The Parabolic Reflector Microphone

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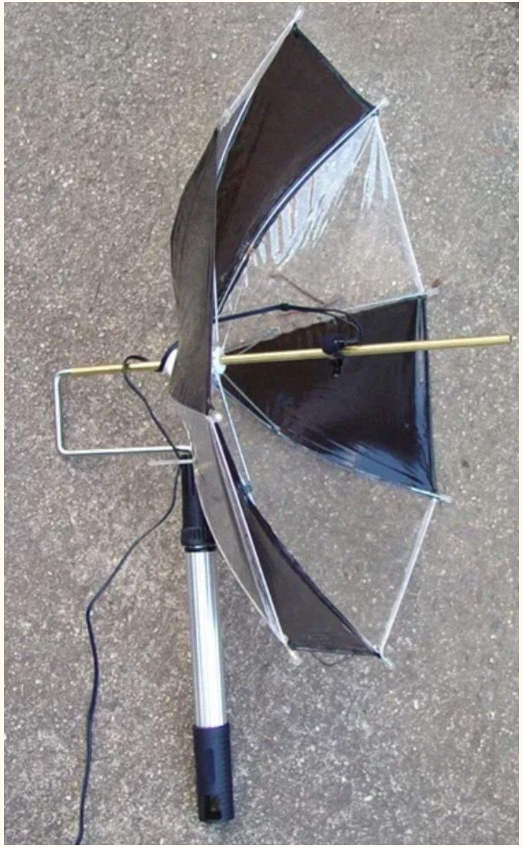
What is a Parabolic Reflector Microphone?

- It is microphone that uses a parabolic reflector to collect and focus sound waves onto a transducer, in much the same way that a satellite dish does with radio waves.
- They have great sensitivity to sounds in one direction, along the axis of the dish, and can pick up distant sounds.
- Typical uses of this microphone include:
    - nature sound recording
    - field audio for sports broadcasting
    - eavesdropping on conversations, for example in law enforcement, military, or security

Activity to Try

- Materials:
  - A small umbrella
  - Small microphone
  - Paint roller
  - Strong tape
  - Wooden dowel
- Assembly
  - Remove the plastic from the paint roller and tape the wooden dowel onto the top metal piece. This will be the handle.
  - Insert the paint roller into the back side of the umbrella and secure with tape.
  - Attach microphone to the wooden dowel where you would think the focus would be located.
  - Run the microphone chord through the back of the umbrella and turn on.

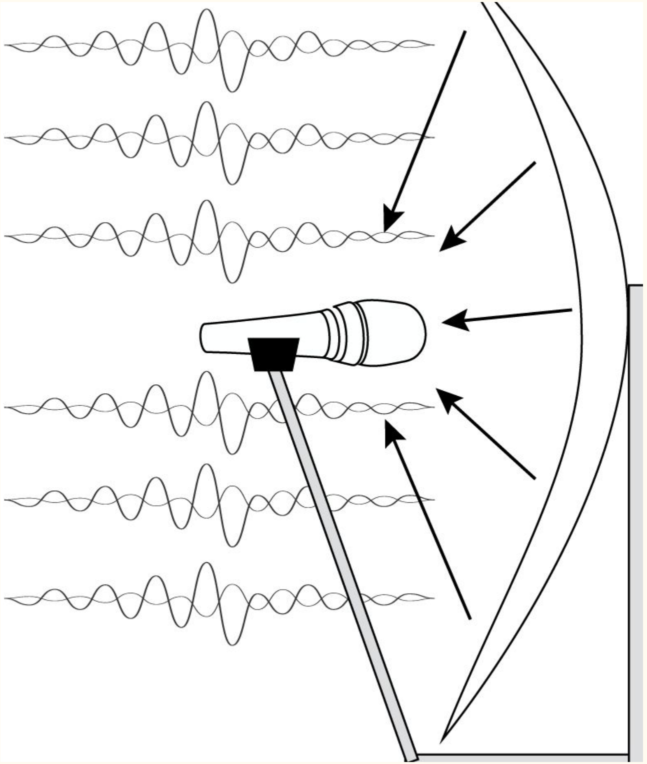


Activity to Try Continued...

