

Unit 4 PROJECT: Real World *PARABOLEMS*

INTRODUCTION

Quadratics are useful for modeling and representing real world scenarios. This allows for professionals and technology to help us predict and understand how variables in the real world interact with one another. Some examples of quadratic applications include projectiles, area of shapes, speed and distance of an object, stress points of materials, and profit and loss of products.

TASK:

To investigate a real scenario relevant to you (or your group) and model it using quadratics. You will do this by taking a photo, video, or real data that creates a parabolic shape. You will sketch a graph and create an equation to represent the data you've collected and variables you set. You will be using desmos (<https://www.desmos.com/calculator>) to assist you in this project. You must conduct an investigation of your scenario to create your very own word problem of varying levels.

For example, Mr. Chang likes to jump when rock climbing. He takes multiple photos or videos of his jump to analyze and model with a parabola. He sets time as his x-axis and height as his y-axis to determine how his jump height is related to time. By creating an equation, he can predict where he would land and make adjustments with respect to jump angle, power/speed, and timing.

Additionally, you will be completing **2 randomly selected word problems per person** as part of your written part. Your written part will consist of:

- 1) Sketch with plotted points supported by a table of values
- 2) Properties labeled on your sketch
- 3) Transformations identified in comparison to the original $y = x^2$ graph
- 4) Calculations to determine your equation in all 3 forms (Standard, Factored, Vertex)
- 5) Interpretation of your graph, axis, and variables in the equation
- 6) Your own created word problem
- 7) 2+ completed word problems

Please refer to the checklist/rubric to make sure all parts are completed.

To celebrate, your teacher will conference with you to check your understanding. You may prepare a portfolio to help your conference (poster, slides, booklet, pamphlet, video, interpretive dance, dramatization, etc).

Group Size: 1 - 3

Each member is responsible for making sure the project is completed fully. There will be a survey amongst each member to determine the contribution percentage of each member.

Written Part Due: Friday, April 26, 2024

Conference Date(s): Monday, April 29, 2024 - Wednesday, May 1, 2024

KNOWLEDGE [10 Marks]

1. What is your real world scenario?

Ideas for pictures/videos/data set:

Google: “parabola _____” or “Time lapse photography _____” and put whatever you’re interested in into the blank.

For example: parabola architecture, time lapse water fountain, parabola sand, parabola motion (better yet: parabolic motion), parabola tree, parabola real life, parabola satellite, time lapse projectile, time lapse motor cross, parabola telephone lines (these are actually catenary curves but-unless you’re in grad school for engineering-it’s close enough), etc.

2. Create a quadratic equation that models your scenario

Save the image to your Desktop along with the image URL—we have to cite sources, even in math class. Upload the image to Desmos using the plus symbol on the upper left-hand side.

Here is an example:

<https://andrewbusch-bvsvd.weebly.com/10i-snowboard-quadratic---alg1b.html>



Or use a Table of Values of a Data Set you collected (*Measured yourself or online*)

3. Graph a quadratic relation over the image using DESMOS by creating an equation in vertex form.

Restriction: The vertex and the y-intercept cannot be the same point. If they are, marks will be taken off your final project grade.

Be sure to print your image with the graph on top of it (when the print page comes up, make sure you’re only printing 1 page). I also suggest logging in to Desmos using your school Google ID and saving your graph to Google Drive—just in case you make mistakes and want to reprint it.

4. Analyze your graph by sketching by hand. Make sure the axes are labeled and scaled correctly. You will need to determine the x-axis and y-axis titles, along with units.

- Label all properties (ie. x-int, y-int, vertex, AoS, Optimal Value, etc) of your parabola
- Describe transformations of vertex form
- Create a table of values with at least 10 points

5. Calculations (show your math!) using algebra [IMPORTANT]

- Determine Vertex Form by using the vertex and another random point from the graph
- Determine Factored Form by using the x-intercept(s) and a random point from the graph
- Convert to Standard Form by expanding and simplifying
Using Standard Form:
 - Completing the Square - Convert your standard form back into vertex form
 - Quadratic Formula - If possible, Convert your standard form back into factored form

6. Relating back to scenario [IMPORTANT]

- Make connections between the properties of your parabola and equation to the real world scenario. Describe the meaning of each number and property.

