Rich Mathematical Task – Algebra I – *Radical Rocks*

Task Overview/Description/Purpose:
• Within the context of planning a day to rock climb at a local venue, students are tasked with writing an equation to model the problem that includes hourly rate and price of equipment rental. They will then create models for two discounts, one on the hourly rate and the other on the equipment rental. After graphing both equations, students will answer a series of questions regarding the better deal, based on the graph and the solutions to the equations given a total dollar amount. Finally, students will be asked to interpret what the point of intersection means within the context of the problem. • Develop models for the original equation and the subsequent equations involving discounts, graph the equations, interpret the results within the context of the problem, and speculate on the meaning of the point of intersection. • The purpose of this task is to deepen their understanding of how models that represent practical situations can change as the constraints of the problem change and how to interpret the results of those changes based on the slope of the lines. This task may serve as a precursor of systems of equation allowing them to speculate on the meaning of the point of intersection of two linear equations before systems of equations are formally introduced.

Standards Alignment: Strand - Functions	
Primary SOL: **A.4** The student will solve a) multi-step linear equations in one variable algebraically; and e) practical problems involving equations. **Related SOL (within or across grade levels/courses):** A.1a, A.4d	
Learning Intentions: • **Content (based on Essential Knowledge and Skills) –** I am learning to interpret and determine the reasonableness of the algebraic and graphical solutions of linear equations that model a practical situation. • **Language –** I am learning to explain my reasoning with mathematical language and provide evidence to support my conclusions. • **Social –** I am working toward mathematical and logical consensus with my collaborative team.	
Success Criteria (Evidence of Student Learning): • I can translate between verbal quantitative situations and algebraic equations. • I can solve multistep linear equations in one variable algebraically. • I can solve practical problems involving equations. • I can interpret and determine the reasonableness of algebraic and graphical solutions of linear equations.	
Mathematics Process Goals	
Problem Solving	Students will use problem-solving strategies as they apply mathematical concepts and skills related to writing equations to model a practical situation and adjust the model for changing constraints.

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Standards Alignment: Strand - Functions	
Communication and Reasoning	Students will engage in discussions with partners/groups and provide written commentary which includes supporting documentation that identifies the evidence and justifies their conclusions.
Connections and Representations	Students will develop multiple representations of a practical situation and explore the connections among the verbal, tabular, graphical, and algebraic representations of the same situation.

Task Pre-Planning

Approximate Length/Time Frame*:* 40-45 minutes

Grouping of Students:

Students can work with partners or in small groups of three of four students. Students should be given time to work independently to read and process their thinking about the problem. Students can then share out with a partner or small group to refine their understanding of equivalency.

Materials and Technology:	**Vocabulary:**
• handheld or Desmos graphing calculators	• Models • Solutions • Discount • Slope • *y*-intercept • properties of real numbers • properties of equality • intersection

Anticipate Responses*:* See Planning for Mathematical Discourse Chart (Columns 1-3)

Task Implementation (Before)

Task Launch:

- "Has anyone ever been rock climbing?" Have students share what they know about rock climbing (cost, equipment, etc.)
- Share information with students about local rock-climbing venues regarding the price of admission, lessons, equipment rentals, etc.
- Ask: "If you were offered different discounts on the price, how would you know what the best deal is?"
- The purpose of this task is to deepen their understanding of how models that represent practical situations can change as the constraints of the problem changes and how to interpret the results of those changes based on the slope of the lines. Both equations will be graphed on the same coordinate plane, but this is not to be introduced as a system of equations, it is a precursor of what is to come. The focus is to examine the graphs and make a conclusion based on the slopes of the lines then solve the problems algebraically to determine if their interpretation was valid.
- When systems of equations are formally introduced in a later lesson, a reminder of the rock-climbing problem could serve to activate prior knowledge of the point of intersection of two linear equations.
- Use underlining, highlighting, using cue words, vocabulary word walls, and making predictions to help students make sense of the task.

Task Pre-Planning

- *To help students access the prior knowledge and vocabulary needed to understand the task, have them* use vocabulary and examples such as two-variable equations, tables of values, slope, *y*-intercept, etc. Use vocabulary to connect solution steps to the properties of equality.

Task Implementation (During)

Directions for Supporting Implementation of the Task

- Monitor – Teacher will listen and observe students as they work on task and ask assessing or advancing questions (see chart on next page)
- Select – Teacher will decide which strategies or thinking that will be highlighted (after student task implementation) that will advance mathematical ideas and support student learning
- Sequence – Teacher will decide the order in which student ideas will be highlighted (after student task implementation)
- Connect – Teacher will consider ways to facilitate connections between different student responses

Suggestions For Additional Student Support

- Use of highlighters to assist students in interacting with the text
- Use of sentences frames to support student thinking
- Use of word wall cards or anchor charts that serve as a point of reference
- Use of Frayer Model for definitions
- Use fewer words and bulleted items to reduce the reading load.

