Unit 1: Engineering Design Process (Engineering Design)

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Title Section

Department of Curriculum and Instruction

Belleville Public Schools

Curriculum Guide

Science: Grade 2

Unit 1: Engineering Design Process

Belleville Board of Education

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Unit Overview

In this unit, children will...

- ask questions, make observations, and gather information to define a problem
- use a design process to solve a problem
- compare the strengths and weaknesses of multiple design solutions

Enduring Understanding

Lesson 1

- **Enduring Understanding:** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- **Essential Question:** What is a design process?

Lesson 2

- **Enduring Understanding:** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
- **Essential Question:** How can we compare design solutions?

Essential Questions

Unit 1 Essential Questions

- What is the design process?

- What are the steps to the design process?
- What is an engineer and what is their role in the design process?
- How can we compare design solutions?
- How do we use the design process every day?

Exit Skills

By the end of Grade 2, Science Unit 1, the students should be able to:

- identify the steps to a design process
- describe the role of an engineer
- determine how to use a design process in every day life
- make a comparison of the strengths and weaknesses of a design solution

New Jersey Student Learning Standards (NJSLS-S) & NGSS

SEP - Asking Questions and Defining Problems

SEP - Developing and Using Models

SEP - Analyzing and Interpreting Data

DCI - Defining and Delimiting Engineering Problems

DCI - Developing Possible Solutions

DCI - Optimizing the Design Solution

CCC - Structure and Function

NextGen Science Standards

2-ESS2-1.6.1	Compare multiple solutions to a problem.
2-ESS2-1.ETS1.C.1	Because there is always more than one possible solution to a problem, it is useful to

	compare and test designs.
2-LS2-2.6.1	students observe the shape and stability of structures of natural and designed objects are related to their function(s).
2-LS2-2.ETS1.B	Developing Possible Solutions
2-LS2-2.ETS1.B.1	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.

Interdisciplinary Connections

Do the Math! pp. 14, 23

LA.RI.2.1	Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.
MA.2.MD.D.10	Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put together, take-apart, and compare problems using information presented in a bar graph.
LA.W.2.6	With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers.
LA.SL.2.5	Use multimedia; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings.

Learning Objectives

Unit 1 Learning Objectives

- SWBAT: ask questions, make observations, and gather information to define a problem to be solved through a design process

- SWBAT: analyze and compare multiple design solutions

Action Verbs: Below are examples of action verbs associated with each level of the Revised Bloom's Taxonomy.

Remember	Understand	Apply	Analyze	Evaluate	Create
Choose	Classify	Choose	Categorize	Appraise	Combine
Describe	Defend	Dramatize	Classify	Judge	Compose
Define	Demonstrate	Explain	Compare	Criticize	Construct
Label	Distinguish	Generalize	Differentiate	Defend	Design
List	Explain	Judge	Distinguish	Compare	Develop

Locate
Match
Memorize
Name
Omit
Recite
Select
State
Count
Draw
Outline
Point
Quote
Recall
Recognize
Repeat
Reproduce

