WAMC Lab Template

Math Concept(s): Piecewise Functions, Systems of Equations, Functions, Domain

Source / Text: N/A

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Attach the following documents:

- Zombie Cruisers Lab – Student Handout/Instructions

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

- This lab is an intermediate lesson between Systems of Equations and Piecewise Functions. It is meant to be an introduction to piecewise functions and therefore proper notation is not yet being introduced. Students will use tape/yarn or Desmos to graph piecewise functions in the guise of a Cruise Ship's sailing route and then must construct a route that is capable of intercepting each Cruise Ship at specific points in their journeys.

Lab Plan

Lab Title: Zombie Cruisers

Prerequisite skills: Students should have an understanding of how to graph linear, quadratic, and square root functions, an understanding of linear functions in Slope-Intercept Form, and ability to create an equation in Slope-Intercept Form.

FOR DESMOS VERSION ONLY Student should also have a basic understanding of how to input equations into Desmos and how to find basic settings.

Lab objective: The objective of this lab is to have students learn how piecewise functions are formed from separate functions and to be able to graph and create them. Additionally, for Desmos Use, there is the additional technology objective of being able to use Desmos as a graphing tool to explore and experiment with mathematical tools.

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

Mathematics K–12 Learning Standards:

- F.IF.C.7 – Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- A-REI.C.6 - Solve systems of linear equations and approximately (e.g., with graphs) focusing on pairs of linear equations in two variables.

Standards for Mathematical Practice:

- Make sense of problems and persevere in solving them.
- Model with mathematics.
- Use appropriate tools strategically.

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

- SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

K-12 Science Standards

- N/A

Technology

- For Desmos Version only - 1.d. Students are able to navigate a variety of technologies and transfer their knowledge and skills to learn how to use new technologies.

Engineering

- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems.

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
x Think Creatively
x Work Creatively with Others
☐ Implement Innovations
Critical Thinking and Problem Solving
x Reason Effectively
x Use Systems Thinking
x Make Judgments and Decisions
x Solve Problems
Communication and Collaboration
x Communicate Clearly
x 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)
x Apply Technology Effectively

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

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

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

Materials

For Desmos Version:

- Student Laptops
- Student Handout/Information Page

For Tape/Yard Version:

- Student Handout/Information Page
- 1 poster sheet, poster board (approx. 2'x 3' or larger)
- 1 roll of masking tape
- 4 foot length of yard/string/twine (1 of each in 7 colors)
- 1 or more colored markers

Set-Up Required:

- Yarn needs to be precut
- If time, make kits including markers, yarn, and tape in a baggie per group

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- Potentially provide translated student handouts for multi-lingual students

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Students will collaborate and have to communicate in order to correctly get their graphs set up and their solutions satisfying all the conditions. They will be expected to produce a final product and are encouraged to be creative in finding ways to do so both on paper or Desmos. They will need to reason and use critical thinking skills as well as apply technology appropriately with the Desmos version.

Cooperative Learning:

- Students will work in small group of 2-3 to complete the graph on paper/poster or through Desmos. Each student will be responsible for graphing at least one Cruse Ship route and solution line.

Expectations:

- My expectations for this lab are for students to connect a potential real-world situation with the idea of piecewise functions and to construct graphs of piecewise functions. For Desmos version, expectations are also for students to learn to gain familiarity with mathematical tools to experiment and estimate solutions.

Timeline:

For Tape/Yarn/Poster Version

- Approximately 5-7 minutes to create the grid, about 20 minutes to put the Cruise Ship functions on the graph with yarn/tape, and up to 15 minutes to put the solutions on the grid and come up with their equations.

For the Desmos Version

- Approximately 20 minutes to put the Cruise Ship functions into Desmos with proper domain restrictions, about 20-25 minutes to experiment with the Desmos tools to find solutions and write their equations.

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- Real world applications would be most categories of work as students must cooperate with each other, follow directions, problem-solve together to derive a given solution and create a final product.

Career Applications

- Any which requires someone to be able to adjust graphs/routes that have multiple functions or data generating types of functions.

Optional or Extension Activities

- Paper/yarn/tape could be done first and then extended into Desmos.

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Zombie Cruisers Lab – Student Information Sheet

Problem:

Three luxury cruise ships have been lost at sea and infected with a zombie virus. Each ship is traveling a different route with a different speed. Your job is to take a speed boat out to each ship to deliver either a vaccine to prevent infection, a cure to reverse the infection, or a bomb that will destroy the newly formed zombies and infection. The most efficient route between points is a straight line so you will be plotting your course as such.

