Objective—Determine how initial velocity and angle of projection affect the projection path of an object.

Due Date—All of the math worked out will be due December 3rd. This will count as a homework grade. The final write-up is due on December 13th (1st and 5th period) and December 14th (2nd and 4th period). This will count as a *test* grade. The assignment should be **printed and ready to turn in at the beginning of class!!** You should also submit the write-up on turnitin.com by the final due date. You will receive a 50 for any work turned in late. If you are absent, it is due the next day you return to school whether or not you have my class that day!

Criterion— The actual math will be graded by criterion A (Knowledge and Understanding). The write up for this assignment will be graded against criterion C (communication) and criterion D (reflection). They are attached for your review.

Assignment—Go to http://phet.colorado.edu/sims/projectile-motion/projectile-motion_en.html. Move the target so that it lines up **on** the horizontal axis at the specified distance assigned to you. Adjust both the **initial speed** and the **angle** in order to hit the **center** of target. Do NOT adjust the mass, diameter, or air resistance. Once you have hit the target, copy the range (here the site is using range to describe the horizontal distance traveled. In your paper be sure to refer to this as horizontal distance.), height, and time stats given for the scoring shot. You will use these stats to make three different functions. Also take a screenshot of your winning shot for use in your paper.

Function 1: Time vs. Height
Function 2: Horizontal Distance vs. Height
Function 3: Time vs. Horizontal Distance
Create scatter plots of your data and then use your calculator to come up with the function that ***best*** represents time vs. height, horizontal distance vs. height, and time vs. horizontal distance. (Not all functions will be the same type!) Record each function. Use the graph program on your computer to graph each function. Find the identifying attributes of the graph, in other words the vertices, x and y intercepts, shape, slope, etc. Explain each attribute within the context of the simulation.
Consider the differences between the three functions. Explain why, within the context, the functions are different.

Repeat this process to find a second path, which will still hit your target. In other words, find a different initial speed and angle which still results in a scoring shot. The initial speed **must be at least 5m/s** different from the first scoring shot! Again copy down the stats of this scoring shot and take a screenshot. Use your stats to create three additional functions as before. Again find the identifying attributes of each function (vertices, intercepts, slope, etc.) Consider how the new functions compare to the original! Interpret the meaning within the context.

(All work up to this point will be due Dec 3rd as a homework grade.)

Write-up—You will be turning in between 600 and 900 words typed and double spaced discussing in an organized manner (this means an introduction, body, and conclusion!) your process, what you have discovered through your process, and a reflection on what you learned.
*Your write-up should include all data collected, functions created, graphs and screenshots of your scoring shots!

Questions that should be considered—This questions are a spring board only for your reflection. You do not need to answer each question. **The answers should naturally come up within the context of your paper; you do not need to force an answer to each question.**

- What affect did changing the initial speed/angle have on the path your object took?
- What method did you use to find an initial speed and angle that worked to hit your target?
- What method did you use to find a second initial speed and angle that worked?

- What types of functions did you create?
- How can the different types of functions be explained within the context of the problem?
- What do the interesting attributes of each graph mean within the context of the problem? (i.e. the vertex, the x and y intercepts, the slope, etc.)
- What limitations do your functions have? What could make them more accurate?
- How should the domain and range be limited for each function to fit the context of the problem?
- How do the second set of functions compare to the first? What are differences and similarities? How can these be explained? Could the differences/similarities have been expected? Why or why not?

Criterion A: knowledge and understanding

Maximum 8

This criterion examines to what extent the student is able to:

• know and demonstrate understanding of the concepts from the five branches of mathematics (number, algebra, geometry and trigonometry, statistics and probability, and discrete mathematics)

• use appropriate mathematical concepts and skills to solve problems in both familiar and unfamiliar situations, including those in real-life contexts

• select and apply general rules correctly to make deductions and solve problems, including those in real-life contexts.

Level	Descriptor	Task Specific—Business Assessment
0	The student does not reach a standard described by any of the descriptors given below	
1 – 2	The student **generally** makes appropriate deductions when solving **simple** problems in **familiar** contexts.	The student correctly identifies at least one path which hits the target and attempts to create functions with the given data. The student may not pick the most appropriate type of function in each case.
3 – 4	The student **generally** makes appropriate deductions when solving **more complex** problems in **familiar** contexts.	The student correctly identifies two paths which hit the target and *correctly* creates at least four functions with the resulting data. The student attempts to identify some of the attributes of each function, with some mistakes.
5 – 6	The student **generally** makes appropriate deductions when solving **challenging** problems in a **variety** of **familiar** contexts.	The student is able to identify two different paths which hit the target and correctly creates six functions with the resulting data. The student identifies most of the attributes of all the functions created. Some attributes may be left out or incorrect.
7 – 8	The student **consistently** makes appropriate deductions when solving **challenging** problems in a **variety** of contexts including **unfamiliar situations**.	The student is able to identify two different paths which hit the target and correctly creates six functions with the resulting data. The student correctly identifies attributes of all functions created.

