WAMC Lab Template

Math Concept(s): Solving Systems of Equations, Graphing Linear Equations, Calculating Distance Between Two Points

Source / Text: Big Ideas: Algebra 1

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Attach the following documents:

- Lab Instructions
- Student Handout(s)
- Rubric and/or Assessment Tool

Short Description (Be sure to include where in your instruction this lab takes place):

Students will determine linear equations to connect specific points on a coordinate plane to create a marble run; a track that takes a marble from a specific starting point to a specific end point. This lab will take place at the end of a unit, where students have learned all prerequisite skills listed below in the lab plan.

Lab Plan

Lab Title: Marble Run

Prerequisite skills: Students will need to know…

1. How to determine the distance between two coordinate points.
2. How to write a linear equation in slope-intercept form.
3. How to write a linear equation in point-slope form.
4. How to determine the slope of a line between two points.
5. How to solve a linear equation for a specific variable.

Lab objective: Students will be able to construct a successful marble run on a coordinate plane both virtually and physically; a successful marble run is indicated by a marble starting at the START point and not falling off any part of the run until the END point.

Standards: *(Note SPECIFIC relationship to Science, Technology, and/or Engineering)*

Mathematics K–12 Learning Standards:

- HSA.CED.A.1: Create equations in one variable and use them to solve problems.
- HSA.CED.A.2: Create equations in two or more variable to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- HSA.CED.A.3: Represent constraints by equations, and by systems of equations, and interpret solutions as viable or nonviable options in a modeling context.

Standards for Mathematical Practice:

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.

- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.

K-12 Learning Standards-ELA (Reading, Writing, Speaking & Listening):

- RST.9-10.3: Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
- RST.9-10.4: Determine meaning of symbols, key terms, or other domain specific words and phrases as they are used in specific technical context.
- RST.9-10.7: Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed verbally or mathematically into words.

K-12 Science Standards

- HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Technology

- 1.2.1: Communicate and collaborate to learn with others.
- 1.3.2: Locate and organize information from a variety of sources and media.
- 2.2.1: Develop skills to use technology effectively.
- 2.4.1: Formulate and synthesize new knowledge.

Engineering

- HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Leadership/21st Century Skills:

21st Century Interdisciplinary themes (Check those that apply to the above activity.)

☐ Global Awareness ☐ Financial/Economic/Business/Entrepreneurial Literacy ☐ Civic Literacy
☐ Health/Safety Literacy ☐ Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION
Creativity and Innovation
☒ Think Creatively
☒ Work Creatively with Others
☐ Implement Innovations
Critical Thinking and Problem Solving
☒ Reason Effectively
☐ Use Systems Thinking
☐ Make Judgments and Decisions
☒ Solve Problems
Communication and Collaboration
☐ Communicate Clearly
☒ Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS
Information Literacy
☐ Access and Evaluate Information
☐ Use and manage Information
Media Literacy
☐ Analyze Media
☐ Create Media Products
Information, Communications and Technology (ICT Literacy)
☐ Apply Technology Effectively

LIFE & CAREER SKILLS
Flexibility and Adaptability
☐ Adapt to Change
☒ Be Flexible
Initiative and Self-Direction
☒ Manage Goals and Time
☐ Work Independently
☒ Be Self-Directed Learners
Social and Cross-Cultural
☒ Interact Effectively with Others
☒ Work Effectively in Diverse Teams

Productivity and Accountability
☒ Manage Projects
☒ Produce Results
Leadership and Responsibility
☒ Guide and Lead Others
☒ Be Responsible to Others

Teacher Preparation: (What materials and set-up are required for this lab?)

