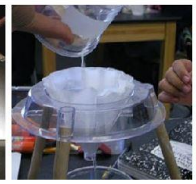
MIX IT UP AND SEPARATE

Fifth Grade - Physical Science





PURPOSE

IN <u>MIX-IT-UP & SEPARATE</u>, STUDENTS WILL:

- Design and build a structure that reduces the effects of the sun on a Gummy Bear 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 separate a mixture of dry materials?

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Students who demonstrate understanding can:

5-PS1-3. **Make observations and measurements to identify materials based on their properties.** [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [*Assessment Boundary: Assessment does not include density or distinguishing mass and weight.*]

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 and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	**PS1.A: Structure and Properties of Matter** • Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.)	**Scale, Proportion, and Quantity** • Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade-levels:
2.PS1.A ; **MS.PS1.A**

Common Core State Standards Connections:

ELA/Literacy -

W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. *(5-PS1-3)*

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. *(5-PS1-3)*

W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. *(5-PS1-3)*

Mathematics -

MP.2 Reason abstractly and quantitatively. (5-PS1-3)

MP.4 Model with mathematics. (5-PS1-3)

MP.5 Use appropriate tools strategically. (5-PS1-3)

3-5-ETS1 Engineering Design

3-5-ETS1 Engineering Design

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	Disciplinary Core Ideas	Crosscutting Concepts
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)	**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)	**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)*

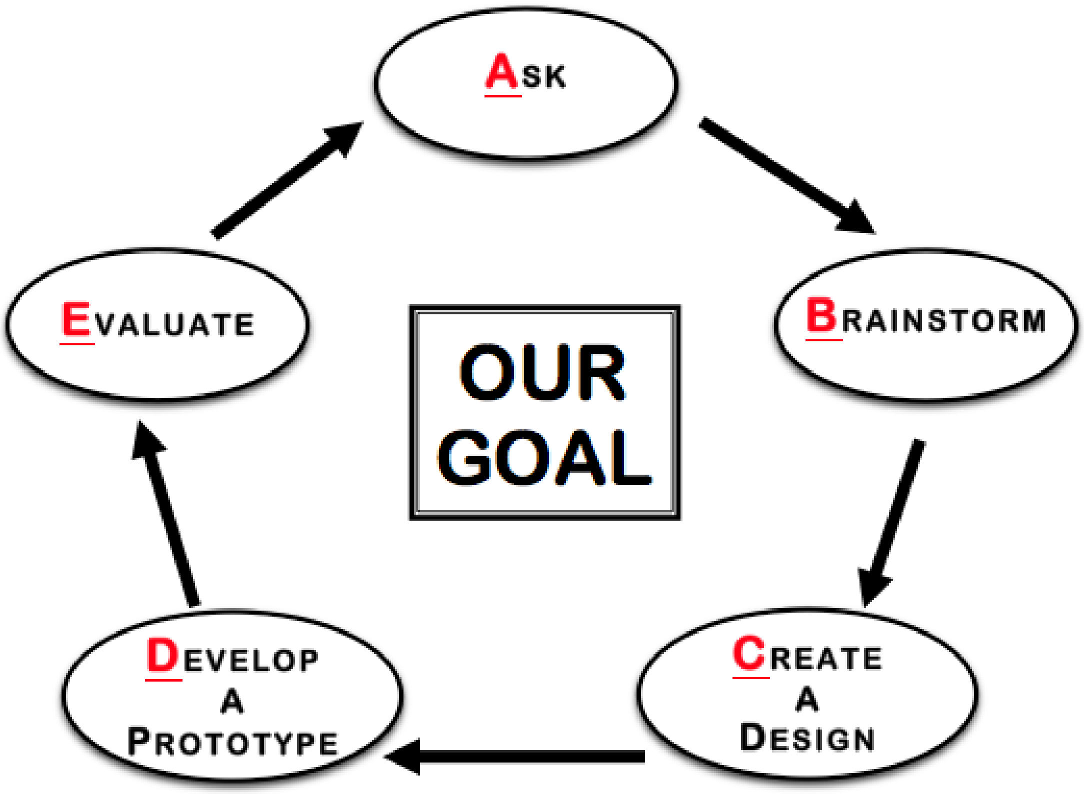
CA ENGLISH LANGUAGE DEVELOPMENT CONNECTIONS

- **P1.5.A.1** Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics
- **P1.5.A.3** Offering and supporting opinions and negotiating with others in communicative exchanges.
- **P1.5.B.5** Listen actively to spoken English in a range of social and academic contexts.
- **P1.5.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 this lesson once students have completed:

FOSS CA – MIXTURES AND SOLUTIONS

- **Investigation 1 (all parts)**

Students will have enough content knowledge to engage in the Separating a Dry Mixture Challenge by exploring through the investigation.