Task Implementation (After)

Connecting Student Responses (From Anticipating Student Response Chart) and Closure of the Task:

- Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion
- Connect different students' responses and connect the responses to the key mathematical ideas to bring closure to the task
- Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion

Teacher Reflection About Student Learning:

- How will student understanding of the content through the use of the process goals be assessed (i.e., task rubric)?
- How will the evidence provided through student work inform further instruction?
- Does vocabulary need further development?
- What was a recurring misconception?
- Are students able to explain their thinking orally or in written form?
- Was guess and check used with mathematical understanding? This is not a course level appropriate strategy even though it can lead to a correct solution.

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Planning for Mathematical Discourse

Mathematical Task: __________Radical Rocks_____________________Content Standard(s):__________A.4(a, e)__________________________

Teacher Completes Prior to Task Implementation			**Teacher Completes During Task Implementation**	
Anticipated Student Response/Strategy *Provide examples of possible correct student responses along with examples of student errors/misconceptions*	**Assessing Questions – Teacher Stays to Hear Response** *Teacher questioning that allows student to explain and clarify thinking*	**Advancing Questions – Teacher Poses Question and Walks Away** *Teacher questioning that moves thinking forward*	**List of Students Providing Response** *Who? Which students used this strategy?*	**Discussion Order - sequencing student responses** • *Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion* • *Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion*
Anticipated Student Response: Initial equation is $13h + 8 = C$	• Explain how you came up with your equation? • What do the 13 and 8 represent in this problem?	• What are you thinking now? • How will you decide what to do next?		
Anticipated Student Response: With \$6.00 discount on equipment $8h + 13 = C - 6$	• How did you arrive at your answer? • What part of your expenses are being discounted?	• Go back to the question. Does this still make sense? • How might you represent that now?		
Anticipated Student Response: With 40% discount on hourly rate $3.2h + 13 = C$ $8h + 8.2 = C$	• What do you know about the discount on the hourly rate? • What does the \$4.80 represent? How does it apply?	• Does your answer seem reasonable? Why or why not? • What can you do now?	**Student C** **Student D** **Student F**	
Anticipated Student Response: With 40% discount on hourly rate $0.4h + 13 = C$	• Can you explain what you were thinking when you worked that out? • What do you know about the hourly rate?	• Does your answer seem reasonable? Why or why not? • What could you do next?		
Anticipated Student Response: Inappropriate scales chosen for graph.	• Why did you decide to choose that scale?	• What is a reasonable number of hours you might be rock climbing?	**Student D**	

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Teacher Completes Prior to Task Implementation			Teacher Completes During Task Implementation	
Anticipated Student Response/Strategy *Provide examples of possible correct student responses along with examples of student errors/misconceptions*	**Assessing Questions – Teacher Stays to Hear Response** *Teacher questioning that allows student to explain and clarify thinking*	**Advancing Questions – Teacher Poses Question and Walks Away** *Teacher questioning that moves thinking forward*	**List of Students Providing Response** *Who? Which students used this strategy?*	**Discussion Order - sequencing student responses** • *Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion* • *Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion*
	• What information did you have?	• What are you thinking now?		
Anticipated Student Response: Unable to articulate the better deal using the graph.	• What do you notice on the graph? • How could you tell when one deal was better than the other?	• How could you use your graph to find the better deal as time passes? • What could you do now to answer the question?	**Student A**	
Anticipated Student Response: When calculating the number of hours for both plans, does not round **down** to the nearest hour.	• What do your answers represent? • Can you pay for part of an hour?	• How would you choose the number of full hours? • What are you thinking now?	**Student B** **Student C** **Student D** **Student E**	
Anticipated Student Response: Unable to articulate how the solutions based on \$35 supports their conclusion.	• What do your answers represent? • Where are the answers located on the graph?	• What are you thinking now? • How can you use what you know to find the number of hours?	**Student F**	
Anticipated Student Response: Does not interpret the point of intersection as length of time for both discounts that the cost is the same.	• Which discount was better at one hour? • Which discount was better at three hours?	• What do you notice between hours one and three? • What do you think that means?	**Student E**	

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Anticipated Student Response/Strategy *Provide examples of possible correct student responses along with examples of student errors/misconceptions*	**Assessing Questions – Teacher Stays to Hear Response** *Teacher questioning that allows student to explain and clarify thinking*	**Advancing Questions – Teacher Poses Question and Walks Away** *Teacher questioning that moves thinking forward*	**List of Students Providing Response** *Who? Which students used this strategy?*	**Discussion Order - sequencing student responses** • *Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion* • *Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion*
Anticipated Student Response: A less efficient strategy was used to determine the number of hours given $35.00 to spend	• Where did you get the idea for how to find the number of hours when both equations were #35.00? • Did that work for both equations?	• What does the point of intersection mean on the graph? • How does that relate to the two equations that were graphed?	**Student B**	
Anticipated Student Response: The graph does not support the conclusion.	• How does your graph represent the two equations? • How can you use your graph to support your conclusion about the better deal?	• How could you change your graph to support your conclusion? • What do you think you will remember for next time?	**Student C** **Student E**	

Name_____________________________________ Date_____________________

Radical Rocks

You and your friends are planning an adventure at Radical Rocks for a fun-filled day of rock climbing. The cost is \$8 per hour plus \$13 for full-day equipment rental. The rental includes a harness, shoes, belay device and a chalk bag.

