

# the Algebra Game

## Conic Sections



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# Getting Started

## Welcome to *The Algebra Game: Conic Sections*

Congratulations on your purchase of *The Algebra Game: Conic Sections*! By using these decks and making connections, your middle school and high school students will visualize, describe, and analyze the associations of the basic concepts of conic graphs and equations. The instructional result is that students develop an understanding of the fundamentals of conic sections while actively building new knowledge from experience.

*The Algebra Game: Conic Sections* enables students to make sense of conic sections by matching foci, eccentricity, and standard form cards for corresponding graphs, equations, and coordinate pairs tables.

Decks are organized to match students' skill level, starting with beginners and progressing to more advanced learners. For example, students can study how the eccentricity affects the graph of a conic section without having to study the effects of the foci or the interaction of eccentricity and the foci.

## *The Algebra Game: Conic Sections* Supports Different Learning Styles

The flexibility of the card decks in *The Algebra Game: Conic Sections* allows teachers to enhance the various learning styles and strengths that students bring to the classroom.

- Students are engaged visually, kinesthetically, and logically as they match, trace, and classify cards in activities and games that focus on the relationships among the characteristics of conic graphs and equations.
- Organizational grids provide the opportunity for students to see how all of the cards fit together.
- Discussion Questions and a Conjecture worksheet allow students to collaborate and describe the ideas shared in groups as well as intuit new algebraic relationships not previously noticed.
- Space is provided on all worksheets for students to write about their observations during activities and games, either independently or as a group.

In addition, teachers can also use the Optional Extension Activity templates to tailor lesson activities to their individual classroom needs.

## *The Algebra Game: Conic Sections* and Math Standards

*The Algebra Game: Conic Sections* supports the Math standards, focusing on Grade 8 and High School Content Standards involving conic graphs and functions. Each Activity is correlated to one or more Math Content Standards, which are identified at the top of each Activity sheet. Correlation tables for Math Content Standards also appear at the front of the book.

*The Algebra Game: Conic Sections* also supports the Math Process standards, which are represented as eight Mathematical Practices listed below. Each Process Standard is aligned with one or more Activities, which are identified in the Process Standards correlation table at the front of the book. For Example, Process Standard 8 is correlated to a matching activity in which students look for similarities between equations and graphs, leading them to look for methods that can be generalized.

### Standards for Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

*Common Core State Standards for Mathematics* (pp. 6–8),  
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# Working with *The Algebra Game: Conic Sections*

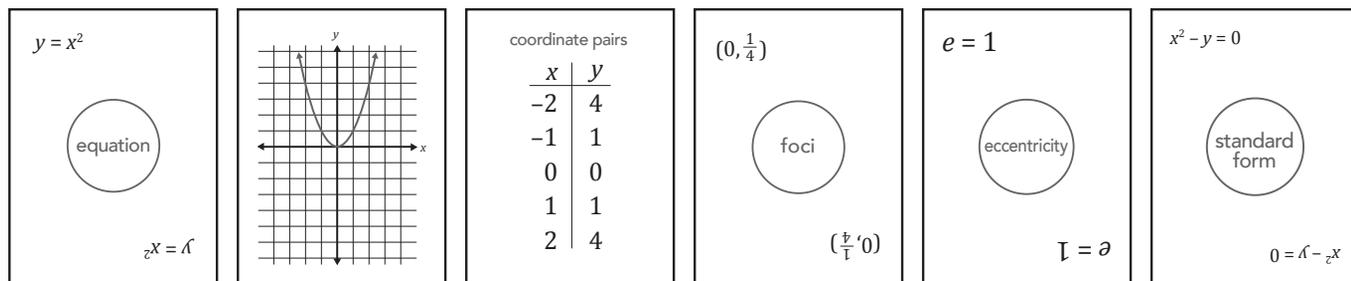
## How to Use the Decks

**Deck Organization** Each of the four decks contains 12 matching sets of six types of cards. Each matching set consists of a card for a unique conic graph and a card for its related equation, as well as cards for the corresponding coordinate pairs table, foci, eccentricity, and standard-form equation. For example, the set of six matching cards for the conic graph  $y = x^2$  are shown below. The **Repair Cards** Extra Masters at the back of the book can be copied, cut out, and filled in to create a custom set of matching cards.

The four decks are organized by type of conic section:

- Deck A has only parabolas.
- Deck B has only circles.
- Deck C has only ellipses.
- Deck D has only hyperbolas.

The table below specifies the number of matching sets in each deck based on the characteristics of each graph and its related equation.



The set of matching cards for  $y = x^2$  includes the Equation, Graph, Coordinate Pairs, Foci, Eccentricity, and Standard Form.

