Name of Project: Investigating functions and variation using simple (water) bottle rockets			**Duration: 3 weeks**	
Subject/Course: Mathematics – Algebra 1		**Teacher(s):** Caroline Torres	**Grade Level: HS**	
Other subject areas to be included, if any: Computer science, Science, Language Arts, Social Studies				

Significant Content (CCSS and/or others)	**CCSS - Mathematics** Domain: Patterns, Algebra and Functions Concept 1: Functions and Relationships – Describe and model functions and their relationships **Engineering, Technology, & Applications of Science** Engineering Design: Using knowledge of the technology, students should be able to correlate how widespread adoption of technology affects society and the environment, especially in regards to changing climate.			
21st Century Competencies (to be taught and assessed) augment list with details	**Collaboration** • Encourages team members to share ideas on data interpretation, design, exploration and testing process. • Takes responsibility for the quality and timeliness of his/her own work; uses feedback; stays on-task during group work		**Creativity and Innovation** • Use of "Rule of Four" – student can represent understanding of task symbolically, numerically, graph/tables, sentential	
	Communication • Clear use of words to describe how rockets have evolved in design • Clear use of words and drawings to convey 2 possible rocket designs		Other:	
	Critical Thinking • Students can demonstrate relationship between rocket design with respect to time, consideration of materials use in rocket design, and how design (exterior) can affect motion of the rocket. • Students can demonstrate an understanding that satellites are propelled into space – rocket carries satellite, satellite is an instrument to collect data to make inferences and/or conclusions			

Project Summary / SCENARIO **/ TASK** (include student role, issue, problem or challenge, action taken, and purpose/beneficiary)	Why launch rockets or satellites? [PBL topic with the essential concept as it relates to investigating functions and variation using simple water bottle rockets] Global warming and climate change are terms for the observed century-scale rise in the average temperature of the Earth's climate system and its related effects. Ocean warming and extreme weather events are two (of many) that scientific evidence shows being greatly affected by global warming. Warming is expected to be greatest in the Arctic, with the continuing retreat of glaciers, permafrost and sea ice. Other likely changes include more frequent extreme weather events including heat waves, droughts, heavy rainfall, and heavy snowfall; ocean acidification; and species extinctions due to shifting temperature regimes In addition to ocean warming, other effects significant to humans include, but are not limited to, the abandonment of populated areas due to flooding. **Problem** What is impacting climate change more significantly – interglacial periods or mankind? **Engineering Tasks** • **(Role)** You are a leading Engineering Geologist working with the University of Arizona • **(Situation)** You have been retained by NASA to determine whether the increase in ocean temperatures and extreme weather events are the result of interglacial periods or man-made. • **(Goal)** It is you job to launch a satellite into space, as well as using what you have learned as an Earth scientist to in order to gather facts and obtain evidence by studying the earth and its (terrain) changes over time. The engineering team that you will be collaborating with will be a geochemist, a geologist, a hydrologist, a computer engineer, and a project manager. • **(Audience)** The Engineering Geologist with work with his/her engineering team in order to collect and organize the data from the satellite images, and from the ground, to present findings to the Environmental Protection Agency (EPA) in one month. • **(Product/performance/purpose)** At the presentation, your team will need to: (1) present facts as gathered using satellite imagery and being on the ground, to answer the question as to what factors lead to global warming, (2) what steps, if any, can be taken to mitigate the climate change process, (3) Create a presentation and materials that will educate the general public, as well as the EPA, so that they can better understand what is actually happening to our planet.
Driving Question /s (essential questions)	• How do we mathematically model a rocket or satellite launch sequence? • How do we know if the ice caps are melting? • Should we continue to explore space? Why • How do we know what a function looks like for a given situation?

Entry Event "Hook"	Engineering Manager (teacher) will launch four similarly designed rockets where volume of water, air pressure, launch angle, overall design of rocket affected how far, high, and close to placed targets rocket landed. (Engineering) Students will be asked by Engineering Manager to inspect rockets to be launch, make observation and predictions (based on observations). **Prizes can be given…math prizes!	
Products	Individual: *Each student engineer will have an assigned role and specific responsibility mapped to the role. Roles are:* • Project Lead (logistics) • Lead Researcher • Prototype developer • Test engineer • Data analyst • Chart/graph creator or design illustrator • Design or video director	Specific content and competencies to be assessed:
	Team: Engineering Team will present academic posters to a panel STEM experts, local businesses or service clubs. Team will respond to the audience's questions. The posters should include items such as data (e.g., charts, tables and graphs), photographs, drawings, other ideas, and any necessary written explanations which help to explain their final design's features and quality.	Specific content and competencies to be assessed: Mathematics • Number Quantities: Reason quantitatively and use units to solve problems • Patterns, Algebra and Functions ➢ Concept 1: Functions and Relationships – Describe and model functions and their relationships Educational Technology Standards • Strand 2: Communication and Collaboration ➢ Concept 2: Digital Solutions Contribute to project teams to produce original works or solve problems. ➢ Concept 3: Global Connections Create cultural understanding and global awareness by interacting with learners of other cultures

Public Audience (Experts, audiences, or product users students will engage with during/at end of project)	• Students will collaborate with engineering students from University, or • Students will collaborate with Raytheon Engineer (volunteer) • Students will collaborate with their engineering teams during the Design, explore, test Engineering Process • Student Engineering Team will present to local business or service clubs.

