the Algebra Game

Linear Graphs

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Contents

Getting Started

Welcome to *The Algebra Game: Linear Graphs*

Congratulations on your purchase of *The Algebra Game: Linear Graphs!* 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 linear equations. The instructional result is that students develop an understanding of the fundamentals of Algebra 1 while actively building new knowledge from experience.

The Algebra Game: Linear Graphs enables students to make sense of linear equations by matching slope and *y*-intercept cards to cards for corresponding graphs, equations, and coordinate pairs tables.

Decks are organized to match students' skills level, starting with beginners and progressing to more advanced learners. For example, students can study how the *y*-intercept affects the graph of a linear equation without having to study the effects of the slope or the interaction of the *y*-intercept and slope.

The Algebra Game: Linear Graphs Supports Different Learning Styles

The flexibility of the card decks in *The Algebra Game: Linear Graphs* 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 linear graphs and equations.
- Organizational grids provide the opportunity for students to see how all of the cards fit together.
- Discussion Questions and Conjecture worksheets 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 card activities and games, either independently or as a group.

In addition, teachers can also use the optional Write-Your-Own Activity templates to tailor lesson activities to their individual classroom needs.

The Algebra Game: Linear Graphs and Math Standards

The Algebra Game: Linear Graphs supports the Math standards, focusing on Grade 8 and High School Content Standards involving linear graphs and equations. 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: Linear Graphs also supports the Math Process standards, which are represented as the 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 involving coordinate pairs tables and slopes because students are required to repeat calculations, 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),

Working with *The Algebra Game: Linear Graphs*

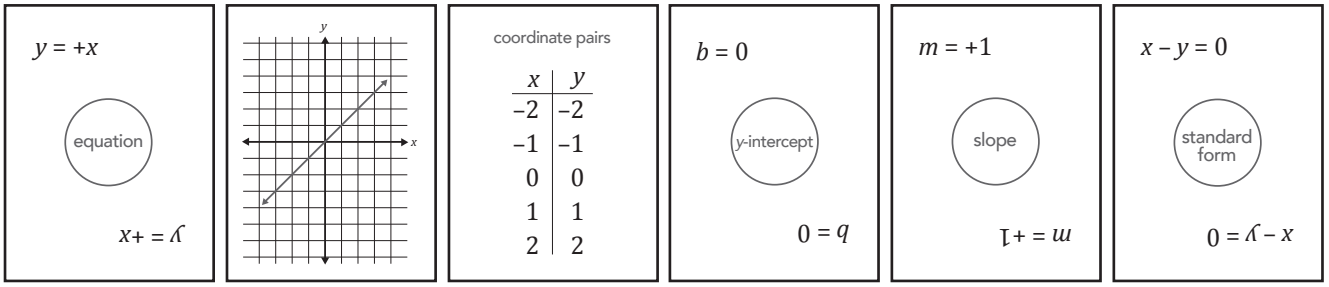
How to Use the Decks

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 linear graph and a card for its related equation in slope-intercept form, as well as cards for the corresponding coordinate pairs table, *y*-intercept, slope, and standard-form equation. For example, the set of six matching cards for the linear equation $y = x$ are shown below. The **Repair Cards** Extra Masters at the back of the book can be copied, cut out, and filled in to replace any misplaced cards or to create a custom set of matching cards.

The four decks are organized by level of difficulty:

- Deck A has only slopes of 1 or –1.
- Deck B uses only integers for *y*-intercept and slope.
- Deck C has equations involving slopes only, both fractions and integers.
- Deck D has a mixture of fractions and integers for both slope and *y*-intercept.

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



equation | graph | coordinate pairs | *y*-intercept | slope | standard form

The set of matching cards for $y = x$, from left to right, includes the Equation, Graph, Coordinate Pairs, *y*-intercept, Slope, and the Standard Form cards.

***Linear Graphs* Card Deck Specifications (Number of Matching Sets per Deck)**				
Features	**Deck A**	**Deck B**	**Deck C**	**Deck D**
$0 <$ coefficient of $x < 1$	0	1	3	5
$-1 <$ coefficient of $x < 0$	0	0	3	3
Coefficient of $x = 1$	5	2	0	0
Coefficient of $x = -1$	7	0	0	0
Coefficient of $x > 1$	0	5	3	1
Coefficient of $x < -1$	0	3	3	3
Intersects axes at integers	12	12	12	9
Intersects axes at fractions	0	0	0	3
Goes through origin	2	3	12	1
Non-function graphs	0	1	0	0
Vertical and horizontal graphs	0	2	0	0

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: Linear Graphs*, 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 Slope. 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 Slope 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: Linear Graphs* 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 four students each (32 students in class).
- Using three decks: Separate the decks into 6 sets (two from each deck level) resulting in enough cards for 5 students in each group.

