Applications of Parabolas 1.0

Teachers Teaching with Technology™
Professional Development from Texas Instruments

Student Activity

7 8 **9** **10** **11** 12

TI-Nspire™ Investigation Student 50 min

Applications of Parabolas

Calculator Instructions: Applications of Parabolas

Watch the video on Parabola Applications 1.0. to help answer the question:

Where are we ever going to use this in the real world?

Check out the world's largest parabola measuring 500m in diameter! This behemoth of a telescope is listening to the universe in search of intelligent life beyond our solar system?

While it is not specifically looking for potential NEOs (Near Earth Objects), it would certainly be able to detect one!

https://youtu.be/Qg5RHJ0uUYY

Search CNEOs – Centre for Near Earth Objects to find out more satellites (parabolic reflectors) are being used to help save the world!

Open the TI-Nspire file: Parabolic Applications 1

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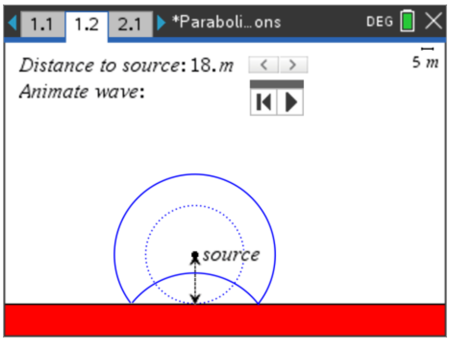
A wave is emitted from the source and travels uniformly outwards in all directions. This could be a sound, light or radio wave. In the diagram opposite part of the wave has hit the wall and reflected.

Adjust the distance to the source (further from the wall) and notice what happens to the 'curvature' of the wave.



Note: Animations take a **lot** longer to come into the picture when the source is a long way away.

Question: 1.

What happens to the curvature of the wave as the source is moved further from the wall (surface)?

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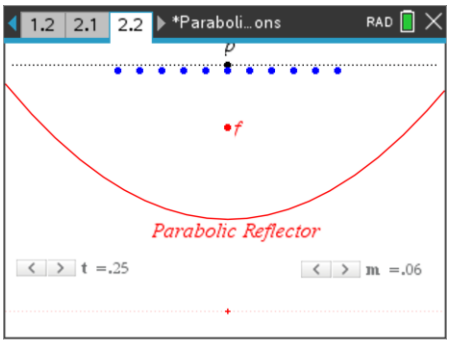
The shape of the parabolic reflector can be changed using slider: '**m**'.

A straight wave front passing through P can be thought of as a series of points. Press slider '**t**' repeatedly, or animate it, to see how each point on the wavefront is reflected when it hits the parabolic reflector.



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Question: 2.

What happens to all the points after they strike the parabolic reflector?

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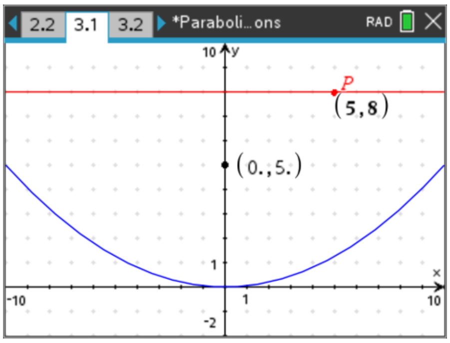

A parabola with equation: $y = 0.05x^2$ has been graphed. The focal point is shown, so too a wave, represented by the line $y = 8$.

Point P is shown with the coordinates: (5, 8). This point can be moved vertically to gain an estimate of how far it is from the line to the curve. Point P moves parallel to the y axis, in the same direction as the wave.

Question: 3.

Point P currently has the coordinates: (5, 8). How far, vertically, is point P from the parabola?

Question: 4.

When point P strikes the surface of the parabolic reflector, how far will it be from the focal point (0, 5)?

Question: 5.

What is the total distance travelled by point P (on the wave) as it travels from $y = 8$ and finally reaches the focal point?

Question: 6.

Write down the coordinates of three other points on the wave at: $y = 8$. Determine each of the distances travelled as they move along the wave, reflect from the parabola and finally reach the focal point. Comment on the result.

Question: 7.

The wave front is moved to a new location: $y = 6$. Write down the coordinates of 3 new points on this wave front. Determine the distance each of your points will travel as they travel along the wave, reflect from the parabolic mirror and then pass through the focal point. Comment on the result.

Question: 8.

Change the curvature of the parabola so that it has the equation: $y = 0.1x^2$, the focal point will move accordingly. Shift the wave front so that it is represented by the line: $y = 5$. Write down the coordinates of 3 new points on this wave front. Determine the distance each of your points will travel as the reflect from the parabolic mirror and pass back through the focal point.

Extension:

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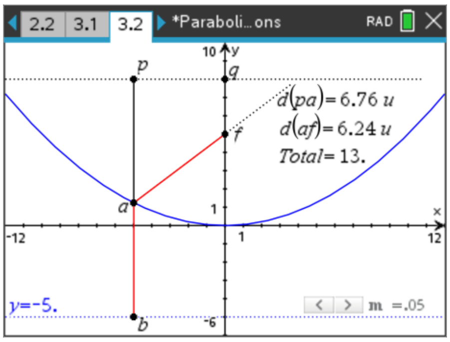

- The line PQ is parallel to the directrix (line passing through b).
- Point Q can be moved up or down along the y axis.
- Point P can be moved along the line PQ.
- The curvature of the parabola can be changed with slider (m).

Question: 9.

Move point P along the line PQ. What do you notice about the total distance: PA + AF?

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Question: 10.

Move point Q. Once again, move point P along the line PQ. What do you notice this time?

Note: Only consider situations where 'a' is below the wave front[1].

Question: 11.

Recall the definition of a parabola, use this to help explain your observations in the previous questions.

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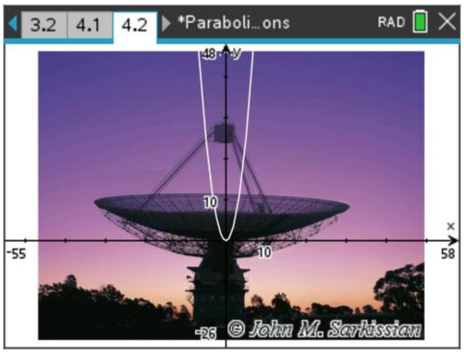

The image in the Graphs application is of the Radio Telescope at Parkes (Australia). The window settings have been scaled to suit the image.

Move the mouse over the graph until it says "graph f1" and shows a double-sided arrow: ⤡

Drag (dilate) the graph until it models the curvature of the telescope, then press:

menu > **Analyse Graph** > **Analyse Conics** > **Foci**

The focal point of the parabola will appear.

Question: 12.

Based on your equation to model the curve of the dish, determine the approximate distance between the dish and the focal point.

Question: 13.

The dish has a diameter of 64 metres, assuming all the energy from a reflected wave arrives at the focal point, with a collection area of radius 5cm. Determine the increase in the intensity.

Question: 14.

The giant dish in China has a diameter of 500 metres, assuming all the energy from a reflected wave arrives at the focal point. If the collection area at the focus has a radius of 10cm. Determine the increase in intensity.

[1] This is a limitation of the construction, not the geometry.

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