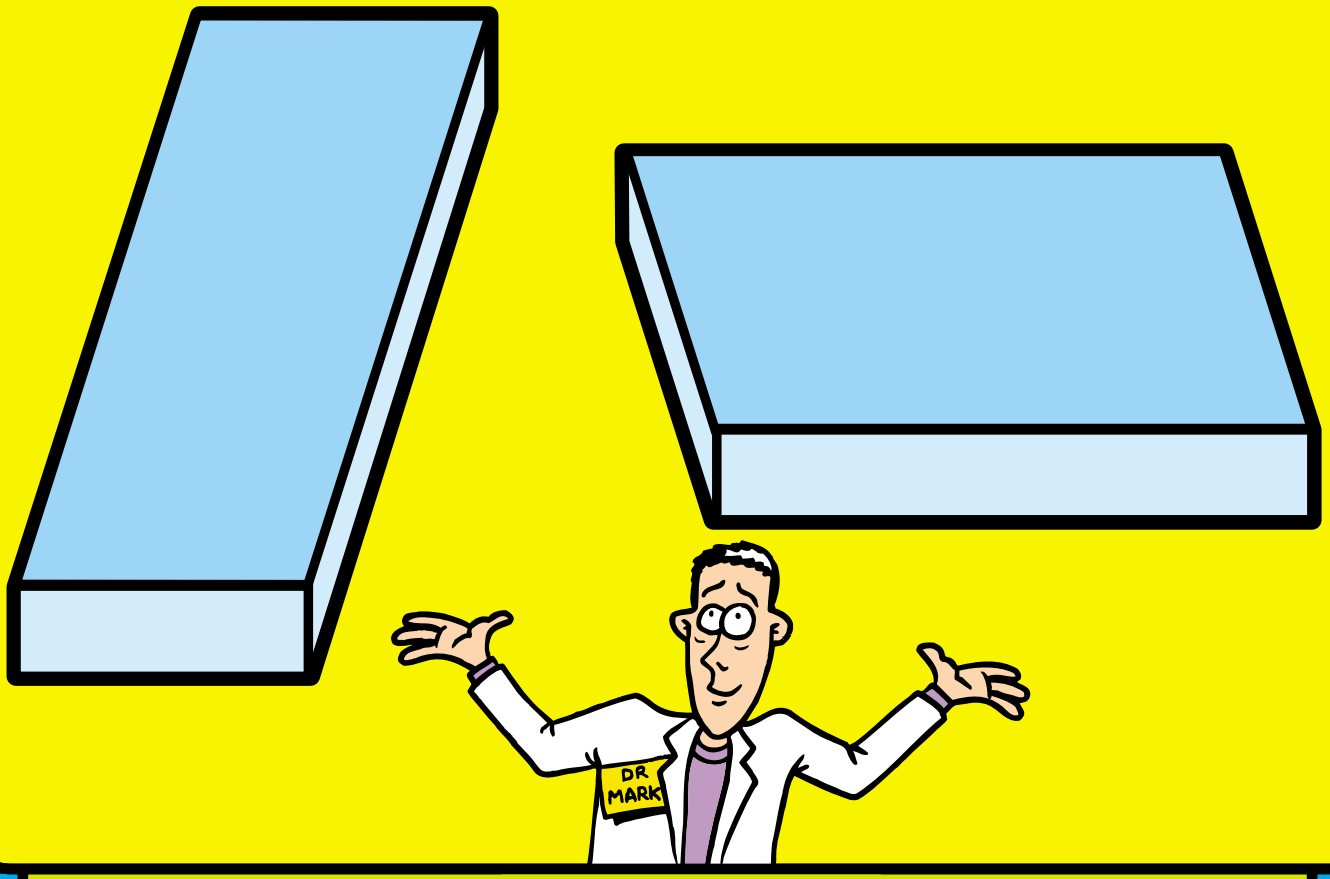
SOME THINGS YOU COULD INVESTIGATE:

1. Use a ruler to measure the actual distances described.
2. Maybe try to draw a similar illusion for yourself, without actually measuring the distances. First draw dots 1 and 2. Then draw dot 3 so that it looks like the vertical distance between dot 1 and 3 is the same as the horizontal distance between dots 1 and 2. Remember not to measure the distances as you draw the dots. Once you've drawn the three dots, only then use a ruler to measure whether you drew them the same distance apart or not.
3. Why not try to re-draw the position of the three dots in a different way to see what happens? For example, you could re-draw the three dots to look like an up-side-down capital 'L', or a backwards capital 'L' or you could change the distances between one or both pairs of dots. Remember to only change one thing at a time to make it a 'fair test'.
4. What do you think is going on?

7 ILLUSION CONFUSION! - MEASURING BLOCKS -

WHAT TO DO:

1. Look at the flat tops of the rectangular blocks drawn 3-D below.
2. Without using a ruler, which flat top looks the widest, which looks the longest or do they look all the same?



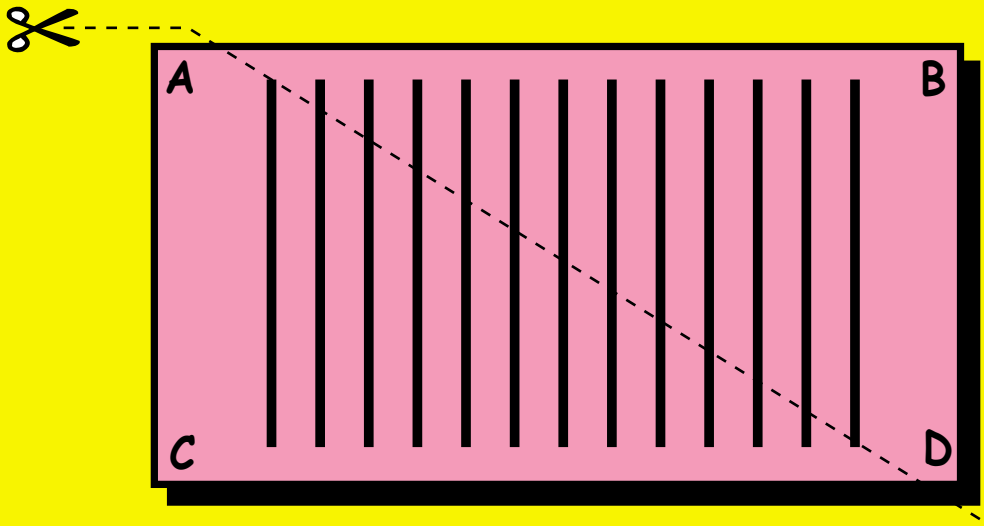
SOME THINGS YOU COULD INVESTIGATE:

1. Use a ruler to measure the actual size of each flat top.
2. Maybe try to draw a similar illusion for yourself, without actually measuring the distances. First draw one of the blocks and then try to draw the other so that both flat tops look the same shape and size. Remember not to measure any of the distances as you draw the blocks. Once you've drawn the two blocks, only then use a ruler to measure whether you drew them the same size and shape or not.
3. Why not try to re-draw the shape of the blocks in a different way to see what happens? For example, you could draw them to look thinner or thicker, or just draw the two tops so that they look like thin sheets rather than blocks. Remember to only change one thing at a time to make it a 'fair test'.
4. What do you think is going on?

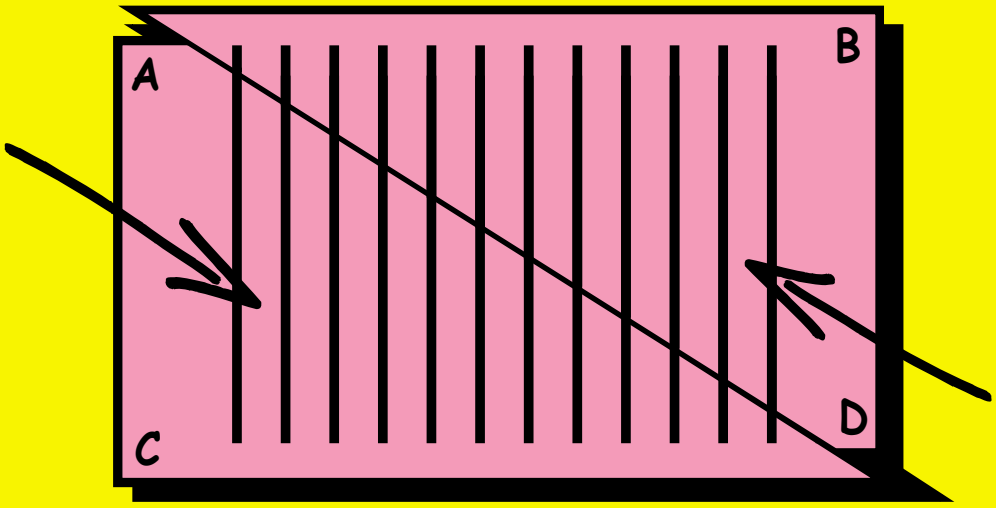
7 ILLUSION CONFUSION! - LOSING LINES -

WHAT TO DO:

1. Take a piece of paper and using a pencil and ruler very carefully draw THIRTEEN thick parallel lines in a rectangular 'block', as shown in the picture just below. Draw the lines 10cm long and 1cm apart. (The lines will be easier to draw if you draw on squared- or graph-paper)
2. Then draw a thin diagonal line AD from one corner of the block of lines to the opposite corner and extend the line to the edge of the paper. Now carefully cut along this line AD.



3. Carefully place the two pieces of paper together again on a table and line up the thirteen lines.
4. Then slowly slide the triangular sheets ACD and ABD past each other along the cut until all the parallel lines line up again as shown below.
5. Now count the parallel lines to see if you still have thirteen.



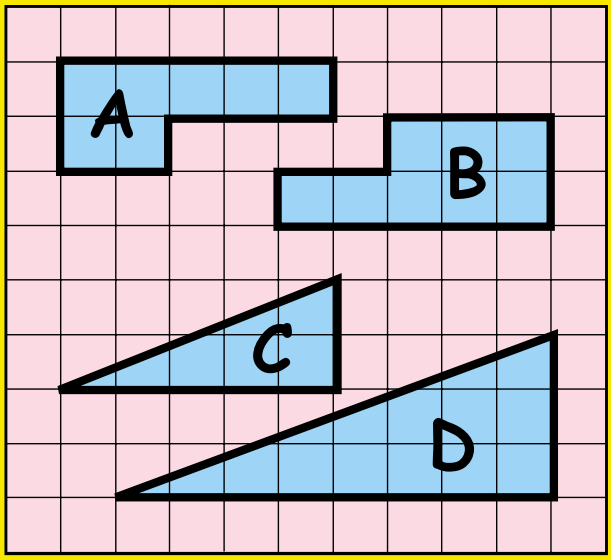
SOME THINGS YOU COULD INVESTIGATE:

1. Why not try drawing the illusion using a different number of parallel lines or different measurements, such as longer or shorter lines and bigger gaps between the lines?
2. What do you think is going on

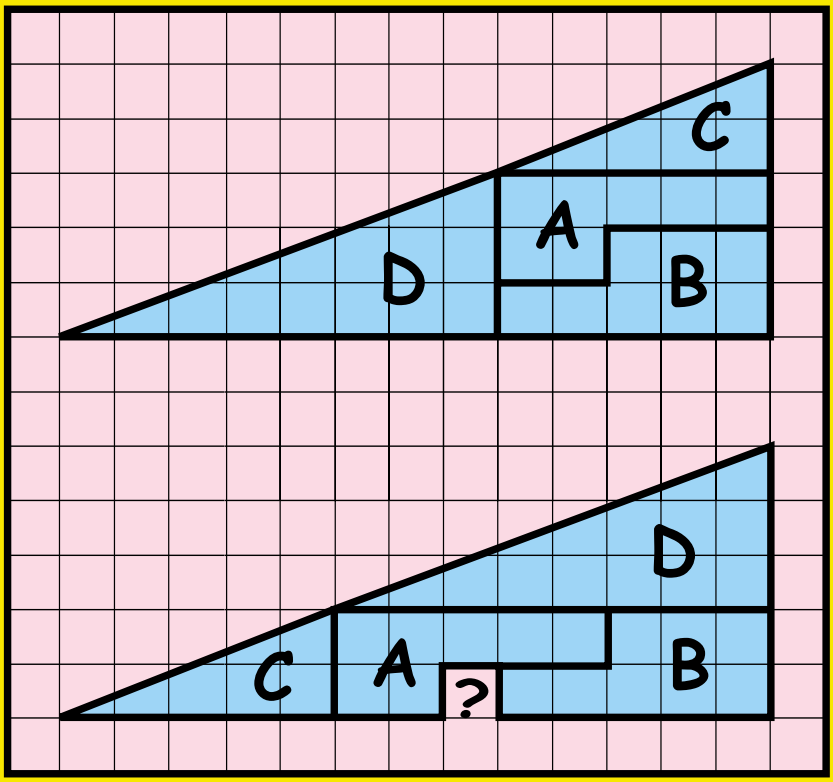
7 ILLUSION CONFUSION! - IMPOSSIBLE TRIANGLE -

WHAT TO DO:

1. You can take a sheet of squared- or graph paper, a pencil and a ruler, and carefully draw the four shapes – **A**, **B**, **C** & **D** - as shown just below on the left .
2. You can then carefully cut the shapes out with a pair of scissors.



3. You can see below that the four shapes can be arranged to fit together to form what looks like two large triangles **1** and **2** below.
4. Note that the four shapes – **A**, **B**, **C** and **D** - are exactly the same in both large triangles. The large triangles also look exactly the same in shape, size and area.



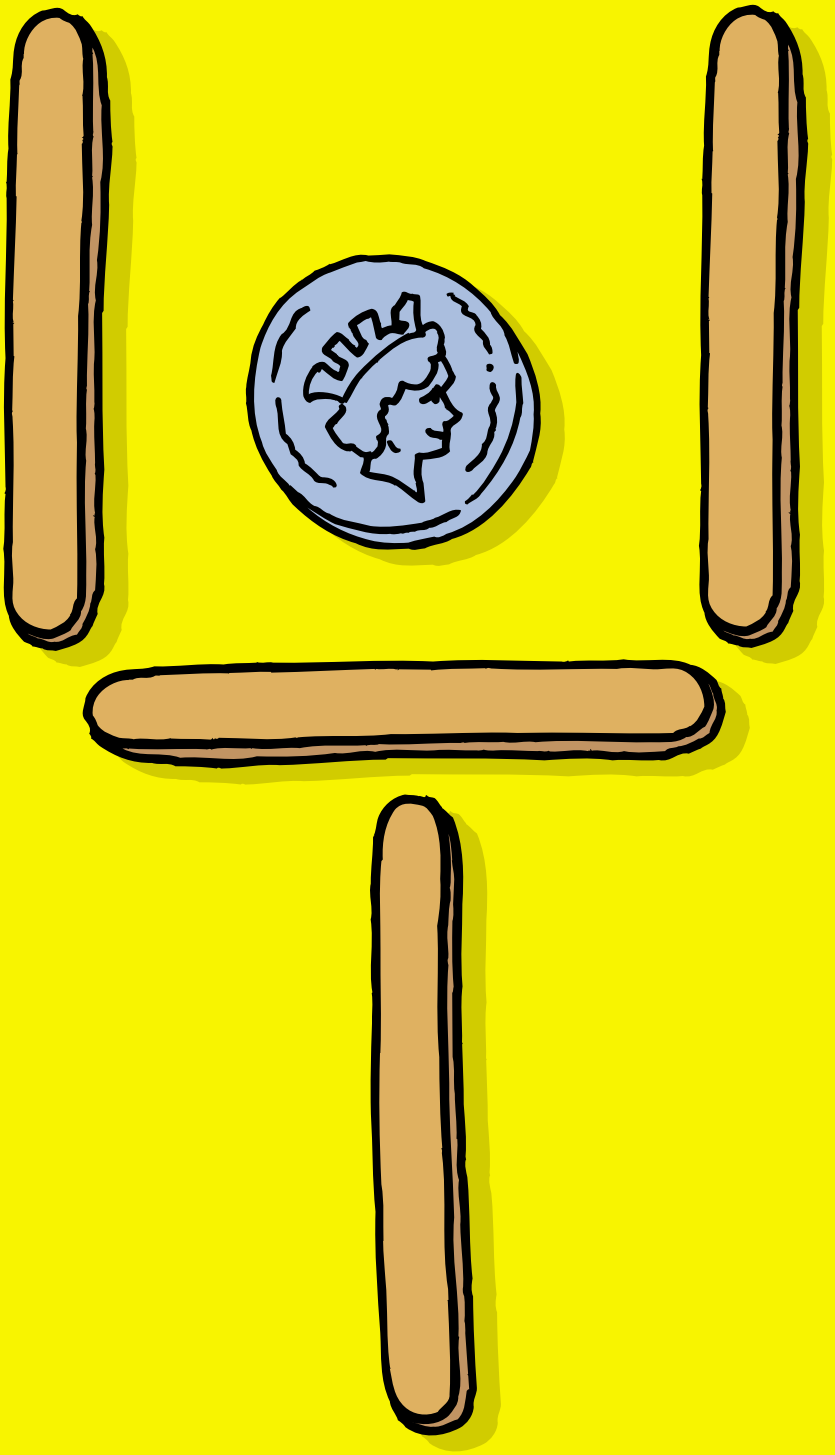
(**CLUE:** The triangular outlines are not what they seem and they are not exactly the same, but how?)

SOME THINGS YOU COULD INVESTIGATE:

If everything really is the same in both large triangles, there should NOT be a square-shape gap – '**?**' – in triangle 2! Try to discover how this illusion works.

8 STICKY PUZZLES 1

Below is a stick-picture of a glass with an object inside. Without touching the object inside, how can you move only **TWO** sticks so that it all ends up looking like the object is outside the glass but the glass remains exactly the same shape?

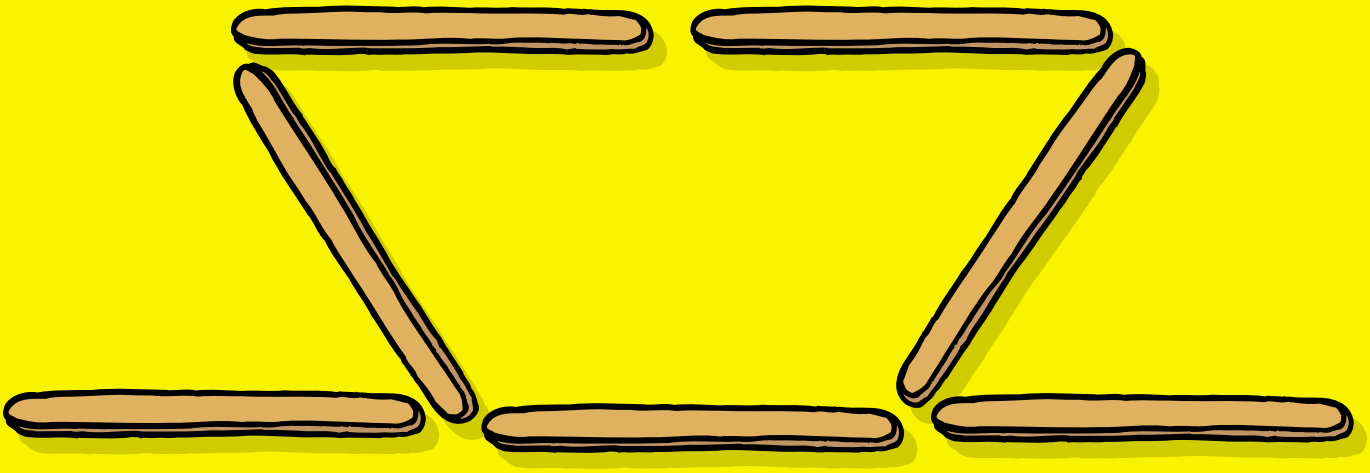


Good clue: The glass will end up looking upside down.