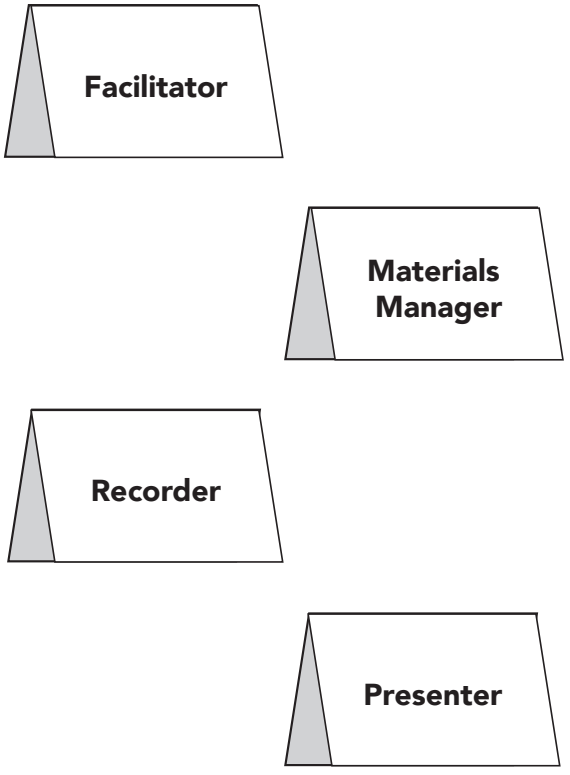
The recommended decks are listed for each Lesson, as well as every Activity and Game. In order for each group to have the exact same cards, you may purchase additional boxed sets for the student groups in your classroom by going to didax.com/the-algebra-game.

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 sheet and one Discussion Questions sheet 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 roles 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.

a. Designate group member roles.
b. Assemble the materials for each group (decks, Activity directions, and so on) in baskets or other similar-size containers. Distribute the baskets, one per group, after general instructions have been presented to the class. Color-code the containers for easy identification.
c. 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.
d. 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.
e. Predetermine the signals 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 algebraic 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 an activity Launch 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. Some suggested cards for a launch, based on selected lesson topics, are listed in the chart below.

Suggested Cards for the Launch
***y*-intercept**: Select Graph and *y*-intercept cards or *y*-intercept and Equation cards from Deck A.
Slope: Select Slope and Graph cards or Slope and Coordinate Pairs cards from all decks.
Slope-Intercept Form: Use three cards: *y*-intercept, Slope, and Equation cards selected from all decks.
Parallel Lines: Select Equation cards or Equation and Graph cards for parallel lines from all of the decks, mostly from Deck A.
Perpendicular Lines: Select Equation and/or Graph cards from Deck C.

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, 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 decks of 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 linear equation 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 discussion 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 sheet on page 38 and one of the Organizational Grid Descriptions on pages 39 through 42, with Discussion Questions on pages 43 and 44. In addition, there is an option to write your own description on page 42. 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 linear 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: Linear Graphs*, students have the opportunity to discover how equations, slopes, *y*-intercepts, 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 Linear Graphs decks, your students will develop a deeper understanding of basic algebraic concepts by actively engaging with *The Algebra Game: Linear Graphs*!

LESSON 1

Coordinate Points on a Graph

Locating Points on a Graph

Students will locate points on the coordinate plane using the *x*- and *y*- axes. To succeed, they must be able to recognize each coordinate from a given coordinate pair (*x*, *y*) or a row in a table.

You may use the Coordinate Pairs Literacy worksheet as a start-up so that students can improve their familiarity with both formats. Allowing time for student discussion regarding orientation of the *x*- and *y*-coordinates will save time in future activities.

Make sufficient copies of all worksheets for students.

Extension Activity: Use the Activity on page 38 and choose one Organization Grid (or use several grids with different groups).

Recommended decks: Deck A, Deck B, Deck C, and/or Deck D

Materials

- Decks A, B, C, and/or D
- One Activity sheet per group for each activity
- Discussion Questions sheets (one of each per group), Coordinate Pairs Tables (one per student) as the activity requires
- **Optional:** Coordinate Pairs Literacy sheet (one per student), Conjecture worksheets (one per group, in back of book); graphing calculators

Matching Coordinate Pairs to Graphs

Activity 1.1

HSF-IF.C.7a: Graph linear functions and show intercepts. *Also* **HSA-CED.A.2** and **HSA-REI.D.10**.

Materials Manager: Divide the decks between group members for sorting.

All: Sort cards into 6 separate stacks: Graph, Slope, Equation, Coordinate Pairs, *y*-intercept, and Standard Form. Pool the stacks so that there are 6 stacks for the whole group.

Facilitator: Put aside the Slope, Equation, *y*-intercept, and Standard Form cards. Place the Graph cards on a table so that all members of the group can see the graphs.

Materials Manager: Deal the Coordinate Pairs cards to all group members.