- At home or in a classroom, ask someone to stand at one end of the room with a cell phone ready to play music at a set volume.
- With the ordinary microphone on the other side of the room, ask the person to play the music while you record the audio.
- Listen to the recording and allow students to predict what will happen to the volume when the parabolic microphone is used. Will the sound be clearer? Louder? Will the audio even change at all?
- Ask someone to stand at the other end of the room with the cell phone ready to play music again at the SAME volume.
- With the parabolic microphone, record the audio once again aiming it directly at the cell phone.
- Listen to the new audio and discuss what happened... Allow the students to apply the mathematics behind a parabola to the situation.

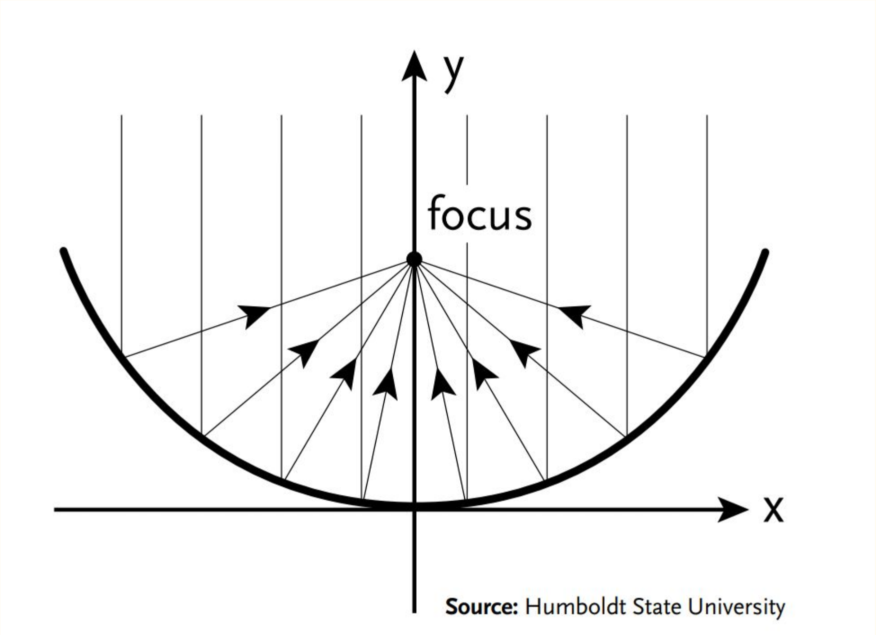
What Happens to the Sound?

- When multiple sound waves from a sound source strike the sloped inner wall of the dish, they bounce back to a focused position in front of the disk.
- When a sound waves hit the parabolic dish, the waves are collected together at the focal point. An ordinary microphone in the proper position can capture an amazing analog amplification of the sound source.
- Larger disks will be able to capture more sounds.



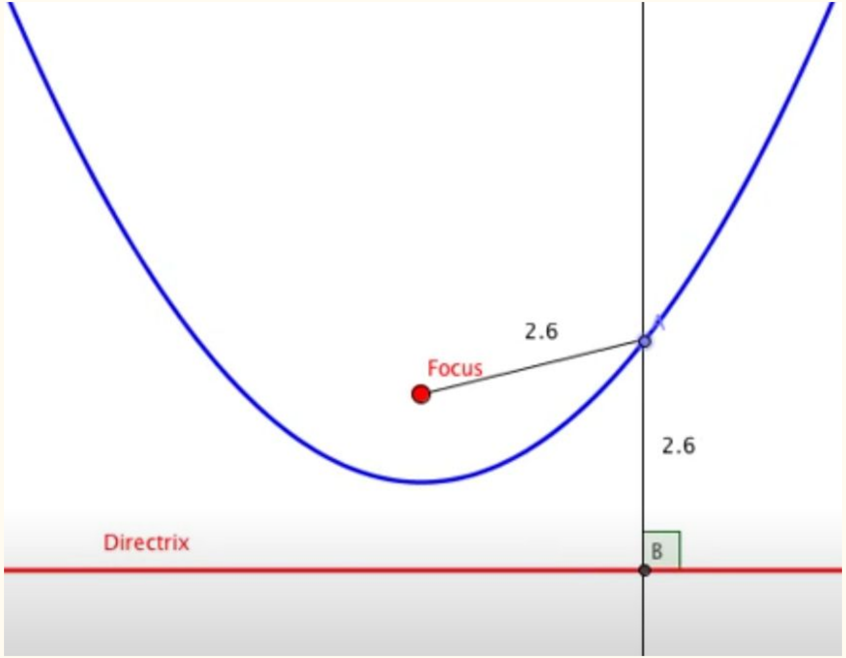
How does it work?

