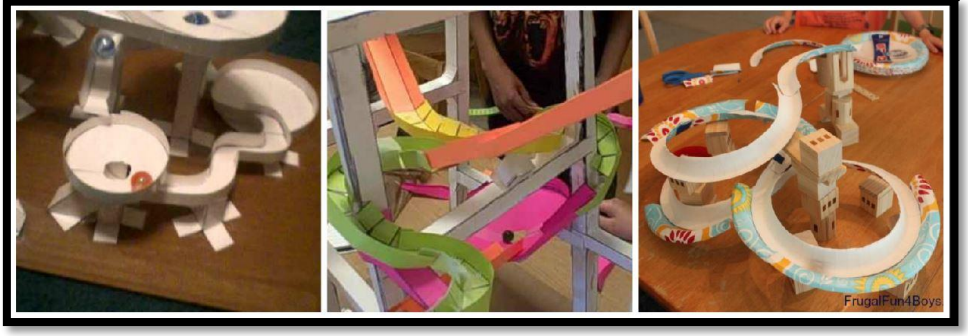
LAUSD Elementary Engineering

ENGINEER A MARBLE ROLLERCOASTER CHALLENGE

Second Grade – Physical Science



PURPOSE

IN THE ENGINEERING A MARBLE ROLLERCOASTER CHALLENGE, STUDENTS WILL:

- Design and build a marble run using the Engineering Design Process (EDP)
- Exhibit understanding of relevant science content/concepts
- Construct relevant questions
- Use appropriate tools and materials to complete task
- Determine effectiveness of their design
- Answer the Focus Question: How can you design a marble rollercoaster that meets the challenge's criteria?

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Students who demonstrate understanding can:

K-2-ETS1-1. **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.**

K-2-ETS1-2. **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.**

K-2-ETS1-3. **Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions.
- Ask questions based on observations to find more information about the natural and/or designed world(s). (K-2-ETS1-1)
- Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1)

Developing and Using Models
Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.
- Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2)

Analyzing and Interpreting Data
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.
- Analyze data from tests of an object or tool to determine if it works as intended. (K-2-ETS1-3)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems
- A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1)
- Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)
- Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)

ETS1.B: Developing Possible Solutions
- 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. (K-2-ETS1-2)

ETS1.C: Optimizing the Design Solution
- Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)

Crosscutting Concepts

Structure and Function
- The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)

Connections to K-2-ETS1.A: Defining and Delimiting Engineering Problems include:
Kindergarten: K-PS2-2, K-ESS3-2
Connections to K-2-ETS1.B: Developing Possible Solutions to Problems include:
Kindergarten: K-ESS3-3, **First Grade:** 1-PS4-4, **Second Grade:** 2-LS2-2
Connections to K-2-ETS1.C: Optimizing the Design Solution include:
Second Grade: 2-ESS2-1

Articulation of DCIs across grade-levels:
3-5.ETS1.A (K-2-ETS1-1),(K-2-ETS1-2),(K-2-ETS1-3); **3-5.ETS1.B** (K-2-ETS1-2),(K-2-ETS1-3); **3-5.ETS1.C** (K-2-ETS1-1),(K-2-ETS1-2),(K-2-ETS1-3)

Common Core State Standards Connections:

ELA/Literacy —

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. (K-2-ETS1-1)
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. *(K-2-ETS1-1),(K-2-ETS1-3)*
W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1),*(K-2-ETS1-3)*
SL.2.5 Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. *(K-2-ETS1-2)*

Mathematics —

MP.2 Reason abstractly and quantitatively. *(K-2-ETS1-1),(K-2-ETS1-3)*
MP.4 Model with mathematics. *(K-2-ETS1-1),(K-2-ETS1-3)*
MP.5 Use appropriate tools strategically. *(K-2-ETS1-1),(K-2-ETS1-3)*
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. (K-2-ETS1-1),(K-2-ETS1-3)

