

**„Les maths à portée de mains“**  
**Hands-on mathematics**  
From March 29 until August 28, 2011

Challenging puzzles, deceiving mirrors, mysterious bridges and more: Check out the fun side of mathematics and put your hands on more than 30 interactive exhibits. The exhibition “Les maths à portée de mains” appeals to all ages.

Experience a different side of mathematics!

“Hands-on” is the exhibition’s first objective, which will allow you to get really involved and experience surprising phenomena yourself.

How can a bridge be constructed without using any nails, glue, robes or other tools? How is rolling dice related to Mozart’s compositions?

Being amazed is the first step to get behind mathematical secrets. This different, very playful way of dealing with mathematics helps to overcome any fears people might have recalling their experiences with mathematics in school.

**PART 1** **Puzzles, tilings & illusions ...** **11 exhibits**

1. The kangaroo-puzzle
2. The Penrose-Puzzle
3. The square puzzle
4. Optical illusions
5. Slide-Through-Frames
6. Do all these fit into the cube?
7. The Tower of Ionah
8. Lights on!
9. Who comes out the farthest?
10. 6 games table
  - 10-1. The T
  - 10-2. Honeycombs
  - 10-3. How many dwarves ?
  - 10-4. Ball pyramid
  - 10-5. 2 pieces pyramid
  - 10-6. 4 pieces pyramid
11. 4 games table
  - 11-1. Conway-Cube
  - 11-2. Tangram
  - 11-3. The square-Triangle
  - 11-4. Soma-Cube

**PART 2** **Enjoy geometry !** **12 exhibits**

12. I am a function
13. Touch a function
14. Pythagoras
15. Testing pythagoras on the scales
16. Giant Kaleidoscop
17. Soap Films
18. Polydron
19. The Leonardo Bridge
20. The brachystochrone problem: which is the fastest track?
21. Square Wheels
22. Constant Width
23. Hold one of the triangles in the light

**Part 3** **Statistics : take your chance !** **5 exhibits**

24. Count the Smarties
25. Knack den Code
26. Musical dice
27. Galton board simulator
28. Make the good choice !

### **The kangaroo-puzzle**

The kangaroos fit together perfectly so that they form a big pattern in total.

The whole pattern is formed from a pair of superimposed kangaroos, which is shifted to the right and left, and up and down.

Similar "tilings" have been created by the Dutch artist M.C. Escher (1898 - 1972)

### **The Penrose Puzzle**

Put the pieces of the puzzle into the frame.

You will create a flower, which forms part of an infinite pattern.

This pattern is particularly interesting because it combines beautiful local symmetry with the lack of any global symmetry.

The infinite pattern is called Penrose tiling after its inventor, Sir Roger Penrose (\*1931).

### **The Square-Puzzle**

Try to fit the eleven squares into the frame.

How big is the frame? Does it form a square?

The first dissection of a rectangle into squares of mutually different size was found only in 1925.

### **Slide-Through-Frames**

You can slide the red Frame completely through the yellow one.

The yellow frame fits completely through the blue one.

How should this go on?

How does it actually go on?

Hint: Is the width of the sides of the frames the same?

### **Square Wheels**

Put the "square wheel" at the edge of the orbit and release it.

Why does it move so smooth?

Pavés de kangourous

### **Touch a function**

Let your hand glide along the rail.

Where does it get caught?

Where does it glide the nicest?

### **Constant Width**

Look at those wheels!

They are obviously not round, but the board on top rolls smoothly at an even height. Why?

### **I am a Function**

Press the Button. Walk to the starting point.

On the Screen a white curve is shown. While moving forth and back on the line on the floor a new, yellow curve develops.

Try to move in such way, that your curve matches the white curve.

### **Break the Code!**

On the screen you see an enciphered text.

Try to guess a letter and write it underneath.

You can select the arrays by touching the screen or using the arrow keys.

Hint: Which letter is the most common in French language?

### **The Tower of Iona**

The aim is to move all disks from one hole to another.

In doing this you must observe the following rules:

1. Always move just one disk at a time.
2. Never put a smaller disk on top of a bigger one.

Professionals can do this task in only 31 moves.

Hint: If you simply never put two of the same colour disks together, then the whole procedure works almost automatically.

### **2-Piece Pyramid**

The two blue pieces combine to form a pyramid.

Hint: What happens to the square face on each piece?

### **4-Piece Pyramid**

The four red pieces combine to form a pyramid.

Hint: Two small red pieces can be put together to form a piece of the blue pyramid.

### **The T**

The four pieces form a big T.

Hint: How is the right angle used?

### **How many dwarves?**

Count the dwarfs! When you interchange the upper parts, 15 men become 14 or vice versa.