Materials

Each lab group will need the following:

- 1 Foam board with coordinate plane drawn on it ($D: \{-20,20\}, R: \{-20,20\}$)
- ≥ 10 push pins (some teachers may prefer to have set points on coordinate foam board already put in for students)
- ≥ 5 strips of heavy cardstock paper or cardboard with a width of 1 inch (this will be the track for the marble)
- 1 marble
- 1 cup (to hold and catch marble)
- 4 Marble Run "Work" Sheets
- 2-4 computers (preferably 1:1 ratio)

Set-Up Required:

- Assemble the items above and place them in lab baskets or some sort of grouping so that they can be distributed to each lab group.
- Prepare an answer key for the online Desmos lab component (print and solve, or virtual screenshots)
- Prepare an example marble run to show students what a finished, successful marble run looks like.
- Have a system prepared to separate students into groups of 4. You may use the following roles for students, if that is how you run your classroom:
    - Leader: In charge of keeping the group on task and making sure things are running smoothly and efficiently. Note: Steps in and helps group members when needed.
    - Supply Manager: In charge of getting supplies, keeping the work space clean and organized, teaching other students how to use supplies (if needed). Note: Steps in and helps group members when needed.
    - Scribe: Keeps a written copy of all calculations, measurements, answers, etc. Ensures that all team members are taking similar, if not identical, notes. Note: Is NOT in charge of doing the whole project by themselves!
    - Helper: Is an extra hand for any group member that is struggling. In charge of morale of the group – provides encouragement, support. In charge of asking teacher for assistance if group says it is necessary.
- Create a Desmos classroom with the Marble Run lab (LINK: https://teacher.desmos.com/activitybuilder/custom/60d23bb5a1394db2a7ab0721) assigned to all students in the classroom. Have students join the Desmos classroom FIRST.

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Each student should have their own computer to do work on, and students are responsible for collaborating and assisting other students in their group.

Cooperative Learning:

- Each lab group must divide the workload and have roles, as were specified in the previous section. Students must collaborate with one another to successfully build the marble run from the materials at hand.

Expectations:

- Students will complete the online Desmos marble run, having a successful run by the end. Once that is completed, students will then create a real-world model of the same marble run using the materials given to them (see materials section).

Timeline:

- This lab can be completed within a single 55-minute class period. Time requirements may dictate that this lab be split between two days, with one day being the Desmos computer activity, the second day being the construction of the Marble Run.

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- What if we were using water instead of marbles?
    - Discuss real world application of plumbing, using gravity to keep water flowing rather than consuming energy

Career Applications

- Plumbing: Construction of pipelines
- Engineering: Construction of waterways

Optional or Extension Activities

- Have students create their own marble run that has 7 points, and must have 2 positive slopes greater than 2.

MARBLE RUN LAB "WORK" SHEET

FORMULAS

Topic	Formula
Slope	$m = \frac{y_2 - y_1}{x_2 - x_1}$
Distance Formula	$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

Prior to building your Marble Run, answer these questions:

1. How long does the first part of the track, Line 1, need to be (**in HALF inches**)?
2. How long does the second part of the track, Line 2, need to be (in half inches)?
3. How long does the final part of the track, Line 3, need to be (in half inches)?

Time to construct your marble run!

a. Label the points you used from Desmos on your foam board coordinate plane.
b. Cut out strips of hard cardstock to use as your track using the measurements you have calculated above. Remember, measure twice and cut once!
    i. Cut your track so that it is 1.25 inches WIDE
    ii. This would be a perfect time to decorate your track as well….
c. Fold 0.25 inch of your width over to make a ledge that can be taped to your foam board.
d. Cut a small strip of tape to connect your track to your board, connected the appropriate points.
    i. If you are connecting two pieces of track, you may want to tape them together as well.
e. Continue to do this for all parts of your track.
f. Place the cup with the marble at the end of the track.
    i. You may have to cut the cup so that it is short enough to fit under your track.
g. Any final details? Any final decorations you can make?
h. When the group is ready, and the track fully assembled, see if it works!

Student Name: _____ Date: _____ Period: _____

MARBLE RUN LAB "WORK" SHEET

FORMULAS

Topic	Formula
Slope	$m = \frac{y_2 - y_1}{x_2 - x_1}$
Slope-Intercept Form	$y = mx + b$
Point-Slope Form	$y - y_1 = m(x - x_1)$
Distance Formula	$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

ONLINE DESMOS MARBLE RUN WORK

1. Determine the first part of the track, let's call it Line 1:

Slope	Equation
Point 1: _____ Point 2: _____	

Be sure to graph your equation in Desmos to complete your virtual marble run!