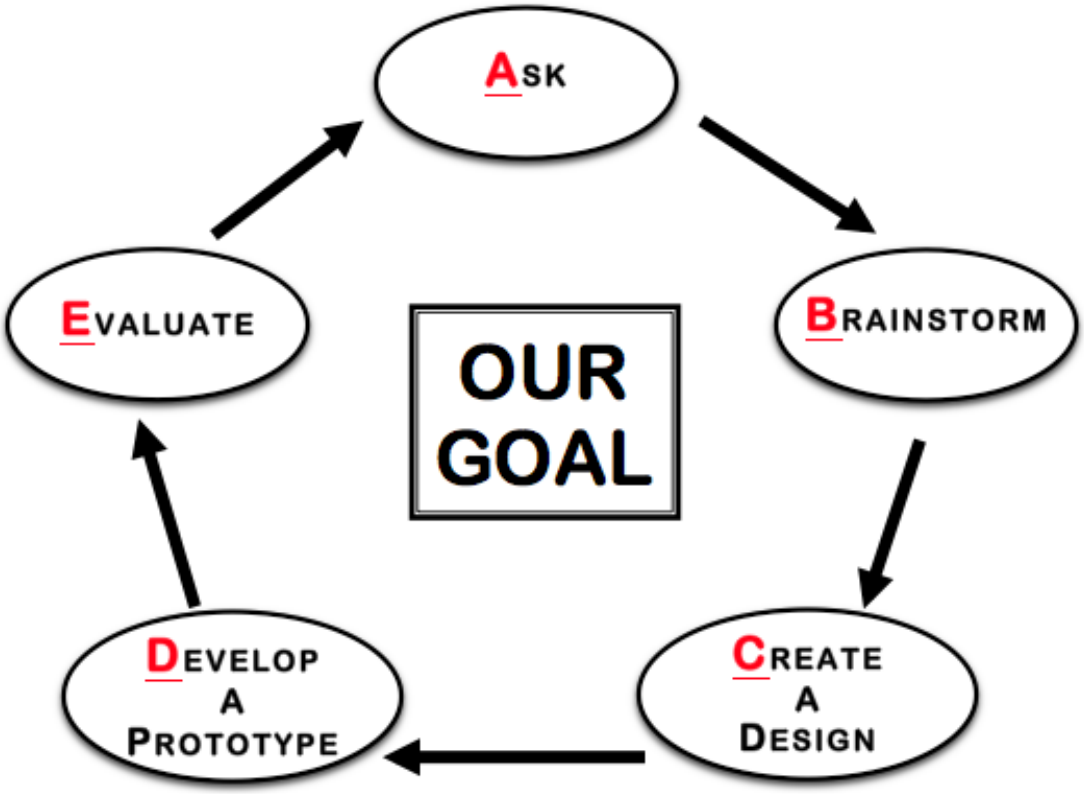
CA ENGLISH LANGUAGE DEVELOPMENT CONNECTIONS

- **P1.K.A.1**: Exchanging information and ideas with others through oral collaborative conversations on a range of social and academic topics
- **P1.K.A.3**: Offering and supporting opinions and negotiating with others in communicative exchanges
- **P1.K.C.9:** Expressing information and ideas in formal oral presentations on academic topics
- **P1.K.C.11**: Supporting own opinions and evaluating others' opinions in speaking and writing

SPECIAL EDUCATION (SPED):

To make accommodations or modifications for students with special needs, provide simple directions, instructions, provide multiple opportunities for repetition, make frequent checks for understanding, use visuals to accompany all vocabulary, simplify questions, be specific with sequence and steps, provide opportunity for paraphrasing, and adjust time and pacing.

THE ENGINEERING DESIGN PROCESS (EDP)



ENGINEERING DESIGN PROCESS (EDP)

ASK

- What is the **problem** or **need**?
- What is already out there?
- What are the **requirements (criteria)** and **restrictions (constraints)**?

BRAINSTORM

- What are possible **solutions**?
- Choose your two best solutions.

CREATE - A - DESIGN

- **Draw** a diagram with labels.
- Have a critical design review (peer review & input).
- What materials are available?

DEVELOP - A - PROTOTYPE

- Follow your best diagram and **build** a prototype.
- **Test** the prototype!