Really good clue: Slide the horizontal stick left or right half its length, then move one of the sticks above.

8 STICKY PUZZLES 2

Below is a stick-picture of a cup and saucer, by moving only **TWO** sticks how can you make it look like a diamond and a triangle together?

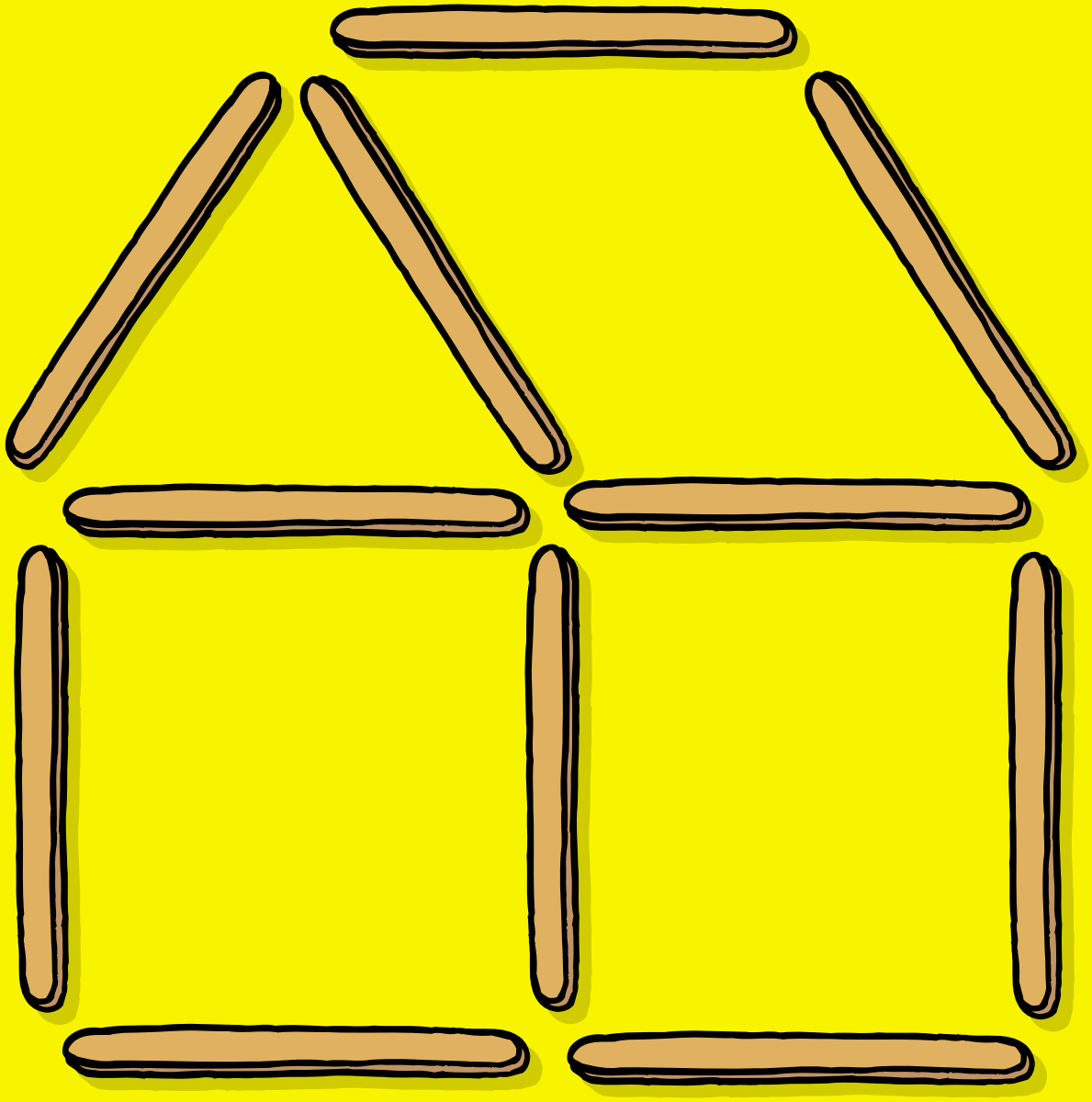


Good Clue: The diamond and the triangle will be touching each other side by side
Another Good Clue: Use one stick from the edge of the saucer and one from the top of the cup

8 STICKY PUZZLES 3

By moving only **ONE** stick how can you:

1. Make it look like the house faces the other way?
2. Make the stick picture below look like two houses?

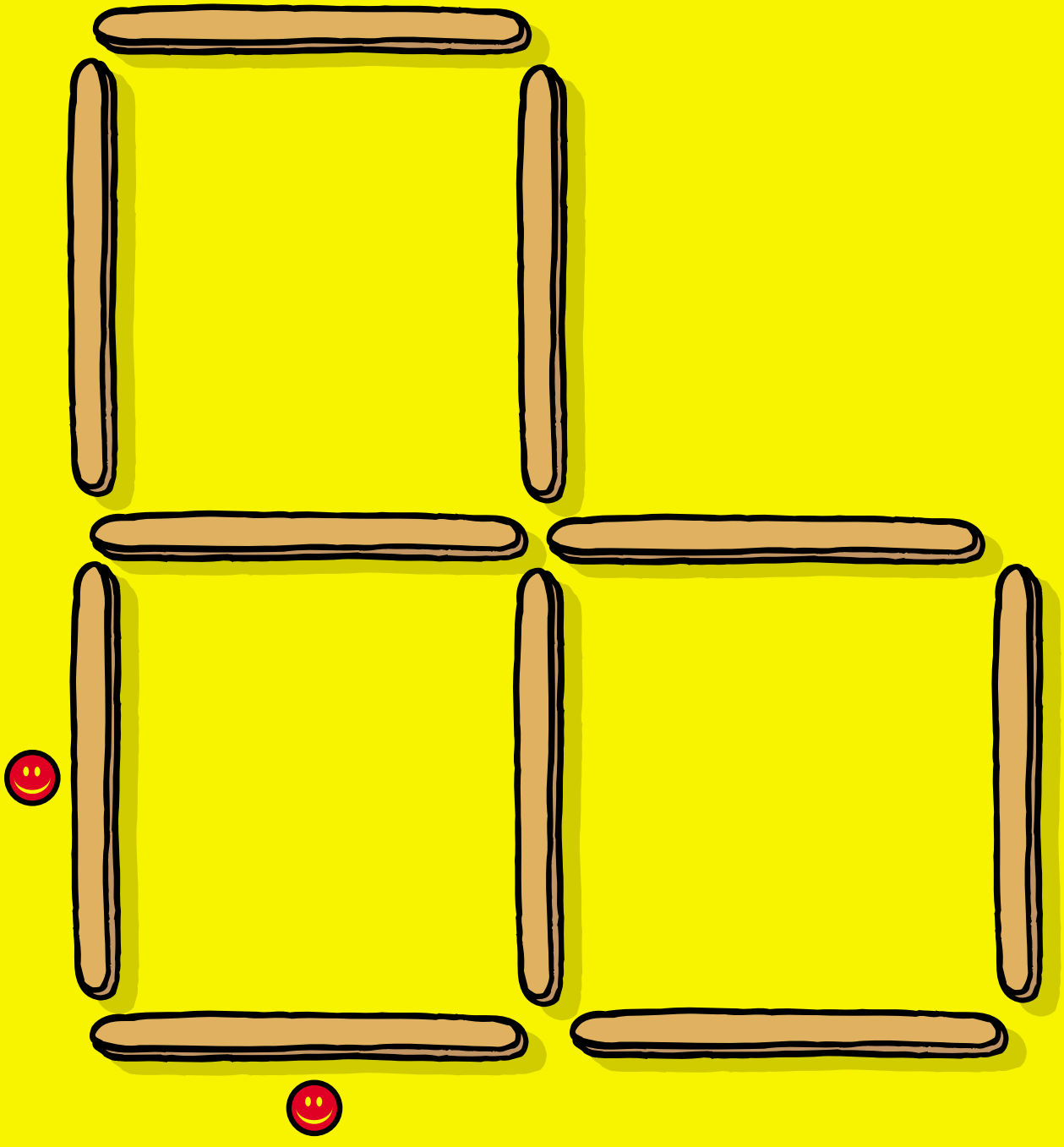


Clue: The stick you need to move for each problem is in the roof.

8 STICKY PUZZLES 4

By moving only **TWO** sticks how can you change the three equal size squares to look like:

1. four equal size rectangles?
2. four equal size triangles?
3. five squares?
4. two equal size triangles and two equal size squares?
5. one large square and one smaller square?
6. three triangles?

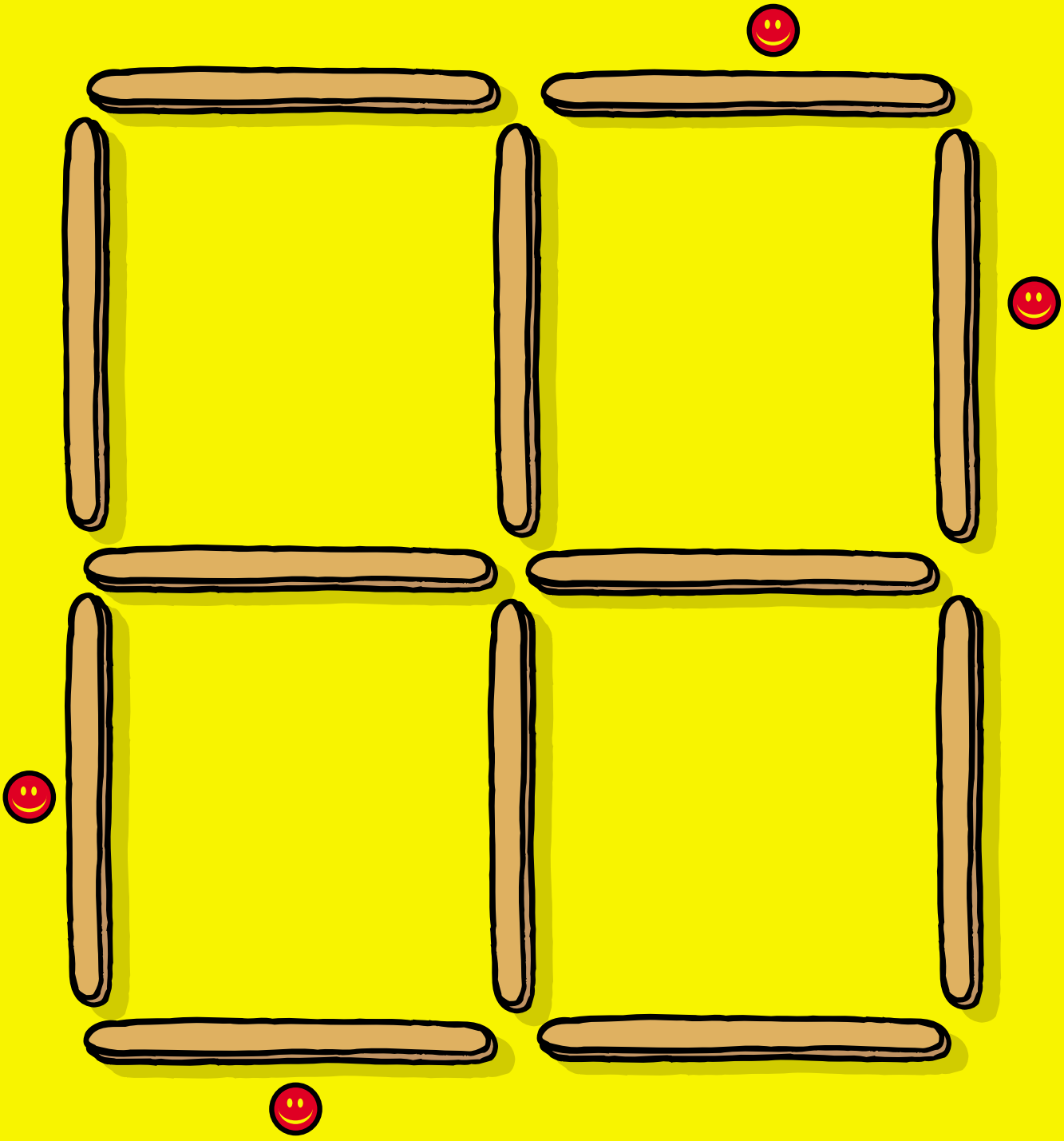


Clue: To answer 1,2,3,& 4 you need to move the sticks next to the smiley faces; for 5&6 the sticks inside.

8 STICKY PUZZLES 5

By moving only **FOUR** sticks how can you change the four equal size squares to look like:

1. Three equal size squares?
2. Eight equal size squares?
3. Six equal size triangles?
4. Eight equal size triangles?



Good clue: You move the same sticks to solve each problem.

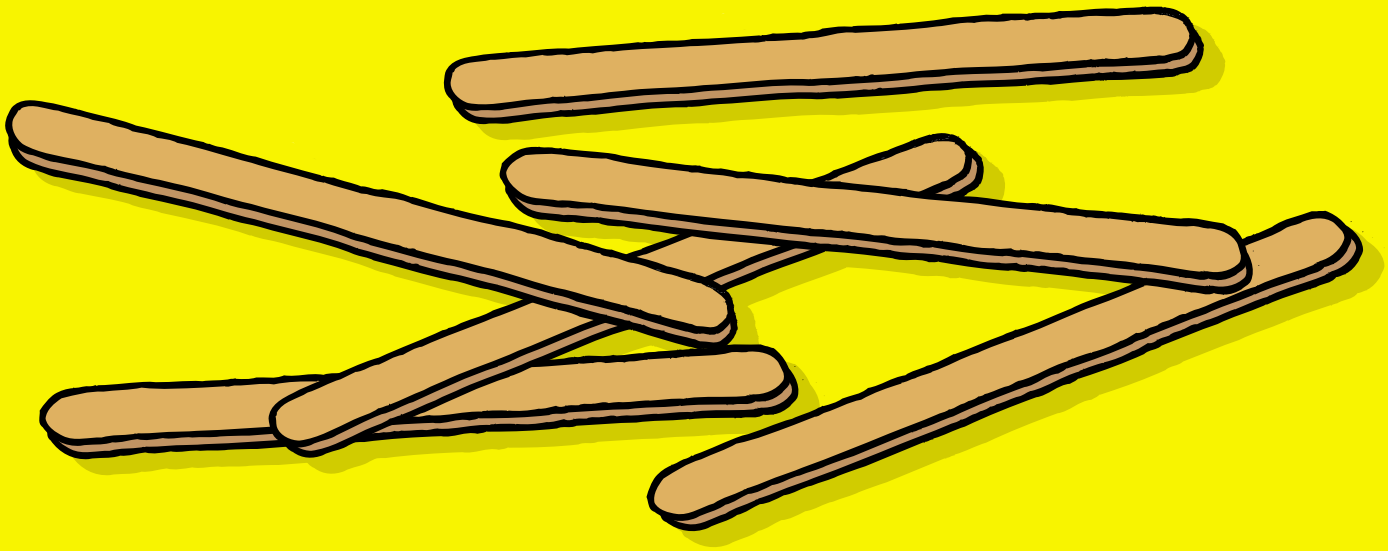
Really good clue: Move the four sticks next to the smiley faces

8 STICKY PUZZLES 6

PART A

In an equilateral triangle, all the sides are exactly the same length.
By using **SIX** identical sticks how can you:

1. Make one equilateral triangle?
2. Make two equilateral triangles?
3. Make four equilateral triangles?



PART B

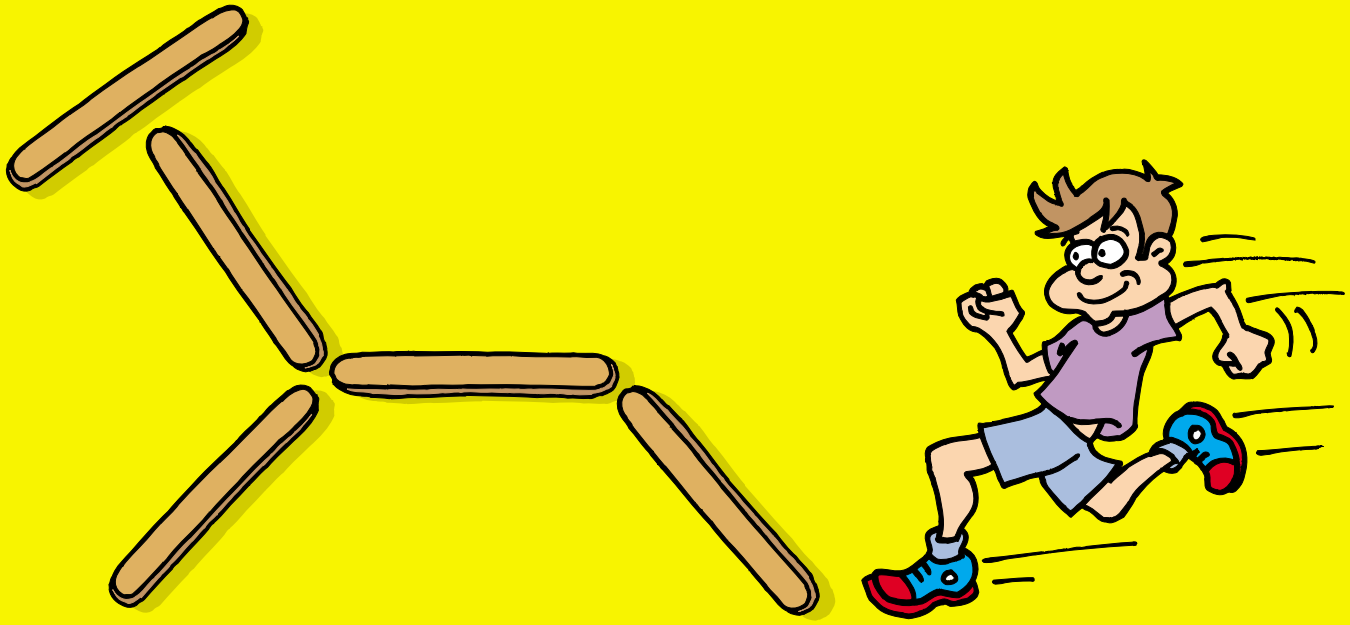
How can you arrange **SIX** identical sticks on the table so that each stick touches **ALL** the other sticks?

Part A clue: To answer questions 1 and 2 you need to think in 2D and for 3 in 3D!
Part B clue: You will need to very carefully arrange the sticks in two layers, so think in 3D again!