All: Match each Coordinate Pairs card to the correct Graph card. Locate at least two points on the graph on the Graph Card that match coordinate pairs on the Coordinate Pairs card.

Recorder: After all cards are matched, 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 posed by the group.

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

Name: _____ Date: _____

Coordinate Pairs Literacy

Draw a line to match each coordinate pair in the table to a coordinate pair on the side. The first one is done for you. Be careful–not all coordinate pairs match.

1.

(1, 3)
(4, 0)

(0, 4)
(–1, 5)

x	*y*
–2	6
–1	5
0	4
1	3
2	2

(3, 1)
(–2, 6)

(2, 2)
(4, –1)

2.

(–4, –2)
(–2, –4)

(–1, –2)
(2, 4)

x	*y*
–2	–4
–1	–2
0	0
1	2
2	4

(2, 1)
(–2, –1)

(0, 0)
(1, 2)

3.

(–6, 1)
(0, –4)

(–2, 0)
(–4, 0)

x	*y*
–2	0
–1	–2
0	–4
1	–6
2	–8

(–1, –2)
(1, –6)

(2, –8)
(–8, 2)

Group Members: _____ _____

_____ _____

Discussion Questions for Activity 1.1

1. Compare the tables on all of the Coordinate Pairs cards. What do you notice about the numbers in each of the *x*-columns?

_____

_____

2. How do you think the numbers in an *x*-column of a table on a Coordinate Pairs card are represented on a Graph card?

_____

_____

3. Look at the tables on the Coordinate Pairs cards. Do you think there are more numbers that will continue the patterns in the *x*- and *y*-columns?

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. _____

_____

_____

Matching Graphs to Patterns in Coordinate Pairs Tables

Activity 1.2

HSF-IF.C.7a: Graph linear functions and show intercepts. *Also* **HSA-CED.A.2** and **HSA-REI.D.10**.

Materials Manager: Divide the decks between group members for sorting.

All: Sort cards into 6 separate stacks: Graph, Slope, Equation, Coordinate Pairs, *y*-intercept, and Standard Form. Pool the stacks so that there are 6 stacks for the whole group.

Facilitator: Put aside the Slope, Equation, Coordinate Pairs, *y*-intercept, and Standard Form cards.

Materials Manager: Deal the Graph cards to all group members. Distribute copies of the Coordinate Pairs Tables worksheet to all group members also.

All: Examine the Graph cards in hand to see if one or more of the cards will match one of the coordinate pairs tables on the worksheet.

Recorder: After all matching cards are identified, read the discussion questions to the group and write the responses that the whole group agrees on. Write responses to all questions, including the new questions the group wrote to ask the rest of the class.

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

Write-Your-Own Optional Activity

1.3

_____

_____

Fill in the blanks to write your own activity title and directions.

Materials Manager: Divide the decks between group members for sorting.

All: Sort cards into 6 separate stacks: Graph, Slope, Equation, Coordinate Pairs, *y*-intercept and Standard Form. Pool the stacks so that there are 6 stacks for the whole group.

Facilitator: Put aside the _____, _____, _____, and _____ cards. Place the _____ cards on a table so that all members of the group can see them.

Materials Manager: Deal the _____ cards to all group members.

All: Work together to match the _____ cards to the _____ cards.

Recorder: After all cards are matched, ask the whole group to decide on two questions to ask the rest of the class. Record the questions as well as the responses that the group agrees are appropriate.

Presenter: Present the group's questions and responses to the class.

Name: _____ Date: _____

Coordinate Pairs Tables

1.

x	*y*
–2	6
–1	3
0	0
1	–3
2	–6

2.

x	*y*
–2	8
–1	3
0	–2
1	–7
2	–12

3.

x	*y*
–2	2
–1	1
0	0
1	–1
2	–2

4.

x	*y*
–2	–8
–1	–4
0	0
1	4
2	8

5.

x	*y*
–2	–5
–1	$-4\frac{1}{2}$
0	–4
1	$-3\frac{1}{2}$
2	–3

6.

x	*y*
–2	5
–1	4
0	3
1	2
2	1

7.

x	*y*
–2	12
–1	7
0	2
1	–3
2	–8

8.

x	*y*
–2	$2\frac{1}{3}$
–1	$2\frac{2}{3}$
0	3
1	$3\frac{1}{3}$
2	$3\frac{2}{3}$

9.

x	*y*
–2	–2
–1	–3
0	–4
1	–5
2	–6

Group Members: _____ _____

_____ _____

Discussion Questions for Activity 1.2

1. Do all of the Graph cards match a table on the Coordinate Pairs Tables worksheet? How do you know?

_____

_____

2. For each matching table on the Coordinate Pairs Tables worksheet, describe how the number patterns in the table are represented by its matching graph.

_____

_____

3. Compare the number patterns in the *y*-columns of the tables on the Coordinate Pairs Tables worksheet. How are the patterns similar? How are they different?

_____

_____

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. _____

_____

_____