EVALUATE

- **Improve** your prototype!
- Conduct more compatibility tests.

BACKGROUND FOR THE TEACHER

You may teach lesson once students have completed:

FOSS CA – Balance and Motion

- **Investigation 4 (all parts)**

Once students have completed FOSS CA – Balance and Motion's Investigation 4 (all parts), students will have enough content knowledge to engage in The Engineering a Marble Rollercoaster Challenge.

Students will work together to make their marble rollercoaster, or a long marble-ramp system. Calling their designs a marble rollercoaster will get students excited about the challenge, but students will also need to know that their marble rollercoaster is a system, a form of technology. This design challenge will provide an opportunity to also review forms of technology that students learned earlier when they completed the technology in a bag activity when they learned that technology can be an object, a system or a process that helps people solve a problem or fulfill a need.

MATERIALS

FOR EACH TEAM (2 students)

- 2 Foam Runways
- 1 Marble
- 1 Plastic cup
- Masking Tape
- Scissors
- Pencils

FOR THE LESSON

- Individual Student Engineering Notebook
- Chart Paper for Vocabulary and Concepts
- Markers
- LCD Projector

GETTING READY

1. **Schedule the Engineering Challenge**
   The challenge will take two-three 30-45 minute sessions to complete.

2. **Gather / obtain materials**
   - Tape may be pre-cut into yard long strips for easier sharing. As you circulate among students carry masking tape, too.
   - Make a plan for distribution, gathering and storing of materials when students are not working on their design.

3. **Prepare a materials station**
   - The foam runways are excellent for guiding marbles, but they are a little fragile. Caution students to remove tape carefully to keep from pulling the foam apart. Even so, the ends where the sections are connected will suffer some wear. After the runways have been used five or six time, it may be necessary to cut a few centimeters off each end to make the sections meet evenly once again.

4. **Print Focus Questions**
   Have Focus Questions printed on self-stick labels OR precut labels for gluing into Engineering Notebook –
   <u>How can you design a marble rollercoaster that meets the challenge's criteria?</u>

GUIDING THE ACTIVITY

Students will engage in the Engineering Design Process (EDP).

1. ASK

Present problem or need

- Inform engineers of the PROBLEM:

"We need to create a fun marble rollercoaster."

Present Focus Question: "*How can you design a marble rollercoaster that meets the challenge's criteria?*"

- Display the Focus Question and have students stick/glue the Focus Question into their Engineering Notebooks.
  "**How can you design a marble rollercoaster that meets the challenge's criteria?"**

Present Requirements and Restrictions

- **Requirements** (Criteria) *standards that must be met; rules/directions that must be followed*:
  - Teams consist of three to four members
  - The long marble ramp-system must be constructed with only the materials provided.
  - The final design that is tested can be taped down to the table, or other classroom furniture. Alternatively, marble ramp-systems may be taped down to cardboard for portability.
- **Restrictions** (Constraints) *limitations that keep something from being the best it could be; may be problems that arise or issues that come up*:
  - Use only the materials supplied by teacher
  - The team design must incorporate an aspect of each team member's design

2. BRAINSTORM

- Observe materials, discuss properties of materials and imagine how they might be utilized.

3. CREATE - A - DESIGN

- Each member must draw a design individually (2-3 minutes), without team member input, into his/her engineering notebook.
  - Title the page "My design"
  - Students should label parts of their design

- Team members share designs with one another (3-5 minutes), compromise, and collaborate in order to create into a "team design" incorporating an aspect of each member's own design. (SEP-1)
  - Title the next page in the engineering notebook, "Team design"
  - Team members should each draw and label parts of this collaborative design

4. DEVELOP - A - PROTOTYPE

- Build !!! (SEP-2)

- Test design
  - Once team long marble ramp-systems are built, students can test their design with a glass marble as part of the next step.
  - Based on the criteria point allocations, students will calculate the point value of their long marble ramp-system to determine if their total fell between the targeted point range.

Rollercoaster Scoring Rubric

Points are awarded for each of the following items included in your group's roller coaster.

