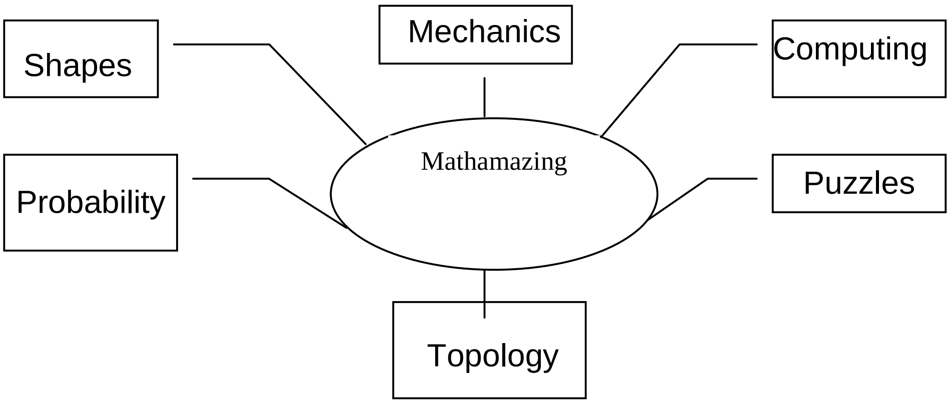
Mathamazing Exhibition
Primary Students' Maths Trail

Teachers' Notes

The Questacon *Mathamazing* exhibition gives visitors the chance to explore and discover mathematics and its importance to everyday situations. Make a bridge, find your age in binary, roll a double six, dissect a Möbius strip or see how fast you can throw! The exhibition dispels the myth that 'maths is boring' by being lots of FUN! The hands on exhibits draw on a number of branches of mathematics:



Many of the exhibits draw connections in arithmetic or algebra. Of course, all are just starting points for further exploration either at school or home. Following are brief descriptions of the exhibits in the *Mathamazing* Primary Students' trail and some ideas for you to try with your class before and after your visit to *Mathamazing.* This should allow you to maximize the impact and value of the visit.

Featured in the exhibition are displays of famous and important mathematicians. Looking at the development of maths over the centuries shows the subject as a dynamic one, not something that was, is and always will be the same.

The Maths Trail guides students through a range of exhibits, covering the topic area outlined above. Eight exhibits from *Mathamazing* have been chosen for this trail. The trail challenges and develops students' skills on observation, prediction, estimation, logical reasoning and experimentation.

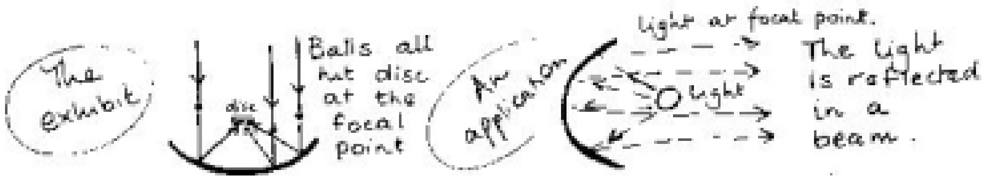
It is a good idea to split up your students into small groups of two or three. This facilitates communication about the exhibits and the ideas involved. Emphasise to your class the importance of each of them reading each exhibit's instructions panel, as well as his or her own trail sheet. Encourage students to come up with reasons for their answers. The group members should share the role of 'reporter', and all of the group should interact with all the exhibits in the trail. While the exhibits on the trail are numbered, they can be visited in any order. You could start the groups at different exhibits to avoid crowding.

Before your visit you will need to photocopy enough worksheets for your students.

The groups' completed sheets are an ideal prompt for further discussion and exploration after the visit to Questacon.

Parabola (1)

This exhibit displays the special relationship between a parabola and its focus. The visitor drops a ball onto a parabolic dish and the ball rebounds onto a plate positioned at the focal point. This illustrates the property that something, in this case the ball, which falls straight into a parabola will hit the curve and bounce to the focus. The reverse also works. Something, for example light or sound, coming from the focal point will bounce off the parabola and travel straight out. This has many applications.

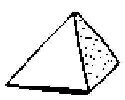


Many older cars' headlights are parabolic dishes (so are modern cars, but they are often elongated and made up of several different partial parabolas). In a headlight the bulb is placed at the focal point. Another use for parabolas is in telescopes and satellite dishes. The detector is placed at the focal point.

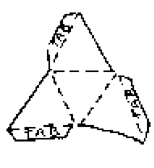
Make a parabola by placing a pan of water (or honey or oil) at the centre of a turntable (such as an old record player or a potting wheel) and spinning it – slowly! Astronomers have recently started to use this technique to make very large telescope mirrors. The liquid they use is molten glass. When the glass cools it is 'frozen' into shape. This saves having to grind a flat piece of glass into shape, which takes several years.

Students could try watching (or videoing) a ball in flight (from side-on) and draw the path they saw it take. This should be close to a parabolic path. With no air resistance it would be perfectly parabolic.

Tetrahedron (2)



How hard can a two-piece jigsaw puzzle be? Very hard indeed when the pieces are three-dimensional! The exhibit consists of two halves of a tetrahedron (triangular pyramid) and the object is to put them back together.