APPLICATION [10 MARKS]

This section is unrelated to your scenario. However, it sets you up for the thinking section.

You will be randomly assigned 2 word problems per person to be completed. These word problems will be 2 of the 6 types taught in this unit.

- Types: Projectile, Number, Geometry, Border, Revenue, archway/bridge

INDICATE WHO DID WHICH QUESTION (2 PER PERSON, 5 MARKS EACH). THIS IS MARKED INDIVIDUALLY.

THINKING [10 MARKS]

1. **Analyze your scenario to design a deeper investigation. Goal is to question and find out other aspects of your scenario**
2. **Design an application question that can be solved using your equation.** *Refer to **Lesson 4.6** for examples of application questions. You will be assessed on the relevancy of your question to your scenario and the complexity of the question.*
 - a. *Provide a full solution to your question. We are looking for you to choose the appropriate method(s) for solving your question, use correct algebra and arrive at the correct answer.*
 - b. *Complexity depends on your level of investigation and parts to your question. It should have multiple layers*

COMMUNICATION [10 MARKS]

1. **Conference with your teacher.** *You will be asked a series of questions that relate to your scenario, quadratic equations, key points etc. Be ready to answer anything that comes your way!*

REAL WORLD PARABOLEMS RUBRIC / CHECKLIST

KNOWLEDGE [10 Marks]

This part is done on the presentation days. Your teacher will mark strictly by probing your understanding

	LEVEL 4 [4 marks]	LEVEL 3 [3 marks]	LEVEL 2 [2 marks]	LEVEL 1 [1 mark]	LEVEL R [0 mark]
<p>Relate transformations of the graph $y = x^2$ to the algebraic representation $y = a(x - h)^2 + k$</p> <p>Determine the basic properties of quadratic relations</p>	<p>Described ALL transformations correctly</p> <p>Determined ALL properties of a quadratic relation</p>	<p>Described MOST transformations correctly</p> <p>Determined MOST properties of a quadratic relation</p>	<p>Described SOME transformations correctly</p> <p>Determined SOME properties of a quadratic relation</p>	<p>Described A FEW transformations with numerous mistakes</p> <p>Determined A FEW properties of a quadratic relation with numerous mistakes</p>	<p>Described transformations, but all incorrect</p> <p>Determined properties but all incorrect</p> <p>Or did not attempt section</p>
<p>Solve quadratic equations and interpret the solutions with respect to the corresponding relations</p> <p>Solve problems involving quadratic relations</p>	<p>Solve quadratic equations ALL correctly</p> <p>Determined ALL three quadratic forms</p> <p>Completed the Square and used quadratic formula proficiently</p>	<p>Solve quadratic equations with FEW mistakes</p> <p>Determined TWO quadratic forms</p> <p>Completed the Square and used quadratic formula</p>	<p>Solve quadratic equations with SOME mistakes</p> <p>Determined ONE quadratic forms</p> <p>Completed the Square and used quadratic formula with some mistakes</p>	<p>Solve quadratic equations with numerous mistakes</p> <p>Attempted to determine quadratic forms</p> <p>Completed the Square and used quadratic formula incorrectly</p>	<p>Solved quadratic equations incorrectly</p> <p>Did not determine any quadratic forms</p> <p>Did not completing the square and did not use quadratic formula</p>
<p>Collect data that can be represented as a quadratic relation, from experiments using appropriate equipment and technology, or from secondary sources; graph the data and draw a curve of best fit, if appropriate, with or without the use of technology</p>			<p>Represented data collected from scenario with a graph correctly</p>	<p>Represented data collected from scenario with a graph with some mistakes</p>	<p>Represented data collected from scenario incorrectly</p> <p>Or did not represent scenario at all</p>

APPLICATION [10 Marks] (Written Part - INDEPENDENT)

