AIR WARFARE DESTROYER ALLIANCE

QUADRATICS
Graphs and Focal Point

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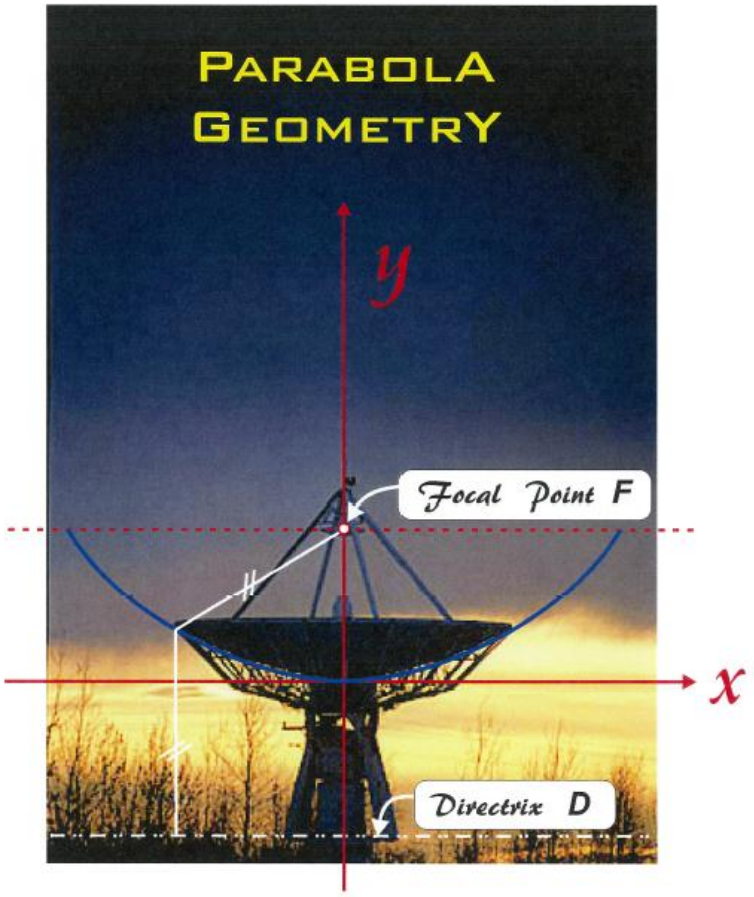
Student's Name :



The aim of this document is to give students the opportunity to trace parabolas with geometric instruments (Compass and Square) and explore the properties of the focal point of parabolas.