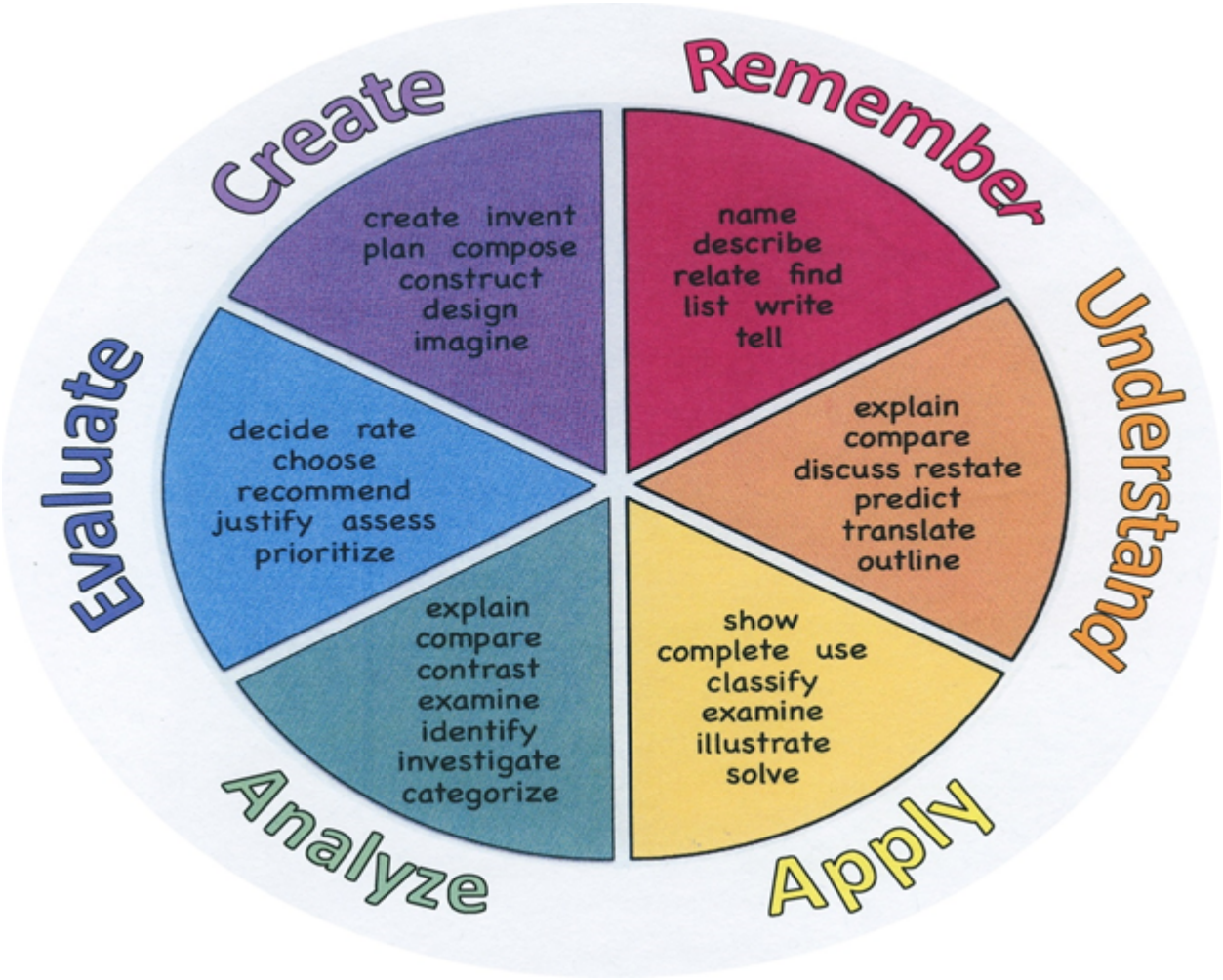
Express
Extend
Give Examples
Illustrate
Indicate
Interrelate
Interpret
Infer
Match
Paraphrase
Represent
Restate
Rewrite
Select
Show
Summarize
Tell
Translate
Associate
Compute
Convert
Discuss
Estimate
Extrapolate
Generalize
Predict

Organize
Paint
Prepare
Produce
Select
Show
Sketch
Solve
Use
Add
Calculate
Change
Classify
Complete
Compute
Discover
Divide
Examine
Graph
Interpolate
Manipulate
Modify
Operate
Subtract

Identify
Infer
Point out
Select
Subdivide
Survey
Arrange
Breakdown
Combine
Detect
Diagram
Discriminate
Illustrate
Outline
Point out
Separate

Assess
Conclude
Contrast
Critique
Determine
Grade
Justify
Measure
Rank
Rate
Support
Test

Formulate
Hypothesize
Invent
Make
Originate
Organize
Plan
Produce
Role Play
Drive
Devise
Generate
Integrate
Prescribe
Propose
Reconstruct
Revise
Rewrite
Transform



Suggested Activities & Best Practices

- Vocabulary Game - Guess the word
- Unit Project - Runaway Wagon
- Student collaborations to build on prior knowledge
- Ramps Activity in text
- Engineer it activity- make your lunchbox better
- Analyze a paper bridge, then plan, build, and test a new design

Assessment Evidence - Checking for Understanding (CFU)

- Compare & Contrast
- Define

- Describe
- Evaluation rubrics
- Exit Tickets
- Explaining
- HMH End-of-Year Test (Benchmark)
- HMH Mid-Year Test (Benchmark)
- HMH Performance-based Assessment (Alternative)
- Illustration
- Journals
- Learning Center Activities
- Quizzes (Formative)
- Self- assessments
- Teacher Observation Checklist
- Think, Pair, Share
- Think, Write, Pair, Share
- Unit review/Test prep
- Unit tests (Summative)

Primary Resources & Materials

HMH Science Dimensions: Teacher Edition, Student workbooks, online resources

HMH Equipment & Safety Kits

HMH Science Dimensions S&E Leveled Readers

- On Level: How Do Engineers Solve Problems?
- Extra Support: How Do Engineers Solve Problems?
- Enrichment: Ben's Engineering Project