STICKY PUZZLES 7+8

7

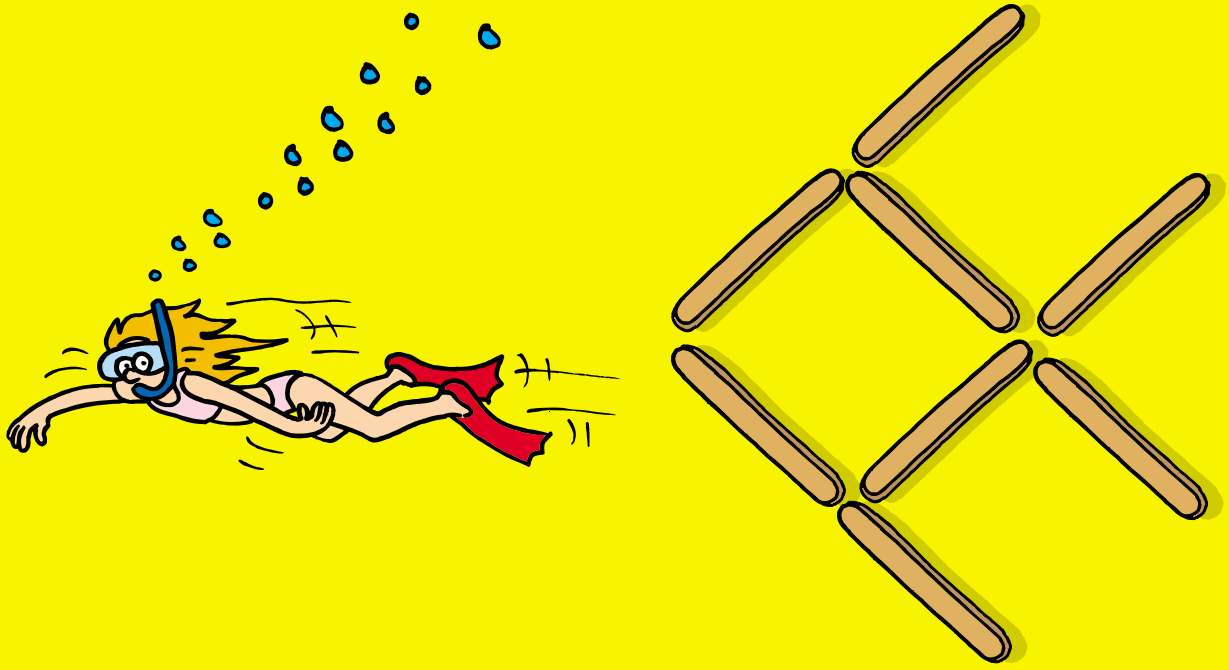
Below is a stick-picture of a boy chasing after a running horse.
By moving only **ONE** stick, how can you make the horse turn around and face the boy?



CLUE : You would **NOT** want to be kicked by this!

8

Below is a stick-picture of a giant fish chasing after a swimming girl.
By moving only THREE sticks, how can you make the fish swim away in the opposite direction?

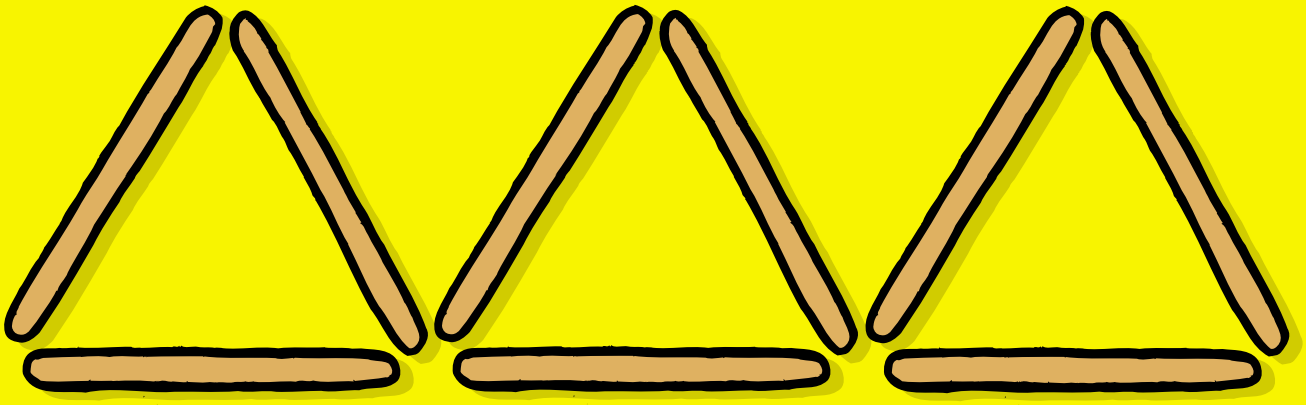


Clue: Try using the two lower fins and the lower part of the fish's face

STICKY PUZZLES 9+10

9

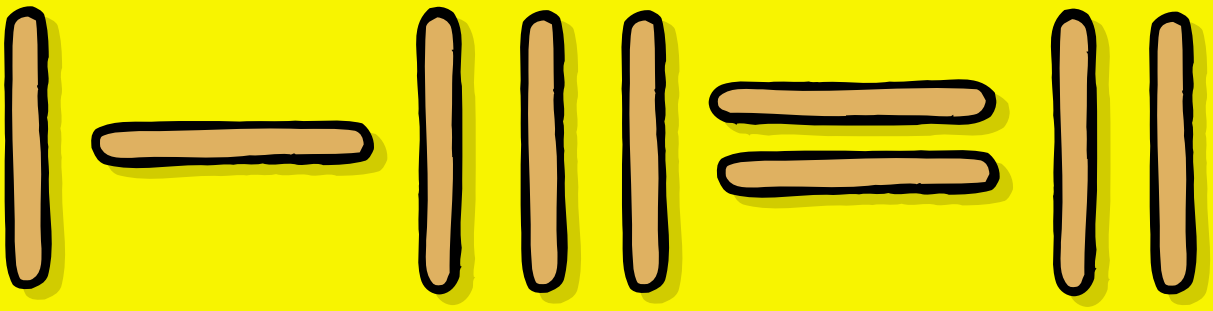
Just below are **THREE EQUILATERAL** triangles.
By moving only **THREE** sticks, how can you make **FIVE EQUILATERAL** triangles?



CLUE : Move one of the end triangles to make four small triangles and one larger triangle

10

Below is a 'stick-sum' using ancient Roman numbers.



In modern numbers it would read: 1 – 3 = 2
The problem is that 1 – 3 = 2 **IS THE WRONG ANSWER!**

By moving only **ONE** stick, and still using Roman numbers,
how can you make the sum read correctly?

Clue: You only need one in front of the equals sign.

PUZZLING PIECES!

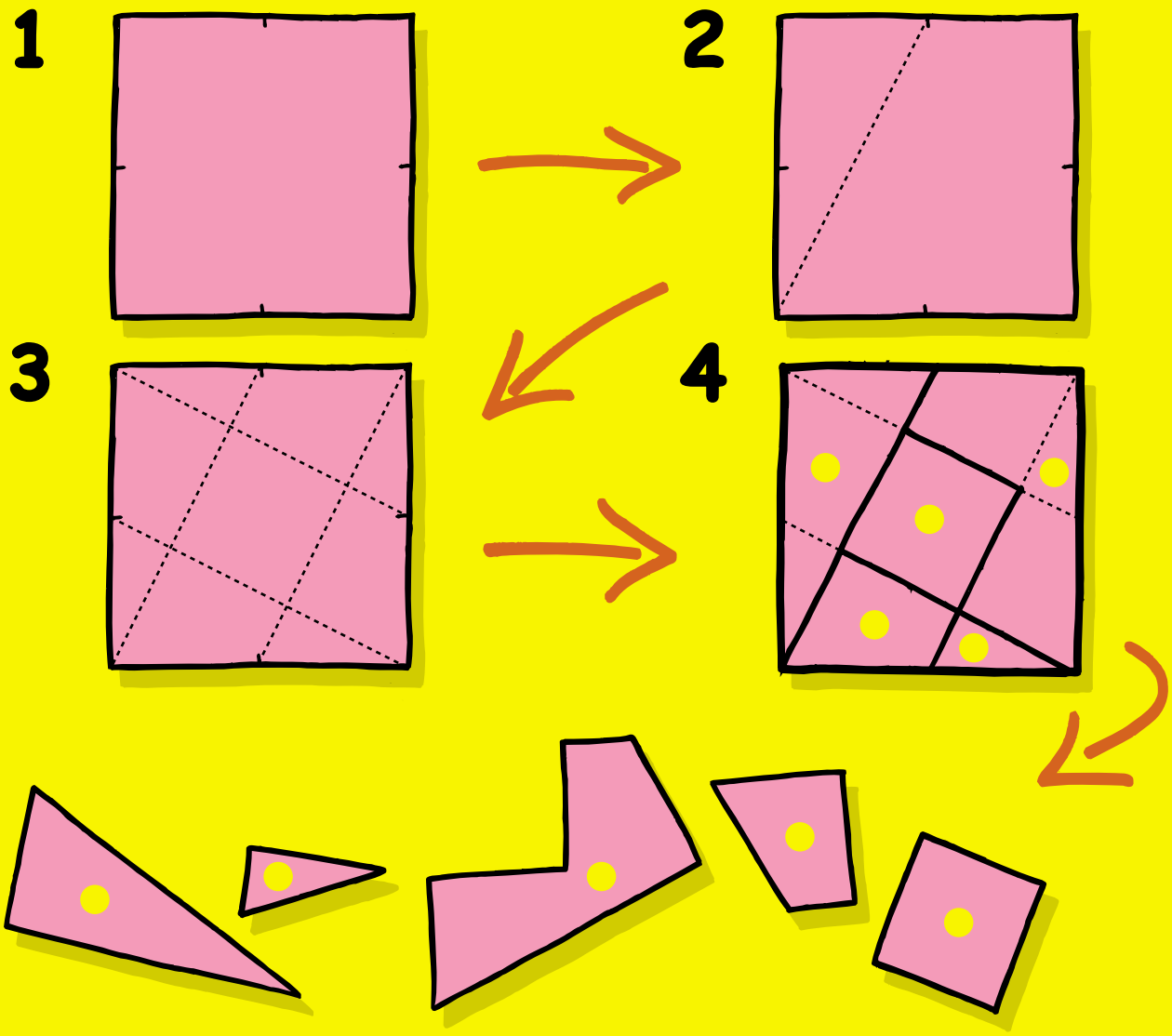
WHAT YOU NEED:

- A sheet of paper or card
- A pencil
- A ruler
- A pair of scissors

WHAT TO DO:

First we need to make our **'Puzzling Pieces'**.

1. Using your pencil and ruler, draw a square on your sheet of paper (or card) and make a tiny pencil mark exactly halfway along each edge of the square
2. Draw a faint, straight line extending between the pencil mark along the top edge of your square down to the bottom-left corner
3. Draw similar lines from each of the remaining three pencil marks to their corresponding opposite corners.
4. Draw the darker lines along the faint lines as shown in figure 4 below, and draw a small spot on each of the five main outlined shapes you can see (the spots are so you know which side should be facing up)
5. Finally, carefully cut up the square until you have the five separate pieces



9

PUZZLING PIECES!

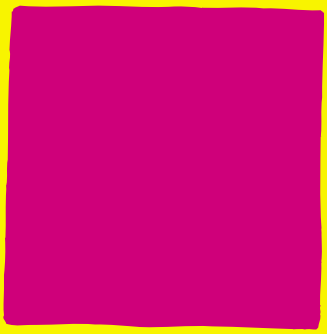
SOME THINGS YOU COULD INVESTIGATE:

Using **ALL** five different-shape pieces with the spot on each, try to make each of the five shapes in turn as shown below.

YOU MUST:-

- Arrange the pieces side by side like you would make a 'picture puzzle'
- Use **ALL** five pieces to make each shape
- Be able to see the spot on each piece
- **NOT** lay or overlap one piece on top of another in any way

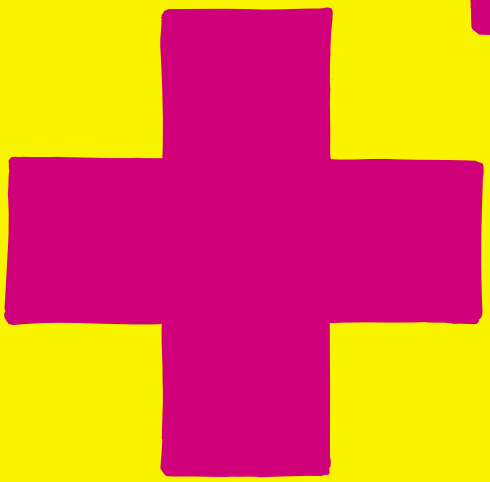
SQUARE



RECTANGLE

TRIANGLE

CROSS



PARALLELOGRAM

FURTHER INVESTIGATION:

Make a set of five pieces **WITHOUT** drawing a spot on each piece - without the spot you won't know straight away which side should be facing up. Shuffle, flip and drop the five pieces a few times onto your table to mix them up. Then try the above investigation again but this time using these un-marked pieces.

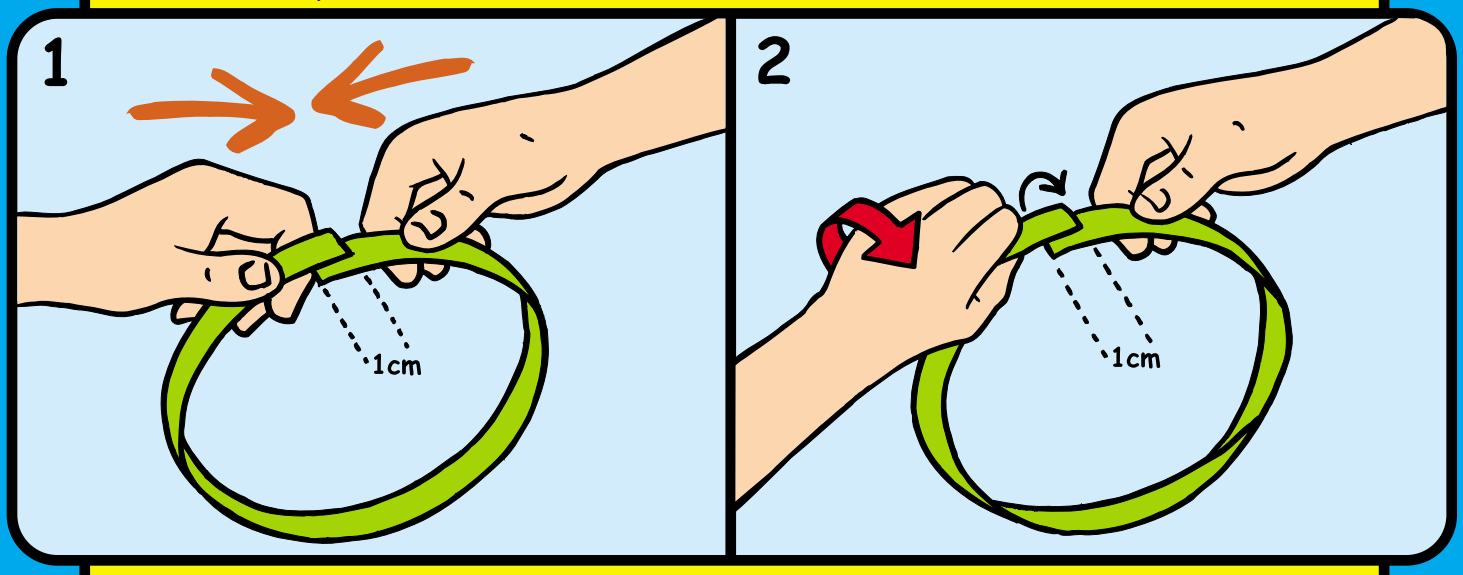
10 VANISHING BANDS & LINKING LOOPS

WHAT YOU NEED:

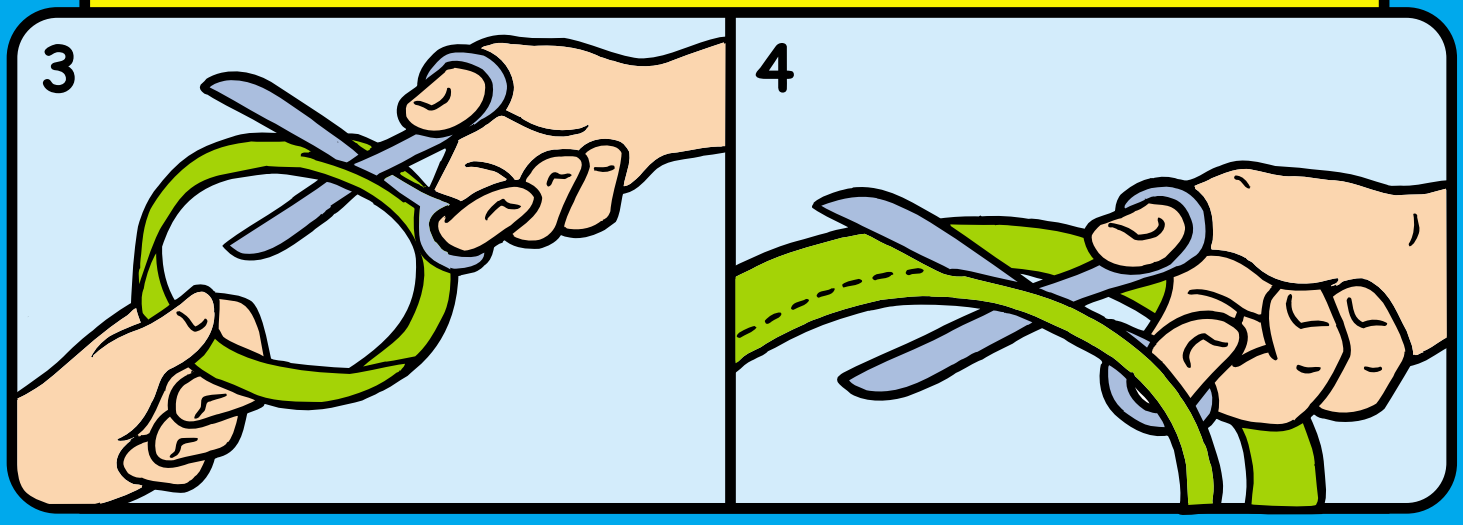
- Several strips of paper about 30cm long (any longer is OK) and about 3cm wide
- A pair of round-nosed 'safety' scissors
- Sticky-tape
- A pencil or pen (optional)

WHAT TO DO:

1. Take a strip of paper and bend it around to make a loop or band, overlapping the ends of the strip by about 1cm.
2. Take hold of one of the overlapping ends, twist or turn it over half a turn (through 180 degrees) and then place it back overlapping the other end again. Then use sticky tape to stick the overlapping ends together. You should now have a loop or band with a half-twist in it."



3. Using the scissors, **CAREFULLY** cut the band length-ways along the centre of the strip, as if trying to cut it into two separate thinner bands. Cut right the way around the band completely and see what happens.
4. Repeat the experiment with a new half-twisted band of paper, but instead of cutting along the centre of the strip, make your cut about one-third of the way in from one 'edge' of the strip. Keep cutting around the band and holding your one-third position from the edge until you come back to where you started from. See what happens this time.