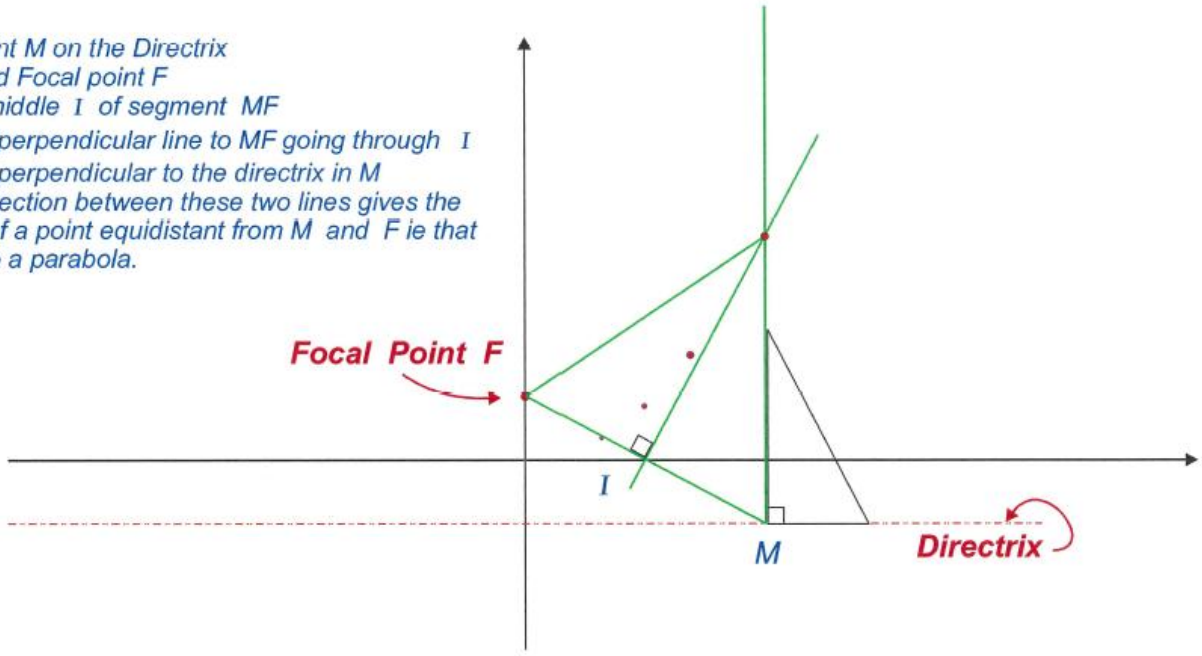
PART 1

Tracing a Parabola with Focal Point and Directrix.

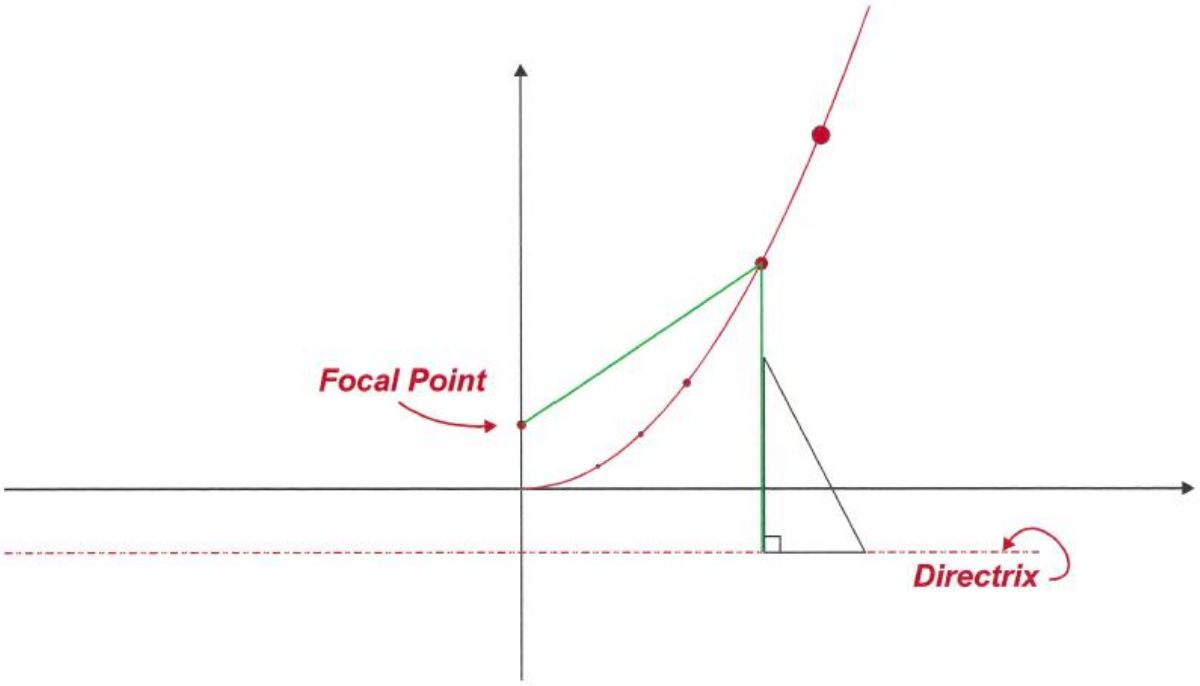
A parabola is the ensemble of points that are a the same distance from a focal point and from a straight line called Directrix.