\* = in the Equation

\*\* = in Standard Form

Conic Sections Card Deck Specifications (Number of Matching Sets per Deck)				
Features	Deck A	Deck B	Deck C	Deck D
Parabolas	12	0	0	0
Circles	0	12	0	0
Ellipses	0	0	12	0
Hyperbolas	0	0	0	12
Translated origin	2	5	3	2
Coefficient* of $x^2 > 1$	3	12	12	5
$0 < \text{Coefficient of } x^2 \leq 1$	7	0	0	0
$-1 \leq \text{Coefficient of } x^2 < 0$	1	0	0	0
Coefficient** of $x^2 = \text{Coefficient of } y^2$	0	12	0	0
Coefficient of $x^2 > \text{Coefficient of } y^2$	0	0	8	9
Coefficient of $x^2 < \text{Coefficient of } y^2$	0	0	4	3
Symmetrical to y-axis	9	7	9	10

**Conic Sections Card Deck Specifications**  
(Number of Matching Sets per Deck)

Features	Deck A	Deck B	Deck C	Deck D
Symmetrical to x-axis	1	7	9	10
Eccentricity = 1	12	0	0	0
Eccentricity = 0	0	12	0	0
Eccentricity > 1	0	0	12	0
$0 < \text{Eccentricity} < 1$	0	0	0	12

**Arranging the Students into Groups** By solving problems and discussing solutions within groups, students reinforce their understanding of the subject matter, resulting in greater retention of material for assessments.

When arranging groups for *The Algebra Game: Conic Sections*, you can introduce the cards before the Activities and Games start. For example, if four students are in each group, you can arrange groups by using four matching cards such as Equation, Graph, Coordinate Pairs, and Foci. Select as many matching sets as needed and distribute the cards to all students in the class. Then, one by one, students with Equation cards can announce their equations to the class or write them on the board. Students with corresponding Graph, Coordinate Pairs, and Foci cards can then self-identify, and groups can be seated together.

Similar strategies can be followed using two matching cards for two partners or use three or more matching cards for making larger groups. You may want to use matching cards that represent an earlier lesson so that students can have a quick review of what happened earlier or absent students can have a chance to catch up.

**Determining the Number of Decks and Levels**

Boxed sets of *The Algebra Game: Conic Sections* include four decks of 72 cards each, for a total of 288 cards. The number of decks needed depends on how many decks are used and how they are divided between groups of students.

- Using four decks with the Activities: Separate each deck into two sets so that you have 8 packages for groups of 4 students each (32 students in class).

- To use three decks, separate these decks into 6 sets (two from each deck level) resulting in enough cards for 5 students in each group (30 students in class).

The recommended decks are listed for each Lesson, as well as every Activity and Game. If you would like all groups to have the exact same cards, then you may purchase additional boxed sets for the student groups in your classroom by going to [didax.com/the-algebra-game](http://didax.com/the-algebra-game).

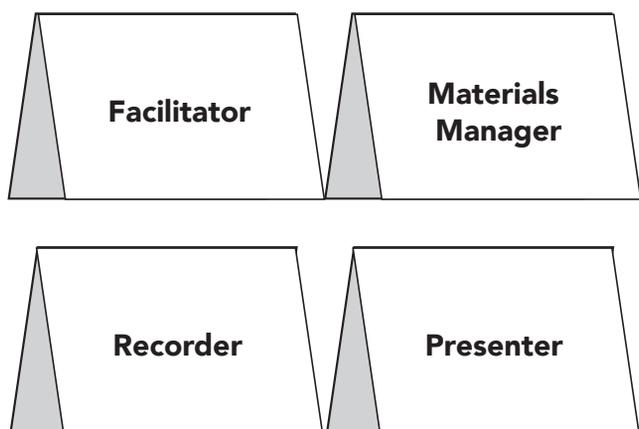
**Before Class Preparation**

**1. Duplicate Activity Instructions and Worksheets**

Activity sheets, Discussion Questions, and some worksheets are located in the lesson itself, while generic worksheets, called “Extra Masters”, are located in the back of the book. Make enough copies so that there is one Activity card and one Discussion Questions worksheet per group for each activity. Requirements for additional materials are listed at the beginning of each lesson.

**2. Assign Student Roles** Arrange the students into groups and assign roles. The Activity instructions describe tasks for each role in the group. For groups with more than four members, additional cards can be created and include Time Keeper, Observer, and/or Encourager.

Make copies of the Role cards in the back of the book and give each student a corresponding card to display in front of themselves. Students should keep track of the role that they have been assigned so as not to repeat the same role in a given session.