Ancillary Resources

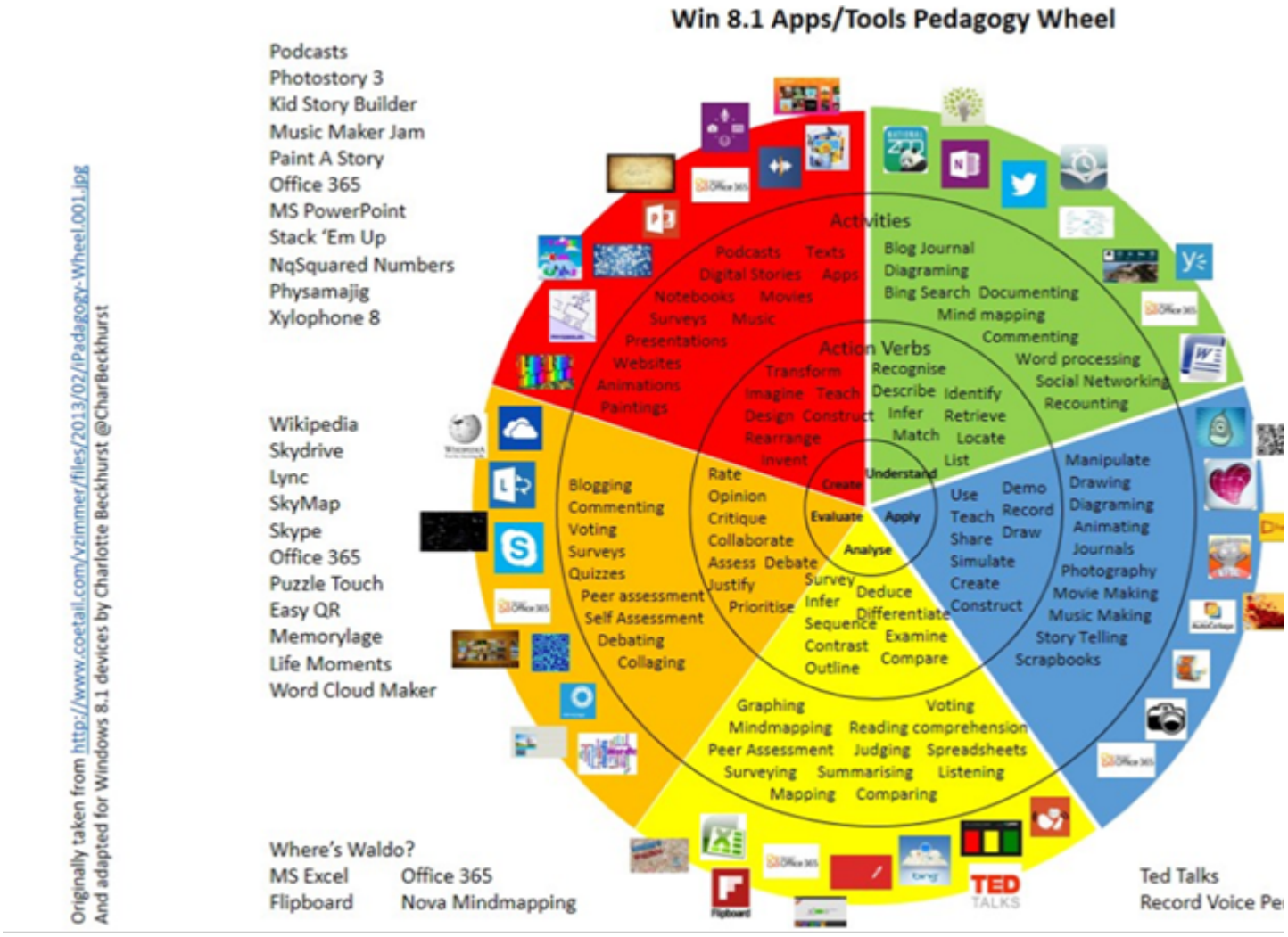
Additional Resources:

- online resources to provide further information to students
- vocabulary cards
- word wall
- posters and charts
- Khan Academy - Engineering Design Process - https://www.khanacademy.org/partner-content/49ers-steam/49ers-gridiron-eng/49ers-innovations-equipment/v/engineering-design-process
- youtube - The Engineering Process - Crash Course Kids - https://www.youtube.com/watch?v=fxJWin195kU
- BetterLesson.com - What Do Engineers Do? - https://betterlesson.com/lesson/620234/what-do-engineers-do-part-1