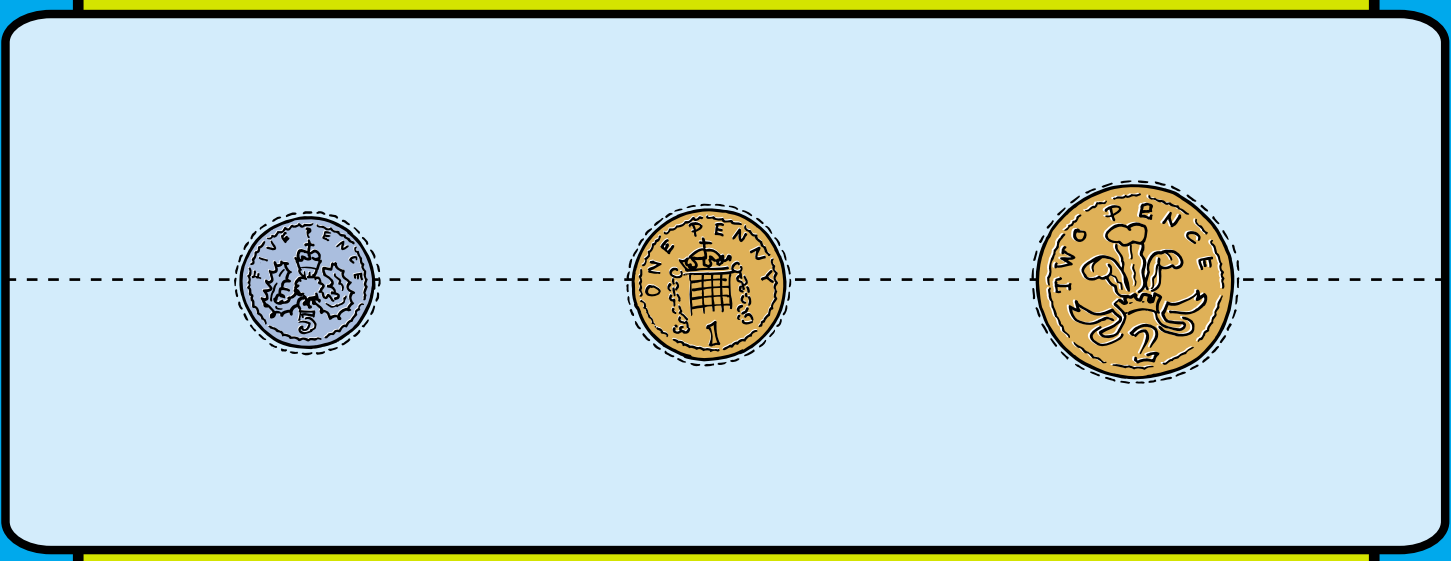
11 SHRINKING COINS OR STRETCHING HOLES?

WHAT YOU NEED:

- A sheet of paper or small sheet of thick, soft but strong **(though NOT stretchy)** plastic. Perhaps you could cut the small sheet of plastic from a thick plastic bag.
- Three different size round coins, such as a 1p, 2p and 5p **(in British money)**
- A fine-tipped pen (or sharp pencil) which will work on the paper or plastic you are using.
- A pair of small, sharp scissors – nail-cutting scissors are very good here.

WHAT TO DO:

1. Take your sheet of paper (or plastic) and **VERY CAREFULLY** draw circles around your three coins as shown below. Make sure that you draw your circles as closely around the edge of each coin as you can.



2. Now use the small pair of sharp scissors to **VERY CAREFULLY AND SLOWLY** cut around each of the circles you've drawn.

   CUTTING HINT: You may find these cuts a little easier to do if you fold the sheet accurately along the dotted line shown above, which cuts each circle in half. On folding, this creates three half or semi-circles to cut around rather than whole circles – but you must fold accurately.

   Either way, you should end up with three holes in the sheet of paper (or plastic), each hole being about the same size as each of the coins.

3. You should be able to carefully push the 2p coin through the 2p-size hole, without damaging or stretching the paper or plastic sheet. Try this for yourself to make sure.

SOME THINGS YOU COULD INVESTIGATE:

1. How can you push the 2p coin through the 1p-size hole without damaging or stretching the paper or plastic sheet?

   CLUE : Bend the hole.

2. Can you push the 2p coin through the 5p-size hole without damaging or stretching the paper or plastic sheet?

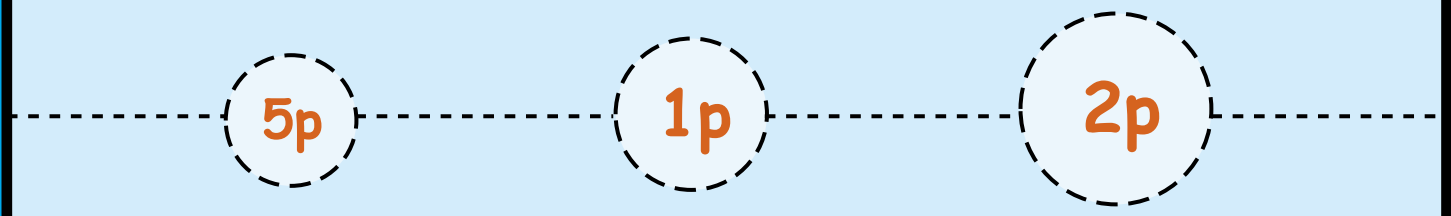
3. How would describe what happens to the holes to make them big enough for the coin to fit through?

4. **A TRICKIER QUESTION USING ALGEBRA**:
   How could you find out what's the smallest size circle through which a 2p coin might be made to fit in the same way?

   CLUE : You could carry on cutting out smaller and smaller holes (though drawing and cutting them could be difficult), or you could think about the numerical relationship between the **diameter** of a circle (which is the widest width across it) and the **circumference** of a circle (which is the distance around the outside).

- CIRCLES TO CUT AROUND -

To save you the effort and time in drawing the circles yourself, you can instead make a copy of this page (onto paper or plastic) and simply cut around the circles I've drawn for you below



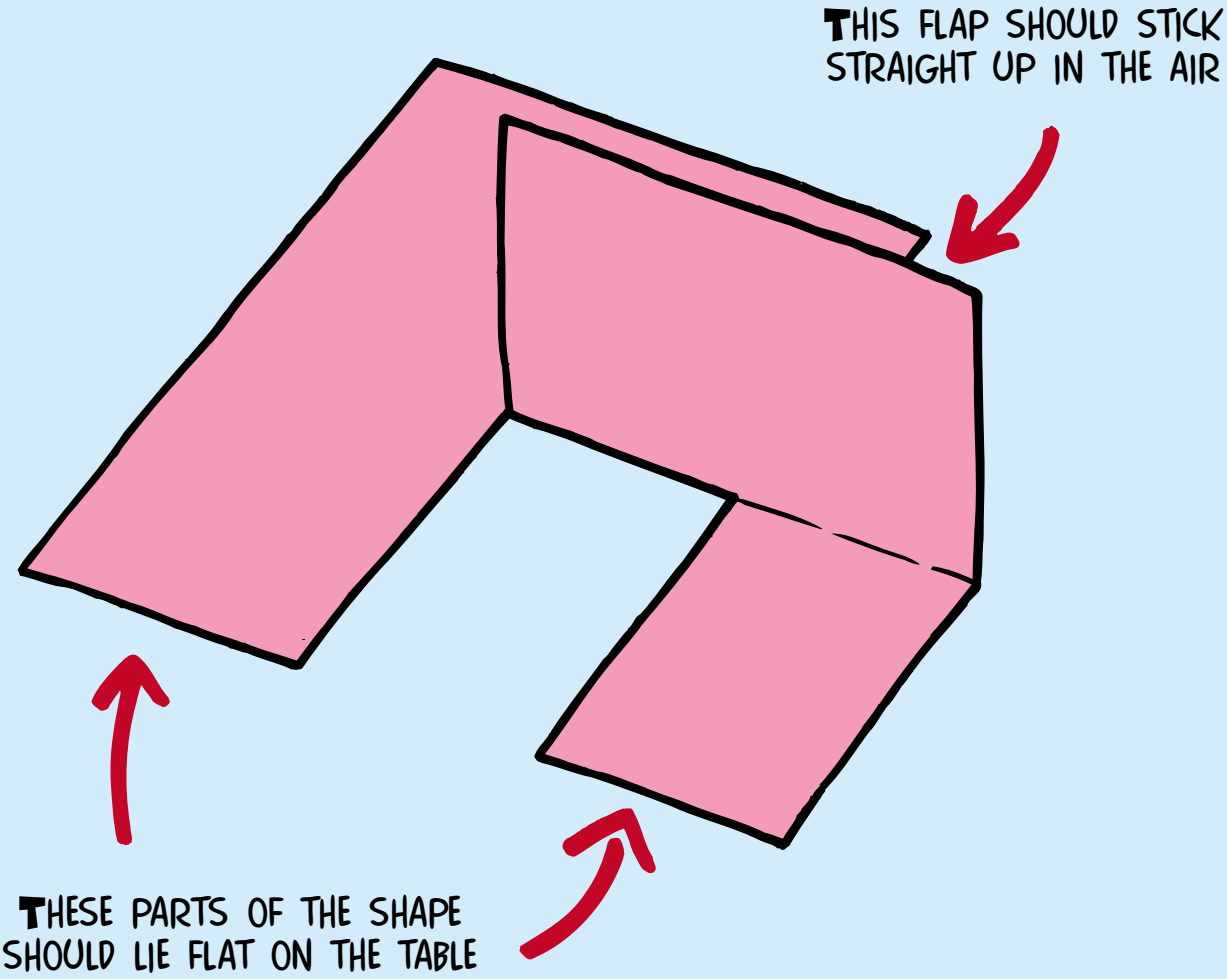
12 STRANGE STRUCTURES 1!

WHAT YOU NEED:

- Some sheets of paper or thin card
- Scissors

WHAT TO DO:

1. Study carefully the 3D-shape drawn below. It can be cut and folded from only one sheet of paper or card.



2. Try to make the above 3D-structure. Use only a single sheet of paper or card and a pair of scissors.

NOTE: You **MUST NOT** use any sticky tape or glue.

CLUE: You only need to make two cuts and two folds

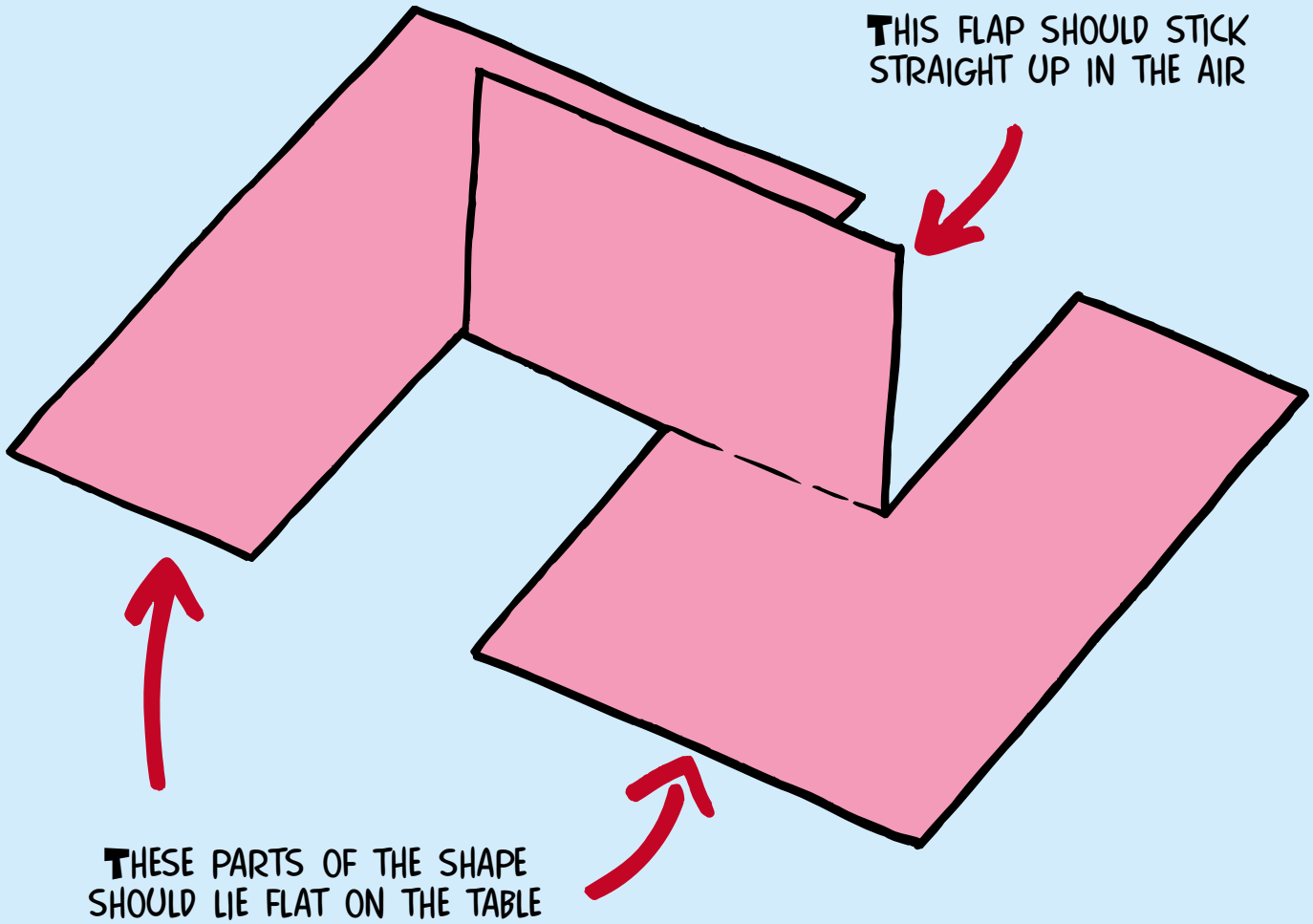
12 STRANGE STRUCTURES 2!

WHAT YOU NEED:

- Some sheets of paper or thin card
- Scissors

WHAT TO DO:

1. Study carefully the 3D-shape drawn below. It can be cut and folded from only one sheet of paper or card.



2. Try to make the above 3D-structure. Use only a single sheet of paper or card and a pair of scissors.

NOTE: You **MUST NOT** use any sticky tape or glue.

CLUE: You only need to make three cuts and two folds

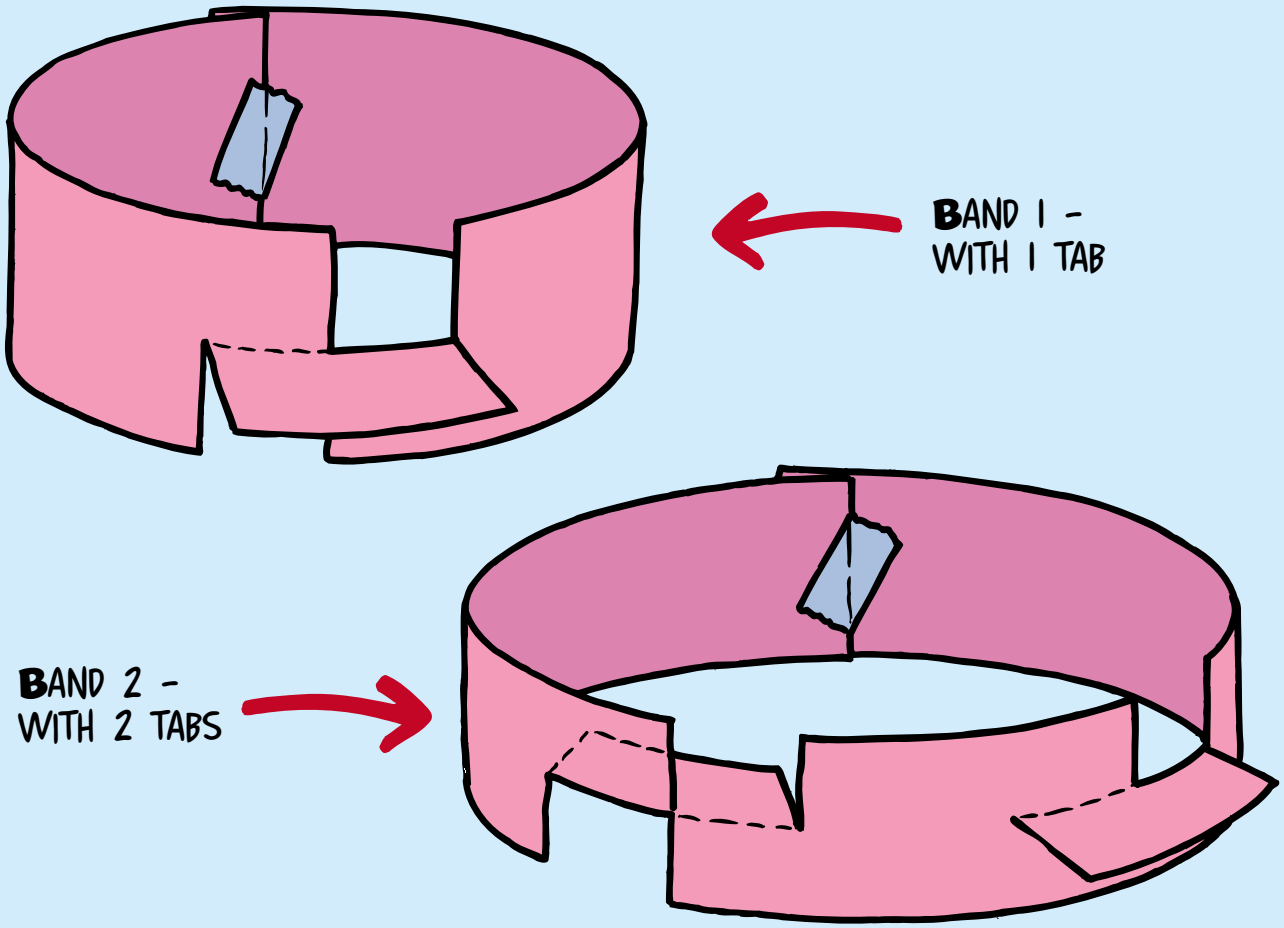
12 STRANGE STRUCTURES 3!

WHAT YOU NEED:

- Some sheets of paper or thin card
- Scissors
- Sticky tape or glue

WHAT TO DO:

1. Study carefully the two 3D-shapes drawn below-Band 1 & 2. Each shows a band made from a single strip of paper or thin card, with flaps or tabs sticking out.