**3. Managing the Groups** The following management ideas are suggestions by teachers for using the cards with groups of students.

- Designate group member roles.
- Assemble the materials for each group (decks, Activity directions, and so on) in baskets or other similar-size containers, such as plastic shoeboxes. Distribute the baskets, one per group, after general instructions have been presented to the class. Color-code the containers for easy identification.
- Work within specific time limits. Use a kitchen timer or a clock. If increased time is needed for any given task, use 5-minute increments.
- If anyone in the group has a question, encourage the member to ask all group members first before the group asks the teacher or outside resource.
- Predetermine the guidelines for students to stop talking and refocus back to the teacher—for example, dim the lights, clap your hands three times, or raise your hand and students raise theirs.

**4. Collect Any Extra Materials You May Need**

Every lesson has a list of materials needed for the specific activities plus some optional items. Some collaborative activities or games may require extra worksheets for recording information or keeping score. The Extra Masters at the end of this book include many additional worksheets for collaborative activities.

To organize and display materials, a pocket chart can be useful. Pocket charts can be found in

most educational catalogs. The pockets should be at least 3 inches wide and allow for at least six matching cards or more in a display.

Many teachers have incorporated graphing calculators and computer software when using these decks. Some teachers provide one graphing calculator for each group, and other teachers allow access to several graphing calculators or computers for the whole class to use as needed. Because the decks provide the opportunity for students to make initial decisions about the graph and conic relationships, using simple text editing or slide show software can be helpful for extending any conjectures or exploring new assumptions in mathematics.

**Lesson Quickstart**

The steps below provide an outline of how a lesson can be organized. Start the class with the activity Launch described below in which students match cards to make groups with 4 or 5 members each.

**Launch the Activity** Give each student one card. Tell the students to locate the other members of their team for today by finding the matching cards. For start-up activities, use cards that match the current day's lesson. For reinforcement, use cards that represent skills learned in an earlier lesson. Suggested cards for a launch, based on selected topics, are listed in the chart below.

Suggested Cards for the Launch
<b>Coordinate Points and Graphs:</b> Select Coordinate Pairs cards and Graph cards from all decks.
<b>Foci Identification:</b> Select Equation and Foci cards from all decks.
<b>Eccentricity Calculation:</b> Select Equation and Eccentricity cards from Deck C or Deck D.
<b>Equation Type Identification:</b> Select Equation cards from all decks.
<b>Graph Type Review:</b> Select Graph cards from all decks.

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As an alternative to a Launch with cards, each lesson includes various worksheets that you can copy and distribute at the beginning of the lesson, allowing students to write their observations as an initial start-up or warm-up class activity. Students can then bring these worksheets with their own observations to the group for discussion.

If you have arranged the materials in baskets or other containers before class for each group then it is appropriate at this time for the Materials Manager in each group to go get the container for their group. You also have the option of distributing the baskets yourself or allowing one student to distribute all of the baskets to the different groups.

**Complete the Activity** Once the groups have been formed and roles have been assigned, students complete the activity by following the instructions on the Activity sheet. Each student takes on their assigned role for that Activity and performs their assigned tasks. Note that if students are working in pairs, you will need to make some minor adjustments to the assigned student roles.

You may notice that all of the Activities start with students dividing the cards and sorting them into stacks by type. One reason for this practice is so that students can have an overview of which cards they will be working with on any given activity. Also, sorting by the type of card allows students to practice their conic sections vocabulary.

**Set Time Limits** Many or most of the Activities, along with their discussion worksheets, can be completed in 15 to 30 minutes. Designate a

specific time frame for students to work within so that there is enough time for students to report their findings to the rest of the class. Time intervals can vary depending on the difficulty of the Activity. For the easier tasks, allow 15 minutes for task and worksheet completion.

**Review Discussion Worksheets** Always allow students to discuss the group's responses to the Discussion Questions in a public classroom forum either during the same day or on the following day. All groups should have the opportunity to present their findings and to ask their questions. You may want to appoint a general Classroom Recorder to record all of the groups' findings or collect the group worksheets before the students leave.

**Extension Activities** As an extension of each lesson topic, students may complete an Extension Activity using the Activity on page 46 and one of the Organizational Grid Descriptions on pages 47 and 48. By organizing all cards in one or more of the decks to create each grid according to its description, students can explore algebraic relationships between conic equations and graphs as they identify patterns in the rows and columns.

**Conclusion** By using the different decks of cards with the activities and games in *The Algebra Game: Conic Sections*, students have the opportunity to discover how equations, eccentricities, foci, and coordinate pairs tables all connect to unique graphs. Whether you use the guidelines in this manual or develop your own structures for using the Conic Sections decks, your students will develop a deeper understanding of conic graphs and equations by actively engaging with *The Algebra Games: Conic Sections*!