Student Name: _____ Date: _____ Period: _____

2. Now, determine the next part of the track, let's call it Line 2:

Slope	Equation
Point 1: _____ Point 2: _____	

Did you have to put any constraints on Line 2 to make it fit as part of the track? If so, what were they?

_____.

3. Now, determine the next part of the track, let's call it Line 3:

Slope	Equation
Point 1: _____ Point 2: _____	

Did you have to put any constraints on Line 3 to make it fit as part of the track? If so, what were they?

_____

Student Name: _____ Date: _____ Period: _____

4. Test your completed marble run on Desmos. Did it work? _____

5. Can you describe this track as a system of equations? Write it below:

My Marble Run

6. Are there solutions to this system of equations? If so, what are they? If not, can you tell me why?

_____

_____

_____

7. Great! Now, it's time to build a real one. Your supply manager should go get a lab bucket full of supplies at this time. Get ready for Round 2!

Student Name: _____ Date: _____ Period: _____

8. How long does the first part of the track, Line 1, need to be (**in HALF inches***)?

Length of Line 1
Point 1: _____ Point 2: _____

***Remember your scale**, when you originally calculate your distance it will be in WHOLE inches. You have to then convert this distance into HALF inches…**

9. How long does the second part of the track, Line 2, need to be (in half inches)?

Length of Line 2
Point 1: _____ Point 2: _____

Student Name: _____ Date: _____ Period: _____

10. How long does the final part of the track, Line 3, need to be (in half inches)?

Length of Line 3
Point 1: _____ Point 2: _____

11. Time to construct your marble run!
    a. Label the points you used from Desmos on your foam board coordinate plane.
    b. Cut out strips of hard cardstock to use as your track using the measurements you have calculated above. Remember, measure twice and cut once!
        i. Cut your track so that it is 1.25 inches WIDE.
        ii. This would be a perfect time to decorate your track as well….
    c. Fold 0.25 inch of your width over to make a ledge that can be taped to your foam board.
    d. Cut a small strip of tape to connect your track to your board, connected the appropriate points.
        i. If you are connecting two pieces of track, you may want to tape them together as well.
    e. Continue to do this for all parts of your track.
    f. Place the cup with the marble at the end of the track.
        i. You may have to cut the cup so that it is short enough to fit under your track.
    g. Any final details? Any final decorations you can make?
    h. When the group is ready, and the track fully assembled, see if it works!

Student Name: _____ Date: _____ Period: _____

12. Did it work? Why or why not?

_____

_____

_____

13. Look at the placement of your pieces of track. Are they on the linear equations that you created in the first part of this lab? Explain why they are or are not.

_____

_____

_____

_____

_____

14. Is it possible to have your track placed differently, and still go through all of the points? If yes, could the track still work (tell me why!)? If no, why not?

_____

_____

_____

_____

_____

_____

Student Name: _____ Date: _____ Period: _____

Solving Systems of Equations by Graphing

Scope & Sequence

1. Lesson 1: Determining the Slope of a Line
    a. Formative Assessment: Exit Ticket
2. Lesson 2: Writing Equations in Slope-Intercept Form
    a. Formative Assessment: Exit Ticket
3. Lesson 3: Graphing Linear Equations in Slope-Intercept Form
    a. Formative Assessment: Exit Ticket
4. Lesson 4: The Distance Formula
    a. Formative Assessment: Exit Ticket
5. Lesson 5: Solving Systems of Equations by Graphing
    a. Formative Assessment: Exit Ticket
6. Lesson 5: Marble Run Lab
7. Summative Unit Assessment