Not only is the tetrahedron an unfamiliar shape, but there is an interesting optical illusion working against you in this puzzle. A square face on each of the two pieces doesn't look square, but rectangular. This is due to the triangles attached to either end. This 'elongation' puts people off the right track.

The tetrahedral shape is fundamental to all living things. The carbon atoms, which form the basis of most of the chemicals in our bodies, more often than not, have their bonds to other atoms in a tetrahedral arrangement. A simple carbon based substance, methane – the most abundant chemical in natural gas – has four hydrogen atoms at the corners of a tetrahedron with a single carbon atom at the centre.

An example of the use of a tetrahedron is for frozen drinks ‘tetra packs’. Your students could make their own tetra packs, to get a pattern, wash and dry a used tetra pack, cut it open to see how it is made.

Möbius Strip (3)

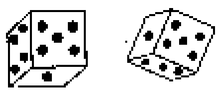
With paper strips, sticky tape and scissors students can explore some of the fascinating properties of the Möbius Strip. In its simplest form a Möbius Strip is a loop of paper made by putting a ‘half-twist’ into it before sticking the ends. By tracing around it you will discover that it only has one side and one edge. It also defies being cut in half down the middle.

After visiting *Mathamazing,* why not try making loops with different numbers of half twists (1,2,3,4,5…)? What happens when you cut these along the middle? Is there a pattern to the results? Your class could make a table like this:

Number of half twists	1	2	3	4	5	6
Number of slides						
When cut in half form how many loops?						

Try cutting the strips a third of the way in from one edge.

Roll the Dice (4)



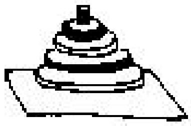
This exhibit deals with the very important areas of probability and chance. Visitors can examine the probabilities associated with rolling two six-sided dice.

Some probabilities are very obvious, such as the chance of getting a head in a toss of a coin (50%). What about tow heads in two tosses? (25%)

An interesting exercise in probability: How many people do you need in a room to have a greater than 50/50 chance that two of them will have the same birthday? The answer has been calculated as only 23. With 50 people it is almost certain that two will share a birthday. Check it with your class!

Tower of Brahma (5)

This exhibit is a game based upon an ancient Hindu legend that said when 64 discs were transferred the world would end. Playing is easy. The puzzle is made up of three pegs. The discs can be moved from one peg to another. The rules are that only one disc can be moved at a time and that a large disc cannot be placed on top of a smaller one. This is a game that can be easily played at school. Start with one disc and work upwards, recording the number of moves required for each number of discs.



The way to calculate the number of moves required is easy. The number of moves is $2^n - 1$, where n is the number of discs. For example with three discs the number of moves is $2^3 - 1 = 8 - 1 = 7$.

Looking a little more deeply into the puzzle reveals the power of powers. The number of moves required to solve the puzzle more than doubles when just one more piece is added. Thus five pieces require 31 moves, while 6 pieces required 63. Amazingly, the number of moves required for 64 disks is 18,446,744,073,709,551,615! This corresponds to one move a second for 600 thousand million years. Mathematics related to this is directly applicable to things such as studying the world's increasing population, which currently doubles once every 32 years or so.

Find Your Age (6)

This exhibit shows a neat way of converting a decimal number (the visitor's age) into binary (base two) equivalent. The visitor checks a series of charts and finds his/her age on some or all of the charts. Each chart corresponds to a different place value in binary code. Using a '1' for 'yes', my age appears in this chart and a '0' fir not appearing, the visitor can write out the binary form of their age.

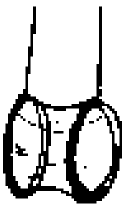
Binary numbers seem to be more complicated than decimal ones, but this largely die to unfamiliarity with them. Computers function on the binary system. Computers are made up of thousands of tiny switches. These switches can either be 'off' or 'on'. These two states correspond to 'zero' and 'one' in binary. Thus a string of these switches represents a binary number in a computer's memory. The exhibits 'Flip Flop' and 'Digital Counter' illustrate how this works.

Binary counting systems as well, such as octal (base 8) and hexadecimal (base 16). These are important in designing computers and electronic circuits.

Catenary (7)

This exhibit explores a very important engineering shape – the catenary curve. It is the only curve which creates a self-supporting arch. The object of the exhibit is to build a catenary arch from the construction blocks provided.

Catenaries standing on their ends are used to build self-supporting arches. The shape of wire hanging between power poles also forms a catenary curve.



Draw a catenary by holding a length of rope next to the blackboard and tracing its outline. Try making different catenaries by

- changing the length of rope

- changing the distance between the two people holding the ends

- changing the height at which one person holds one end of the rope.

Your students might suggest some uses for these shapes.

You can also make a catenary curve by dipping two parallel rings into a soap solution. The surface is always the smallest possible area and in this case forms a catenary.

Newton's Cradle (8)

The apparatus is named after Sir Isaac Newton, who, among other things, pioneered the study of moving objects like those in this exhibit.

When one ball is released and hits the other four balls one ball moves out the other side.

Something for your student to try at school is to line up several marbles between two rulers on a smooth table or floor. Roll another marble of the same size towards the line of marbles (use rulers as a set of 'tracks') and see what happens. Try two or more marbles colliding with the original line of marbles. What happens if there are more rolling marbles that stationary ones? What happens if the marbles are not the same size?