2. Try to make each of the above 3D-structures. Use only the materials listed above but note that you must use the sticky tape (or glue) ONLY to join the ends of the strip to make the band, as shown in the drawings above.
3. Try to make the above structures by starting with an uncut band of paper

CLUES: for Q2 - First cut, then fold, then join the ends together;
and for Q3 - Twisted bands

13 POTTY PAPER-CLIPS!

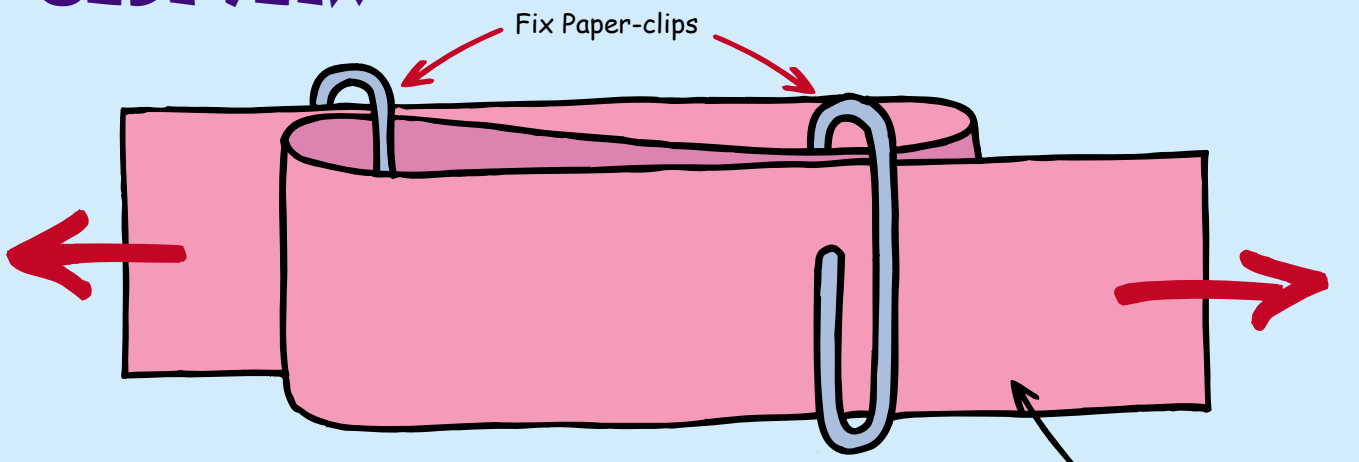
WHAT YOU NEED:

- A few strips of paper
(thicker paper may 'work better' than thinner paper)
- 2 or more metal or plastic paper-clips
(larger paper-clips may 'work better' than smaller ones)

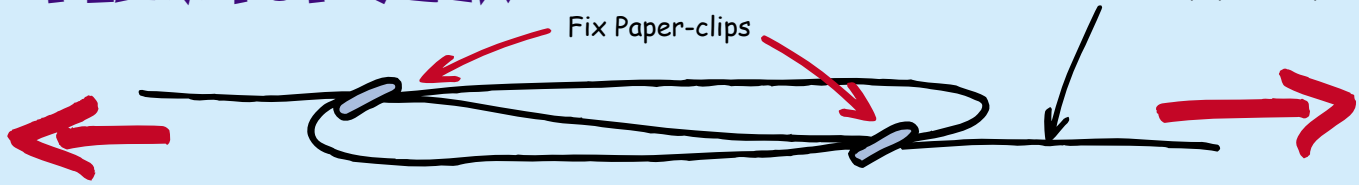
WHAT TO DO:

1. Take a strip of paper and two paper-clips. As shown below, fold the paper strip and fix the paper-clips to hold the folded strip in place:

SIDE VIEW



PLAN/TOP VIEW



2. Firmly grip each end of the paper strip still sticking out and pull the ends firmly and evenly in opposite directions as shown by the arrows in the above picture.
3. Keep pulling the ends of the paper strip firmly and smoothly in opposite directions until the paper-clips are flipped from the strip.

THE PAPER-CLIPS ARE FLIPPED FROM THE STRIP AND LINKED TOGETHER!

SOME THINGS YOU COULD INVESTIGATE

1. Can you see how the paper strip links the paper-clips together?
2. Suppose you first saw a robot do this 'trick' and so you had no way of knowing how hard it pulled the ends of the strip apart. How would you still know for sure that this trick doesn't use much force in linking the paper-clips together?
3. How can you join **MORE** than two paper-clips together in one go?

14 SHAPING STARS 1

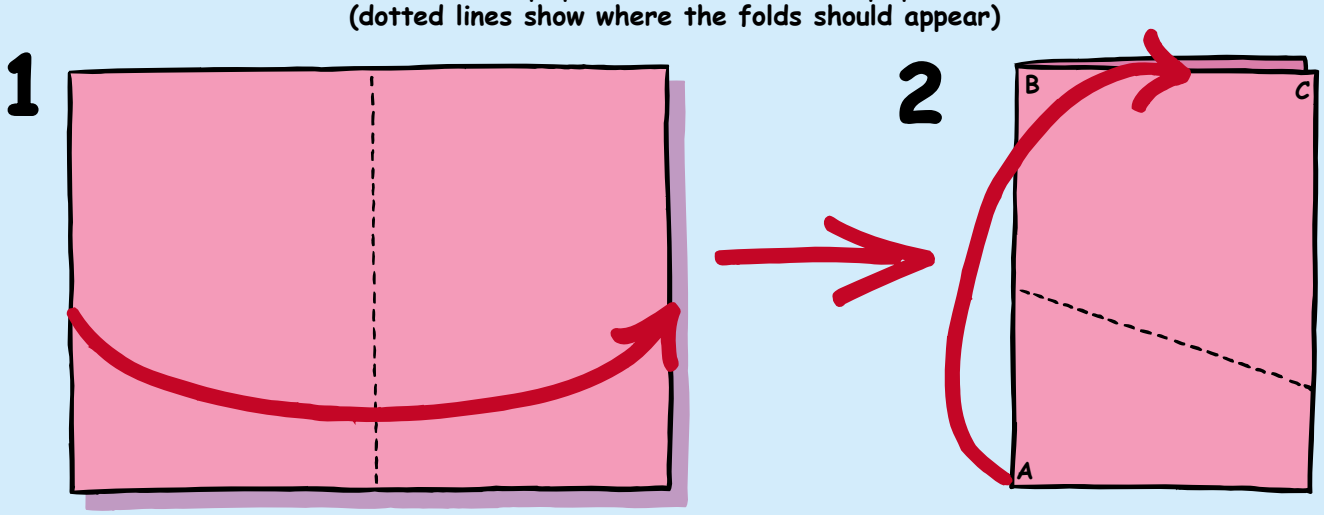
WHAT YOU NEED:

- A sheet of thin A4 or similar size paper
- A pair of strong scissors

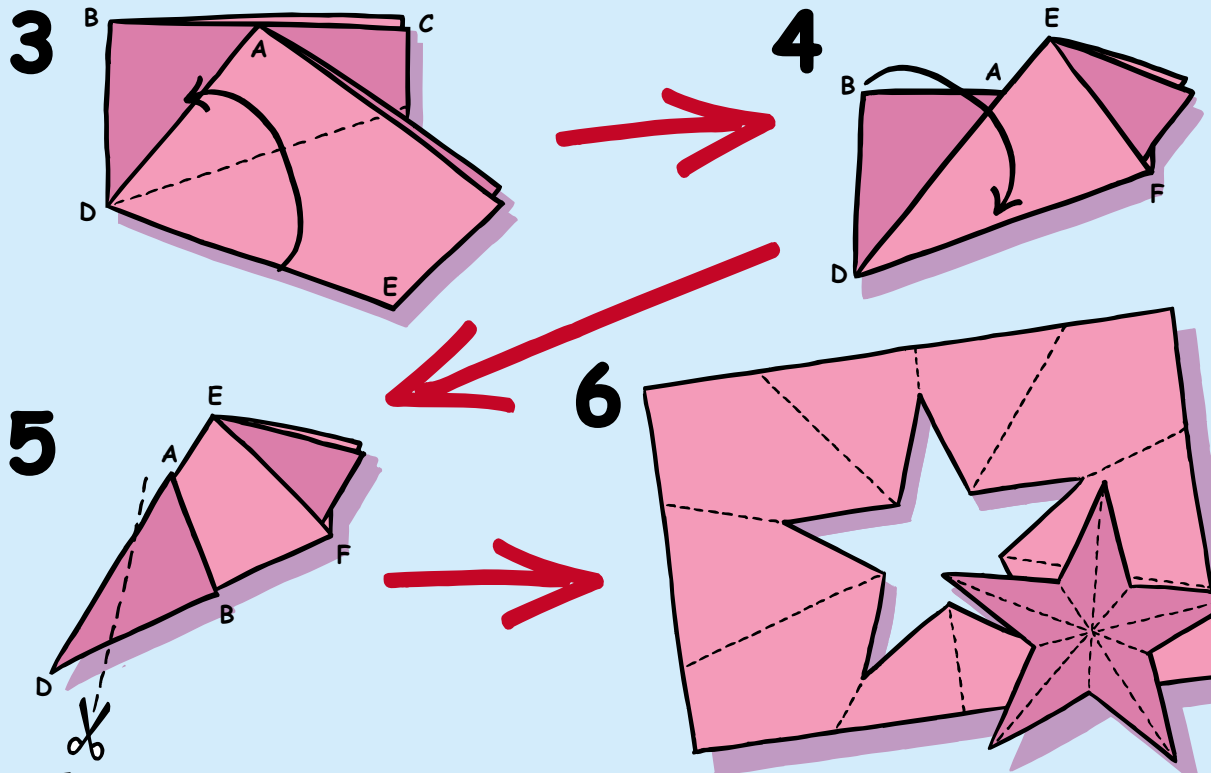
WHAT TO DO:

(Read the words and look at the pictures):

STEPS 1+2 : Fold the sheet of paper in half - thinner paper is easier to fold and cut
(dotted lines show where the folds should appear)



STEPS 2+3 : Fold the corner **A** upwards to ½-way along the top edge **BC**
STEPS 3+4 : Fold edge **DE** upwards to line up with edge **AD**
STEPS 4+5 : Fold edge **BD** down (around edge **AD**) to line up with edge **DF**



STEPS 5+6 : Cut along the dotted line shown and unfold both pieces to find two stars!

SHAPING STARS 2

WHAT YOU NEED:

- A sheet of thin A4 or similar size paper

NOTE : The activity below will be much easier to do if you use very thin paper (thin tracing paper or thin pages from an old glossy magazine, catalogue or newspaper can be good)

- A pair of strong scissors

WHAT TO DO:

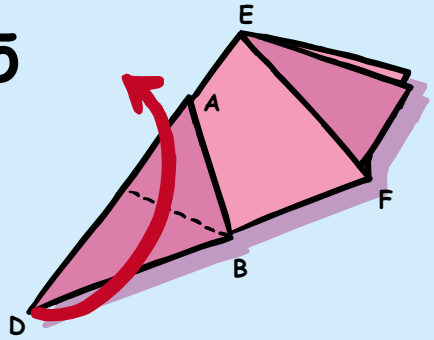
(Read the words and look at the pictures):

REPEAT STEPS- described for **'SHAPING STARS 1'**

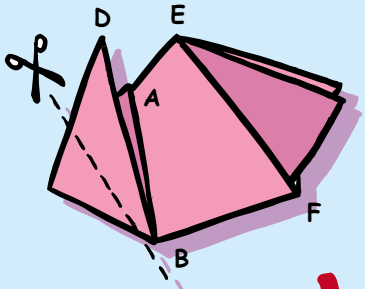
Then,

STEPS 5+6 : Fold corner **D** upwards so that edge **BD** lines up with edge **AB**

5

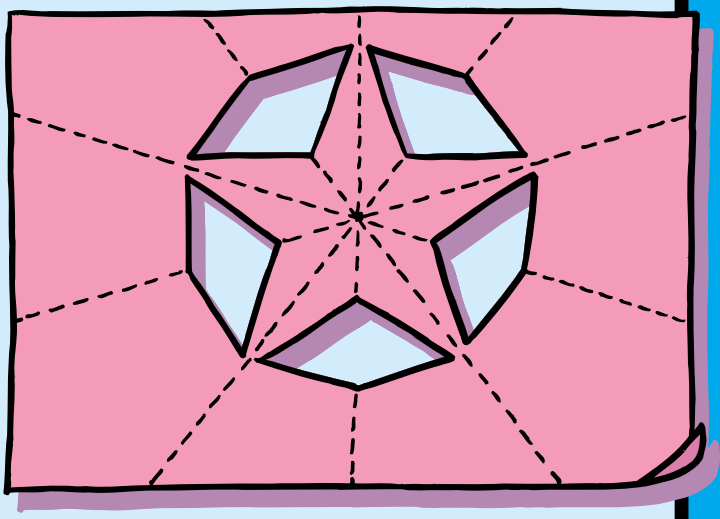


6



STEPS 6+7 : Cut along the dotted line shown, starting the cut very close to **but not exactly at** corner **B**. The cut should be about parallel to edge **EF**. Finally, unfold the pieces to find a star!

7



YOU WILL SEE 5 DIAMOND-SHAPES
&
A STAR IN A DECAGON!

SOME THINGS YOU COULD INVESTIGATE

In
'SHAPING STARS 1'
&
'SHAPING STARS 2'
you can change the shape of your finished pieces of paper. Try changing the way you make your folds in the paper or changing the way you make your scissor cuts or try changing both at the same time!

For example, I asked you to make straight cuts at particular angles. Investigate what happens when you change the cut angle or don't make straight cuts – try curved or wiggly cuts instead.

HOLEY PAPER!

OR HOW TO CUT A HOLE IN A SHEET OF PAPER BIG ENOUGH TO FIT YOUR WHOLE BODY THROUGH!

WHAT YOU NEED:

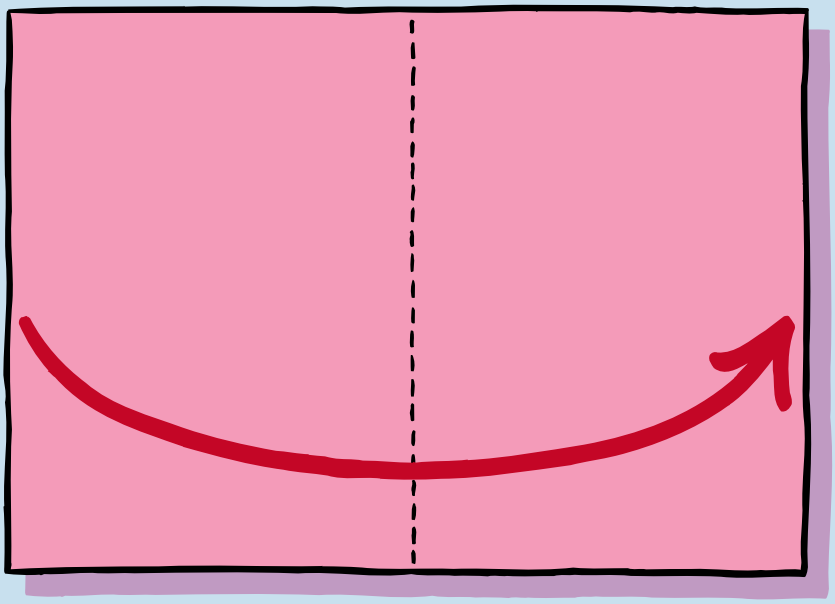
- A sheet of A4 or similar size paper
- A pair of scissors

WHAT TO DO:

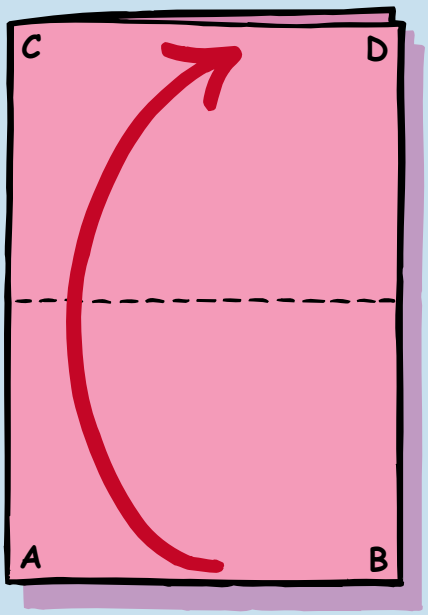
(Read the words & look at the pictures):

STEPS 1+2+3 : Fold a sheet of paper in half and then in half again the other way, bringing edge **AB** up to edge **CD** (see figures 2 & 3)
(dotted lines show where the folds should appear)

1



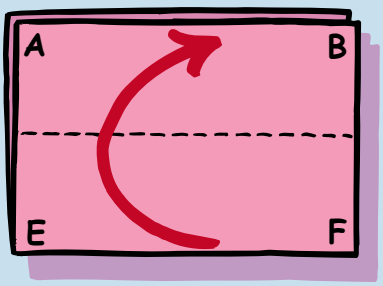
2



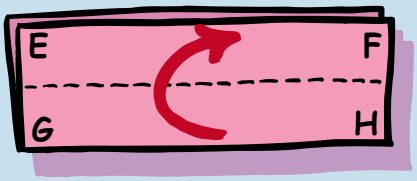
STEPS 3+4 : Fold the paper in half again, bringing edge **EF** up to edge **AB**

STEPS 4+5 : Fold the paper in half once more, bringing edge **GH** up to edge **EF**

3



4



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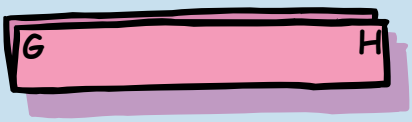
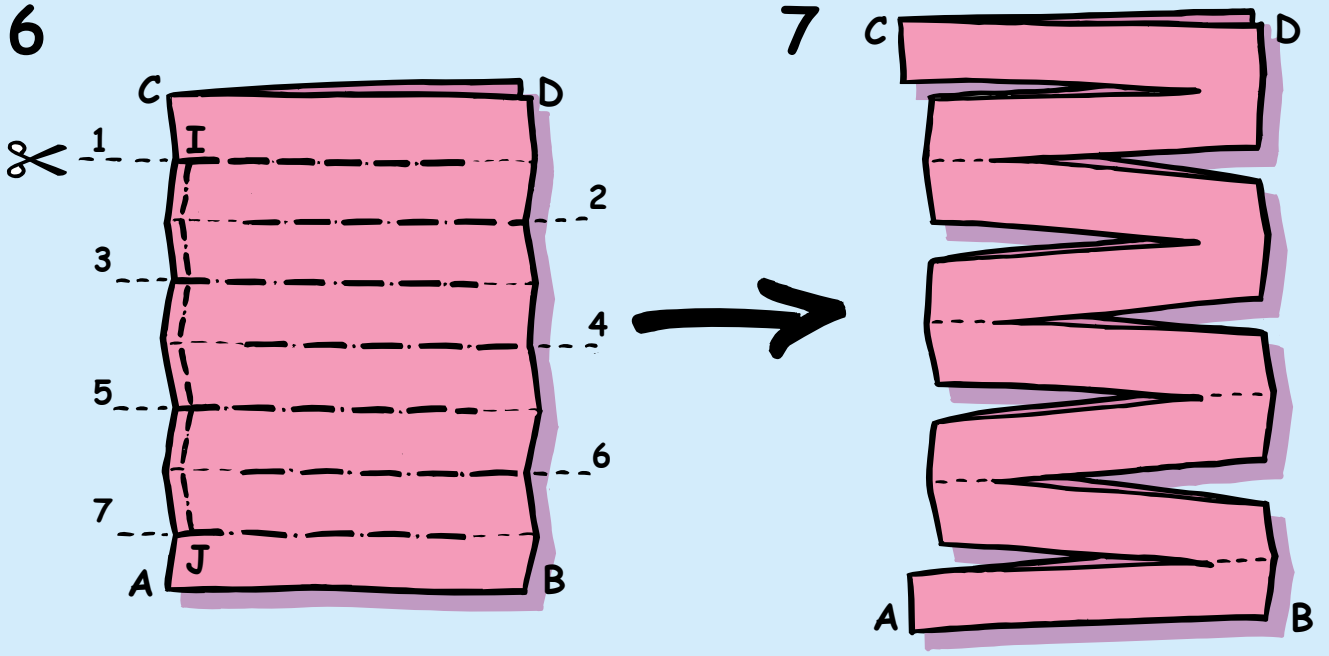


SEE THE NEXT PAGE OVER FOR THE FINAL INSTRUCTIONS

HOLEY PAPER! - MORE INSTRUCTIONS

STEPS 5+6 : From figure **5**, unfold the paper back to where it has only one fold, as shown in figure **2** on the previous page. You should see seven creases, as shown by the seven horizontal dotted/dashed lines in figure 6 below:

STEPS 6+7 : Make all eight cuts shown by the dark-dashed lines in figure **6** below:
NOTE: FIRST make the cut **IJ** very close to the still folded edge **AC**.
This cut should run between the two end creases, shown as **1** & **7**.
Then cut along the creases **1** to **7** in alternate directions, making sure that your cuts stop before they reach the opposite edge of the paper. You should end up with what looks like a row of 'strips' all joined together.