The travel route of each cruise ship will be given in three parts (making up a piecewise function):

- Part One: Uninfected – you can deliver a vaccine to prevent infection
- Part Two: Exposed – you can deliver a cure to reverse infection and prevent further illness
- Part Three: Zombified – you can no longer cure the ship and must destroy it so no one else becomes infected.9

Cruise Ship One – The Brimstone Legacy – Northern (Top) Ship

$$\begin{cases} 2y - 4x = 16, 0 \le x \le 3 \\ y + \sqrt{3x} + 11, 3 < x \le 12 \\ 16y - x^2 = 128, 12 < x \le 15 \end{cases}$$

Cruise Ship Two – The Sapphire Siren – Middle Ship

$$\begin{cases} y + 3x = 6, 0 \le x \le 4 \\ y = -x^2 + 15x - 50, 4 < x \le 10 \\ y = \sqrt{10x} + 4x - 50, 10 < x \le 15 \end{cases}$$

Cruise Ship Three – The Whirlwind's Fury – Southern (Bottom) Ship

$$\begin{cases} x^2 - 2y = 36, 0 \le x \le 6 \\ y = -\sqrt{2x + 4} + 4, 6 < x \le 16 \\ y = 13x - 210 \end{cases}$$

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Mission One

Your goal is to create a route that will allow you to deliver a vaccine to prevent infection and save everyone's vacation (and lives) – you get to be a beloved hero and widely celebrated for your success!

1. Create a line that intercepts all three cruisers while they are still UNINFECTED (first stage).
    a. Write an equation that represents your route

    b. List the contact points (where you intercepted the cruisers)

Mission Two

The passengers aboard the cruise ships have been exposed and infected! No one's turned into a zombie yet, but they only have a limited time before that happens and the illness had made them start having fevers and acting erratically – their original travel routes have changed. You have to come up with a route that will allow you to deliver a cure that will stop the infection and prevent them from turning into zombies.

1. Create a line that intercepts all three cruisers while they are EXPOSED (second state).
    a. Write an equation that represents your route

    b. List the contact points (where you intercepted the cruisers)

Mission Three

The passengers aboard the cruise ship have all turned into Zombies! It's too late for them and with no one living at the helm, the ships have changed course yet again and are likely to run ashore and spread the infection. It is up to you to plot a route where you can deliver a small explosive that will disable the engine and sink the ship so they can't hurt anyone else.

1. Create a line that intercepts all three cruisers while they ZOMBIFIED (third stage).
    a. Write an equation that represents your route

    b. List the contact points (where you intercepted the cruisers)

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Mission Four

You're trying to save everyone but the luck and the seas are making it very difficult. Start at either the North or South and plot a route to deliver a cure to your first ship that is Uninfected status. However, once you've done that, a storm rolls in and you must recalculate your route to be able to deliver a vaccine to the second ship that is now in Exposed status. Great news, you've saved a lot of people, but your own engine gave out and by the time you fix it, you can only destroy the last ship because they are now Zombified.

1. Create a piecewise function that starts at the top or bottom of the graph. Your first part will go through the first section of one ship, the second part will go through the second section, and the third will go through the third section.
    a. Use straight lines only in the form of y = mx + b
    b. FOR DESMOS ONLY
        i. You can change your slider equation to y = mx +b
        ii. Your sliders must be set to -50 and 50 for both!

2. Write the equations with the intervals in {} at the end. Your first one should start at 0 and the last one should end at 20.
    a.

    b.

    c.

3. List the intercept points for each part of your mission four function.

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INSTRUCTIONS IF USING DESMOS

1. Enter each Battle Cruiser's route as a piecewise function on Desmos.
    a. Each piece should be its own function followed by domain restrictions in {}
    b. Each piece of the Cruiser's route should be the same color, change this in settings as needed.
2. Enter your standard slope-intercept equation of y = mx + b and create sliders for m and b.
    a. Make the thickness of this line a 5 in the settings to make it easier to see and change its color to be different than each of the Cruisers
3. Use the sliders to adjust the speedboat line until it intercepts the cruisers at the desired points.
4. Take a screen shot of each solution and save it for our follow-up assignment.
5. For the last question, you may want to add each piece of your solution as a separate/permanent entry while you work with the next to make sure they line up correctly.

