MATHEMATICS

How to Fold a Curve

Waxed paper is all the material needed to paperfold a parabola, hyperbola or ellipse. With cardboard, needle and thread, conic sections can be curvestitched.

See Front Cover

By MARTHA G. MORROW

➤ WAXED PAPER, cardboard, needle and thread are the intriguing materials you can use to "draw" geometric curves.

Some kids, not too interested in geometry, are now told to produce conic sections by folding paper or sewing cardboard with gaily colored thread. This kind of homework is fun, and an easy way to become acquainted with curves.

Parabolas, hyperbolas and ellipses are among the many curves that can be created both by curve stitching and by paper folding. Quite exact figures result from simple beginnings.

A point within a circle helps you paperfold an ellipse; a point outside a circle is all you need locate for a hyperbola. Two straight lines form the framework for curve stitching a parabola.

Thread pulled tightly between two points produces as straight a line as you can draw with ruler and pencil. When many lines are involved, it is often easier and more exact to stitch them than to draw them.

If you fold a piece of paper and crease it, you again create a straight line. How much simpler and quicker to make a series of lines by creasing them than to bother with ruler and pencil.

Waxed Paper Can Be Used

Waxed paper such as housewives often keep in the kitchen is excellent for paperfolding as it shows up the crease nicely. After creasing a number of lines, just straighten the paper out again and notice the figure created by the creases.

If you have forgotten what a parabola looks like, refresh your memory by paperfolding one. Although your figure will show up best if you use waxed paper, you can paperfold thin paper such as tissue paper or onionskin. Or if you have nothing better handy, you can use newspaper.

Draw a straight line on your piece of paper. If no ruler is available, you can use the edge of a book or magazine as your guide, or perhaps you can draw a fairly straight line freehand. Far above or below the line mark a point, which for convenience you can call F.

Fold the paper so that the point F touches the line, and crease the paper. Fold again so that F touches another part of the line and crease. After you have made many creases in this manner, your creased lines will begin to outline a parabola.

To curvestitch a parabola, you need a needle, strong but thin thread such as button or embroidery thread, and a piece of cardboard. On the cardboard draw two straight lines which meet at a point to form an angle. On both these lines, beginning at the place where they intersect, mark off a dozen equally-spaced points. Label the points on both lines from 1, 2, 3 and so on to 12. But on one line begin numbering at the point where the lines meet; on the other line begin at the point farthest from the vertex of the angle.

To make a good-looking curve, use thread that shows up well against the cardboard. Stitch from 1 to 1, 2 to 2 and so on until all duplicate numbers have been connected. When you have finished, your stitches should outline a parabola, or, to be more exact, should form the envelope of a parabola.

Circle With Point to Make Hyperbola

A hyperbola, which is difficult to draw even with geometrical tools, is easy to paperfold. To begin, you need draw on waxed paper only a circle and mark a point F outside the circle.

If you do not have compasses to make your circle, draw it with thumb tack, pencil and string. Stick a thumb tack in the middle of your piece of waxed paper and place a loop of thread around it. If you keep the thread taut with a pencil, the pencil will describe a circle as you move it around the tack.

Fold the paper so that F, which can be any point outside the circle, touches some point on the circle, and crease the paper. Repeat this folding and creasing operation for many points around the entire circumference of the circle and crease each fold. One of the branches of the hyperbola will begin to take shape first, but if you keep folding and creasing eventually both branches will appear.

For an ellipse you need only a large circle and a point F inside the circle. Fold the paper so that F touches some point on the circumference and crease the paper. Continue folding and creasing for many points around the entire circumference of the circle until the ellipse becomes visible. F and the center of the circle are the foci of the ellipse thus formed.

An ellipse, you may remember, is relatively simple to draw with pencil, string and paper. You draw it pretty much the same way you would a circle, only loop the thread around two thumb tacks instead of just one. Stick a pencil inside the loop and pull the string taut, then move your pencil to all possible positions while keeping the string taut, and you draw an ellipse.

Definition of Forms

An ellipse is usually defined as the path (called the locus in mathematics) of a point which moves in such a way that the sum of its distances from two fixed points is constant. The thumb tacks are your fixed points, and the loop of string keeps the pencil's distance from them constant. By geometry it is easy to prove that the figure formed by paper folding is likewise an ellipse.

A parabola is defined as the path of a point which moves so its distances from a fixed point and a fixed line are equal. In a hyperbola, the difference of the distances of a moving point from two fixed points is constant.

An interesting kit on curves has been designed by M. H. Ahrendt of the National Council of Teachers of Mathematics and Lt. Col. Robert C. Yates of the United States Military Academy in cooperation with SCIENCE SERVICE. So that teachers, pupils and those who remember a bit of their high school geometry can have fun with conic sections, 12,000 kits are being distributed throughout the country.

Diagrams on cardboard help those using the kits to curvestitch not just the easy-to-make parabola, but also an ellipse and hyperbola. Red and blue embroidery thread, and a large-eyed needle are supplied for making professional-looking models. Waxed paper is furnished for the paper-folding experiments. So readers can understand the relationship between the various conic sections, directions and materials are supplied for making a tricky three-dimensional double cone.

Some of the forms that can be made using materials and instructions in the kit are shown on the cover of this week's SCIENCE NEWS LETTER.

A few of these curve kits have been reserved for readers of SCIENCE NEWS LETTER. Just send 75 cents to Science Service, 1719 N St., N. W., Washington 6, D. C., and ask for the Curve Kit.