Student Name: _____ Date: _____ Period: _____

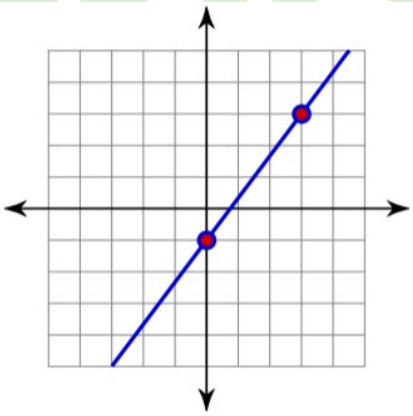
Lesson 3: Graphing Linear Equations in Slope-Intercept Form

Learning Target: _____

_____

Entry Task

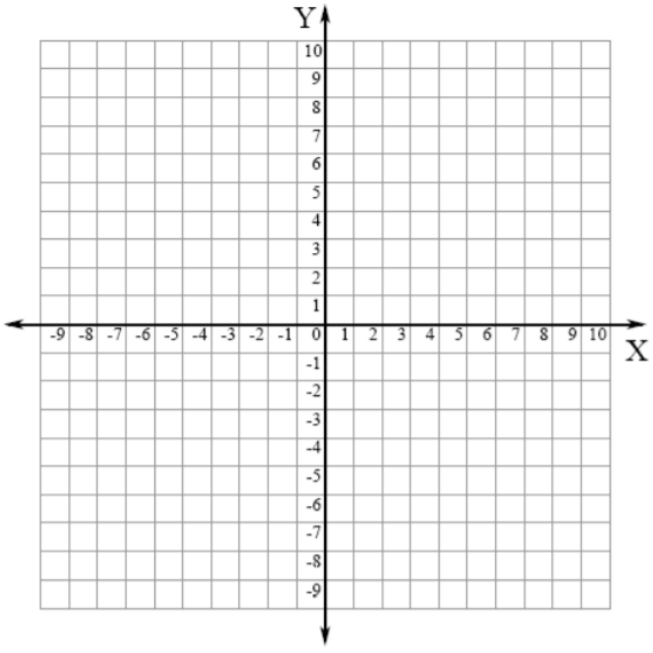
1. Write an equation in slope-intercept form for the line on the graph below:



2. WONDER: What if you were only given the equation? How would you graph the line?

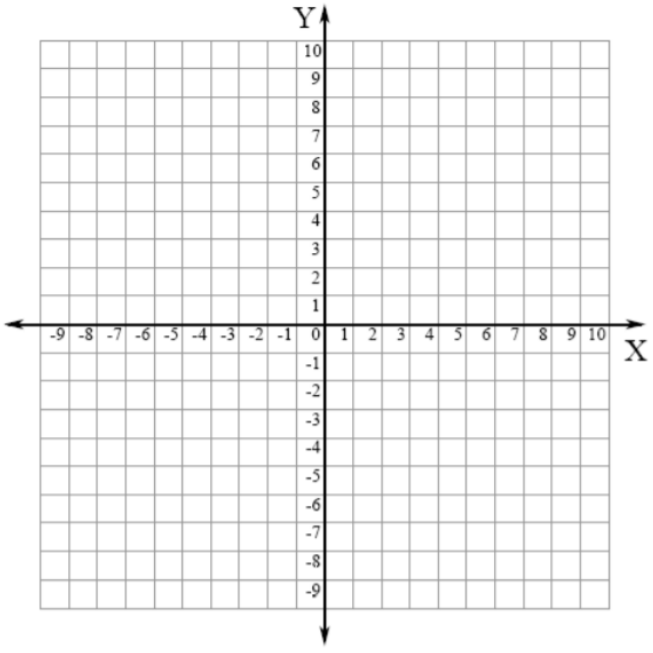
Example 1

Graph the equation $y = 4x + 2$.