- A parabola is a specific geometric curve that has a distinct mathematical property. When a straight line hits any point on the inner surface of a parabolic curve it reflects off the slope to a single common point centered in front of the curve. This position is the focal point (focus) of the parabola.

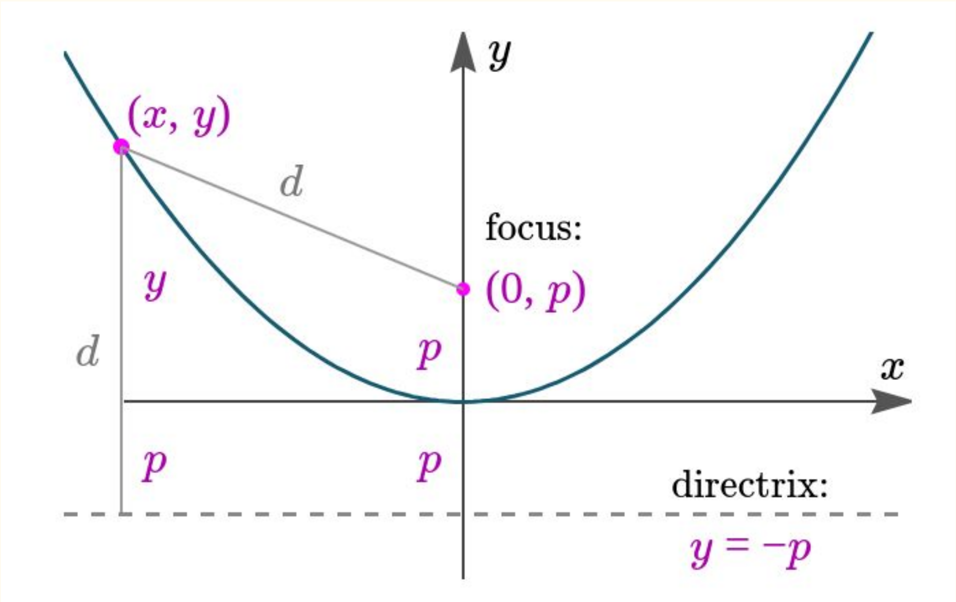


Mathematics Behind It

- As we know, the parabola is defined as the locus of a point which moves so that it is always the same distance from a fixed point (called the focus) and a given line (called the directrix).
- If sound waves are going towards the dish (parabola), they reflect and hit the focus point. We will be discussing the process of finding the location of the focus point, which is where the microphone should be positioned



Mathematics Behind It



In this graph:

- The focus of the parabola is at (0,p).
- The directrix is the line y=-p.
- The focal distance is |p| (distance from the origin to the focus, and from the origin to the directrix. Since distance is always positive, we take the absolute value of it).
- The point (x,y) represents any point on the curve.
- The distance d from any point (x,y) to the focus (0,p) is the same as the distance from (x,y) to the directrix.
  - d=y+p
- The axis of symmetry of this parabola is the y-axis.

