# Equations of Lines

Sample task from achievethecore.org
Task by Illustrative Mathematics, annotation by Student Achievement Partners

GRADE LEVEL Eight

IN THE STANDARDS 8.EE.B

WHAT WE LIKE ABOUT THIS TASK

Mathematically:

- Presents an unfamiliar problem that students must make sense of (MP1).
- Keys directly on the meanings of parameters in a linear equation.
- Involves two basic forms for the equation of a line (not just the for $y = mx + b$ but also the form $ax + by = c$).

In the classroom:

- Encourages students to share their developing thinking.
- Allows students to use precise mathematical language in their arguments (MP3, MP6).

This task was designed to include specific features that support access for all students and align to best practice for English Language Learner (ELL) instruction. Go here to learn more about the research behind these supports. This lesson aligns to ELL best practice in the following ways:

- Provides opportunities for students to practice and refine their use of mathematical language.
- Allows for whole class, small group, and paired discussion for the purpose of practicing with mathematical concepts and language.
- Elicits evidence of student thinking both verbally and in written form.
- Includes a mathematical routine that reflects best practices to supporting ELLs in accessing mathematical concepts.
- Provides opportunities to support students in connecting mathematical language with mathematical representations.

MAKING THE SHIFTS[1]

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|---|---|
| Focus | Belongs to the Major Work[2] of eighth grade |
| Coherence | Builds solid foundations for high school algebra |
| Rigor[3] | Conceptual Understanding: primary in this task |
| | Procedural Skill and Fluency: secondary in this task |
| | Application: not targeted in this task |

1 For more information read Shifts for Mathematics.
2 For more information, see Focus in Grade Eight
3 Tasks will often target only one aspect of rigor.

## INSTRUCTIONAL ROUTINE

*The steps in this routine are adapted from the Principles for the Design of Mathematics Curricula: Promoting Language and Content Development.*

Engage students in the Stronger and Clearer Each Time Mathematical Language Routine to introduce this task. This will provide students with a structured, interactive opportunity to reflect on and refine their current understanding of simultaneous linear equations.

Allow students to begin working on the task individually. They will then engage in the routine Stronger and Clearer Each Time--Convince Yourself, a Friend, a Skeptic.

Convince Yourself: Students will write a first draft of their initial thinking around the two questions in the task.

Convince a Friend: Students write a second draft that explains WHAT they know about these lines and HOW they know it is true, knowing a classmate will be reviewing it. This draft can include words, pictures, and/or numbers. Students trade these explanations with a "friend" who will give written or oral feedback on the solution and justification.

Convince a Skeptic: students write a third draft, incorporating feedback from their "friend" and taking it a step further to explain WHY what they know is true by including supporting evidence with a skeptic reviewer in mind. They should anticipate counter-arguments. This draft can include words, pictures, and/or numbers. The third drafts are traded once again with a partner who will give feedback as a "skeptic."

Final Revision: Students should take any feedback from the "skeptic" and finalize their solution and justification.

## LANGUAGE DEVELOPMENT

Ensure students have ample opportunities in instruction to read, write, speak, listen, and understand the mathematical concepts that are represented by the following terms and concepts:

- Terms
- Graphs
- Equations
- Constants
- Intersect
- Coordinate
- Point

Students should engage with these terms and concepts in the context of mathematical learning, not as a separate vocabulary study. Students should have access to multi-modal representations of these terms and concepts, including: pictures, diagrams, written explanations, gestures, and sharing of non-examples. These representations will encourage precise language, while prioritizing students' articulation of concepts. These terms and concepts should be reinforced in teacher instruction, classroom discussion, and student work.

ELLs may need support with the following Tier 2 words during the classroom discussion:

- Figure
- Interpret
- Described
- Imagine
- Trace
- Tip

## ADDITIONAL THOUGHTS

This task related directly to the cluster heading 8.EE.B, "Understand the connections between proportional relationships, lines, and linear equations." Specifically, for each 1 unit moved horizontally, a point moving along the line $y = ax + b$ moves a units vertically. Notice how this sentence involves a proportional relationship, a line in the plane, and the equation of that line.