Example 2

Graph the equation $12x + 6y = 18$



Student Name: _____ Date: _____ Period: _____

Rally Coach

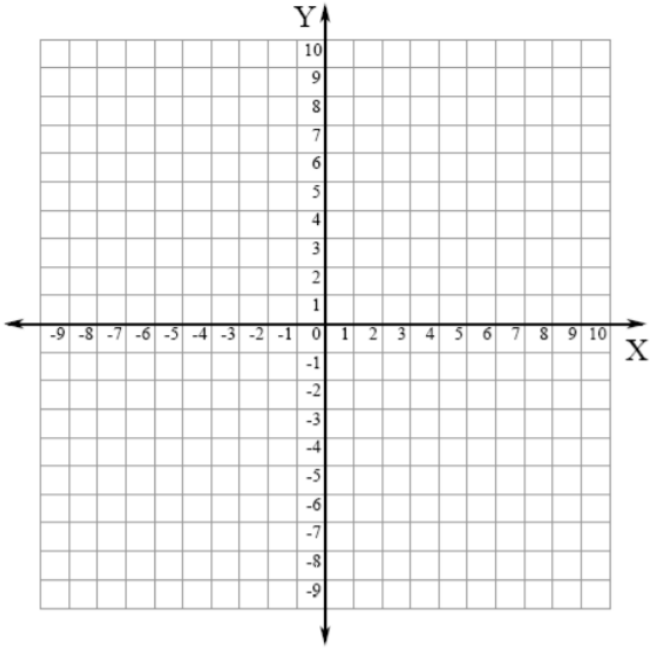
Choose who will be Partner A and Partner B. Partner A will solve the problems marked A, with Partner B coaching them through if they get stuck. Partner B is NOT allowed a pencil during this time. Then, switch for the problems marked B. When both sections are done, please raise your hand for a check in with the teacher.

A. Graph the following equations on the coordinate system to the right.

i. $y = x - 3$

ii. $2y - 10 = -4x$

iii. $-5x + y = 1$

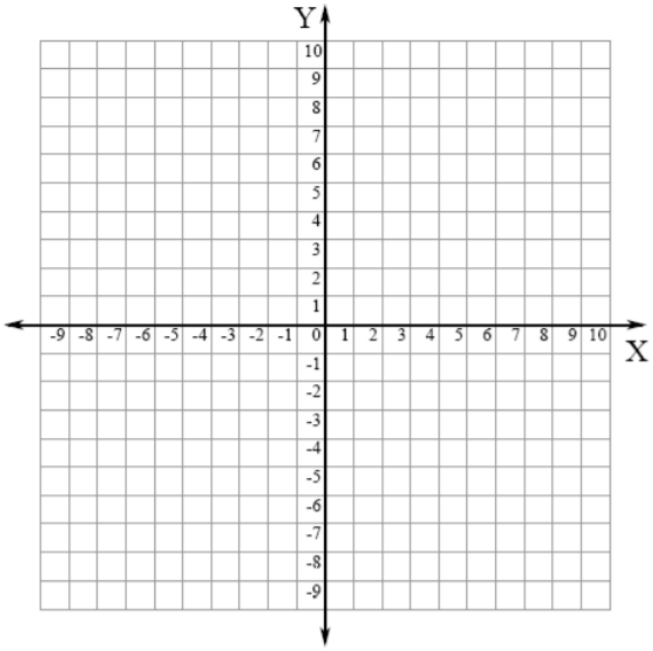


B. Graph the following equations on the coordinate system to the right.

i. $y = 3x + 5$

ii. $5y + 10 = -2x$

iii. $6 - 2y = -x$



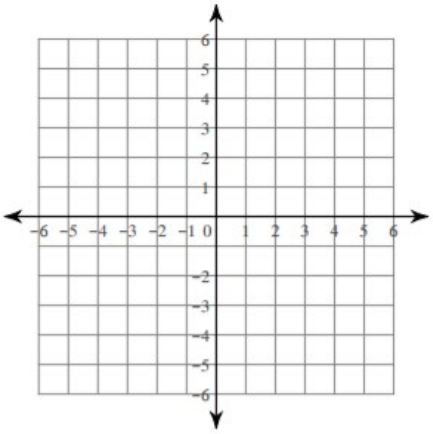
Student Name: _____ Date: _____ Period: _____

Practice

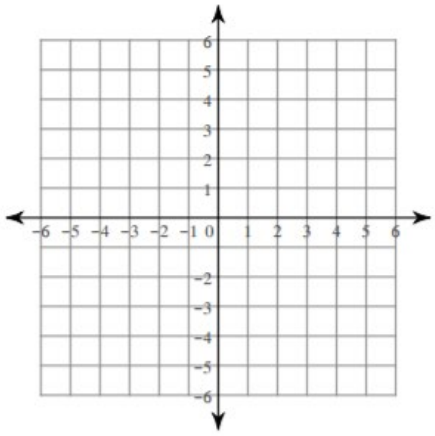
This section can be completed with a partner or independently. When done, see your teacher for a check.

