Hooked on Conics

Introduction to Conic Sections

Tammy Cooper, Lydia Baker, MacKenzie Corrigan
Published by *K20 Center*

Grade Level	11th – 12th Grade	**Time Frame**	95 Minutes
Subject	Mathematics	**Duration**	1-2 Class periods
Course	Precalculus		

Essential Question

How do the key features of conic sections help in constructing the equations and graphs?

Summary

In this lesson, students will be introduced to all four conic sections, first by manipulating light to create the conics, then by participating in a card sort to match graphs, key features, and their equations. Next, students will formalize their knowledge through a flow chart and an informational video before participating in an expert stay-and-stray strategy, where they will teach their peers about conic sections. The lesson concludes with a check for understanding to ensure that students can graph and identify key features given the equation of each conic section.

Snapshot

Engage

Students use a flashlight and table to create conic sections with the light.

Explore

Students use a card sort to group equations, graphs, and key features with each conic section.

Explain

Students complete a flowchart to determine conic sections and watch a video to formalize their knowledge of each conic section.

Extend

Students practice differentiating key features of each conic section through the Expert Stay and Stray strategy.

Evaluate

Students complete practice problems and review and correct peers' responses.

Standards

Oklahoma Academic Standards Mathematics (Precalculus)

PC.CS.1.2: Identify key features of conic sections (foci, directrix, radii, axes, asymptotes, center) graphically and algebraically.
PC.CS.1.3: Sketch a graph of a conic section using its key features.
PC.CS.1.4: Write the equation of a conic section given its key features.

Attachments

- Card Sort (Answer Key)—Hooked on Conics.docx
- Card Sort (Answer Key)—Hooked on Conics.pdf
- Card Sort—Hooked on Conics.docx
- Card Sort—Hooked on Conics.pdf
- Classifying Conic Sections Flowchart (Answer Key)—Hooked on Conics.docx
- Classifying Conic Sections Flowchart (Answer Key)—Hooked on Conics.pdf
- Classifying Conic Sections Flowchart—Hooked on Conics.docx
- Classifying Conic Sections Flowchart—Hooked on Conics.pdf
- Conic Sections Key Features (Answer Key)—Hooked on Conics.docx
- Conic Sections Key Features (Answer Key)—Hooked on Conics.pdf
- Conic Sections Key Features—Hooked on Conics.docx
- Conic Sections Key Features—Hooked on Conics.pdf
- Conic Sections Practice Problems (Answer Key)—Hooked on Conics.docx
- Conic Sections Practice Problems (Answer Key)—Hooked on Conics.pdf
- Conic Sections Practice Problems—Hooked on Conics.docx
- Conic Sections Practice Problems—Hooked on Conics.pdf
- Lesson Slides—Hooked on Conics.pptx
- Playing with Light—Hooked on Conics.docx
- Playing with Light—Hooked on Conics.pdf

Materials

- Lesson Slides (attached)
- Playing with Light (attached; one per student)
- Card Sort (attached; one per group)
- Card Sort Answer Key (attached)
- Classifying Conics Flowchart (attached; one per student)
- Classifying Conics Flowchart (Answer Key) (attached)
- Conic Sections Key Features (attached; one per student)
- Conic Sections Key Features (Sample Responses) (attached)
- Conic Sections Practice Problems (attached; one per student)
- Conic Sections Practice Problems (Answer Key) (attached)
- Flashlight (one per group)
- Cardboard boxes (Optional)

5 minutes

Engage

Teacher's Note: Preparing the Lesson

The Playing with Light handout has 2 per page. Cut it in half before the lesson. Prior to the activity, consider watching the How to Visualize and Model Conic Sections with a Flashlight to understand what is happening in this activity.

Use the **Lesson Slides** to guide the lesson. Introduce the lesson by asking the essential question and explaining the objectives on **slides 2-4**.

Split the class into groups of 2-4 students, provide each group with a **Playing with Light** handout (attached) and flashlight, and use **slide 5** to introduce the activity to the class. Explain to students that when you turn on your flashlight and point it towards the wall, you can see a cone of light, with the tip of your cone being your flashlight and the base of your cone being the plane that it intersects. When you hold the flashlight at a different angle to the wall (or plane), the shape of the light will change. Tell students that with their groups, they will investigate these changes and record them on their handout.

Dim the classroom lights to the best of your ability and instruct the groups to complete the table on their handout. Encourage students to utilize the word bank as necessary.

Teacher's Note: Guiding the Activity

If you cannot easily dim the light in your classroom, consider providing cardboard boxes for each group to use to investigate the changes in the shape of light.

