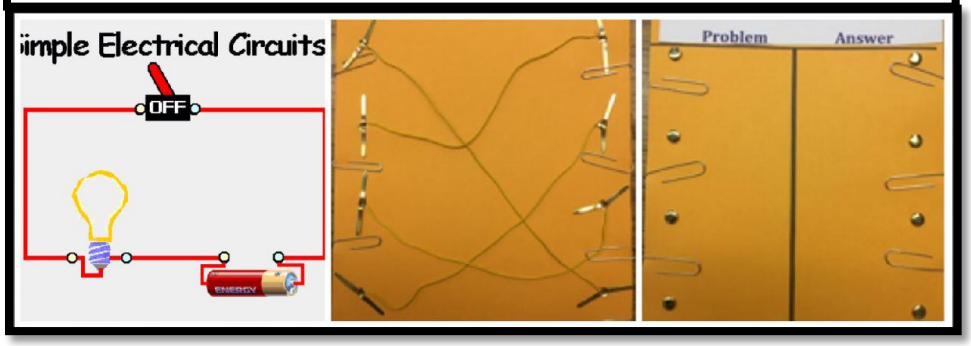
LAUSD Elementary Engineering

ELECTRIFYING BOARD GAME CHALLENGE

Fourth Grade - Physical Science



PURPOSE

IN THE <u>ELECTRIFYING BOARD GAME</u>, STUDENTS WILL:

- Plan, design, and create a board game using electricity
- Exhibit understanding of relevant science content/concepts
- Construct relevant questions
- Use appropriate materials provided to complete their task
- Determine effectiveness of their design
- Answer the Focus Question: <u>How can we create a board game that lights up?</u>

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Students who demonstrate understanding can:

4-PS3-2. **Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.** [*Assessment Boundary: Assessment does not include quantitative measurements of energy.*]

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.	**PS3.A: Definitions of Energy** • Energy can be moved from place to place by moving objects or through sound, light, or electric currents. **PS3.B: Conservation of Energy and EnergyTransfer** • Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. • Light also transfers energy from place to place. • Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.	**Energy and Matter** • Energy can be transferred in various ways and between objects.

Connections to other DCIs in fourth grade: N/A

Articulation of DCIs across grade-levels:
MS.PS3.A ; **MS.PS3.B** ; **MS.PS4.B**

Common Core State Standards Connections:
ELA/Literacy -

W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-PS3-2),

W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-PS3-2)

Students who demonstrate understanding can:

4-PS3-4. **Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*** [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [*Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.*]

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

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Apply scientific ideas to solve design problems.

Disciplinary Core Ideas

PS3.B: Conservation of Energy and EnergyTransfer

- Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.

PS3.D: Energy in Chemical Processes and Everyday Life

- The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.

ETS1.A: Defining Engineering Problems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. *(secondary)*

Crosscutting Concepts

Energy and Matter

- Energy can be transferred in various ways and between objects.

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World

- Engineers improve existing technologies or develop new ones.

Connections to Nature of Science

Science is a Human Endeavor

- Most scientists and engineers work in teams.
- Science affects everyday life.

Connections to other DCIs in fourth grade: N/A

Articulation of DCIs across grade-levels:
K.ETS1.A ; **2.ETS1.B** ; **5.PS3.D** ; **5.LS1.C** ; **MS.PS3.A** ; **MS.PS3.B** ; **MS.ETS1.B** ; **MS.ETS1.C**

Common Core State Standards Connections:

ELA/Literacy -

W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-PS3-4)

W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-PS3-4)

Mathematics -

4.OA.A.3 Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding. *(4-PS3-4)*

3-5-ETS1 Engineering Design

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Students who demonstrate understanding can:

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

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 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)

ETS1.B: Developing Possible Solutions

- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
- Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)

ETS1.C: Optimizing the Design Solution

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)

Crosscutting Concepts

Influence of Engineering, Technology, and Science on Society and the Natural World

- People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1)
- Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

Connections to 3-5-ETS1.A: Defining and Delimiting Engineering Problems include:
Fourth Grade: 4-PS3-4

Connections to 3-5-ETS1.B: Designing Solutions to Engineering Problems include:
Fourth Grade: 4-ESS3-2

Connections to 3-5-ETS1.C: Optimizing the Design Solution include:
Fourth Grade: 4-PS4-3

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

Common Core State Standards Connections:

ELA/Literacy –

RI.5.1	Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *(3-5-ETS1-2)*
RI.5.7	Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(3-5-ETS1-2)*
RI.5.9	Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS1-2)
W.5.7	Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1),(3-5-ETS1-3)
W.5.8	Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. *(3-5-ETS1-1),(3-5-ETS1-3)*
W.5.9	Draw evidence from literary or informational texts to support analysis, reflection, and research. *(3-5-ETS1-1),(3-5-ETS1-3)*

Mathematics –

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

CA ENGLISH LANGUAGE DEVELOPMENT CONNECTIONS

- **P1.4.A.1** Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics
- **P1.4.A.2** Interacting with others in written English in various communicative forms (print, communicative technology, and multimedia)
- **P1.4.A.3** Offering and supporting opinions and negotiating with others in communicative exchange

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)

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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 this lesson once students have completed:

FOSS CA – MAGNETISM AND ELECTRICITY

- **Investigation 2, Parts 2 – 5**

After completing Investigation 2, Part 5, students will know how to build a simple circuit including a switch, and understand that metals are conductors of electrical energy.