Students will apply their knowledge of physical and chemical properties of previously introduced substances in order to design a method of separation of a heterogeneous mixture. As a basis of understanding, students must recognize that matter can be identified by its properties and can differentiate between a mixture and solution. Physical properties such as color, shape, texture, and solubility allow us to draw conclusions about the material (substance, matter) being observed.

A **mixture** is a substance made by combining two or more different materials. A **solution** is a special type of homogenous mixture of two or more substances, where one substance is dissolved into another. Parts of a solution include a **solute** (a substance that dissolves is a solvent) and **solvent** (a substance in which a solvent dissolves in a solution). A solute easily dissolves in a solvent, thus making it more soluble than other substances. New material is neither created nor destroyed, and there are processes to test for the original substance such as separation of a solution through evaporation. When two or more different substances are mixed together, they can sometimes form new substances whose properties differ from the properties of the original substances.

As scientists, we can gather that a change has occurred and use our understanding of physical properties with familiar substances to help us identify those unknown substances or products that were created out of a chemical reaction.

MATERIALS

FOR EACH TEAM

- 1 Mesh Screen
- 1 Filter Paper
- 1 Funnel (FOSS)
- Plastic Cups
- Sticky Notes
- Craft Sticks
- Syringe, 50mL
- Container, 1/2 L
- Water
- Hand Lenses
- Evaporation Dish
- Cups or dishes to be used for observation of substances
- Chart Paper

FOR THE LESSON

- Individual Student Engineering Notebooks
- 3 spoons, 5 mL
- 1 container of gravel
- 1 container of diatomaceous earth (powder)
- 1 container kosher salt
- Snack zip baggies

GETTING READY

1. **Schedule the Investigation**
   The challenge will take about two-to-three days of 45-60 minute session to complete.

2. **Gather/Obtain Materials**

3. **Prepare Materials**
   - Set up a materials station to include separation tools: mesh screens, filter papers, craft sticks, funnel, syringe, and water.
     - (If limited on supplies, quantities of materials that can be used can be listed under constraints-one screen, one filter per team.
     - Optional additional supplies may also be made available: ex. toothpicks, tweezers, cheese cloth
   - Prepare bags of mixtures. (1 per each team and an extra to be used by the teacher to establish the context of the challenge.) Spoon 10 mL of each substance into a plastic zip bag, seal, and shake vigorously to mix contents.
   - Prepare observation dishes (cups) of each substance. Place 5mL each - gravel, salt, and powder-into individual dishes. (1 set per group).

4. **Plan Teams**
   Predetermine collaborative teams of 3-4 students.

5. **Focus Question**
   Post the Focus Question and Engineering Design Process -
   <u>How can you separate a mixture of dry materials?</u>

GUIDING THE ACTIVITY

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

1. ASK

Setting Up the Context

- Begin by sharing with students that there's been an accident in your chemical storehouse. While there wasn't a big blow-up or explosion that occurred, there was still something troubling that happened. When you went into your science box to gather materials, you found that some of the substances you have been storing spilled out of their containers. To keep as much of the material intact as possible, you gathered what you could. Unfortunately, all the substances were mixed together. The problem is that these substances need to be used for future lessons but cannot be mixed-up. Sadly, you do not have the funds to purchase new chemicals, so you must figure out how to return each substance back to its original container.

Present Problem or Need

- Design a method to separate a mixture of dry materials. Your goal is to get each of the dry materials into individually labeled cups.

- Display the bag containing the dry mixture. Use this opportunity to recruit their help in solving your problem and achieve the ultimate goal of separating the mixture of dry materials into individually labeled cups.

- Have students record the Focus Question in their engineering notebooks - <u>How can you separate a mixture of dry materials?</u>

- Encourage students to come up with their OWN questions about materials, criteria, and constraints. Questions that may arise include:
    - *What is the material we have to separate?*
    - *What's in the bag?*
    - *What can I use to separate the materials?*
    - *How much time do we have?*

- *Do all the materials have to be separated from each other? What if there is some left?*

Present Requirements and Restrictions

- **Requirements** (Criteria) *standards that must be met; rules/directions that must be followed(:*
  - Students must work in collaborative teams.
  - The mixture should be separated so that each substance ends up in its own individual cup

- **Restrictions (Constraints)** 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
  - Limited materials (i.e. no more than one filter paper, one screen)
  - Time: 20 minutes to create design (planning phase); 30-45 minutes to develop & test prototype

2. BRAINSTORM:

- Distribute a magnifying lens to each student and a set of observation dishes to each group (include a popsicle stick to use in exploring the material.) These are the dry materials in the bag. Allow students to first examine each of the substances, asking them to note the physical properties of the substances they are observing in their notebook. This is important, as it will help students determine how a mixture might be separated. For example, the larger particles may be easier to separate than the substances that are finer in texture or the same in color.