# Parabolas

## Graphs of Quadratic Functions

This activity investigates parabolas by studying the effects of changing the coefficients. (If you used *The Algebra Game: Quadratic Equations*, students will find these activities a natural extension of the activities from Quadratic Deck D.) Have students use the information in their textbooks as a guide for which techniques to use in these activities.

You can use the blank templates at the end of the manual to write your own investigation activities. Or encourage your students to use them to create their own activities.

Remember to make sufficient copies of all worksheets for students.

**Extension Activity:** Use the Making A Grid activity sheet on page 46 and choose one of the grids for students to use (or use several grids with different groups).

**Recommended decks:** Deck A

### Materials

- Deck A
- One Activity sheet for each activity (one per group)
- Discussion Questions sheets (one per group), Parabola Graph Literacy Worksheet (one per student), Combine Record Worksheet (p. 55) and Compiled Record for Literacy Worksheet (p. 54), both one per group
- **Optional:** Conjecture Worksheet (p. 51), graphing calculators

## Exploring the Effect of the Coefficient

### Activity

1.1

**HSF-IF.C.7a:** Graph linear and quadratic functions and show intercepts, maxima, and minima.  
Also **HSG-CPE.A.2.**

**Materials Manager:** Distribute the Parabola Graph Literacy Worksheet to all group members.

**All:** Work together to complete the observation notes on the Parabola Graph Literacy sheet. Combine the group's notes on the Compiled Record for Literacy Worksheet. Put away the Parabola Graph Literacy sheets.

**Materials Manager:** Divide the deck between group members for sorting.

**All:** Sort your cards into 6 stacks: Graph, Foci, Equation, Coordinate Pairs, Eccentricity, and Standard Form. After sorting, pool the card stacks so there are only 6 stacks for the group.

**Facilitator:** Put aside the Eccentricity, Coordinate Pairs, Foci, and Standard Form cards. Place the Equation cards on a table for all members of the group to see.

**Materials Manager:** Divide the Graph cards between group members for matching.

**All:** Match each Graph card to the correct Equation card. Use the information and notes from the Compiled Record for Literacy Worksheet.

**Recorder:** Read the Discussion Questions to the group. Write the responses that the whole group agrees on. Be sure to include responses for the two new questions.

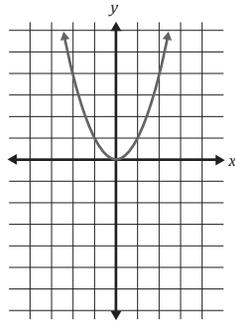
**Presenter:** Report the group's responses to the class.

# Parabola Graph Literacy Worksheet

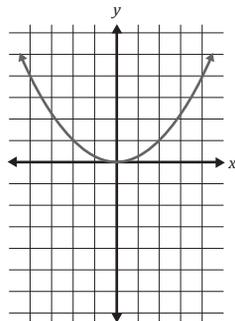
The equations match the parabola graphs. Write notes about what you notice as connections between the equations and the graphs. Justify your notes in the space provided.

Notes

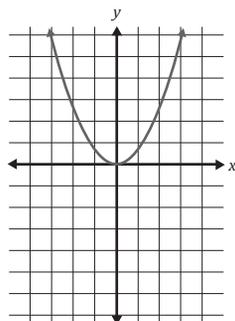
1.  $y = x^2$



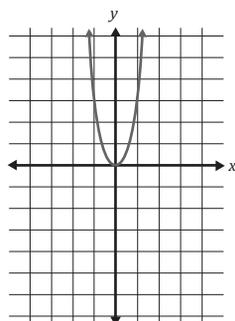
2.  $y = \frac{1}{4} x^2$



3.  $y = \frac{2}{3} x^2$



4.  $y = 3x^2$



Describe all the patterns you can find. For more space use the back.

Group Members: \_\_\_\_\_  
\_\_\_\_\_

## Discussion Questions for Activity 1.1

1. Separate the parabola matched sets into two groups: parabolas that open up and parabolas that open down. Describe all similarities in the group of parabolas that open up. Which numbers in the equation do you think make the changes in the parabola graph?

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2. Match the Coordinate Pairs cards to the parabola graph sets. Write your responses on the Combine Record Worksheet.

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3. How do you think the coefficient of the squared term controls the matching graph?

**Explain.** \_\_\_\_\_  
\_\_\_\_\_

As a group, write two questions to ask the rest of the class. Before asking the questions, decide as a group on acceptable responses.

**Question 1.** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Question 2.** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_