STEP 8 : Finally, **VERY CAREFULLY** unfold and open up these paper 'strips' to reveal a hole or loop large enough to fit your whole body through!

16 MAGIC MILKMAN'S WALLET!

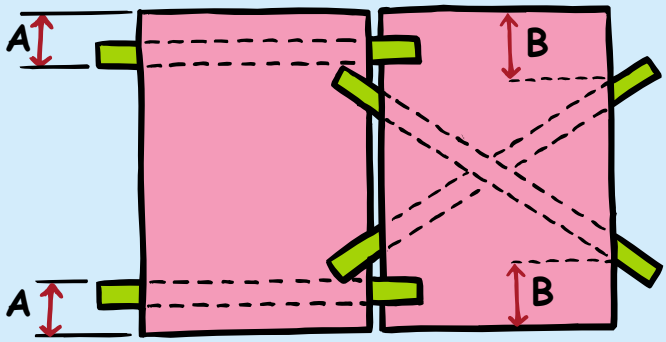
WHAT YOU NEED:

- Two pieces of stiff card – say, about A5 size: approximately 21cm x 15cm
  (bigger or smaller is also OK)
- Four paper strips – each about 15mm wide and long enough to fix onto the cards as shown in the diagrams
  (if you're using the card sizes I've mentioned above, then your paper strips will need to be about 20cm long).
- Pencil
- Ruler
- Scissors
- Good glue for sticking card and paper (or a stapler)
- Some paper money
  (or a similar sized piece of paper – just make sure that your piece of paper is a little smaller than your pieces of stiff card and that one side of the paper looks different from the other)

WHAT TO DO:

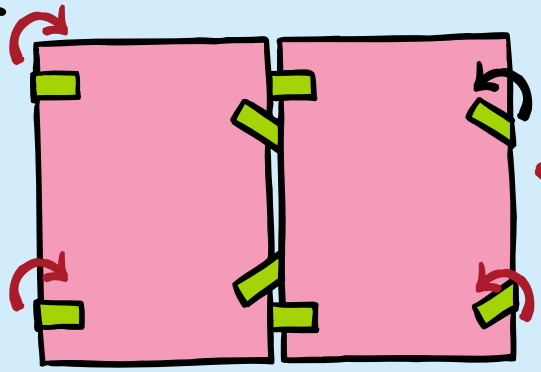
1. Lay the four strips under the two cards so that the eight ends are sticking out, with the cards positioned side-by-side and almost touching, as shown in diagram **1**. Make sure the inside edges of the two horizontal strips are nearer to the top and bottom of the cards than are the two crossed strips, as I've shown below with measurement **'A'** smaller than **'B'**.
2. Glue (or staple) the eight ends onto the top surfaces of the cards. The four ends sticking out from between the two cards are already in position for fixing but the other four ends sticking out from the outside left and right edges of the two cards will need to be folded back over the edges of the cards and glued (or stapled), as shown in diagram **2**.

1



'A' must be **SMALLER** than 'B'

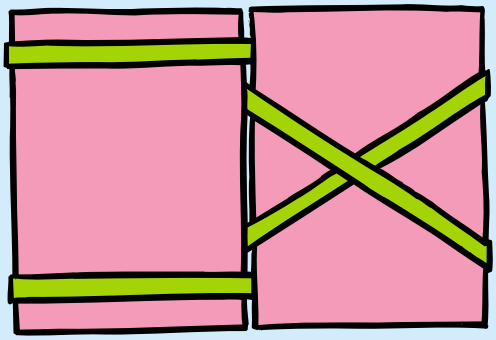
2



The first time I saw the 'Magic Wallet' was when I was very young – about 5 or 6 years old, I think. Our milkman used to have one and he kept paper money in it. On Saturdays he would come to our house to collect the money for all the milk he'd delivered during the previous week (which was quite a lot because there was my mum and dad plus three of my brothers, three sisters and me!). I think the wallet he had was made of two rectangular pieces of stiff board covered in leather, joined together in a rather peculiar and clever way using four elastic straps, similar to the way I've shown in the pictures. The straps were also there to hold the paper money inside. When you gave the milkman paper money he would put it into this very peculiar wallet in a very peculiar way. He would rest the money in the fold of the wallet, close the wallet and open it again, and the money would now be tucked behind the straps! He could also make it look like the money 'magically' moved from one side of the wallet to the other just by closing the wallet and opening it again! Totally weird! Anyway, it wasn't until I grew up that I learnt how to make the Magic Wallet for myself. I also discovered, by the way, that it's sometimes called the 'Milkman's Wallet'. So that's why I'm calling it the 'Magic Milkman's Wallet', in honour of my old milkman!

3. If you've used glue, wait for it to dry before moving anything. Then turn your completed 'Magic Milkman's Wallet' over and it's ready to use!

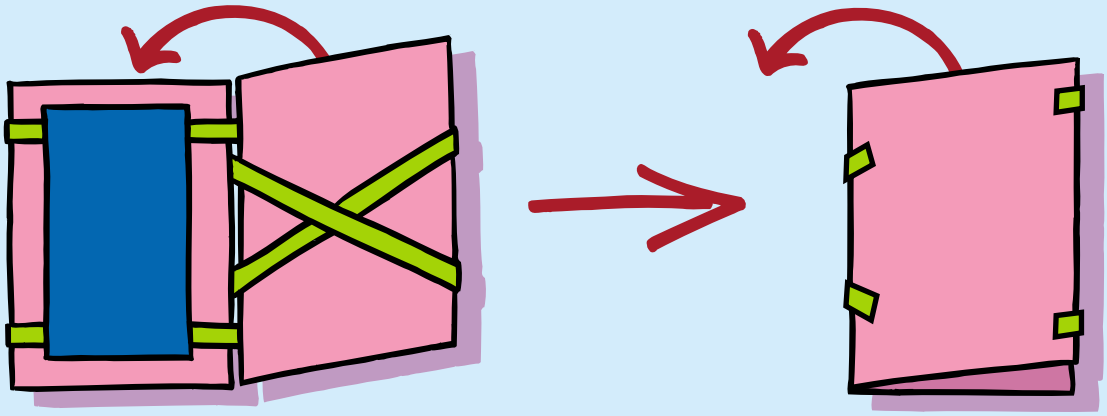
3



THE COMPLETED MAGIC MILKMAN'S WALLET!

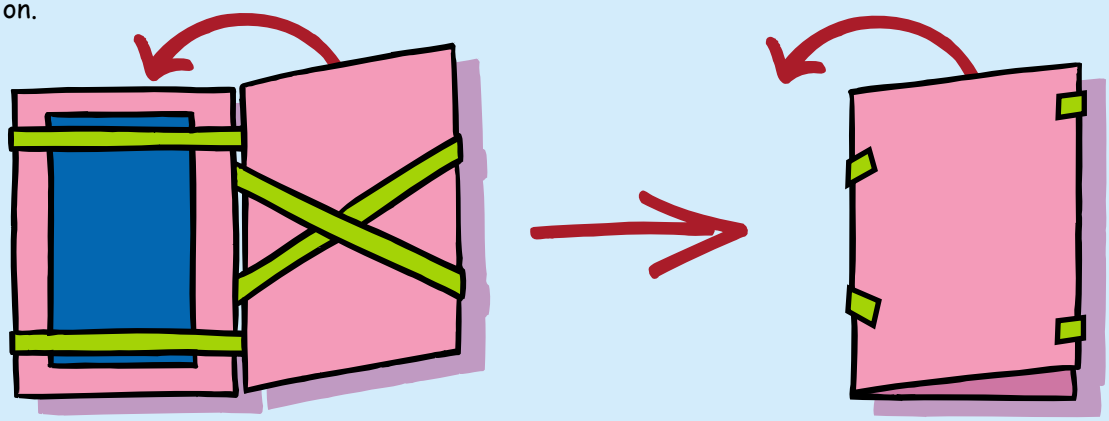
SOME THINGS YOU COULD INVESTIGATE:

1. Hold the wallet open in one hand like a book and rest your paper money (or other piece of paper) on the wallet so that it rests on top of the two horizontal paper strips as shown below. Close the right side of the wallet over it. What happens when you try to re-open the wallet but this time from the folded edge on the right-hand side? Try to describe what's going on.
   (**HINT:** Also note which way up your piece of paper is facing before and after you re-open the wallet)



2. Repeat investigation 1 above, but this time rest the piece of paper on top of the crossed strips.

3. Hold the wallet open in one hand like a book and tuck your paper money underneath the two horizontal paper strips as shown below. Close the right side of the wallet over it. What happens when you try to re-open the wallet but this time from the folded edge on the right-hand side? Try to describe what's going on.



4. Repeat investigation 3 above, but this time tuck the piece of paper underneath the crossed strips.

SOME THINGS YOU MIGHT'VE DISCOVERED

FROM INVESTIGATING 1 & 2:

From both **1 & 2** you should have discovered that:

- you could in fact re-open the wallet perfectly well from the folded edge
- when you re-opened the wallet the paper was tucked underneath the crossed strips
- the paper was facing the same way up for **1** but the other way up for **2**
- the paper was resting against the same piece of stiff card before AND after you re-opened the wallet for 1, but swapped from resting against one piece of stiff card to the other for 2
- the pairs of strips swap from resting against one piece of stiff card to the other when you re-open the wallet

FROM INVESTIGATING 3 & 4:

From both **3 & 4** you should have discovered that:

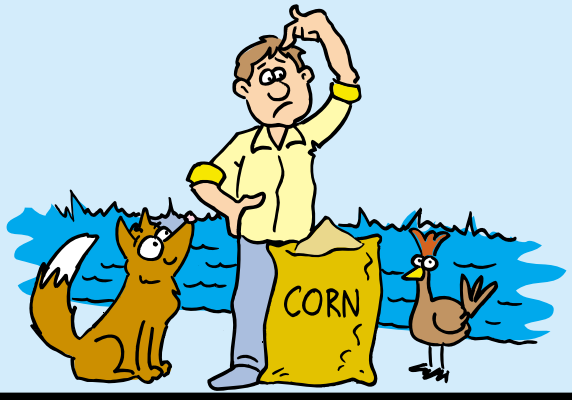
- as with **1 & 2**, you could in fact re-open the wallet perfectly well from the folded edge
- the paper was resting against the same piece of stiff card before **AND** after you re-opened the wallet
- the paper always faces the same way up
- when you re-opened the wallet the paper was tucked underneath the crossed strips for 3, and tucked underneath the horizontal strips for 4
- the pairs of strips swap from resting against one piece of stiff card to the other when you re-open the wallet

17 BRAIN STRETCHERS!

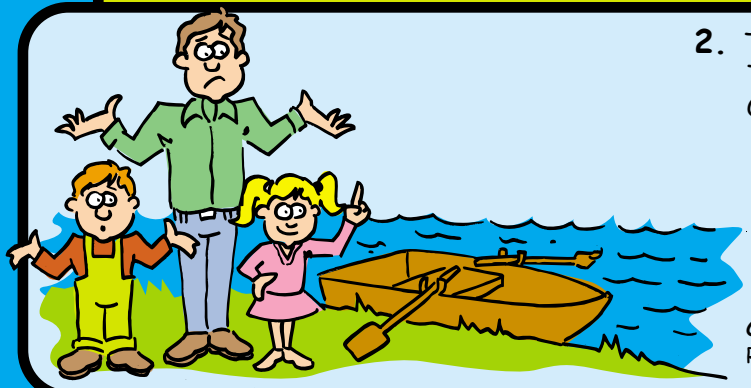
WHAT YOU NEED:

- The Brain Stretchers that follow – I've given you ALL the information you need, plus a useful clue if you need it, to answer each problem. So you have no excuse for getting any wrong!
- Your brain - you can try all of the 'Brain Stretcher' problems on your own if you want to
- A pen (or pencil) and some paper might be useful for making notes
- The answers on pages 106 to 109 to check your answers

1. A man has to get a fox, a chicken and a sack of corn across a river. He has a small rowing boat but it can only carry him and one other thing. If the fox and the chicken are left alone together, the fox will eat the chicken. If the chicken and the corn are left together, the chicken will eat the corn. How does the man get them all across the river?



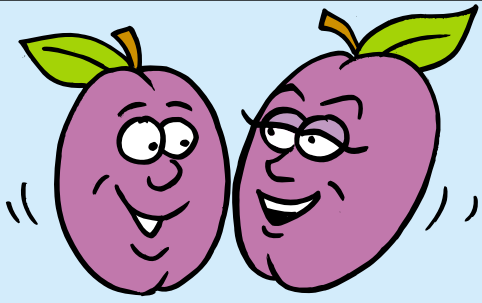
CLUE:
Remember that the boat can carry things both ways across the river



2. Two children and one adult need to get across a river. They have a boat but the boat can only carry one adult OR two children. How do they all get across?

CLUE:
Remember that the boat can carry things both ways across the river

3. Mr. & Mrs. Plum have six daughters and each daughter has one brother. How many people are in the plum family?



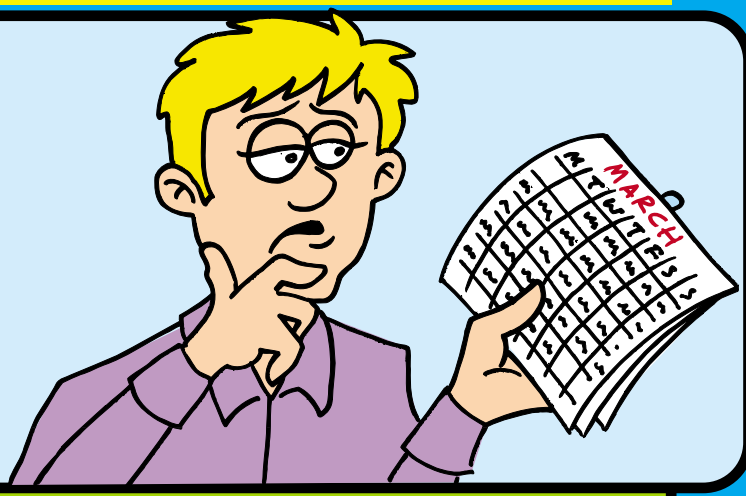
CLUE:
Not as many as you might at first think.

4. Two fathers and two sons went fishing. Each of them caught a fish and none of them caught the same fish. However, they only caught a total of three fish. How is this possible?

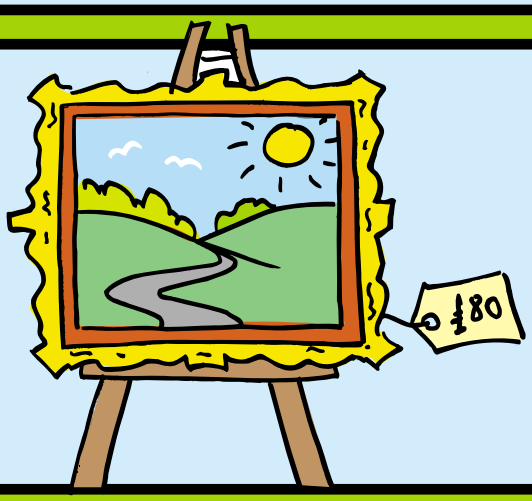
CLUE:
There are only three fishermen, but how so?

17 BRAIN STRETCHERS!

5. If today is Monday, what is the day after the day before the day before tomorrow?



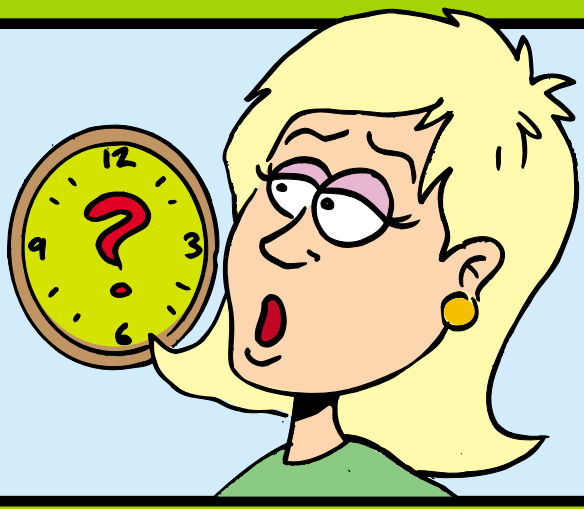
CLUE:
It might be easier to work through the sentence backwards and break it down into segments.



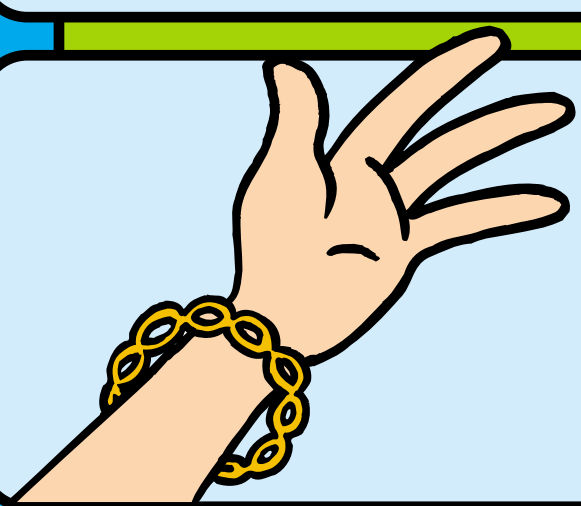
6. A shop bought a painting for £70, sold it for £80, bought it back for £90, and sold it again for £100. Did the shopkeeper make any money? What amounts?

CLUE:
Start off with some money in the till, say, £100

7. If 2 hours ago it was as long after one o'clock in the afternoon as it was before one o'clock in the morning, what time would it be now?



CLUE:
"As long after as it was before" is the same as saying, "halfway between".