Sketch the graph of each line.

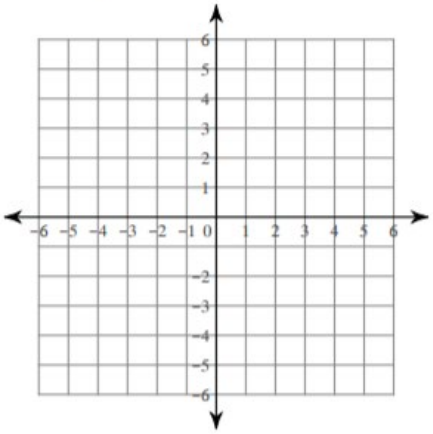
23) $y = -2x + 2$



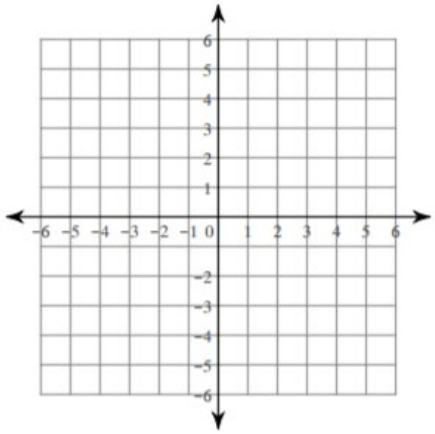
24) $y = \frac{3}{5}x - 4$



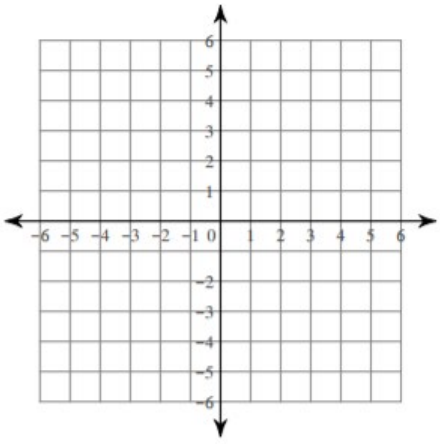
25) $y = \frac{1}{4}x + 1$



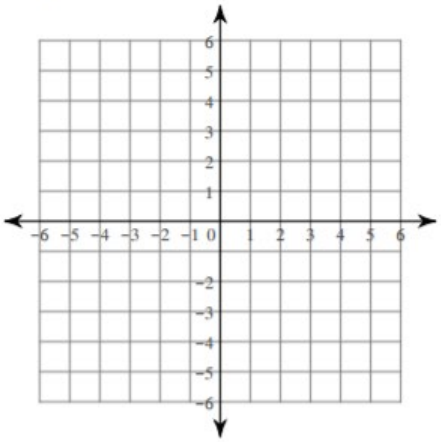
26) $y = x$



27) $y = -\frac{1}{3}x - 2$



28) $y = -4$

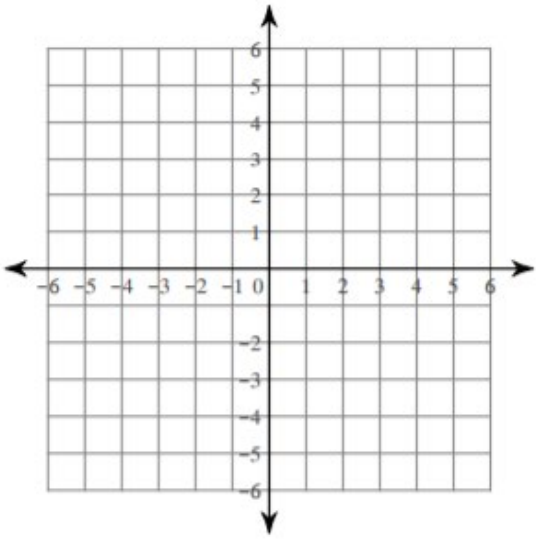


Student Name: _____ Date: _____ Period: _____