20 minutes

Explore

Teacher's Note: Preparing the Lesson

Before this point in the lesson, print, cut, and laminate the Card Sort for each group. Depending on class size, try to make each group have between 2-4 students so that all students stay on task.

Keeping students in the same groups from the Engage, transition to **slide 6**, and give each group a set of the prepared Card Sort. Explain to the class that they will work with their groups to match the five equations, graphs, and key features together for each conic section.

Teacher's Note: Optional Card Sort Pacing

Depending on your class's prior knowledge, read the following scaffolding and determine how much to provide to your students. If choosing to provide additional scaffolding, unhide **slides 7-13** in the Lesson Slides.

Display **slide 7**. Have the students go through the cards and remove the cards with only one word on them. Tell the students that they have found the four conic sections.

Display **slide 8**. Have the student locate the standard form of each conic section. **These cards are shaded grey** and match the equation with its correct conic section.

Depending on your students' prior knowledge, they may or may not know the equation for a hyperbola and an ellipse. Explain to the students that these two equations look similar, but a hyperbola uses subtraction, and an ellipse uses addition.

Display **slide 9**. Have the groups match each equation (symbol) card with its appropriate conic section.

Display **slide 10**. Ask students to go through all of the graphs (number cards) and classify them by placing them under one of the four conic section cards. As students sort the cards, walk about the room, and ask guiding questions about circles and parabolas, asking students what they look like and how to identify them. Ask students to analyze the similarities and differences between the graphs to help group similar graphs together. Encourage students to use graphing technology to visualize what the hyperbola and ellipse graphs look like.

Display **slide 11**. Discuss with the class how to identify circles, their equation, and what key features can be identified from their graph/equation. Ask students to sort through the key feature (letter) cards and pull out any that belong to circles.

Students should have 5 equations, graphs, and key feature cards for circles. Instruct them to work with their group to match the correct equation, graph, and feature cards together. Encourage students to use graphing technology to check their work.

Display **slide 12**. Discuss with the class how to identify parabolas, their equation, and what key features can be identified. Ask students to sort through the key feature (letter) cards and pull out any that belong to parabolas.

Students should have 5 equations, graphs, and key feature cards for parabolas. Instruct them to work with their group to match the correct equation, graph, and feature cards together. Encourage students to use graphing technology to check their work.

Display **slide 13**. Next, have students refer to the grey-shaded cards to understand what key features can be identified in hyperbolic and ellipse graphs. Ask them to sort the remaining key feature cards to the correct conic section.

Instruct them to work with their group to match the correct equation, graph, and feature cards together for hyperbolas and ellipses. Encourage students to use graphing technology to check their work.

20 minutes

Explain

Transition to **slide 14** and give each student a copy of the **Classifying Conics Flowchart**. Using prior knowledge and the card sort, have the groups work together to complete the flowchart.

When complete, ask the students to take a picture of their completed card sort to reference later. Shuffle and rubber band the cards together, and return the card to a specific place in the classroom.

Review correct responses for the Flowchart on **slide 15** and encourage students to keep the flowchart in a place to refer to in the future. If students have a math notebook or folder, consider gluing or stapling it in.

Teacher's Note: Pacing the Lesson

During a traditional 45-minute class period, this lesson will naturally need to be paused and resumed the next day. A smooth transition could be to pause the lesson after completing the Classifying Conics Flowchart and resume on optional slide 16 the next day.

Teacher's Note: Optional Re-Engage

To begin day two of the lesson, show **slide 16**. If choosing to do this, unhide slide 16 in Lesson Slides. Ask students to get out their classifying conics flowchart from yesterday and use a scrap paper or a personal whiteboard to write down everything they remember from yesterday's lesson. After students have had an opportunity to write down what they can recall, introduce the Stand up, Sit down strategy and collect a list of information learned the previous day

Display **slide 17** to share the Introduction to Conic Sections video for students to formally learn about each conic section and the key features of its graph.

Embedded video

https://youtube.com/watch?v=XYWF2yPJdGE

Teacher's Note: Facilitating the Lesson

Upload or link the Introduction to Conic Sections video in your class LMS so that student groups can access the video later in the lesson to review the content.

Optional: Real-World Application

Circles, Ellipses, Parabolas, and Hyperbolas play a significant role in various fields of science, engineering, and everyday life. Here are some real-world applications for each conic section. If time allows, consider engaging in a conversation with your class to discuss these real-world applications.