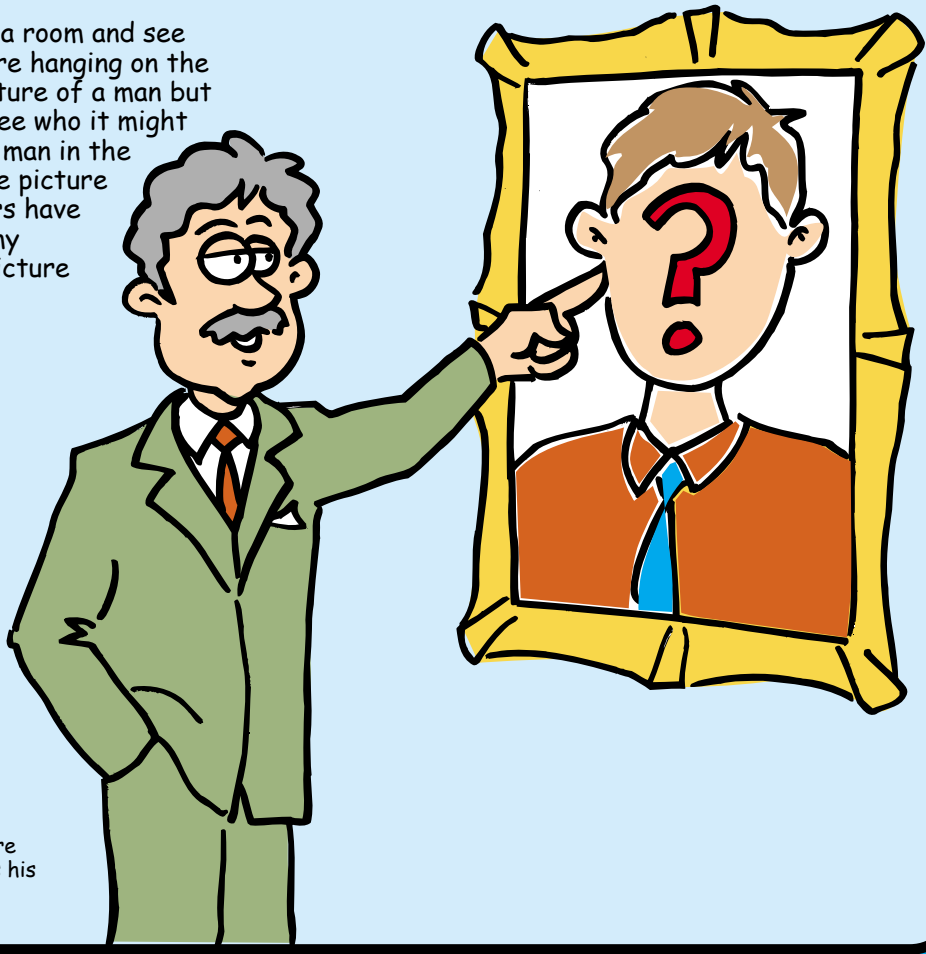


8. You have four identical small pieces of gold chain, each made of three links. You need to have the four pieces linked together to make a closed bracelet or circle. The jeweller charges £5 for each link that has to be opened and closed again. What is the minimum it will cost to have the bracelet made? Explain you answer?

CLUE:
It's less than £20

BRAIN STRETCHERS!

9. You look through a doorway into a room and see a man looking at a portrait picture hanging on the wall. You can see that it is a picture of a man but you can't see clearly enough to see who it might be. So you ask the man who the man in the picture is. The man points to the picture and replies, "Brothers and sisters have I none and this man's father is my father's son." Whose portrait picture is the man looking at?
Explain your answer.



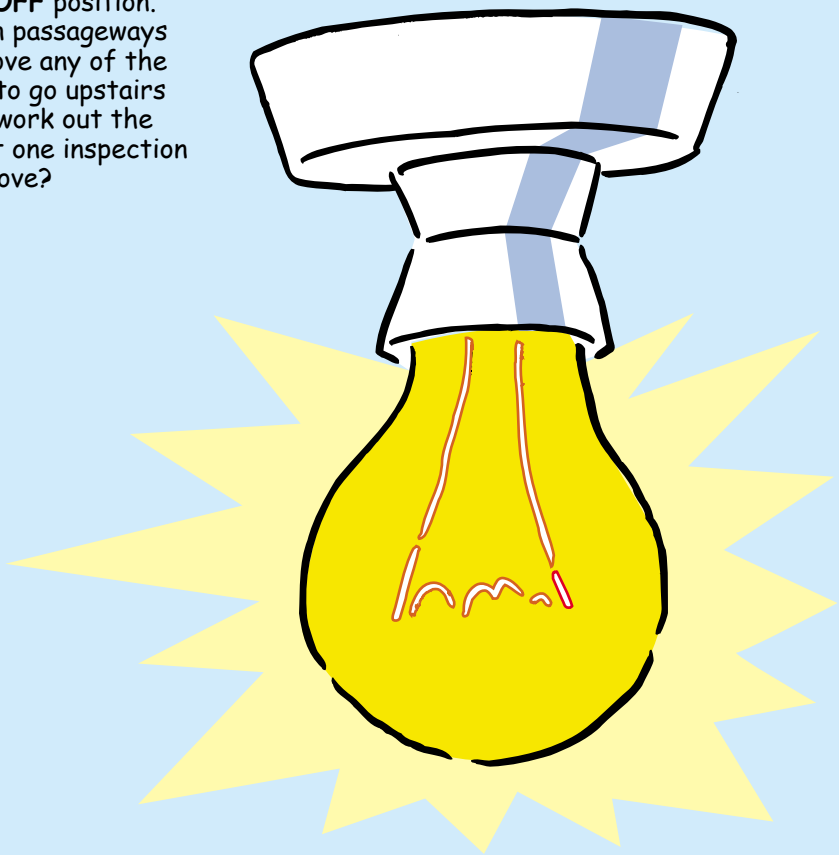
CLUE:
It might be easier to imagine that you are the man talking and remember that he is his father's son.

10. Three friends agree to share a taxi from the airport into the nearest town. When they arrive, the meter reads £25. Each friend gives the driver a £10 note. The driver gives them back five £1 coins as change. Each man then takes one of the £1 coins and they give the driver the remaining two £1 coins as a tip. They get out and the taxi drives away. One friend turns to the others and says, "Just a minute, after getting back a £1 coin each, we each spent nine pounds, which makes twenty-seven pounds altogether, and the driver has two pounds, bringing the total to twenty-nine pounds. So what happened to the other one pound?"
Can you explain the answer?

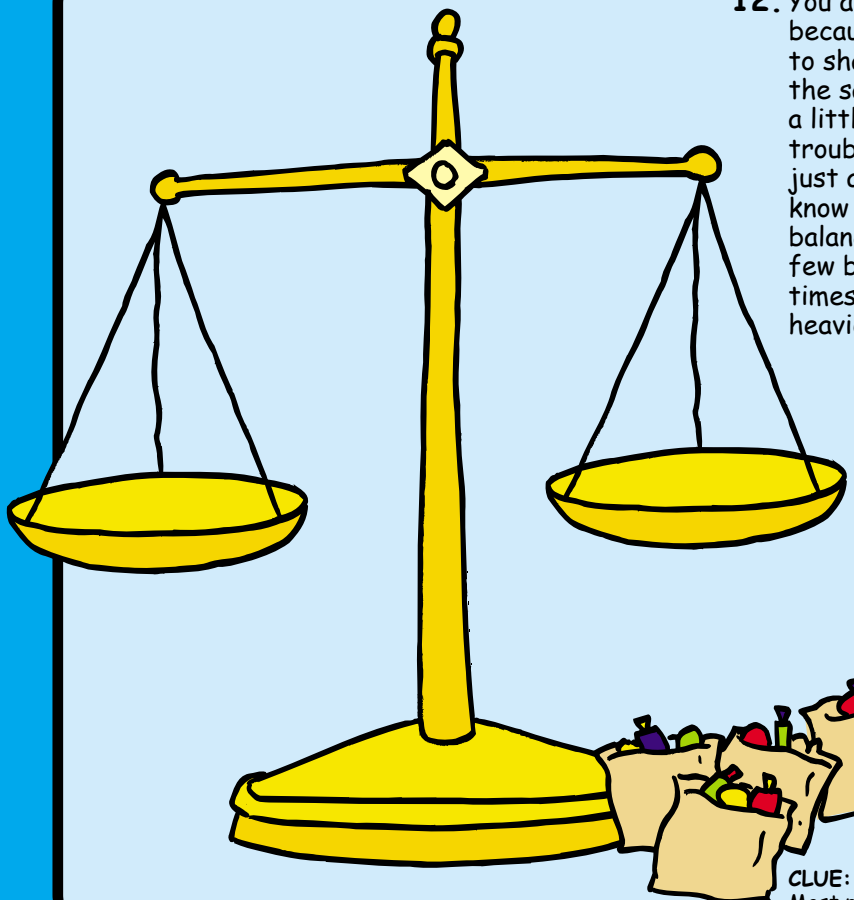
CLUE:
How much money did the driver get altogether?

17 BRAIN STRETCHERS!

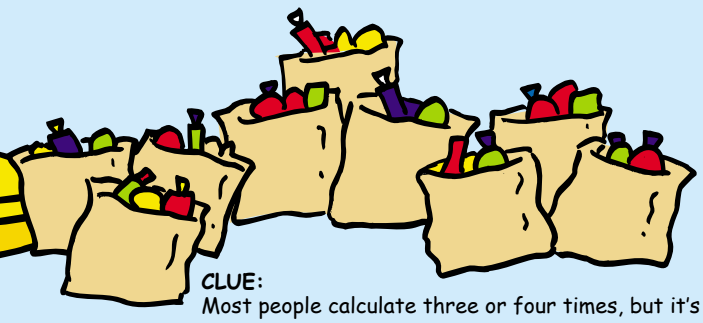
11. In the entrance hallway of a large, tall building there are three light switches in a row in the **OFF** position. Each switch controls 1 of 3 light bulbs in passageways on the very top floor above. You may move any of the switches but you only have enough time to go upstairs to inspect the bulbs once. How can you work out the switch used for each light bulb with just one inspection of the light bulbs in the passageways above?



CLUE:
You will need to be able to touch the light bulbs.



12. You and eight friends have been having a small party because it's your birthday. You have nine 'goody-bags' to share out. The bags and contents are all exactly the same apart from in one bag, which you know has a little something extra in it especially for you. The trouble is, apart from knowing that your bag must be just a little bit heavier than the others, you don't know which bag it is. However, you do have a set of balance scales in the kitchen big enough to hold a few bags in each pan. What is the least number of times you will need to use the scales to find your heavier 'goody-bag'?



CLUE:
Most people calculate three or four times, but it's not! How so?

18 BRAIN BENDERS!

WHAT YOU NEED:

- The Brain Benders questions that follow
- At least one other friend to work with because you can't do these 'Brain Benders' on your own
- A pen (or pencil) and some paper might be useful for making notes
- The answers on pages 114 to 117

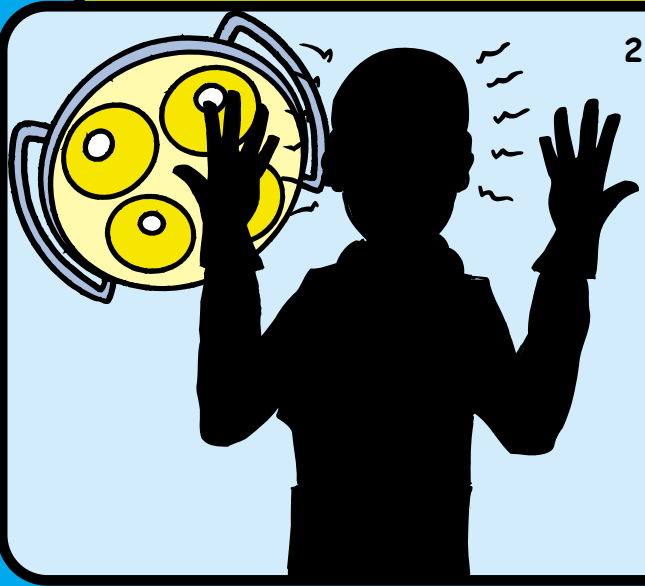
WHAT TO DO:

1. Decide out of you or your friends who's going to ask the question – let's say it's you for now
2. You need to read a question to yourself in silence and then read the answer. Make sure you understand the question and answer properly.
3. You must then read the question to your friends (or let them read it for themselves)
4. Your friends must then see how many other questions they need to ask you about the problem for them to be able to get the right answer. They can suggest an answer at any time. The important thing here is that your friends are ONLY allowed to ask you questions which need a 'YES' or a 'NO' answer – these are called 'closed questions'. In other words, you are ONLY allowed to say 'YES' or 'NO' to their questions and you are NOT allowed to answer any questions which need more than a 'YES' or a 'NO' answer! That's why you need to make sure that you understand the question and answer properly. Understand?
5. Only give your friends the clue if they're really struggling and you think they need it to help them.

1. While walking in the woods one day, you come across an unconscious man in a cabin. He is slumped in a chair and has some cuts and bruises on his face. What happened to him?

NOTE – You can only ask questions which need a 'YES' or a 'NO' answer.

CLUE: The cabin may not be what you first think it is.



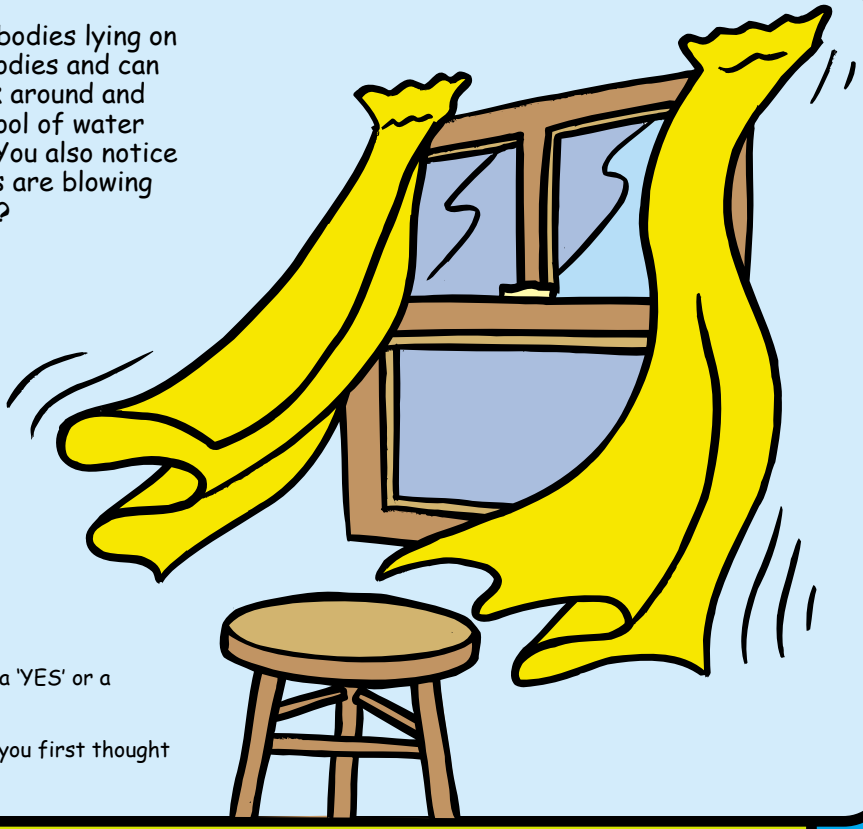
2. A father and his young son are driving along a dark country road at night in a heavy thunder storm. Suddenly lightening strikes nearby and causes the father to crash the car. Both the father and his son are seriously injured in the accident. Someone in a nearby house calls an ambulance and they are both rushed to the nearest hospital. The emergency surgeon is called and the son is taken into the operating theatre. The surgeon looks at the boy's face and says with great distress, "I can't operate on this boy, he's my son!" How can this be true?

NOTE – You can only ask questions which need a 'YES' or a 'NO' answer.

CLUE: The surgeon may not be the person who you first think they are.

BRAIN BENDERS!

3. You go into a room and find two dead bodies lying on the floor. You look carefully at the bodies and can see no obvious fatal injuries. You look around and notice that the bodies are lying in a pool of water and are surrounded by broken glass. You also notice that a window is open and the curtains are blowing gently in the breeze. What happened?



NOTE – You can only ask questions which need a 'YES' or a 'NO' answer.

CLUE: The two bodies may not be who or what you first thought they were.

4. John Smith was surprised to see his window slide open and was quite shocked when he saw two strangers climb inside. John continued to watch with fascination as the two thieves quietly removed some expensive jewellery, artwork and even some money left on the table. The thieves then climbed back out of the window and closed it again quietly. Incredibly, you might think, John simply went back to what he had been doing before the thieves arrived and very soon he'd pretty much forgotten about the entire incident! Why didn't John, who was in perfect health, even try to stop the thieves or at the very least call the police after they had left?

NOTE – You can only ask questions which need a 'YES' or a 'NO' answer.

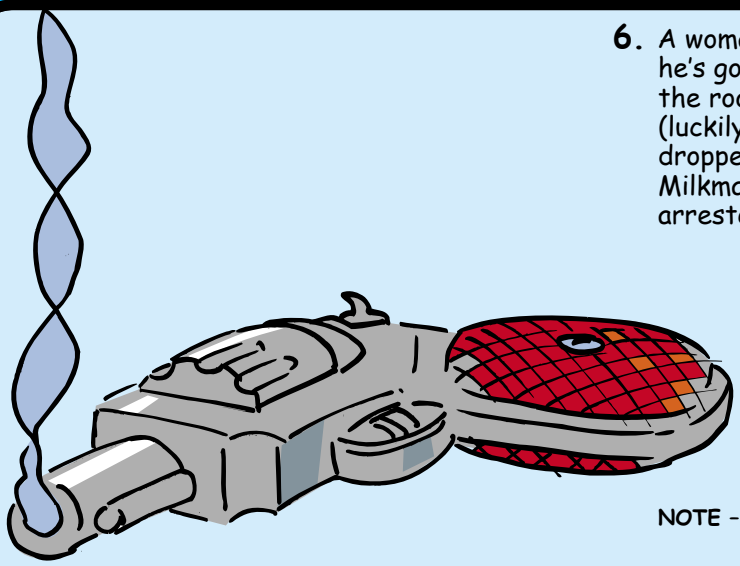
CLUE: John doesn't understand what's going on, but why?

BRAIN BENDERS!

5. There is a man shut in a small room who has a sudden attack of claustrophobia (fear of enclosed spaces). The man feels desperate to open the door to get outside but knows that if he did open the door, he would surely die.
Can you explain this?

NOTE – You can only ask questions which need a 'YES' or a 'NO' answer.

CLUE: He wouldn't die if he opened the door in your room and ran outside.

