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| **Lesson Title** | ***Designing an artifact to separate a mechanical mixture*** | | | |
| **Grade Level:**  8th, 9th, 10th, and 11th | **Time required:** 90 minutes to 180 minutes depending on thestudents | **Lesson Dependency:** None | **Subject Areas:** Physical Science, Chemistry, Math, Language Arts, and Art |  |
| **Summary** | The goal of the lesson is to expose students to real life situations in which they will have to apply what they know about a topic to solve a problem. Students will learn how engineers approach problems especially when they do not have all the information required to solve the problem. In addition, students will work in collaboration to decide which design is more feasible after analyzing the constraints given. Students will create a visual presentation followed by an oral presentation in which they will explain the process they follow to find the best solution to solve the problem given. | | | |
| **Engineering Connection** | Engineers are faced every day with problems they have to solve to improve the quality of life of the general population. By applying what they know about science and mathematics, engineers design new products, redesign processes to make them more efficient, and make decisions to ensure that the safety of the public is guaranteed. Engineers are problem solvers, and they use their creativity to find feasible solutions taking into consideration the constraints posed by the same problem. In this activity, students will work in groups to document the engineering design process. Given a task, students will brainstorm, design, test, and redesign to create a final product with value. | | | |
| **Learning Objectives** | Students should be able to:   1. Apply what is known about physical properties of matter to separate a mixture 2. Define what engineering is 3. Describe how engineers help others 4. Apply the engineering design process when designing an artifact 5. Write a design brief 6. Justify decisions by creating a decision matrix | | | |
| **Educational Standards** | **Science and Math** | **Engineering and Technology** | **Art** | **Language Arts.** |
|  | **SC.8.P.8.4 Classify and compare substances on the basis of characteristic physical properties that can be demonstrated or measured; for example, density, thermal or electrical conductivity, solubility, magnetic properties, melting and boiling points, and know that these properties are independent of the amount of the sample.**    **SC.8.P.8.9 Distinguish among mixtures (including solutions) and pure substances.**    **SC.912.P.8.2 Differentiate between physical and chemical properties and physical and chemical changes of matter.**    **SC.8.N.1.2 Design and conduct a study using repeated trials and replication.**    **SC.912.N.1.7 Recognize the role of creativity in constructing scientific questions, methods and explanations.**    **SC.912.N.4.2 Weigh the merits of alternative strategies for solving a specific societal problem by comparing a number of different costs and benefits, such as human, economic, and environmental.**    **MAFS.K12.MP.2.1 Reason abstractly and quantitatively. Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.**    **MAFS.K12.MP.5.1 Use appropriate tools strategically.**  **Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.**    **MAFS.K12.MP.6.1 Attend to precision.**  **Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.** | **CTE-TECED.68.COMTEC.01.06 Consider factors that influence the design of a message, such as the intended audience, medium, purpose, and nature of the message.**    **CTE-TECED.68.COMTEC.01.07 Use symbols, measurements, and drawings to promote clear communication by providing a common language to express ideas (e.g. airport symbols and signs).**    **CTE-TECED.68.COMTEC.04.05 Produce an audio and/or visual product using electronic communication technology.**  **CTE-TECED.68.ENTECH.10.01 Use design as a creative planning process that leads to useful products and systems.**  **CTE-TECED.68.ENTECH.10.03 Identify criteria and constraints that are requirements for a design.**  **CTE-TECED.68.ENTECH.11.02 Define brainstorming as a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.**  **CTE-TECED.68.ENTECH.11.01 Identify the design process involving a set of steps, which can be performed in different sequences and repeated as needed.**  **CTE-TECED.68.ENTECH.10.05 Evaluate criteria and constraints that are requirements for a design.** | **VA.912.O.3.2 Create a series of artworks to inform viewers about personal opinions and/or current issues.** | **LAFS.8.W.1.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.**   1. **Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.** 2. **Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.** 3. **Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.** 4. **Use precise language and domain-specific vocabulary to inform about or explain the topic.** 5. **Establish and maintain a formal style.** 6. **Provide a concluding statement or section that follows from and supports the information or explanation presented.**     **LAFS.8.SL.2.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.** |

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| **Worksheet and attachments** | 1. [Vocabulary Activity and paragraph](https://docs.google.com/document/d/1GSOu0a7uPLsugp3uYxP8-VVKol5BLYhrH7TWjHKCnMo/edit) 2. [Design Worksheet](https://docs.google.com/document/d/1t_y3nfndOheLiWmZ0rB2ek41Qwte7UyOnQp8RoB8uOk/edit) 3. [Designing an artifact to separate a mechanical mixture visual presentation](https://docs.google.com/presentation/d/1yGI0jodRwUjOGAZ8Tnurl4rxPHcSujh1CHzhD5im2rc/edit#slide=id.ga9b4ed4f28_20_4) 4. [Rubric. Visual and Oral Presentation](https://drive.google.com/drive/u/0/folders/0B8duBBwUHgZ8WmtZRTVFU0x4S1U) | | | |
| **Material List** | * The mixture (enough for all groups) * Plastic cups (six per group) * Twine (one per group 3 feet long) * Scissors | | * Computers * Timer (one per group) * Toothpicks * Balance (digital or triple beam) | |
| **Prerequisite Knowledge** |  | | | |
| **Lesson background and concepts for teachers** |  | | | |
| **Associated Activities** | 1. [Vocabulary Activity and Reflection paragraph](https://docs.google.com/document/d/1GSOu0a7uPLsugp3uYxP8-VVKol5BLYhrH7TWjHKCnMo/edit) 2. [Design Worksheet](https://docs.google.com/document/d/1Bzn2-F7wPaMepjcZqKh9NVL12FG4tJzhYdSHYtslv6M/edit) 3. Visual Presentation (created by students and documenting the design process) | | | |
| **Lesson Closure** | After the oral presentations, the instructor can hold a discussion with the class to close the topic. Examples of closure discussion / questions are shown below.   1. What was the most difficult or challenging part of the project? 2. What kept you trying and looking for a solution? 3. What do you think of engineers now? Do you think that being an engineer is easy? Why? 4. What are some skills you think a student needs to major in engineering? 5. Why do you think it is important to follow the steps of the engineering design method? 6. Do you know any engineer? What do they do? Do all engineers design?   If the instructor is teaching an engineering class, closure questions can be designed in a way that they lead to the next engineering lesson. | | | |
| **Vocabulary/Definitions** | 1. **Engineering design method :** The engineering design process is a series of steps that guides engineering teams as they solve problems. 2. **constraints** : a limitation or restriction.: "time constraints make it impossible to do everything" "the availability of water is the main **constraint on** food production". 3. **feasibility** : the state or degree of being easily or conveniently done.: "the feasibility of a manned flight to Mars". 4. **decision matrix :** A decision matrix is a tool that helps business analysts and other stakeholders evaluate their options with greater clarity and objectivity 5. **algorithm** : a process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.: "a basic **algorithm for** division". | | | |
| **Assessments** | **Pre-lesson assessment** | **During the lesson assessment** | **Post lesson assessment** |  |
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| **Lesson Extension** | The instructor can enrich the lesson by implementing different activities. For example, students can create a decision matrix using excel, but in addition, they can be asked to weigh the criteria used to make the decision. Also, the instructor can introduce flowcharts to introduce students to the automation of processes. |