Technology Infusion

Technology available:

- SMART Technology
- Online Websites (Teachertube, youtube, discovery ed, PBS Kids, Khan Academy, kahoot!)
- Computer access
- Online activities and assessments - HMH
- Google Classroom - post questions for students to answer to check for understanding/assess



Alignment to 21st Century Skills & Technology

Mastery and infusion of 21st Century Skills & Technology and their Alignment to the core content areas is essential to student learning. The core content areas include:

- English Language Arts;
- Mathematics;
- Science and Scientific Inquiry (Next Generation);
- Social Studies, including American History, World History, Geography, Government and Civics, and Economics;
- World languages;
- Technology;
- Visual and Performing Arts.

CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP11	Use technology to enhance productivity.
TECH.8.1.2	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.2.2.C	Design: The design process is a systematic approach to solving problems.
TECH.8.2.2.C.1	Brainstorm ideas on how to solve a problem or build a product.
TECH.8.2.2.C.CS2	The application of engineering design.
TECH.8.2.2.D.3	Identify the strengths and weaknesses in a product or system.

21st Century Skills/Interdisciplinary Themes

- Communication and Collaboration
- Creativity and Innovation
- Critical thinking and Problem Solving
- ICT (Information, Communications and Technology) Literacy
- Information Literacy
- Life and Career Skills
- Media Literacy

CAEP.9.2.4.A.2	Identify various life roles and civic and work - related activities in the school, home, and community.

21st Century Skills

- Civic Literacy
- Environmental Literacy
- Financial, Economic, Business and Entrepreneurial Literacy
- Global Awareness
- Health Literacy

CAEP.9.2.4.A.2	Identify various life roles and civic and work - related activities in the school, home, and community.
CAEP.9.2.4.A.4	Explain why knowledge and skills acquired in the elementary grades lay the foundation for future academic and career success.

Differentiation

Preview vocabulary - use vocab cards with illustrations to preview vocab, then have them match the picture to the vocab word and definition.

Have students work with an assigned partner to come up with an explanation of what an engineer does.

Do a mini-workshop to reteach skills to struggling students, using manipulatives if possible, or have students jigsaw instruction once they have demonstrated understanding.

Differentiations:

- Small group instruction
- Small group assignments
- Extra time to complete assignments
- Pairing oral instruction with visuals
- Repeat directions
- Use manipulatives
- Center-based instruction
- Token economy
- Study guides
- Teacher reads assessments allowed
- Scheduled breaks
- Rephrase written directions
- Multisensory approaches
- Additional time
- Preview vocabulary
- Preview content & concepts
- Story guides
- Behavior management plan
- Highlight text
- Student(s) work with assigned partner
- Visual presentation
- Assistive technology
- Auditory presentations
- Large print edition
- Dictation to scribe
- Small group setting

Hi-Prep Differentiations:

- Alternative formative and summative assessments
- Choice boards
- Games and tournaments

- Group investigations
- Guided Reading
- Independent research and projects
- Interest groups
- Learning contracts
- Leveled rubrics
- Literature circles
- Multiple intelligence options
- Multiple texts
- Personal agendas
- Project-based learning
- Problem-based learning
- Stations/centers
- Think-Tac-Toes
- Tiered activities/assignments
- Tiered products
- Varying organizers for instructions

Lo-Prep Differentiations

- Choice of books or activities
- Cubing activities
- Exploration by interest
- Flexible grouping
- Goal setting with students
- Jigsaw
- Mini workshops to re-teach or extend skills
- Open-ended activities
- Think-Pair-Share
- Reading buddies
- Varied journal prompts
- Varied supplemental materials

Special Education Learning (IEP's & 504's)

- Modified assignment format - When brainstorming ideas for design solutions, provide struggling students with sentence stems/sentence starters to help them focus on the assignment.

- Work with a group of struggling students to get them started and try to help them generate ideas and frame their questions and ideas.

- additional time for skill mastery

- assistive technology
- behavior management plan
- center-based instruction
- check work frequently for understanding
- computer or electronic devices used
- extended time on tests and quizzes
- have student repeat directions to check for understanding
- highlighted text visual presentation
- modified assignment format
- modified test content
- modified test format
- modified test length
- multi-sensory presentation
- multiple test sessions
- preferential seating
- preview of content, concepts, and vocabulary
- printed copy of board work/notes provided
- Provide modifications as dictated in the student's IEP/504 plan
- reduced/shortened reading assignments
- reduced/shortened written assignments
- secure attention before giving instructions/directions
- shortened assignments
- student working with an assigned partner
- teacher initiated weekly assignment sheet
- use open book, study guides, test prototypes

English Language Learning (ELL)

- Have ELL students make their own vocab cards with definitions and illustrations and allow them to use these cards during their assessment.