Activity 1 **You will need a pair of compass and a square. This is how to proceed.**

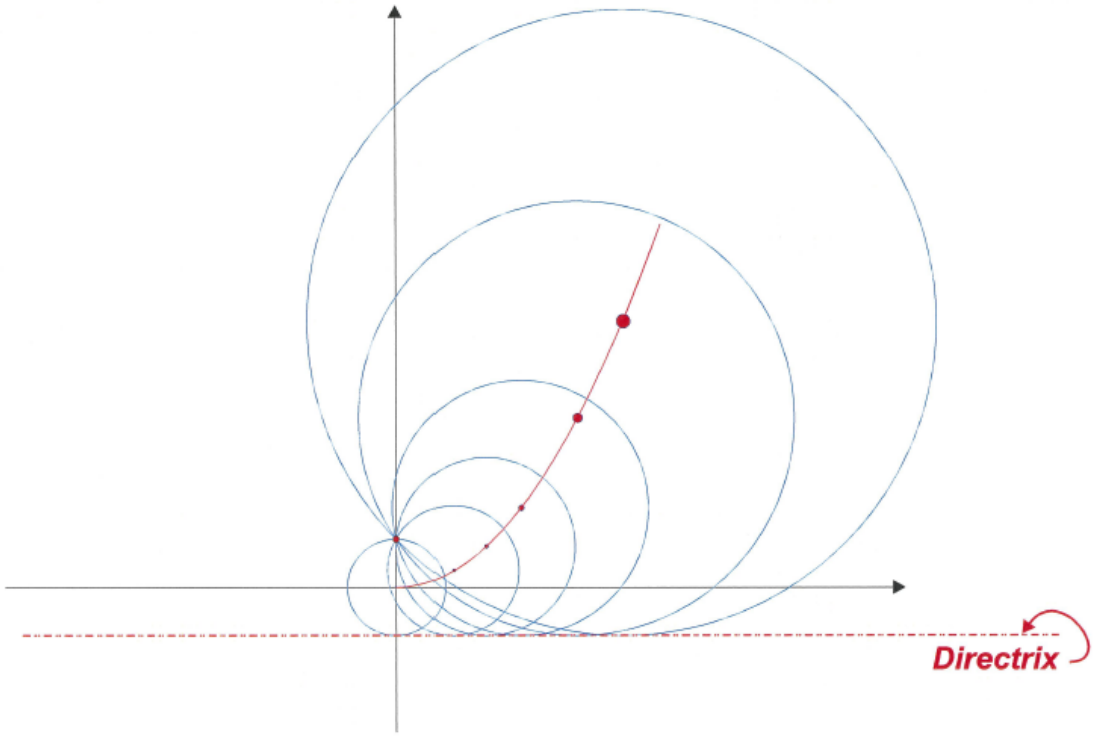
1) Pick a point M on the Directrix
2) Join M and Focal point F
3) Find the middle I of segment MF
4) Trace the perpendicular line to MF going through I
5) Trace the perpendicular to the directrix in M
6) The intersection between these two lines gives the location of a point equidistant from M and F ie that belongs to a parabola.



Activity : Trace the other side of this parabola



ACTIVITY 2) ***Another way that could be used to trace a parabola would be to " roll " circles of different diameters on the directrix and stop them when the circle cuts the Focal Point. The centre of the circle is then part of the parabola.***