- Allow students to visit the materials station to handle tools and *think* about how materials and tools can be used, but do not allow any equipment to be taken back to their table quite yet. During this time, you can also pass out the mixture of dry materials (one to each team) but instruct students that the bag will be opened during the testing (Design-A-Prototype) phase.

****Remind students of safety protocols when handling chemicals****

- Encourage groups to come up with their solutions, think about the focus question, and about requirements and restrictions.

- As you facilitate the Brainstorm process, prompting questions may include:
  - There are some substances you may already be familiar with. Is there a substance that you think you might be able to identify? What evidence do you have?
  - How might knowing physical properties help us separate matter?
  - What do you already know about mixtures?
  - How can you imagine the materials being used might help you separate the dry mixture of solids?

- Use this time to confirm the substances being used as gravel, powder, and salt. Reiterate materials need to be separated into individual cups so that gravel ends up in its own cup, powder in its own cup, and salt in its own cup.

- Students should be recording thoughts and ideas in their notebook as the discussion is-taking place.

- Collect observation dishes.

3. CREATE - A - DESIGN

- Distribute three cups to each team. Teams will label each cup with a sticky note to indicate which separated substance will eventually end up in the cup. (G labeled cup-gravel, P labeled cup-powder, and S labeled cup-salt.) Remind them that their goal is to get each substance from the mixture of dry materials bag into its own cup.

- Students will use this time to create and record a systematic plan for separation in their notebooks and chart a final group design.

- Without influencing their plans, see if they propose adding water at the start of their separation process. This includes having a sequential plan for using screens and filters and recognizing that evaporation is necessary in order to separate the salt solution (if water was added) from the rest of the mixture.

- **Teacher Tip!** Allow individual thinking and recording time to Create-A-Design. Students then share ideas within their team. The final design plan for separation should reflect each team. members' idea and all members need to have a part or say in this process.

- **Look for**… *diagrams, labeling, a sequential order to planning, and shared ideas.*

4. DEVELOP - A - PROTOTYPE

- Revisit the previous day's work.

- Once the plans have been developed, students can begin gathering the materials they need for separation. This will now be the testing phase of the EDP in which groups will get to construct or build their prototype.

- Note the need for evaporation dishes to separate the salt solution for students who added water to their plan of separation. It is only necessary to have students place a small amount of salt solution in the dish, as evaporation time has to be accounted for.

- Test design!

- Facilitating questions may include:
    - *Can you describe how_______________ will help you separate__________?*
    - *How will you know that you were successful in separating the mixture of dry materials?*

- *What role is particle size playing in your ability to successfully separate a mixture?*
- *How are you selecting your filtering order?*
- *How are you recording your design process?*
- *How are you collaborating/sharing the team responsibility?*
- *How does your process reflect each team members' ideas?*
- For groups who decided to use water as part of the separation process –
  - *Which substance are you trying to separate?*
  - *How much water will you use?*
  - *How will you know when you have just the salt in the individual cup vs. a solution that is still a mixture of water and salt?*

- **Teacher Tip!** Emphasize the use of academic vocabulary when students are responding to facilitating questions or writing in their notebooks. Encourage the use of responding in complete sentences to help develop language. For example, instead of having the students talk about the substances or materials as "stuff" or "things", redirect them by having them identify the substances and materials by name. *"I am using the screen to separate the gravel. The holes are larger on the screen, so I think that the gravel will stay on top of the screen and the rest of the substances will fall through into the cup."* Provide sentence frames as needed.

5. EVALUATE

- After each team has had the opportunity to develop a prototype and test, allow time for team reflection and self-evaluation.

- Time should be allocated for a gallery walk of each team's design, charting, and prototype.

- Facilitating questions may include:
  - *What commonalities/differences did you notice about each teams' approach to separating a mixture of dry materials?*

- *What do you like about a team's design? How did they meet the criteria?*
- *What did you find challenging? How did you problem-solve or work around that challenge?*
- *How would you improve a teams' design?*
- *How would you measure the success of working through this design challenge?*
- *How would you measure the success of team collaboration?*

- Give teams the opportunity to revise their initial design plan, improve, and retest, thus flowing back into the different phases of the Engineering Design Process. This may also be occurring naturally during the testing phase of the process.

- Students should be recording on their group chart as well as in their notebooks.

- Teams can rewrite their method of separation in a detailed way that others can follow and carry out.

- Students will answer the Focus Question in their notebooks.
  - Sentence frames can be used for scaffolding.
  - Encourage students to include information about both their successes and failures.

Extension

- *What are other situations where we might need to separate mixtures?*
- *What tools and methods might we use then?*
- *Examples may include:*
  - *Washing rice or beans in a colander to separate small rocks,*
  - *Straining tea or coffee grounds using filters,*
  - *Retrieving sea salt (for seasoning) using the process of evaporation,*
  - *Picking out tomatoes from a salad manually,*
  - *Separating magnetic materials such as nickel, iron, and steel from non-magnetic materials using a magnet in the scrap metal industry.*