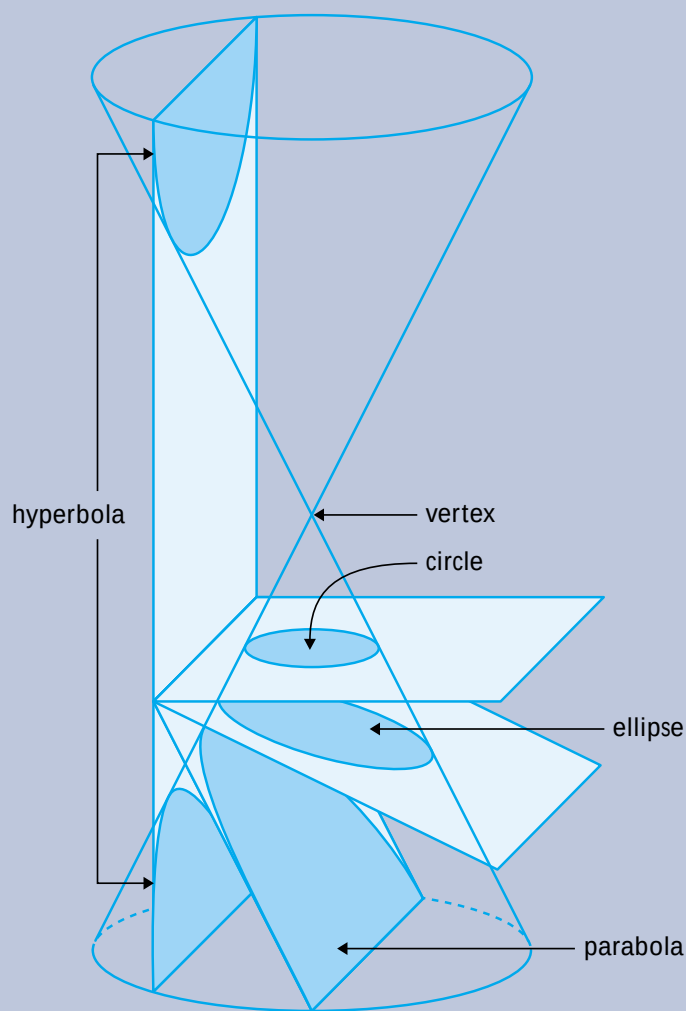


Chapter

7u

Investigating Loci and Conics

Functions and Relations



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Circles, parabolas, ellipses, and hyperbolas are conic sections. Astronomers describe the orbits of planets and satellites using conical curves. Today a meteorologist may determine, for example, the circulation speed of a cone-shaped hurricane by finding the tangent to a conic section. You may see conics in satellite dishes, car headlights, and architectural structures.

A plane slicing through a cone at various angles produces a conic section. A horizontal slice produces a circle; a vertical slice produces a hyperbola. A diagonal slice, cutting through the bottom and the side of a cone, produces a parabola. Another diagonal slice, cutting through only the side of a cone, produces an ellipse.

In this chapter, you will

- construct and describe models to represent certain conditions, or a described locus of points
- use locus definitions to determine equations of conics: circles, parabolas, ellipses, and hyperbolas
- determine and explore geometric models for conics using technology and concrete materials
- investigate and determine the key features of conics
- sketch graphs of conics
- pose and solve problems about conics

Connections



The Chapter Problem

Designing a Bridge

Designing a bridge that will support a road or railway and provide a pathway underneath the bridge is a frequent task for engineers. There are many things to consider when designing a bridge. The focus of this problem is the design of an arch that will allow vehicles to pass under it. An arch may be a semicircle, a semiellipse, a parabola, or a hyperbola.

Your task is to design several different arches. Each arch must be from 5 m to 6 m high and must span a two-lane road that is 11 m wide. The arch must also allow trucks to travel in either lane of the road. The largest truck that might pass under the arch is 3 m wide and 4 m high.

You are to create at least three bridge designs in this chapter—a semicircle, a semiellipse, and a parabola—that will satisfy the above criteria. For each design, show the following:

1. a diagram of the design with dimensions
2. the equation of the curve and a graph of the curve
3. that two trucks of the given dimensions will be able to pass, side by side, under the archway. Make sure that you allow space between the trucks, as well as at the sides of the road.

Conclude by recommending the best design. As well as using your own calculations to support your recommendations, you might also research which bridge designs are more common or which arches offer the best support.

For help with this problem, see pages 583, 594, and 604.

Challenge 1

Satellite dishes are widely used in the telecommunications field. The cross section of a satellite dish may be a parabola, a hyperbola, or a semiellipse.

One simple way to understand how a satellite dish works is to experiment with a flashlight.

1. What is the shape of a flashlight's reflector? Find and verify the equation of this shape.
2. Is the light source at the focal point of the cone of light? Shine the light on the wall. How does the shape on the wall change as you change the angle of the flashlight? Creating a circle of light may be easy, but how would you change the circle to an ellipse? Can you make a parabola?
3. Trace the reflections on a piece of paper and determine the conics you have created. Justify your choice of conic by determining and verifying the equation of each.
4. Find out about a satellite dish in your area and use the dimensions of the dish to determine which conic it resembles.



Challenge 2

Computer-assisted design (CAD) has hundreds of applications. Automobile, aircraft, aerospace, and ship designers use CAD to design vehicles. Many graphics and logos are created using CAD. In a CAD drawing of a building, you would see a “wireframe” outlining the curves of a surface. Many of the curves you see in graphic designs or architectural structures are parts of conic sections. The “golden arches” of a popular fast-food restaurant resemble a pair of parabolas.

Find a picture in a magazine, or a logo, that includes a curve that you think resembles a conic—an ellipse, a parabola, or a hyperbola. Make a conjecture about the type of conic. Trace the curve on a piece of a paper. Then draw an x - y plane on graph paper. Centre the curve about the origin of the coordinate plane. Choose several points on the curve and model the curve by determining an equation. Test other points on the curve to see how well they “fit” your algebraic model or equation. Make a conclusion about the appropriateness of your model and justify your reasoning. Present your results as a poster and be sure to include the original picture or a photocopy.

Web Challenge

For a related Internet activity, go to www.math.nelson.com.