Resources Needed	On-site people, facilities: • Computer laboratory, single work stations • Large desks, large open area for student engineering groups to collaborate and prepare drawing • Large field in order to conduct safe water bottle rocket launch [for Entry Point}
	Equipment: • 25 computer stations that have internet connection • 25 computer stations that have the memory to run simulators (for subsequent parts of this unit – this lesson is an introduction) • 3 Bottle Rockets for Entry Point/Hook (Teacher) • Air compressor, extension cord, protractor [for Entry Point] • 1-2 gallons of water [for Entry Point] • Tent spikes to secure rocket launcher • Tape measure (large) • Funnel • Safety goggles
	Materials: Post-It (Poster) Notes scissors Colored pencils (30) 14 inch PVC pipe Markers (Sharpies or other pens with dense ink) 30 1-litre plastic bottles Poster cardboard Duct Tape Thin, flexible plastic 3-ring notebooks (for fins or canards) Blasa wood
	Community Resources: NA

Reflection Methods (Individual, Team, and/or Whole Class)	Journal/Learning Log • Team Engineering log/Project planning matrix (see attached) • What is your answer to the Driving Question now? How did your thinking about the DQ change during the project? • What skills did you learn in the project that relate to a particular subject in school? • How did you get along with engineering team members? • What did you spend most of your time on? • What are things that didn't work?		Focus Group	
	Whole-Class Discussion • Small (engineering team) group discussion, followed by whole class discussion		Fishbowl Discussion	
	Survey		Other Groups share things that didn't work – what were their strategies to move towards resolving problem	

(Teacher) Notes:

OBSERVING THE EARTH – why make observations?

- Multiple lines of scientific evidence show that the climate system is warming
- Earth observation satellites have become more important in recent years. They can be used to find mineral deposits, fresh water supplies, and even sources of pollution.
- Satellites can also monitor how ecosystems respond to change.
- In recent years, a great deal of satellite and computer power has been used to monitor global warming

PROJECT DESIGN: STUDENT LEARNING GUIDE

Project: Investigating functions and variation using simple (water) bottle rockets

Driving Question: How do we mathematically model a rocket or satellite launch sequence?

Final Product(s) Presentations, Performances, Products and/or Services	Learning Outcomes/Targets content & 21st century competencies needed by students to successfully complete products Functions and Relationships – Students will describe and model functions and their relationships using: graphical, written/verbal, numeric and/or symbolic representation (Rule of Four).	Checkpoints/Formative Assessments to check for learning and ensure students are on track	Instructional Strategies for All Learners provided by teacher, other staff, experts; includes scaffolds, materials, lessons aligned to learning outcomes and formative assessments
(individual **and** team)	Student(s) develop ability to understand variation by completing tables from rocket simulations Student(s) develop expertise through the Engineering Design Process, EDP – Explore, Design, Test of water bottle rockets	Students will use data and observations from simulations and their research on bottle rockets to document/record process of design, test and explore - EDP Mini-Notebook *(see attachments)*	Using Phet or other similar types of simulators, students explore variation (of air pressure, volume of water, launch angle, center of gravity)
	Student(s) understand overall context of variation in the water bottle rocket EDP and will convey level of acquisition verbally, as a presentation.	Students will record (any) rocket design changes in EDP Mini-Notebook. Changes in the rocket design will have recorded reasons and outcomes of design change.	Using Phet or other similar types of simulators, students explore variation (of air pressure, maximum height, volume of water, launch angle, center of gravity) and document simulator observations and data on data table provided *(see attachments)*
	Student(s) understand overall context of variation in the water bottle rocket EDP and will convey level of acquisition verbally, as a poster that contains drawings, tables, observations, data and conclusions.	**Teacher will do "Exit Ticket" as FA** • Why are the plots/graphs on simulator a parabola and not linear (or a line)? • Why did bottle rocket not travel very far when you put little, or no water in the rocket? • What determines how far a bottle rocket travels?	Students will use materials to design, test and build water bottle rocket. Students will test rocket, make observations and record observations in EDP Mini-notebook *(see attachments)*