Unit 1: Engineering and STEM

CONTENT AREA: STEM	**GRADES:** 8	**UNIT:** 1 of 2
Pacing: September to January (1 Semester)		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. ● Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1) **Developing and Using Models** Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing	**ETS1.A: Defining and Delimiting Engineering Problems** ● The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** ● A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) ● There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) ● Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) ● Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** ● Although one design may not perform the best across all tests, identifying the	**Influence of Science, Engineering, and Technology on Society and the Natural World** ● All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1) ● The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world. ● Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)	characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) ● The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MSETS1-4)	

Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include:
- Physical Science: MS-PS3-3

Connections to MS-ETS1.B: Developing Possible Solutions Problems include:
- Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5

Connections to MS-ETS1.C: Optimizing the Design Solution include:
- Physical Science: MS-PS1-6

Articulation of DCIs across grade-bands: 3-5.ETS1.A (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3); 3-5.ETS1.B (MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4); 3-5.ETS1.C (MS-ETS1-1), (MSETS1-2), (MS-ETS1-3), (MS-ETS1-4); HS.ETS1.A (MS-ETS1-1), (MS-ETS1-2); HS.ETS1.B (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3), (MS-ETS1-4); HS.ETS1.C (MS-ETS1-3), (MS-ETS1-4)

Common Core State Standards Connections:
ELA/Literacy –
- RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)
- RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ETS1-3)
- RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ETS1-2),(MS-ETS1-3)

- WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2)
- WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ETS1-1)
- WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-ETS1-2)
- SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ETS1-4)

Mathematics –

- MP.2 Reason abstractly and quantitatively. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4)
- 7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)
- 7.SP Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. (MS-ETS1-4)

Performance Expectations:

- **MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

- **MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

- **MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

- **MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Evidence Statement(s): See Anticipatory Set(s)

Essential Question: How does engineering shape our lives? How is engineering incorporated into our lives? How/in what new way will engineering be used next?

21st Century Skills and Career Ready Practices: CRP2, CRP4, CRP5, CRP6, CRP7, CRP8 ,CRP11,CRP12

Technology: 8.1.8.A.1, 8.1.8.A.2, 8.1.8.A.3, 8.1.8.A.4, 8.1.8.A.5, 8.1.8.D.2, 8.1.8.D.3, 8.1.8.D.4, 8.1.8.D.5, 8.2.8.A.2, 8.2.8.B.1

Technical Terms (Suggested)	Core Instructional Materials	Assessment Statement
STEM 21st Century Skills Engineering Buoyancy Density Hydrodynamics (Fluid Dynamics) Catapult Accuracy Power Simple Machines (and types of) Law of Motion Inversely Proportional Unbalanced / Balanced Force / Net Force Velocity Action / Reaction Propulsion Air Pressure Potential / Kinetic Energy Tension Bridges (and all associated terms) Upcycle Air Resistance / Friction Gravity on falling objects (terminal velocity) Solar Power Convection, conduction, radiation Heat absorption Circuit (and types of) ** All terms should be taught in context rather than in isolation. These terms should be addressed after conceptual understanding.**	Technology: Chromebooks Smart Board Google Apps for Education (Docs, Sheets, Slides, etc.) VR Viewers Classroom Materials: Notebooks Pens/Pencils Colored Pencils Aluminum foil Cardboard Masking Tape Scissors Popsicle sticks Coke cans Rubber bands Plastic spoons Bottle caps Straws Balloons Rulers Cardboard tubes Duct tape Mouse traps Gears Springs String (all types) Bridge kits Balsa wood Elmer's wood glue Exacto knives Blueprint paper Cotton balls Foam	Students who understand the concepts are able to: ● Think creatively and critically ● Collaborate with peers ● Understand the parts of the system(s) being discussed ● Use newfound skills to solve real world problems.