Activity : Trace the other side of this parabola

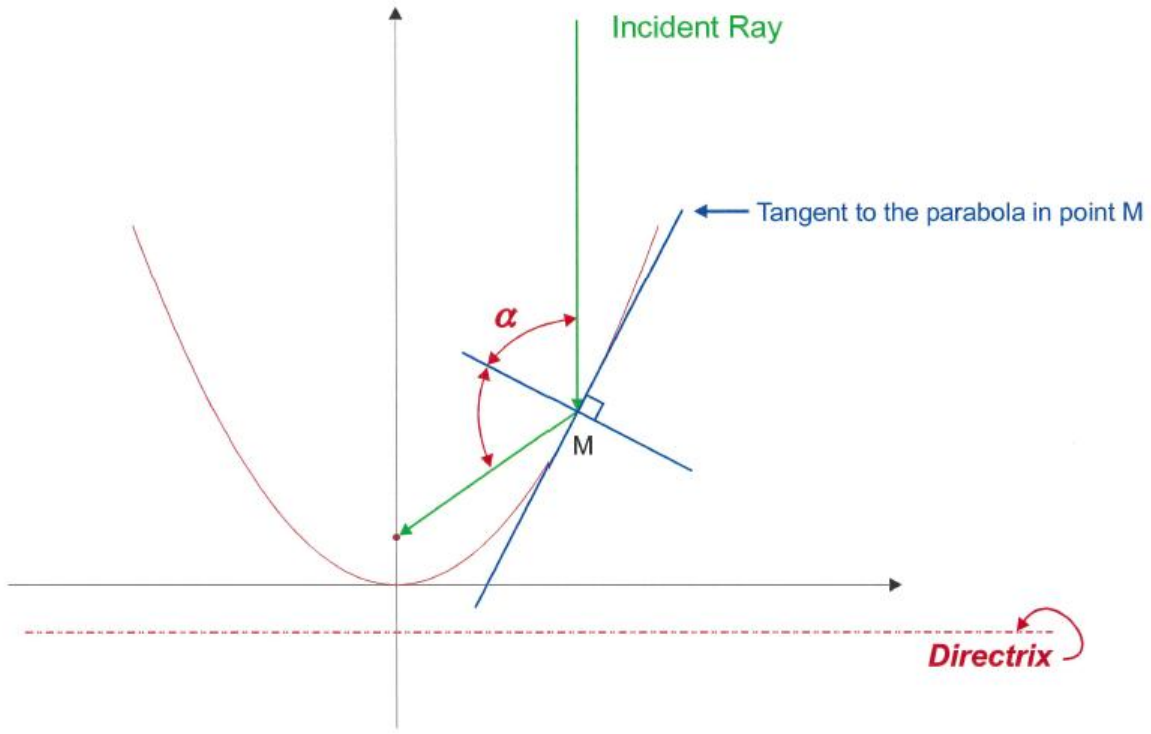
The graph you have just traced is called a parabola and is the shape used to design satellite dishes all around the world.

PART 2

Property of the Focal Point.

1) Pick a point M on the Parabola
2) Trace a vertical line hitting the parabola on M (simulating a ray of light, or an electro magnetic wave)
3) Trace the perpendicular to the tangent to the parabola in M
4) Measure the angle α between the perpendicular and the incident ray
5) Trace the same angle on the other side of the perpendicular. The intersection with the vertical axis gives the position of the foyer.

Activity : Try tracing other rays to check (with a square and a protractor) that they all end up crossing on the Focal Point F



This is the overarching property of Parabolas. They are very good at concentrating the energy they receive in one single point.

The property can be reversed : if you place a source of light (or electro-magnetic waves) in the location of the Focal Point, the emerging beam of light will be parallel and will therefore be able to reach great distances. A typical application would be the parabolic mirrors at the back of head lights in cars or in Radars.

PART 3

Example of application for the use of Solar Energy.

Parabolas are very efficient at capturing the energy radiated by the Sun.

Some industrial applications have been built around the world.

The first solar powered power plant was built in France in the Pyrenees mountains. The reflected light was focused on the top of a tower which had a tank of sodium that could reach in excess of 400 degrees centigrade. This heat in turn was transferred to water through an exchanger which produced steam that made a turbine power an electric generator.

The Spanish and Americans are building bigger versions and solar thermal energy should play a substantial role in the future of energy production.

Check it out on the Internet !

PART 4

Further research:

The Air Warfare Destroyer main Radar is a Phase Array Radar. Find out in what way this Radar system is different from the classic parabolic antenna Radar system.

Classic Radar (Rotating)

Phased Array Radar
(No moving parts)