- 2 Word Problems given at random out of 6 types
- Types: Projectile, Number, Geometry, Border, Revenue, archway/bridge

- 5 marks per person, No guiding checklist provided

THINKING [10 Marks]

This part is done on the presentation days. Your teacher will mark strictly by probing your understanding

	LEVEL 4 [4 marks]	LEVEL 3 [3 marks]	LEVEL 2 [2 marks]	LEVEL 1 [1 mark]	LEVEL R [0 mark]
Reasoning and Proving					
Making comparisons, conclusions and justifications connected to the data	Justifies with a direct connection to the model presented, with evidence of reflection	Justifies with a direct connection to the model presented	Justifies with some connection to the model presented	Justifies with a limited connection to the model presented .	Little to no connection to the model presented .
Connecting					
Relate mathematical ideas to situations drawn from other contexts	Makes strong connections	Makes appropriate connections	Makes simple connections	Makes weak connections	Makes no connections
Selecting Tools and Computational Strategies					
Select and use appropriate tools and strategies to model the data, or solve a problem			Selects and applies accurately, and logically sequenced	Selects and applies with minor errors, omissions or mis-sequencing	Selects and applies with major errors, omissions, or mis-sequencing

COMMUNICATION [10 Marks]

This part is done on the presentation days. Your teacher will mark strictly by probing your understanding

	LEVEL 4 [4 marks]	LEVEL 3 [3 marks]	LEVEL 2 [2 marks]	LEVEL 1 [1 mark]	LEVEL R [0 mark]
Communication					
Communicates a correct solution to the above question with...	...excellent clarity and precise use of math terminology.	...good clarity and good use of math terminology.	...some clarity and with some use of math terminology.	...limited clarity and with limited use of math terminology.	...little or no clarity with little to no terminology.
Student solutions on all questions are consistently...	...very well organized with excellent use of notation / conventions	...well organized with good use of notation / conventions	...organized with some use of notation / conventions	...somewhat organized with limited use of notation / conventions	...unorganized, use limited to no notation / conventions or blank
Poster / Visuals accompanying conversation/ presentation				Has visual or poster	No visuals or poster
Representing					
Uses algebraic model to explain data/scenario				Connection made between algebraic model and scenario to	No connections made between algebraic model and scenario to

				interpret and extrapolate	interpret and extrapolate
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Checklist for the written part of “Real World Parabolems”

Digital Modelling

- ☐ Photo of real-life scenario
- ☐ Desmos: quadratic equation in vertex form that models the real-life scenario
 - ☐ Vertex and the y-intercept are not the same point

Graph sketched by hand

- ☐ Graphed by hand the quadratic equation found with desmos
 - ☐ X-axis, y-axis titles
 - ☐ X-axis, y-axis scales and units
 - ☐ labeled with all key features of the parabola
- ☐ Wrote transformations of vertex form
- ☐ 10 values in table of values

Full Calculations using algebra

- ☐ Using the graph: found vertex form
- ☐ Using the graph: found factored form
- ☐ Using vertex/factored form: found standard form
 - ☐ Complete the Square (standard to vertex form)
 - ☐ Quadratic Formula (standard to factored form)

Real-life significance

- ☐ Key features of parabola
- ☐ Numbers in the quadratic equation

Two Word problems (individual - Application Section)

- | | |
|--|---|
| <input type="checkbox"/> Scenario modeled by a quadratic equation | <input type="checkbox"/> Scenario modeled by a quadratic equation |
| <input type="checkbox"/> Completed calculations | <input type="checkbox"/> Completed calculations |
| <input type="checkbox"/> Final statement | <input type="checkbox"/> Final statement |
| <input type="checkbox"/> <i>Completed 2 assigned word problems (Person 1)</i> | |
| <input type="checkbox"/> <i>Completed 2 assigned word problems (Person 2, if in group)</i> | |
| <input type="checkbox"/> <i>Completed 2 assigned word problems (Person 3, if in group)</i> | |

Deeper Investigation (Thinking Section)

- ☐ Created an application question that can be solved by your quadratic equation
- ☐ Completed full solutions to your application question