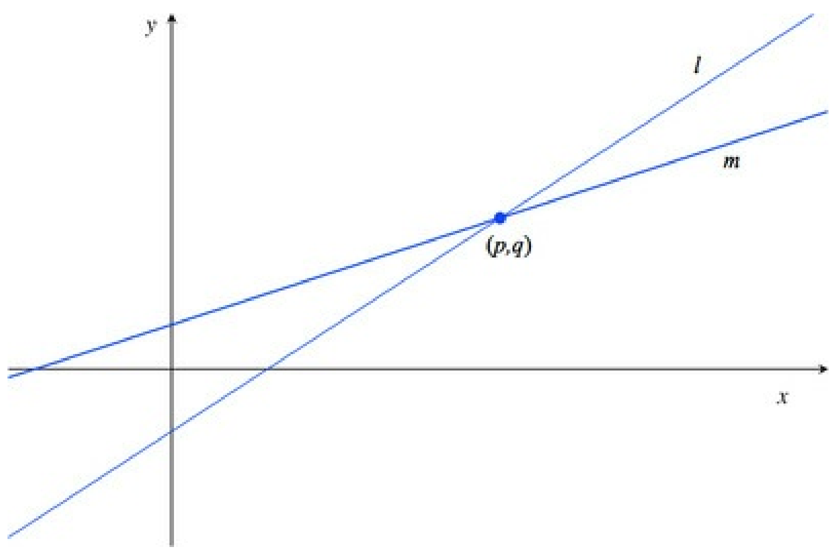
This task in itself doesn't build/rely upon procedural skill with equations of lines in the plane, but tasks of that nature are appropriate in grade 8 as well.

For more insight into the expectations for slope and linear equations in grade 8, read pages 10–12 of the progressions document, *6–8 Expressions and Equations*, available at www.achievethecore.org/progressions.

# 8.EE Equations of Lines

## Task

The figure below shows two lines. One is described by the equation $4x - y = c$ and the other by equation $y = 2x + d$, for some constants $c$ and $d$. They intersect at the point $(p, q)$.




a. How can you interpret $c$ and $d$ in terms of the graphs of the equations above?

b. Imagine you place the tip of your pencil at point $(p, q)$ and trace line $l$ out to the point with $x$-coordinate $p + 2$. Imagine I do the same on line $m$. How much greater would the $y$-coordinate of your ending point be than mine?

## Commentary

This task requires students to use the fact that on the graph of the linear equation $y = ax + c$, the $y$-coordinate increases by $a$ when $x$ increases by one. Specific values for $c$ and $d$ were left out intentionally to encourage students to use the above fact as opposed to computing the point of intersection, $(p,q)$, and then computing respective function values to answer the question.

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Solution:

a. If we put the equation $4x - y = c$ in the form $y = 4x - c$, we see that the graph has slope 4. The slope of the graph of $y = 2x + d$ is 2. So the steeper line, $l$, is the one with equation $y = 4x - c$, and therefore $-c$ is the $y$ coordinate of the point where $l$ intersects the $y$-axis. The other line, $m$, is the one with equation $y = 2x + d$, so $d$ is the $y$-coordinate of the point where $m$ intersects the $y$-axis.

b. The line $l$ has slope 4. So on $l$, each increase of one unit in the $x$-value produces an increase of 4 units in the $y$ value. Thus an increase of 2 units in the $x$-value produce an increase of $2 \cdot 4 = 8$ units in the $y$-value. The line $m$ has slope 2. So on $L_2$, each increase of 1 unit in the $x$-value produces an increase of 2 units in the $y$-value.

   Thus an increase of 2 units in the $x$-value produces an increase of $2 \cdot 2 = 4$ units in the $y$-value.

   Thus your $y$-value would be $8–4 = 4$ units larger than my $y$-value.