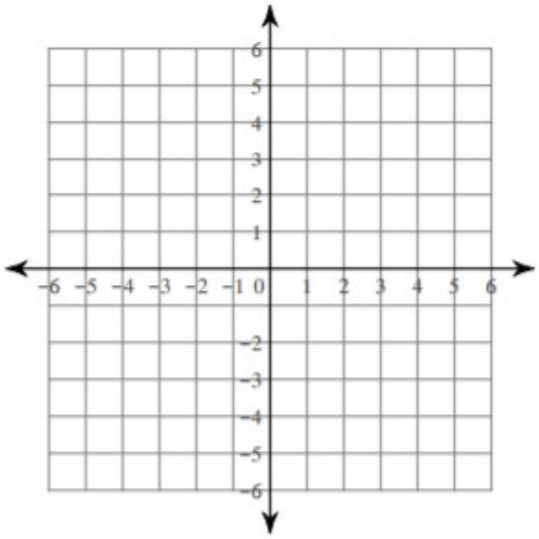
Lesson 3: Exit Ticket

Graph the following lines on the coordinate planes. Be sure to use a ruler!

29) $y = -\frac{3}{4}x + 2$



30) $y = \frac{2}{5}x + 5$



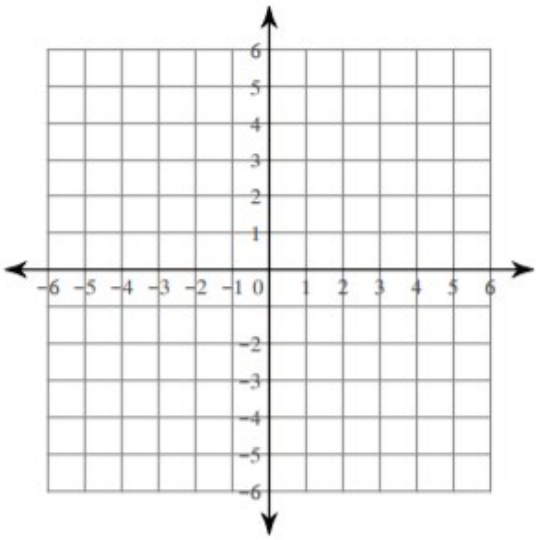
Student Name: _____ Date: _____ Period: _____

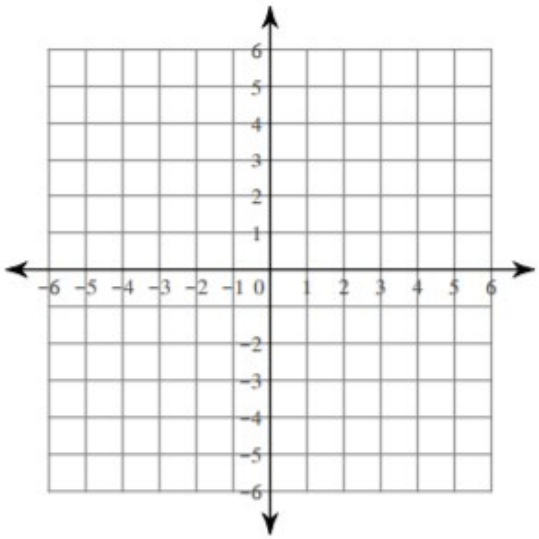
Lesson 3: Exit Ticket

Graph the following lines on the coordinate planes. Be sure to use a ruler!