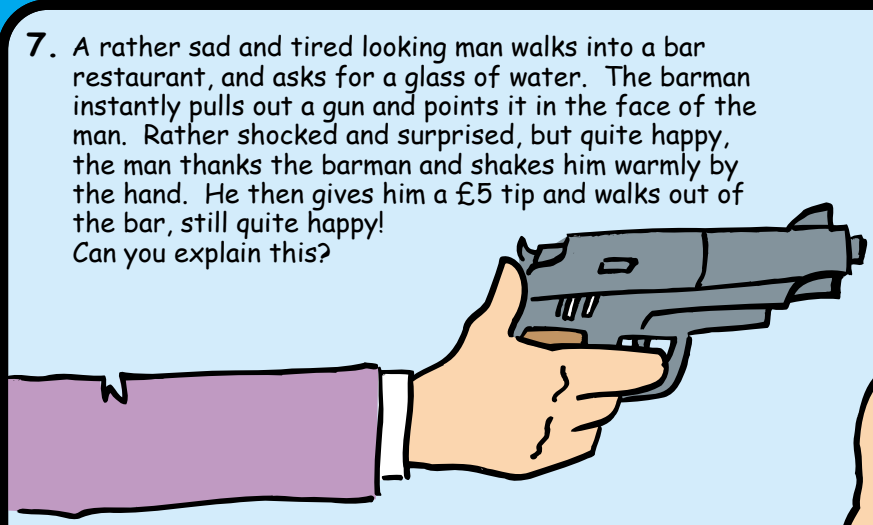


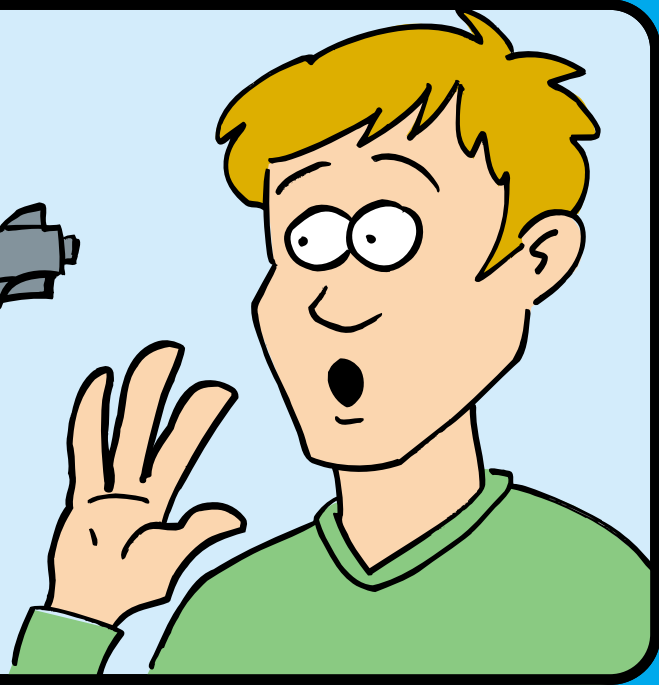
6. A woman's screams are heard and she shouts, "Oh God, he's got a gun. NO!". A gunshot is heard. Police rush in to the room to find a woman who has fainted through shock (luckily the man fired at the ceiling!), the smoking gun dropped on the floor in the middle of the room, the Milkman, the Dentist and the Doctor. They instantly arrested the Milkman for the crime. Why?

NOTE – You can only ask questions which need a 'YES' or a 'NO' answer.

CLUE: What name could you use for a woman who delivers milk?

7. A rather sad and tired looking man walks into a bar restaurant, and asks for a glass of water. The barman instantly pulls out a gun and points it in the face of the man. Rather shocked and surprised, but quite happy, the man thanks the barman and shakes him warmly by the hand. He then gives him a £5 tip and walks out of the bar, still quite happy!
Can you explain this?





NOTE – You can only ask questions which need a 'YES' or a 'NO' answer.

CLUE: Some say that having a shock can be quite useful in certain circumstances.

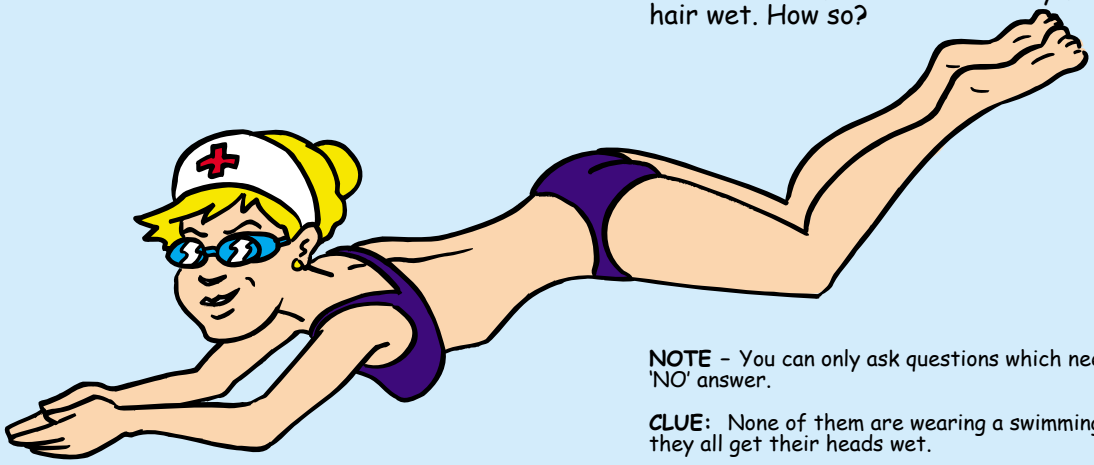
BRAIN BENDERS!

8. There is a small boy who lives in a flat or apartment on the 20th floor of a tall tower block. Every morning when he leaves for school, he gets a sloppy 'good bye' kiss from his mum at the door and goes into the elevator on his own, pressing the button for the bottom floor. On the bottom floor he is met by his girlfriend and her mum. Her mum then takes them both to school. After school, he comes back to the tower block with his girlfriend and her mum again. He goes into the elevator on his own and presses the button for the 15th floor. When he gets up to the 15th floor, he gets out of the elevator and walks up the stairs the rest of the way to his apartment on the 20th floor. So why doesn't he go all the way up to the 20th floor in the elevator?

NOTE – You can only ask questions which need a 'YES' or a 'NO' answer.

CLUE: If his mum was with him, he would go all the way up to the 20th floor in the elevator.

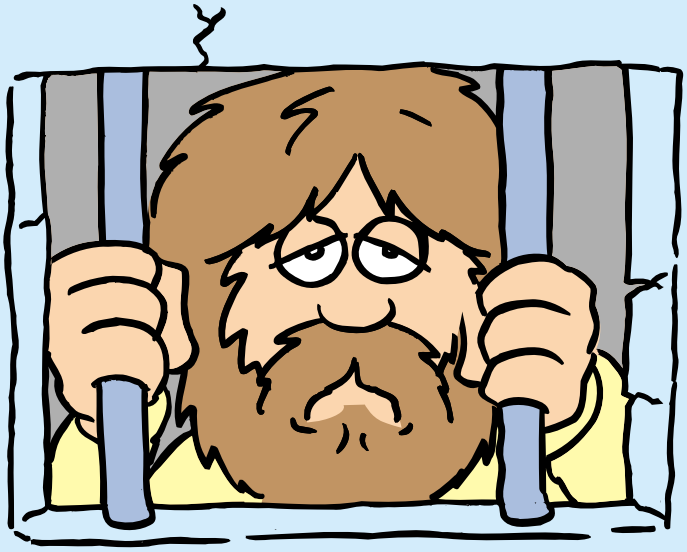
9. Six nurses are competing in a hospital swimming race. They ALL dive head-first completely down into the water at the start of the race and only five of them get their hair wet. How so?



NOTE – You can only ask questions which need a 'YES' or a 'NO' answer.

CLUE: None of them are wearing a swimming cap and, or course, they all get their heads wet.

10. There's a forgotten prisoner in a cell with no food or water. The cell next door has a good store of food and a well with water in it. The prisoner survives just fine for many weeks before the prison guards remember him. How does he survive?



NOTE – You can only ask questions which need a 'YES' or a 'NO' answer.

CLUE: What would stop him leaving his cell?

19 CRACKING CODES 1

WHAT YOU NEED:

- The four 'CRACKING CODES' investigations that follow
- Some paper and a pencil (or pen) to maybe make some notes with

WHAT TO DO:

1. Look below at the numbers with some matching letters written underneath.

1	2	3	4	5	6	7	8
C	E	I	N	S	T	U	V

2. Before I, Dr Mark, started doing mad maths with school children I used to do something else for a job. To find out what I used to do, you will need to do all of the ten sums written below. Try to do them in your head if you can.

2+3	9−8	6÷2	7−5	8÷2	1+5	1×3	9−4	2×3

SOME THINGS YOU COULD INVESTIGATE:

1. Try to find the answer to all of the ten sums above. Do each sum one after the other starting on the left.
2. Match each number you get with its letter as shown above. You should end up with a word that will tell you just what I used to do.
3. Once you've worked out how the code works, why not make up some of your own to try on other people?

19 CRACKING CODES 2

WHAT TO DO:

1. The colours of the rainbow are usually written as: Red, Orange, Yellow, Green, Blue, Indigo and Violet. Look at the row of letters below.

1. R O Y G ? ? ?

Can you work out what letters should be in the place of the question marks?

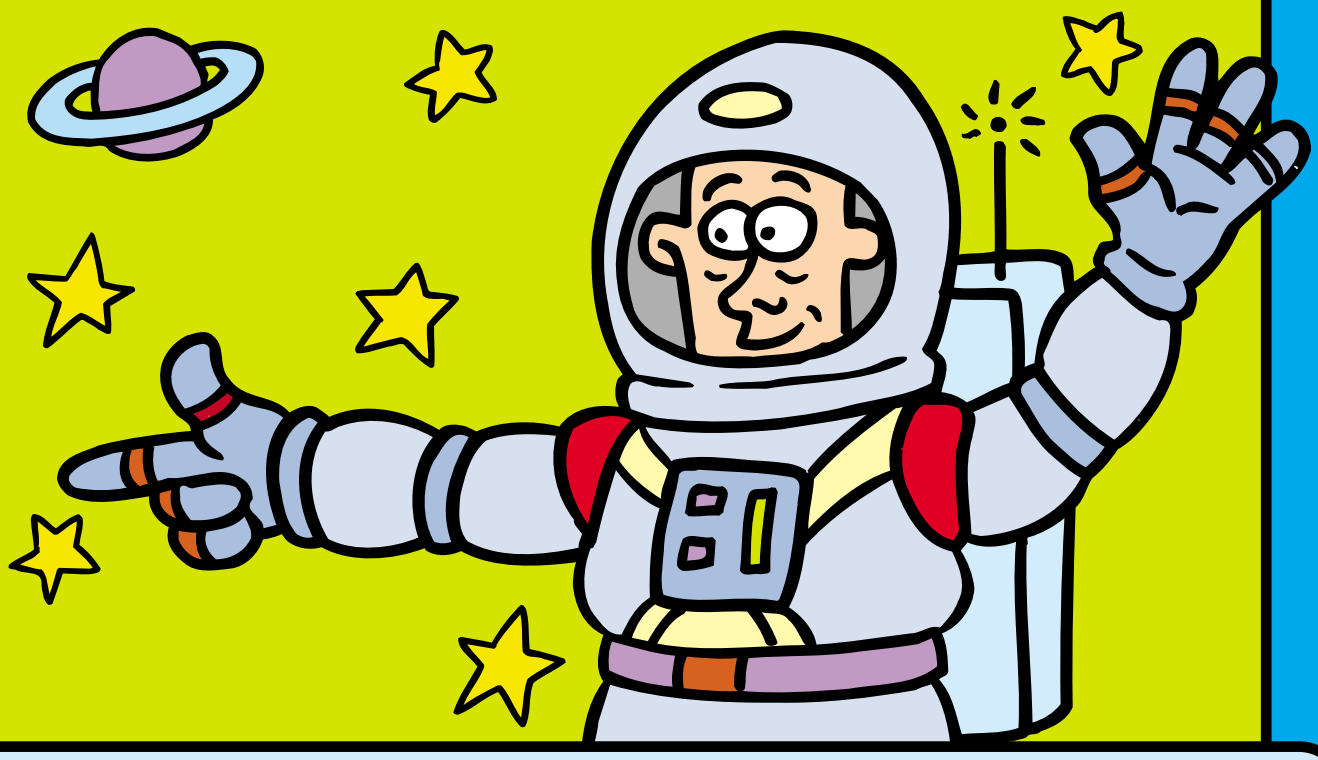
2-5. Below are four more rows of letters. Can you work out what the letters stand for in each row and so work out what letters should be in the place of the question marks?

2. O T T F F S S ? ? ?

3. M T W T F ? ?

4. J F M A M J J ? ? ? ? ?

CLUE for questions 2, 3 & 4: If you think about these problems in the right way you will find them as easy as one, two, three.....every day of the week.....every month of the year

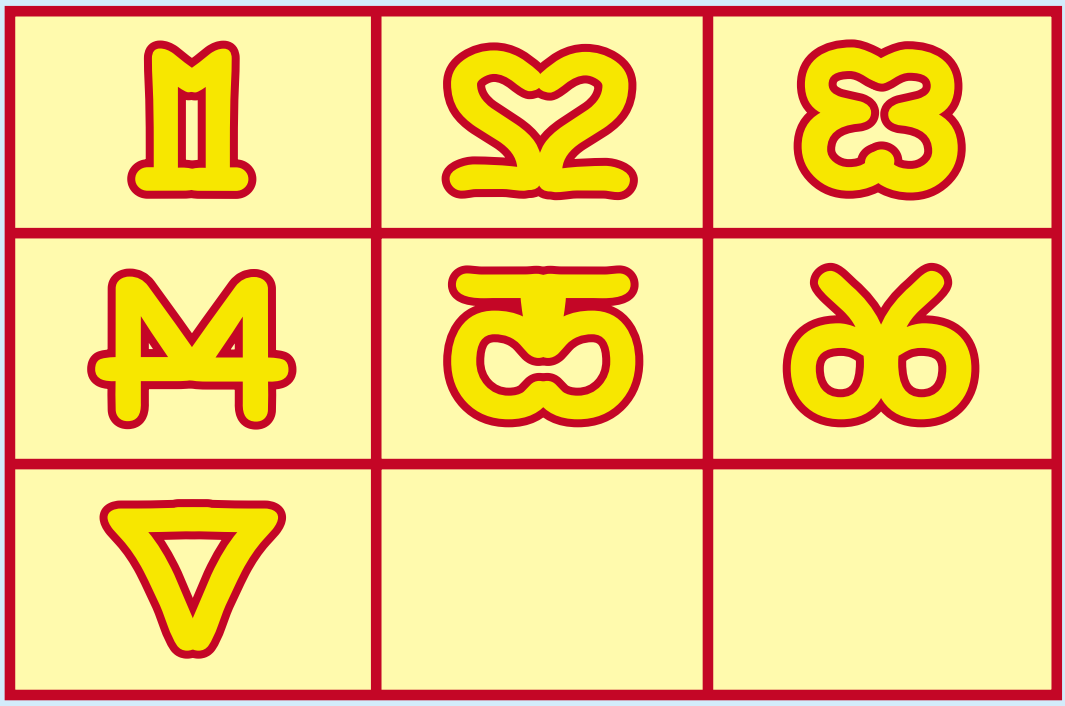


5. M V E M J S ? ? ?

CLUE for questions 5: Dr Mark was a space scientist

19 CRACKING CODES 3

WHAT TO DO:
Look at the strange figures in the grid below. Can you work out the code and then draw the two figures that should be in the two empty boxes?



(**CLUES**: It's as easy as looking in a mirror and writing one, two and three OR Think numbers and not pictures)

SOME THINGS YOU COULD INVESTIGATE:
Why not try writing out this 'code' in front of somebody who hasn't seen it, to see if they can work it out? Be careful how you write it if you do it in front of them, otherwise they may see what's going on. To confuse them you could write the first figure as a capital 'M' with a line underneath, then a heart with a line underneath, and so on. The important thing is to somehow disguise what you're writing. Otherwise write it out where they can't see you and show them afterwards.

CRACKING CODES 4

WHAT TO DO:
Look at the strange figures in the grid below. Can you work out the code and then draw the two figures that should be in the two empty boxes?

CLUES: It is as easy as looking in a mirror and writing letters, OR Think letters and not pictures)

SOME THINGS YOU COULD INVESTIGATE:
When you work out how this code works, why not try it with other 'patterns' or perhaps try writing your name in the same way?

20 SHUFFLING COINS!

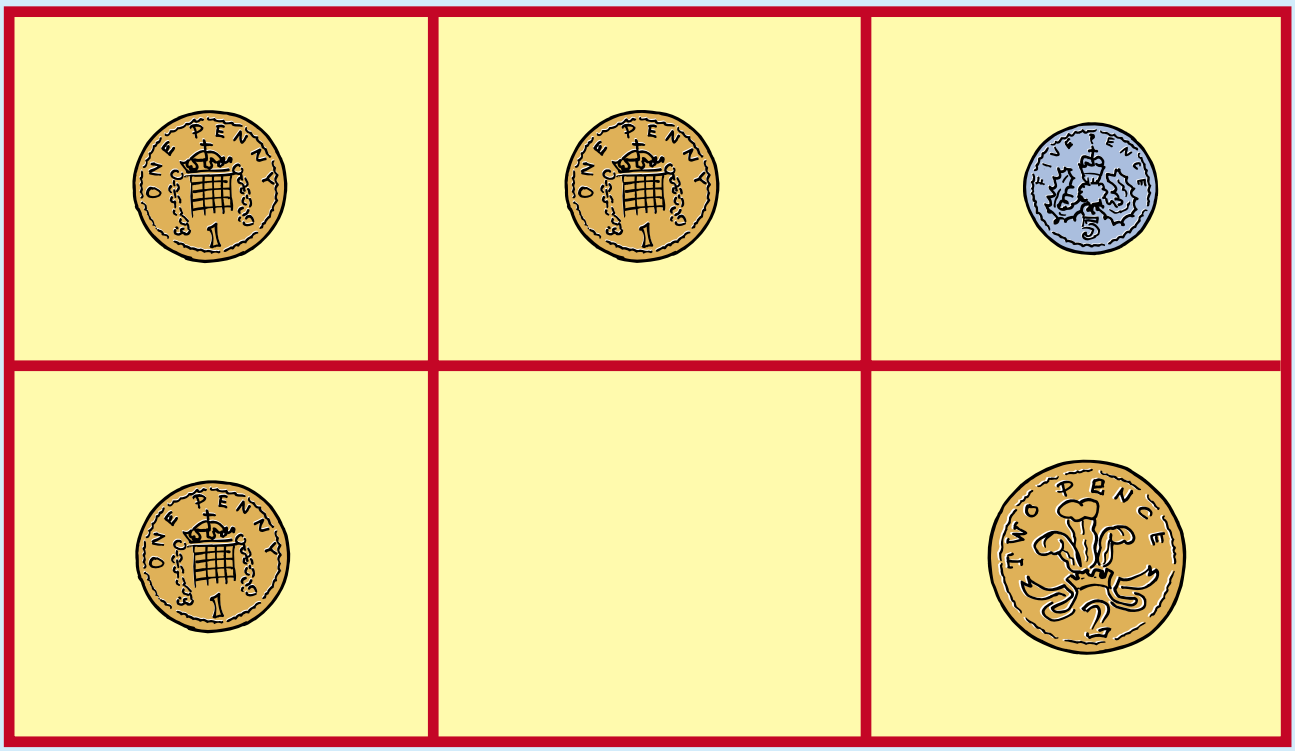
WHAT YOU NEED:

- A copy of the grid below
- Three different types of 'counter' – coins are good and easy to get, such as 1p, 2p and 5p coins (in British money).

You'll need three of the same of one type of counter and one counter each for the other two types. For example, below I'm going to use three 1p coins, one 2p coin and one 5p coin.

WHAT TO DO:

1. Place the coins as shown in the grid below in their 'starting positions'.
2. The object of the game is to end up having swapped the positions of the 5p and the 2p by moving or shuffling all the coins around within the grid. In other words, the 2p should end up where the 5p is now and the 5p should end up where the 2p is now. It doesn't matter where the 1p's end up but all five coins must still be on the grid with one empty square.
3. RULES: A coin can move by sliding it into an empty space that's to the left, right, above or below BUT coins cannot jump over other coins and coins cannot move diagonally.
4. Count how many moves you need to make to swap the positions of the 5p and 2p coins.
5. Think of a way to record the moves you make so that someone else could use your record to repeat the same moves for themselves.



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