	Plastic bags Paper bags Newspaper Clear plastic wrap Black paint Snap circuit kits Batteries Electrical cords	

Modifications

English Language Learners	Special Education	At Risk	Gifted & Talented
Scaffolding Word walls Sentence/paragraph frames Bilingual dictionaries/translation Think alouds Read alouds Highlight key vocabulary Annotation guides Think-pair-share Visual aides Modeling Cognates	Word walls Visual aides Graphic organizers Multimedia Leveled readers Assistive technology Notes/summaries Extended time Answer masking Answer eliminator Highlighter Color contrast	Teacher tutoring Peer tutoring Study guides Graphic organizers Extended time Parent communication Modified assignments Counseling	Curriculum compacting Challenge assignments Enrichment activities Tiered activities Independent research/inquiry Collaborative teamwork Higher level questioning Critical/Analytical thinking tasks Self-directed activities

5E Model

Performance Expectation: MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Engage: Anticipatory Set	What is STEM? To introduce the topic I will show the students the following videos and then discuss with them the expectations of this class and how it will be run differently than normal classes (groups, building, brainstorming, etc). What is STEM? https://www.youtube.com/watch?v=5GWhwUN9iaY

	Why is STEM important? https://www.youtube.com/watch?v=fbtthVVDgek What most schools don't teach: https://siliconstemacademy.com/about-silicon-stem-programs/blog/why-are-stem-classes-so-important
Exploration: Student Inquiry	What is the engineering portion of STEM? I will have the students break up into groups and research the different types/examples of engineering I want them to look up. They will need to keep track of sources and use proper citations. Afterwards they will present their findings to the class before we begin our first project.
Explanation: Concepts & Practices	In these lessons: Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): ETS1.A: Defining and Delimiting Engineering Problems, ETS1.B: Developing Possible Solutions and ETS1.C: Optimizing the Design Solution.
Elaboration: Extension Activity	Have students complete additional activities from the following unit: Foil and Cardboard Boat Challenges https://www.scientificamerican.com/article/bring-science-home-shipping-science/ https://www.instructables.com/id/Penny-Barge-Activity/ http://pbskids.org/designsquad/build/watercraft/ Build a Catapult http://www.vivifystem.com/blog/2014/12/23/catapult-challenge
Evaluation: Assessment	Assessment Tasks The students will work in groups to help write a formal lab report about one of the two elaboration activities from this topic. Students will also have at least two quizzes on the material covered and scientific principles used during each activity.

5E Model	
<u>Performance Expectation</u>: MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	
Engage: Anticipatory Set	Action, Reaction! (Newton's 3rd Law). What are Newton's Laws of Motion? I will demonstrate Newton's 3 Laws to the Class and have them take guided notes. After, they will watch the following video on just his third law. Have students watch and list all action/reaction situations from the video: https://www.youtube.com/watch?v=EgqcGrB3re8 Demonstration of Newton's 3rd Law on the ISS: https://www.nasa.gov/stemonstrations-newtons-third-law-rocket-races.html
Exploration: Student Inquiry	1. What is propulsion? How does it work? Where in our world/society is it used? What is propulsion in swimming? https://www.real-world-physics-problems.com/physics-of-swimming.html Students will research propulsion in water and air and give real life examples. 2. What are simple machines? What have we been able to accomplish throughout history with the use of simple machines?
Explanation: Concepts & Practices	<u>In these lessons:</u> Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. <u>Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas):</u> ETS1.A: Defining and Delimiting Engineering Problems, ETS1.B: Developing Possible Solutions and ETS1.C: Optimizing the Design Solution.
	<u>Have students complete additional activities from the following unit</u>:

Elaboration: Extension Activity	Balloon Race Cars https://www.stevespanglerscience.com/lab/experiments/balloon-powered-race-car/ https://www.teacherspayteachers.com/Product/Balloon-Car-STEM-Challenge-Engineering-Design-Process-2399369 Balloon Rocket https://www.stem.org.uk/resources/elibrary/resource/336420/balloon-rocket Mousetrap Race Cars https://sites.google.com/a/littleblue.usu.edu/stem/topics/mouse-trap-car Video: https://www.youtube.com/watch?v=ynNw6RtEEGk
Evaluation: Assessment	Assessment Tasks The students will write a formal lab report about one of the three elaboration activities from this topic. Students will also have at least two quizzes on the material covered and scientific principles used during each activity.