Hint: Do the dwarfs before and after have the same height?

### **Ball Pyramid**

Put the four pieces together to form a pyramid.

Hint: Where on the pyramid are the long pieces found?

### **Honeycombs**

Arrange the hexagons around the designated hexagon so that only the same colours meet one another.

### **Conway-Cube**

The red and blue blocks combine to form a solid cube.

Hint: What is the position of the small cubes inside the big cube?

### **The Square-Triangle**

The four pieces fit together to form either a square or an equilateral triangle.

Soma-Würfel

### **Tangram**

Put the seven pieces together to form a square.

Hint: How big will the square be?

Where do the right triangles lie?

### **Soma-Cube**

Form a cube out of the seven coloured pieces.

Hint: How big will the cube be?

### **Polydron**

With these colourful shapes you can build different bodies. You can serve the pictures as an inspiration.

### **The Leonardo Bridge**

When built, this bridge remains stable without using nails, rope, or glue. In the photograph you can see how the bridge is assembled. Start by building a small bridge, then try to enlarge. This construction is an invention of Leonardo da Vinci (1452-1519).

### **Lights on!**

The aim is to light up all seven lights.

When pressing a button the status of the corresponding light and the status of the adjacent lights change: If one light was turned off it will turn on and vice versa.

Hint: It is possible to reach the aim with a maximum of seven moves!

### **Musical Dice**

Here you can compose a unique piece of music.

From a total of 176 bars, 16 will be chosen by chance.

To make your choice either you throw a pair of dice 16 times, or simply let the computer throw virtual dice for you.

The number of possibilities is 759,499,667,166,482.

This number is so gigantic that it is extremely unlikely that your composition has ever been played before.

This experiment originated with Wolfgang Amadeus Mozart (1756-91).

### **Pythagoras**

Flip the pieces over to change one big square into two smaller ones.

Hold the triangle up to the corresponding sides of the squares.

What do you observe?

This proof of the Pythagorean Theorem was already known in 9th century in India.

### **Testing Pythagoras on the Scales**

Put the two small squares on one side of the balance, the big square on the other.

What do you observe?

Then place the squares along the sides of the triangles.

What is the result?

You can make a corresponding experiment also with the other figures.

### **Giant Kaleidoscope**

Bend down and enter the giant kaleidoscope.

From which angles do you see yourself?

Observe the coloured edges of the mirrors.

### **Soap Films**

Carefully pull it out the frames and observe the fantastic structure that has been created.

Important Hint: Do not stir it! Foam ruins the lovely structures.

### **Count the Smarties**

Hold one of the frames against the poster.

Count the smarties inside the frame.

The frame covers exactly 1/100 of the area of the poster.

How many smarties are on the poster?

### **Do all these fit into the cube?**

Each of these coloured solids perfectly fits into the cube.

For each solid there is a trick.

In which relation is the star and the pyramid?

### **Who comes out the farthest?**

Are you able to stack the pieces so that one of them is completely beyond the edge of the table?

All pieces should be kept horizontally.

Hint: You can reach your goal with 4 squares.

### **The brachistochrone problem: which is the fastest track?**

1st experiment:

Start the race of the balls on one curved and one straight track.

Which ball arrives first at the bottom?

2nd experiment:

Hold the balls at two different heights on the curved tracks.

Release them simultaneously.

Which ball arrives first at the bottom?

### **Hold one of the triangles in the light.**

Try to hold it in such a way that its shadow matches one of the small triangles on the wall.

### **Galton board Simulator**

The Galton board, also known as bean machine or quincunx, is a device invented by Sir Francis Galton to demonstrate the central limit theorem and the normal distribution.

The machine consists in a vertical board with several rows of pins. Balls are dropped from the top through the pins, and bounce left or right (in equal chances) as they hit the pins. Eventually, they are collected into urns at the bottom. The ball columns obtained in the urns approximate a bell curve.

### **Make the good choice**

This exhibit is an illustration of The Monty Hall problem, a probability puzzle loosely based on the American television game show "Let's Make a Deal". The name comes from the show's original host, Monty Hall.

This problem is also called the Monty Hall paradox, as it is a veridical paradox in that the result appears absurd but is demonstrably true.

A well-known statement of the problem was published in Marilyn vos Savant's "Ask Marilyn" column in Parade magazine in 1990:

"Suppose you're on a game show, and you're given the choice of three doors: Behind one door is a car; behind the others, goats. You pick a door, say No. 1, and the host, who knows what's behind the doors, opens another door, say No. 3, which has a goat. He then says to you, "Do you want to pick door No. 2?" Is it to your advantage to switch your choice?"