- Show pictures or videos of engineers at work and have students brainstorm/discuss what an engineer is based on what they have seen in the pictures/videos.

- using videos, illustrations, pictures, and drawings to explain or clarify
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student’s learning
- allowing students to correct errors (looking for understanding)
- allowing the use of note cards or open-book during testing
- decreasing the amount of work presented or required

- having peers take notes or providing a copy of teacher's notes
- modifying tests to reflect selected objectives
- providing study guides
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- reducing the number of answer choices on a multiple choice test
- teaching key aspects of a topic - eliminate nonessential information
- tutoring by peers
- using computer word processing spell check and grammar check features
- using true/false, matching, and fill in the blank tests in lieu of essay tests

At Risk

- If students are expected to answer an extended response question on an assessment, work in a small group with at-risk students to outline how they would go about answering the question and have them work on that question with as much scaffolding as necessary prior to taking the rest of the assessment.

- Show pictures or videos of engineers at work and have students brainstorm/discuss what an engineer is based on what they have seen in the pictures/videos.

- allowing students to correct errors (looking for understanding)
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning
- allowing students to select from given choices
- allowing the use of note cards or open-book during testing
- collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test.
- decreasing the amount of work presented or required
- having peers take notes or providing a copy of the teacher's notes
- marking student's correct and acceptable work, not the mistakes
- modifying tests to reflect selected objectives
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- teaching key aspects of a topic - eliminate nonessential information
- tutoring by peers
- using authentic assessments with real-life problem solving
- using true/false, matching or fill-in the blank tests in lieu of essay tests
- using videos, illustrations, pictures, and drawings to explain or clarify

Talented and Gifted Learning (T&G)

- Have these students evaluate all the solutions proposed by the teams within the class to determine the best solution.

- Have students use the design process and manipulatives to prove their arguments and disprove others

- Have students further investigate the job of an engineer and how they are abl to make the world a better place/how they are able to contribute to society as a whole.

- above grade level placement option for qualified students
- advanced problem-solving
- allow students to work at a faster pace
- cluster grouping
- complete activities aligned with above grade level text using benchmark results
- create a blog or social media page about their unit
- Create a plan to solve an issue presented in the class or in a text
- debate issues with research to support arguments
- flexible skill grouping within a class or across grade level for rigor
- Higher order, critical & creative thinking skills, and discovery
- multi-disciplinary unit
- teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities
- utilize exploratory connections to higher-grade concepts
- Utilize project-based learning for greater depth of knowledge

Sample Lesson

Unit Name: ENGINEERING DESIGN PROCESS

NJSLS: ATTACHED

Interdisciplinary Connection: ELA

Statement of Objective: Students will use a design process to define and solve a problem and construct an argument using evidence to support a claim.

Anticipatory Set/Do Now: ASK: What is the first step in a design process? (Define a problem). Have children pose a question and define a problem with the wagon.

Learning Activity: Students will turn and talk to dicuss the following - how can you stop a wagon from rolling away when you let go of the handle? Review the essential questions to prepare them to work. Students will work collaboratively to brainstorm design solutions to solve the problem of the runaway wagon. Provide a variety of materials, but encourage children to use other materials they find in the classroom.

Student Assessment/CFU's: Challenge students to find and record a solution that would work when the wagon is facing uphill, downhill, and on a level surface.

Materials: wagons/toy wagons, rope or string, blocks and boxes of various sizes, playground balls, heavy objects

21st Century Themes and Skills: Communication and Collaboration, Critical Thinking and Problem Solving

Differentiation/Modifications: have student repeat directions to me to clarify understanding, check work product for understanding

Integration of Technology: Students will record their results in a shared Google sheet and then submit (turn in).

LA.SL.2.1	Participate in collaborative conversations with diverse partners about grade 2 topics and texts with peers and adults in small and larger groups.
TECH.8.1.2.F.CS3	Collect and analyze data to identify solutions and/or make informed decisions.
2-ESS2-1.ETS1.C.1	Because there is always more than one possible solution to a problem, it is useful to compare and test designs.
2-LS2-2.ETS1.B.1	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.
2-PS1-1.3	Planning and Carrying Out Investigations