Mathematics Behind It

- According to the definition of the parabola, any point (x,y) on the parabola is equidistant from the focus and the directrix. Hence the equation:

$$\sqrt{[(x-0)^2+(y-p)^2]}=y+p$$

- Then we can square both sides of the equation and get:

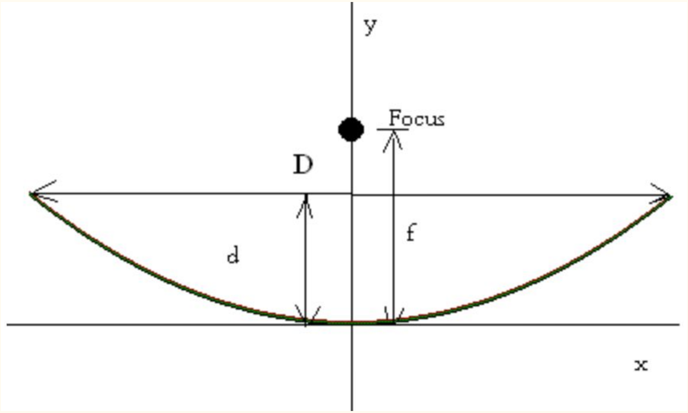
$$(x-0)^2+(y-p)^2=(y+p)^2$$

- When we simplify this, we get the formula for a parabola involving the focal distance p:

$$y=x^2/4p$$

Mathematics Behind It

- If we know the dimensions of the dish, we can then find the focal distance which gives the position of the focus relative to the position of the dish.
- D is the diameter of the dish
- d is the depth of the dish
- f is the focal distance
- The focal length is found by equating the general expression for *y:*
  - $y = x^2/4f$
  - This gives you the focal length that tells you the location of the focus point, which is where to position the microphone.



Let's Try!

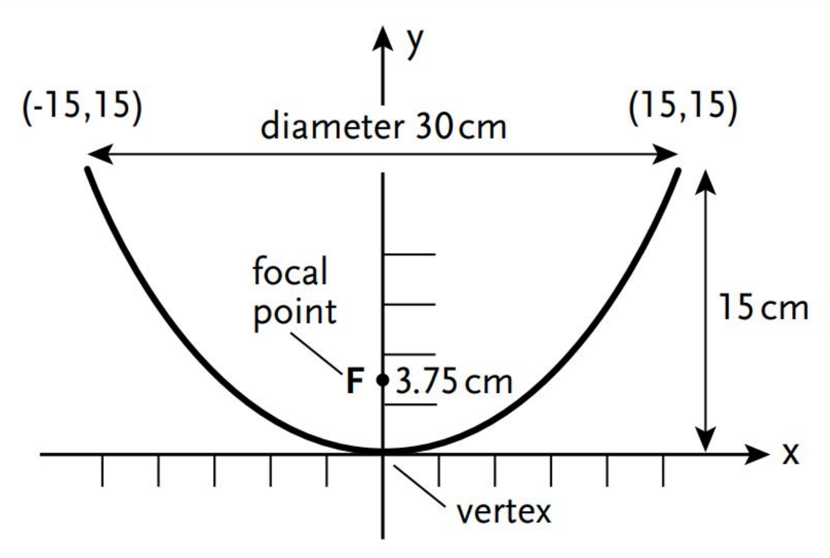
If the diameter of a parabola is 30 centimeters, and its depth is 15 centimeters. How far is the focal point from the vertex of the parabola?

$$f = D^2 / 16d$$

$$f = (15^2)/(4*15)$$

$$f = 225cm^2/60cm$$

$$f = 3.75 \text{ cm (focal point)}$$



Sources

https://www.videomaker.com/article/f20/17144-how-to-build-a-parabolic-mic-dish

https://kloverproducts.com/klover-mik/applications/

https://www-tc.pbs.org/wgbh/nova/teachers/activities/pdf/3406_solar_03.pdf

https://www.analyzemath.com/parabola/parabola_focus.html

https://www.intmath.com/plane-analytic-geometry/4-parabola.php

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