29) $y = -\frac{3}{4}x + 2$

30) $y = \frac{2}{5}x + 5$



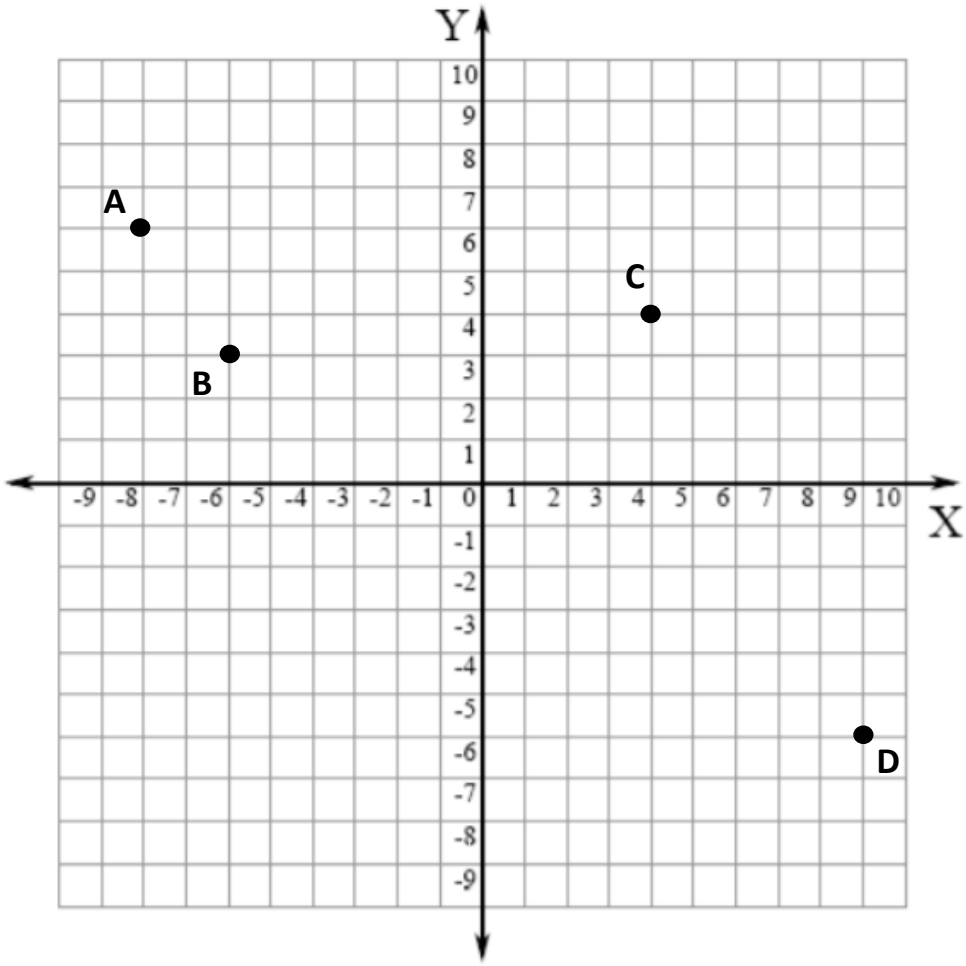


Student Name: _____ Date: _____ Period: _____

Solving Systems of Equations by Graphing Summative Assessment

You are given the following foam board. Construct a marble run to connect all points on the coordinate system below. Be sure to answer all the questions after the drawing. You must have a completed graph before turning in the exam.

Please be sure to BOX all final answers and show your work. You may use a calculator and ruler.



1. What is the equation for line $\overline{AB}$ in slope-intercept form?

2. What is the length of line $\overline{AB}$?

Student Name: _____ Date: _____ Period: _____

3. What is the equation for line $\overline{BC}$ in slope-intercept form?

4. What is the length of line $\overline{BC}$?

5. What is the equation for line $\overline{CD}$ in slope-intercept form?

6. What is the length of line $\overline{CD}$?

7. Write the system of equations made by Line $\overline{AB}$ and $\overline{BC}$. What is the solution to this system?

8. Write the system of equations made by Line $\overline{BC}$ and $\overline{CD}$. What is the solution to this system?