INSTRUCTIONS IF USING PAPER, YARN, & TAPE

Materials (per group):

Lab Student Information Sheet
1 poster sheet, poster board (approx. 2'x 3' or larger)
1 roll of masking tape
4 foot length of yard/string/twine (1 of each in 7 colors)
1 or more colored markers

1. Use the masking tape to tape off a coordinate grid on the poster sheet or poster board.
    a. Label the x and y axis as well as a scale (should need no more than -5 to 20 on the x axis and -20 to 20 on the y axis.
2. Assign each length of yarn to one item:
    a. Cruiser 1
    b. Cruiser 2
    c. Cruiser 3
    d. Speedboat (represented 4 ways)
        i. Mission 1
        ii. Mission 2
        iii. Mission 3
        iv. Mission 4
3. Using the yarn for each cruiser, graph each piecewise function. Use masking tape as needed to hold it in place in approximate shape.
4. Using the yarn designated for the speedboat, graph the solutions to each mission (one color for each) and attach with masking tape as needed.

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Zombie Cruisers After Action Report – Power Point

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Congratulations Zombie Cruises on your success in dealing with our rogue cruise ships. As with any mission, you have to create a report to let the higher ups know what happened so we can make sure the next mission goes just as well, or better!

For this mission report you will create a PowerPoint presentation that addresses the required questions. Each group will have a report, you do not have to do them individually, but every participant must contribute to the report.

Overview of Required Slides	
Tape/Yarn/Poster Version	**Desmos Version**
Title Slide – Mission Name and Participants	No changes
Intro Slide – Describe your plan of attack, etc.	No changes
Mission One Solution – give line equation and solution points	Include screenshot
Mission Two Solution – give line equation and solution points	Include screenshot
Mission Three Solution – give line equation and solution points	Include screenshot
Mission Four Solution – give line equation and solution points	Include screenshot
Analyzation Slide	May include screenshots
Reflection Slide	No Change

You may use more than one slide for a section if you run out of room – more is okay, less is not.

Title Slide

- Names of all group members
- Give your mission a creative (school-appropriate) name.

Intro Slide

- Explain the steps you took to solve the problem
    - How did you organize your information?
    - What parts were you confused over?
    - How did you divide the work?

Mission One/Two/Three/Four Slides

- Screenshot (if on Desmos) or picture if want of your poster.
- Explain how you decided your solution satisfied the mission requirements.
- Equation of your solution route/mission line.
- List of meeting points for each ship (where the lines intersected).

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Analyzation Slide

- What is real-world meaning of the slope in this problem? How does that affect your solution route?
- What would a negative slope mean in the context of this problem?
- What is the real-world meaning of the y-intercept in this problem? How does that affect your solution route?
- Desmos Only
    - How did you decide what to set the min and max on your sliders to?
    - How did the sliders affect the shape/location of your line?
    - Describe how you used the sliders to create your equation.

Reflection Slide

- What was your favorite and least favorite part of this mission?
- What worked really well in this mission?
- What went not so great in this mission?
- How could you improve upon this mission if you had to do it again?
- What else do you need to know before attempting a mission like this again?
- What grade would you give your performance on this mission? Why?
- On a scale of 1 to 4, rate your comfort level with this mission.
    - 1 – Need a Lot of Help
    - 2 – Need a Little More Help
    - 3 – I could do it Okay on my Own
    - 4 – I can do it on my Own AND I can Teach it to others.

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Grading Rubric

	Points				
Component	**5**	**4**	**3**	**2**	**1**
Graph Constructions	All lines are graphed correctly with very minor or no errors on paper or Desmos	All lines are graphed on paper or Desmos with few minor errors.	Most lines are graphed on paper or Desmos with few errors.	Some missing lines and many errors.	No work at all.
Solution Lines	All four mission lines have been graphed and have equations given for them.	Either four graphed mission lines with minor errors or only three mission lines graphed.	Either three lines with few to no errors graphed or only two lines graphed.	Either two lines graphed with few to no errors or one line graphed.	No work at all.
Completeness	Mission Report has all required slides and all questions answered.	Mission Report has all required slides but missing some minor information.	Mission report has missing slides or many missing questions.	Mission report is missing most slides and information that is required.	No work at all.
Accuracy	Lines and equations are correct.	Most lines and equations are correct.	About half the lines and equations are correct.	Less than half the equations and lines are correct.	No work at all.
Neatness	The Mission Report is well-designed and organized. The Graph is easily read and has appropriate scales listed.	The Mission Report has some minor organizational errors. The Graph may have minor neatness issues or missing labels.	The Mission Report is not in order or not well organized, pictures cannot be seen, text on the wrong slide, etc. The Graph is messing and/or missing labels, yarn falling off, tape covering labels, too much tape, etc.	The Mission Report is completely unorganized, and slides are all over the place. The Graph has lines that are falling off, missing or no labels at all.	No work at all.