Write an equation to represent your total cost for the day.

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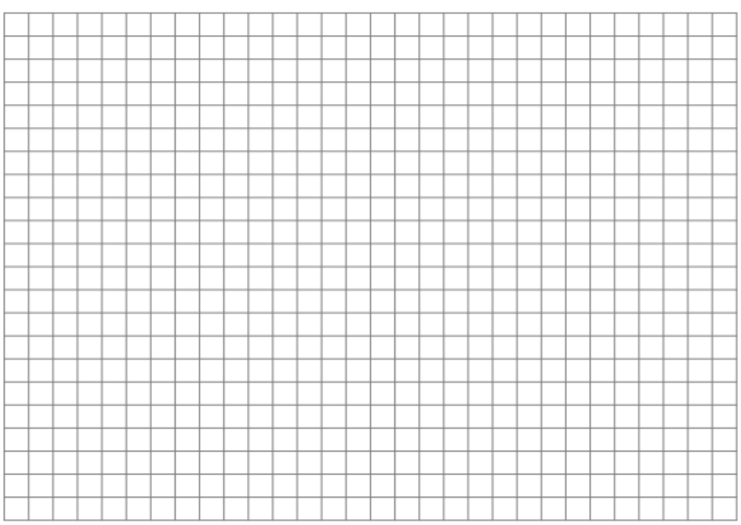
1) **You found an online coupon that offers a \$6.00 discount on the full-day equipment rental. How does this change your equation above? Write a new equation.**

2) **Your friend received a coupon in the mail offering a 40% discount off the hourly rate? How does this change your original equation above? Write a new equation.**

3) **Graph the equations from Questions 1 and 2 above. Choose a scale and label the axes.**



4) Which coupon offered the better deal? Use the graph to support your conclusion.

5) You have a total of $35.00 to spend. How many hours can you purchase for the day?

- **Find the number of hours for the equations in Question1 and Question 2 on the previous page.**

- **Does this support your conclusion from Question 4? Justify your answer.**

6) Refer to your graph, did the two lines intersect?

If so, what is the approximate coordinate for the point of intersection?

What does this point represent within the context of this problem?

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Rich Mathematical Task Rubric

	Advanced	Proficient	Developing	Emerging
Mathematical Understanding	Proficient Plus: • Uses relationships among mathematical concepts	• Demonstrates an understanding of concepts and skills associated with task • Applies mathematical concepts and skills which lead to a valid and correct solution	• Demonstrates a partial understanding of concepts and skills associated with task • Applies mathematical concepts and skills which lead to an incomplete or incorrect solution	• Demonstrates little or no understanding of concepts and skills associated with task • Applies limited mathematical concepts and skills in an attempt to find a solution or provides no solution
Problem Solving	Proficient Plus: • Problem solving strategy is efficient	• Problem solving strategy displays an understanding of the underlying mathematical concept • Produces a solution relevant to the problem and confirms the reasonableness of the solution	• Chooses a problem solving strategy that does not display an understanding of the underlying mathematical concept • Produces a solution relevant to the problem but does not confirm the reasonableness of the solution	• A problem solving strategy is not evident or is not complete • Does not produce a solution that is relevant to the problem
Communication and Reasoning	Proficient Plus: • Reasoning is organized and coherent • Consistent use of precise mathematical language and accurate use of symbolic notation	• Communicates thinking process • Demonstrates reasoning and/or justifies solution steps • Supports arguments and claims with evidence • Uses mathematical language to express ideas with precision	• Reasoning or justification of solution steps is limited or contains misconceptions • Provides limited or inconsistent evidence to support arguments and claims • Uses limited mathematical language to partially communicate thinking with some imprecision	• Provides little to no correct reasoning or justification • Does not provide evidence to support arguments and claims • Uses little or no mathematical language to communicate thinking
Representations and Connections	Proficient Plus: • Uses representations to analyze relationships and extend thinking • Uses mathematical connections to extend the solution to other mathematics or to deepen understanding	• Uses a representation or multiple representations, with accurate labels, to explore and model the problem • Makes a mathematical connection that is relevant to the context of the problem	• Uses an incomplete or limited representation to model the problem • Makes a partial mathematical connection or the connection is not relevant to the context of the problem	• Uses no representation or uses a representation that does not model the problem • Makes no mathematical connections

Task Supporting Documents