MATERIALS

FOR EACH TEAM

- Sticky notes
- Paper clips
- Index cards
- Manila file folders
- Card stock (various sizes and colors)
- D-cell battery
- D-cell battery holder
- Wires (20 gauge; insulated 10 cm -20 cm)
- Small bulb (#222)
- Bulb holder (#023-2814)
- Hole puncher
- Wire stripper
- Aluminum foil (cut and thinly folded to make conductors)

- ¾" – 1" masking tape (for insulating aluminum foil "wires")
- Scissors
- Rulers

FOR THE LESSON

- Individual student engineering notebooks

GETTING READY

1. **Schedule the Engineering Challenge**
   The challenge will take about 5 days of 30-45 minute sessions to complete.

2. **Gather / Obtain Materials**

3. **Prepare Materials Station**

4. **Watch the Following Video:**
   How to Make an Electronic Matching Game
   www.youtube.com/watch?v=z8wadyalsy0

GUIDING THE ACTIVITY

Students will engage in the Engineering Design Process (EDP)

1. ASK

Setting Up the Context

- Your community toy store needs new board games. The old board games at this store are not selling. They are not exciting enough for the new generation of consumers. There is a contest for the best board game design. The prizes are $1,000 for 1st place, $500 for 2nd place, and $300 for third place. The store manager is accepting new and exciting board game designs in the next two weeks!

Present Problem or Need

- The challenge is to design an exciting, new board game for the contest. The old-fashioned board games are too boring. Kids want games that light up!

- Have students record the Focus Question in their engineering notebooks - How can we create a board game that lights up?

- Encourage students to come up with their OWN questions about materials, criteria, and constraints.

Present Requirements and Restrictions

- **Requirements** (Criteria) *standards that must be met; rules/directions that must be followed)*:
  - Students must work in collaborative teams of 3 to 4 members.
  - Board game must consist of 4 – 6 questions with corresponding answers connected by ***hidden*** conductors (like the Mystery Boards of Investigation 2, Part 5)
  - The board games can be about any subject we have learned during the year (literature, social studies, math, science, etc.)
  - The board game must have a title and playing rules.

- Each game must have an ANSWER CHECKER that lights up when correct answers are selected.

- **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 materials provided at materials station
  - Only one light bulb and one battery

2. BRAINSTORM

- Teams evaluate the available materials and determine their usefulness based on their properties.

- Teams discuss how their previously gained knowledge electrical circuits fits into making the circuitry of the game board.
  - If teams are unsure of how to create the ANSWER CHECKER, ask them to think back on how they found the hidden conductors in the Mystery Boards [Investigation 2, Part 5]

3. CREATE - A - DESIGN

- Each member must draw a design individually, without team member input, into his/her science notebook.
  - Title the page "My design"
  - Students should label the parts of their design (i.e. cardstock, lightbulb, insulated wires, etc.)

- Team members share designs with one another, compromise, and collaborate in order to create into a "team design."
  - Title the page "Team design"
  - Team members should label the parts of their design

- Teachers will approve a design if it fulfills all the requirements and restrictions.

- The design must clearly indicate how the questions will be connected to the corresponding answers using hidden conductors.

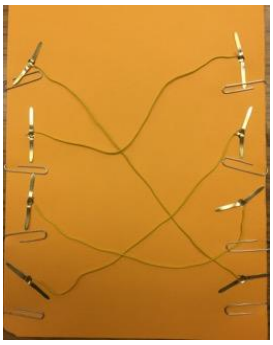
- After the team's board game design has been approved by the teacher, teams must decide upon questions/answers and resubmit the design for final approval.

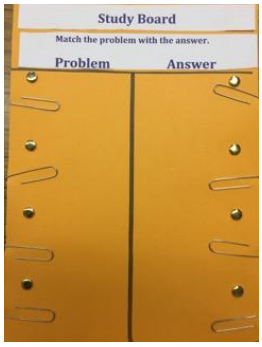
4. DEVELOP - A - PROTOTYPE

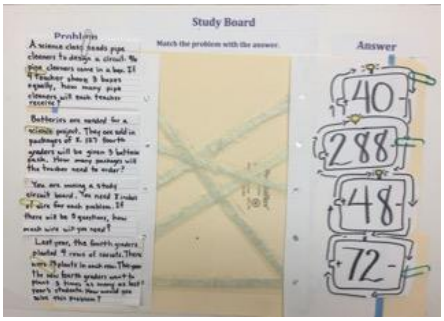
- Upon final approval, the "Getters" gather the materials listed on the Team Design from the materials table.

- Teams build according to their plan.

- Test design
  - If the lightbulb illuminates when the correct answer is selected, students have correctly wired their circuit game boards.







- Teams complete their prototype by adding a title and game rules.

5. EVALUATE

- Teams exchange game boards with one another.
  - Does every game board work as planned?
  - Are the game rules clear and complete?

- After observation of other game boards and input from colleagues, teams redesign and rebuild as needed.

- Students will answer the Focus Question in their notebooks.
  - Sentence frames can be used for scaffolding. For example, "We created a game boards that light up by _____."
  - Encourage students to include information about both their successes and failures.