Grades

A	B	C	D	F
23-25 points	18 – 22 points	12 – 17 points	6-11 points	5 points

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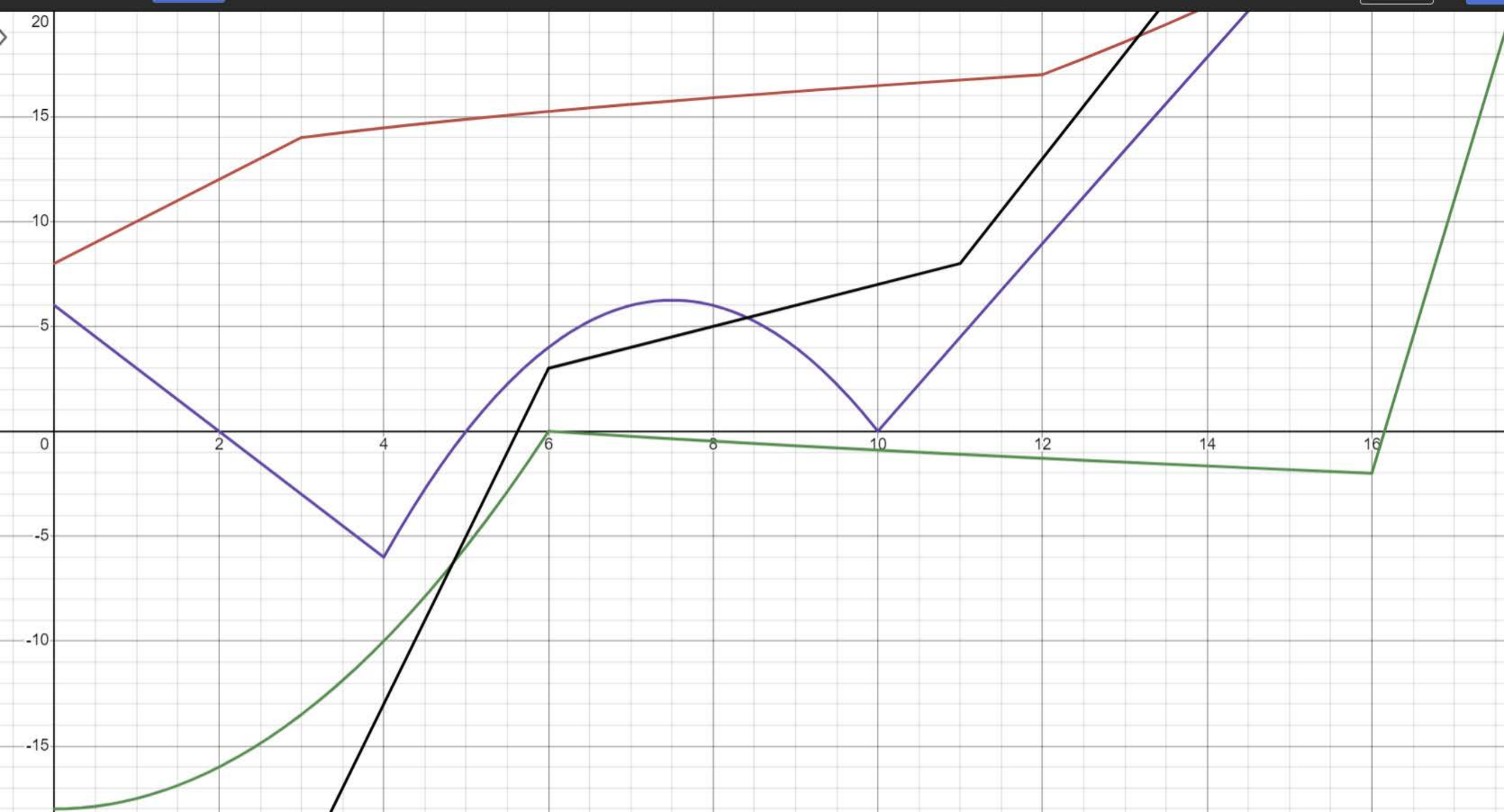
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