Circles

- **Architecture and Design**: Used in the design of wheels, domes, and circular windows.
- **Signal Transmission**: Antennas often radiate signals in circular patterns.

Ellipses

- **Astronomy**: The orbits of planets, moons, and comets are elliptical, as described by Kepler's First Law.
- **Medicine**: MRI machines use the properties of ellipses for imaging techniques.
- **LASIK Surgery**: The cornea is often modeled as an ellipse. Laser eye surgeries reshape the cornea, adjusting its curvature to correct refractive errors (e.g., myopia, hyperopia, or astigmatism). Mathematical models using conic sections guide the reshaping process.

Parabolas

- **Projectiles**: The trajectory of any object under uniform gravity (ignoring air resistance) is parabolic.
- **Architectural Designs**: Parabolic structures (e.g., arches and roofs) combine strength with aesthetic appeal, seen in monuments and modern buildings.

Hyperbolas

- **Navigation and Communication**: Hyperbolas are fundamental in systems like GPS and LORAN, which use hyperbolic positioning to determine location.
- **Optics**: Hyperbolic lenses and mirrors are used in advanced telescopes for correcting optical aberrations.
- **Engineering**: Cooling towers of power plants often have hyperbolic shapes to ensure structural efficiency and airflow optimization.

30 minutes

Extend

Teacher's Note: Guiding the Activity

Assign students to groups of 2-4, this can be the same grouping from the Engage and Explore. Assign each group one of the 4 conic sections. For smaller classes, you may only have one group for each type of conic section. For larger groups, you may have more than one group assigned to a conic section.

Show **slide 18** and pass out **Conic Sections Key Features** handout (attached) to introduce the next activity to the class. Inform students that they will identify key features of their conic section before sketching the graph and writing an equation based on an existing graph.

Teacher's Note: Guiding the Activity

As groups work, walk about the room to keep students on task. Encourage the use of graphing technology like Desmos or a TI calculator to help students identify key features and sketch their graphs.

Once groups have completed their conic section, transition to **slide 19**, introduce the Expert Stay and Stray strategy, and provide each student with the remaining conic section pages.

Assign all students a number 1 through 4. Ask students assigned number 1 to be the first expert while the other group members rotate to the next table. Start a class timer of 5 minutes or use the timer on slide 19 and instruct students to listen carefully to the expert talk about their conic section while they fill in their notes.

Once the timer is complete, ask a different student to stay at the table group to become the new expert, and all other students move to the next table.

Repeat this process a total of 4 times.

Teacher's Note: Guiding the Activity

Students should only be the expert 1 time during this activity.

Once all students have had the opportunity to learn about all 4 conic sections from their classmates, instruct the students to return to their seats and place their note pages in a place like their notebooks or binders to refer to later.

20 minutes

Evaluate

Transition to **slide 20** and give each a copy of the **Conic Sections Practice Problems** handout (attached). Tell students not to write their names on this paper. Instruct students to use their notes, graphing technology, and any other tools to help them solve the four problems on their paper in the time provided.

Start a class timer for 10 minutes or use the timer on slide 20 and walk about the room while students work. Answer questions and keep students on task.

When the timer has elapsed, ask the class to turn in their paper without their name written on it to a predetermined location in the classroom. Once all papers have been collected, shuffle them and randomly hand back one paper per student.

Transition to **slide 21** and ask the students to write their names at the top of this piece of paper, start the class timer for 10 minutes, and instruct students to use this time to review the work on the paper, make corrections, and complete any work.

When the time has finished, ask the students to turn in their paper to a predetermined location in the classroom to be graded.

Resources

K20 Center. (2021, September 21). K20 Center 5 minute timer. [Video]. YouTube. https://www.youtube.com/watch?v=EVS_yYQoLJg

K20 Center. (2021, September 21). K20 Center 10 minute timer. [Video]. YouTube. https://www.youtube.com/watch?v=9gy-1Z2Sa-c

K20 Center. (n.d.). Card sort. Strategies. https://learn.k20center.ou.edu/strategy/147

K20 Center. (n.d.) Expert stay and stray. Strategies. https://learn.k20center.ou.edu/strategy/2650

K20 Center. (n.d.) Stand up, sit down. Strategies. https://learn.k20center.ou.edu/strategy/1771

K20 Center. (2025, January 23). Hooked on Conics [Video]. YouTube. https://www.youtube.com/watch?v=XYWF2yPJdGE

MathLawes. (2023, April 18). How to Visualize and Model Conic Sections with a Flashlight (90 sec.) [Video]. YouTube. https://www.youtube.com/watch?v=DMehuSl2hsc