Notes

• **Unfamiliar situation**: challenging questions or instructions set in a new context in which students are required to apply knowledge and/or skills they have been taught.

• **Deduction**: reasoning from the general to the particular/specific to reach a conclusion from the information given.

• **Context**: the situation and the parameters given to a problem.

Criterion C: communication in mathematics

Maximum 6

Students are expected to use mathematical language appropriately when communicating mathematical ideas, reasoning and findings—both orally and in writing.

This criterion examines to what extent the student is able to:
• use appropriate mathematical language in both oral and written explanations

• use different forms of mathematical representation

• communicate a complete and coherent mathematical line of reasoning using different forms of representation when investigating problems.

Students are encouraged to choose and use ICT tools as appropriate and, where available, to enhance communication of their mathematical ideas. Some of the possible ICT tools used in mathematics include spreadsheets, graph plotter software, dynamic geometry software, computer algebra systems, mathematics content-specific software, graphic display calculators (GDC), word processing, desktop publishing, graphic organizers and screenshots.

Achievement level	Descriptor	Task Specific (Projectile Motion)
0	The student does not reach a standard described by any of the descriptors given below	The student does not reach a standard described by any of the descriptors given below
1 – 2	The student shows **basic use** of mathematical language and/or forms of mathematical representation. The lines of reasoning are **difficult to follow**.	The student explains their process, but in an unorganized manner which is hard to follow. The student only minimally or unsuccessfully uses graphs, tables, screenshots, or functions.
3 – 4	The student shows **sufficient** use of mathematical language **and** forms of mathematical representation. The lines of reasoning are **clear** though **not always logical** or **complete**. The student moves between different forms of representation **with some success**.	The student explains process in an organized manner which is mostly easy to read and understand. The student uses at least 2 forms of representation (graphs, tables, screenshots, and functions) but not always successfully.
5 – 6	The student shows **good use** of mathematical language and forms of mathematical representation. The lines of reasoning are **concise, logical and complete**. The student moves **effectively** between different forms of representation.	The student explains process in an organized manner that is easy to read and understand. The student uses graphs (gives title and labels axises), tables (gives title and labels rows or columns), screenshots (gives title), and functions (defines variables) properly within the text of their paper.

Notes

• **Mathematical language**: the use of notation, symbols, terminology and verbal explanations.

• **Forms of mathematical representation**: refers to formulae, diagrams, tables, charts, graphs and models used to represent mathematical information.

Criterion D: reflection in mathematics

Maximum 6

MYP mathematics encourages students to reflect upon their findings and problem-solving processes.

This criterion examines to what extent the student is able to:

- explain whether his or her results make sense in the context of the problem
- explain the importance of his or her findings in connection to real life where appropriate
- justify the degree of accuracy of his or her results where appropriate
- suggest improvements to the method when necessary.

Achievement level	Descriptor	Task Specific (Projectile Motion)
0	The student does not reach a standard described by any of the descriptors given below	The student does not reach a standard described by any of the descriptors given below
1 – 2	The student **attempts to explain** whether his or her results make sense in the context of the problem. The student **attempts to describe** the importance of his or her findings in connection to real life where appropriate.	The student attempts to discuss and justify methods used. The student attempts to discuss meaning of the functions within context of the problem.
3 – 4	The student **correctly but briefly explains** whether his or her results make sense in the context of the problem. The student **describes the importance** of his or her findings in connection to real life where appropriate. The student **attempts to justify** the degree of accuracy of his or her results where appropriate.	The student only briefly discusses and justifies the methods used. The student minimally discusses the meaning of the functions within the context of the problem and is mostly correct in their explanation. The student may provide minimal suggestions for improvement.
5 – 6	The student **critically explains** whether his or her results make sense in the context of the problem. The student provides a **detailed explanation** of the importance of his or her findings in connection to real life where appropriate. The student **justifies** the degree of accuracy of his or her results where appropriate. The student suggests improvements to his or her method where appropriate.	The student justifies methods used and explains where methods may have been flawed and suggests improvements. The student correctly discusses the meaning of the functions within the context of the problem. The student also justifies the accuracy and any limitations in the context of real life for the functions created.

Notes

- **Explain**: give a detailed account including reasons or causes.
- **Describe**: give a detailed account.