5E Model	
Performance Expectation: MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	
Engage: Anticipatory Set	Bridges: An Engineering Feat - Students will research one of the listed bridges I have available and create a 5 slides presentation to describe its features to the class.
Exploration: Student Inquiry	1. Students will watch a short video about what does into designing a bridge and the types of bridges that are built. https://www.youtube.com/watch?v=SbCVRr5eANA Students will explore the different types of bridges and look into a design that will suit our classes bridge challenge. They will have to submit a formal sketch and explanation of the bridges structures before final approval. Various Bridge Types and How They Work: https://www.youtube.com/watch?v=52ECMAIWOxA

	https://www.youtube.com/watch?v=xqKAmRoNT6U 2. UpCycling Cardboard into STEM Projects! Using cardboard and leftover class materials students will research, design and create Roller Coasters, Robotic Hands, Cardboard VR Viewers and more!
Explanation: Concepts & Practices	In these lessons: Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): ETS1.A: Defining and Delimiting Engineering Problems, ETS1.B: Developing Possible Solutions and ETS1.C: Optimizing the Design Solution.
Elaboration: Extension Activity	Have students complete additional activities from the following unit: Build a Bridge https://www.instructables.com/id/Balsa-Wood-Bridge/ https://www.usbr.gov/lc/region/programs/bridgebuilding/Presentation.pdf Kid Project Example: https://www.youtube.com/watch?v=fowpjyBIxY4 Cardboard Construction Rollercoaster: https://www.teachengineering.org/activities/view/duk_rollercoaster_music_act http://stem.hcoe.net/2017/03/stem-roller-coaster-challenge/ Robotic Hand https://www.instructables.com/id/Robotic-Hand-Science-Project/ https://www.scientificamerican.com/article/build-an-artificial-hand/ Cardboard VR Viewers https://www.teacherspayteachers.com/Browse/Search:google%20cardboard

	https://www.computerworld.com/article/2881175/emerging-technology/diy-build-your-own-google-cardboard-vr-viewer.html
Evaluation: Assessment	Assessment Tasks The students will write a formal lab report about two of the four elaboration activities from this topic. Students will also have at least three quizzes on the material covered and scientific principles used during each activity.

5E Model	
Performance Expectation: MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	
Engage: Anticipatory Set	The History of Safety. I would like to explore the topic of safety and how it has changed over the years (seatbelt, baby regulations, etc). Students will watch the following video as an example before breaking out into groups and finding their own to post and share.
Exploration: Student Inquiry	1. Design Challenge: The Egg Drop! - Students will need to research and take notes to have an understanding of parachutes and reducing air resistance on a falling object. 2. The class will work in groups to research one type of alternative energy source. They will create a one page informative handout for their classmates on the type chosen, which will be added into their notes. 3. Students will work in small groups to take apart and put together a small object of their choosing. They may use the internet to find any information that will assist them (old user manual PDF, directions on how to use tools, etc.)
Explanation: Concepts & Practices	In these lessons: Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): ETS1.A: Defining and Delimiting Engineering Problems, ETS1.B: Developing Possible Solutions and ETS1.C: Optimizing the Design Solution.
	Have students complete additional activities from the following unit:

Elaboration: Extension Activity	Egg Parachute https://stem.neu.edu/programs/ayp/fieldtrips/activities/eggdrop/ https://www.teachengineering.org/activities/view/ucd_eggdrop_activity1 Solar Cooker: How can we harness solar energy? Is it affordable? Economical? What is occurring to make our ovens work? https://www.homesciencetools.com/article/how-to-build-a-solar-oven-project/ https://www.shareitscience.com/2016/07/solar-oven-STEM-engineering-design-challenge.html Snap Circuits https://stem.neu.edu/programs/ayp/fieldtrips/activities/snapcircuits/ https://www.pinterest.com/mollyla/snap-circuits-stemmakerspace/
Evaluation: Assessment	<u>Assessment Tasks</u> The students will write a formal lab report about two of the three elaboration activities from this topic. Students will also have at least two quizzes on the material covered and scientific principles used during each activity.