Creativity points

•Every 50 cm of height	1 point
•Go down a hill, back up, then down again.	1 point
•Go down, and then around in a circle.	1 point
•Go in a loop-the-loop.	2 points
•Go in a spiral.	3 points

Performance Points

Rolling time of the marble from start to cup is less than 5 seconds

- 1 point

Rolling time of the marble from start to cup is 5 seconds or longer

- 2 points

The glass marble successfully completes the roller coaster and lands in the cup

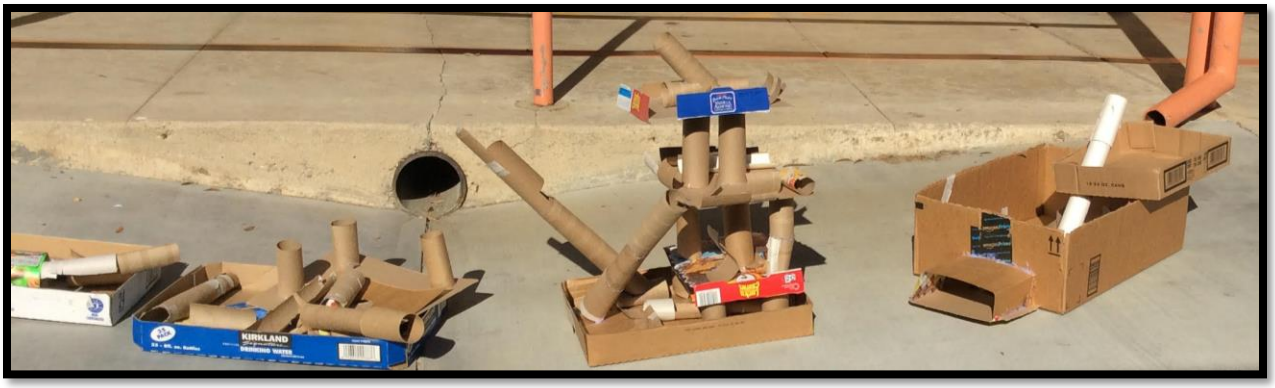
- 3 points

5. EVALUATE

- Teacher facilitates discussion about student successes and challenges (SL.K.1). Students may observe other teams solving similar problems in a different way and consider modifying their own designs.

- After observation of other designs and input from colleagues (SL.K.1), students **redesign** and **rebuild**.

- Have students answer the Focus Question in their engineering notebooks using both text and diagrams.
  - For scaffolding, sentence frames work well.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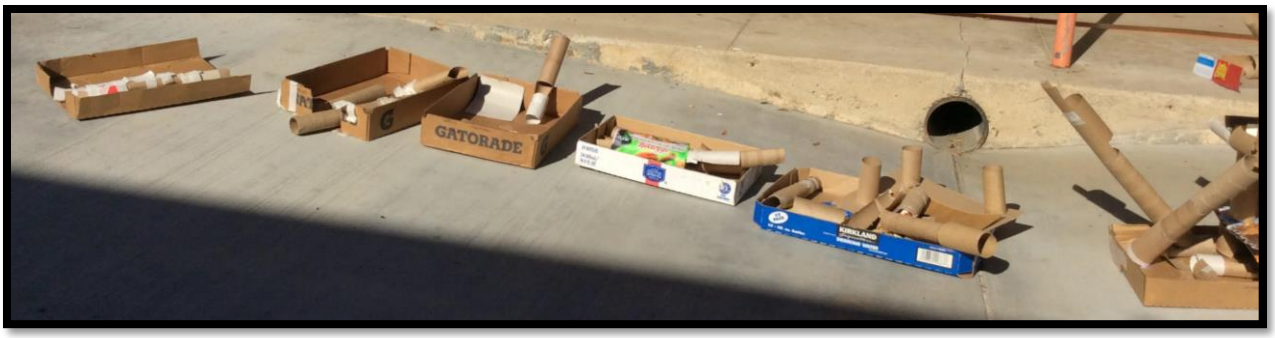
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