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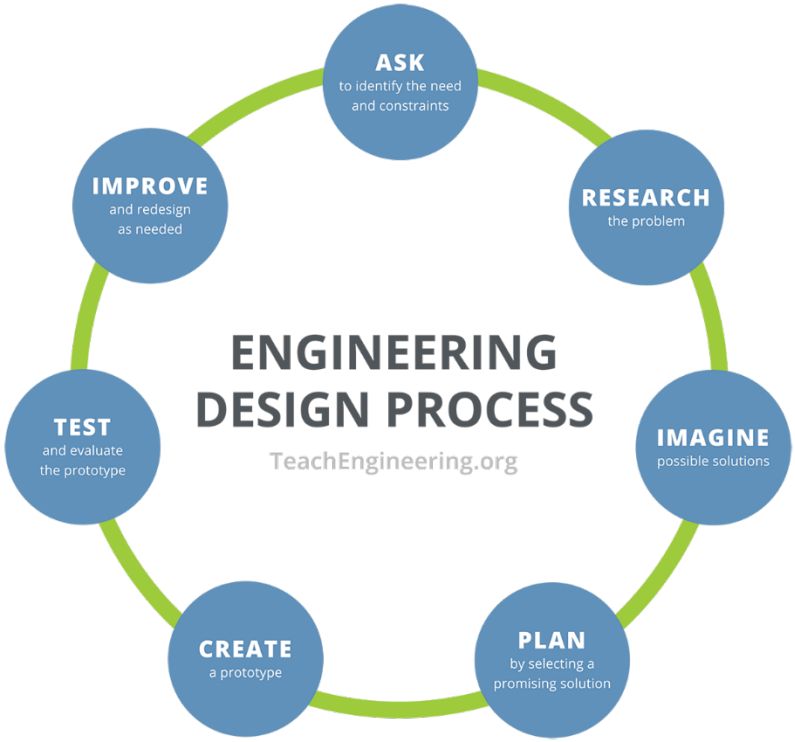
Engineering Design Process Worksheet

Introduction

Objective: You will use the engineering design process to design and build a Geiger counter prototype.



Ask

Your challenge: Each group will make a Geiger counter to measure the background radiation in different locations at your school.

What are the constraints of the challenge?

- You must use Arduino parts.
- It must measure radiation count per minute.

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Research

Phenomenon:

1. Watch the following video: https://www.youtube.com/watch?v=s9APLXM9Ei8 (2:38 minutes)

2. As you watch the video, write down a phrase, statement, or portion of dialogue that stands out to you.

3. At the end of the video, share your chosen phrase, statement, or portion of dialogue and discuss it with your group.

4. Answer the following: What does the following quote from the trailer mean to you?

   "Every atom of uranium is like a bullet..."

5. Explore types of radiation by completing the guided reading:

(Start of guided reading)

Guided Reading: Nuclear Radiation and the Human Body

Nuclear radiation is energy released from the nucleus of unstable atoms. It occurs naturally (such as in rocks and cosmic rays) and can also be man-made (in medical imaging or nuclear power). There are three main types:

- **Alpha particles**: Heavy and slow; blocked by paper or skin.
- **Beta particles**: Smaller and faster; can pass through skin but stopped by materials like aluminum.
- **Gamma rays**: Energy waves; very penetrating and can pass through the human body.

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Radiation is all around us—this is called **background radiation**. We are exposed through sunlight, soil, food, and even inside our bodies. Although small amounts are normal, high doses can be harmful.

Effects on the body depend on the dose, duration, and part of the body exposed. Radiation can damage cells, especially fast-dividing ones like those in the skin, bone marrow, or stomach. Low doses may cause little harm, but high exposure can lead to burns, radiation sickness, or cancer.

Despite risks, radiation has many **positive uses**. It helps doctors detect and treat diseases (such as cancer), sterilize equipment, and even preserve food. Scientists use strict safety measures when working with radiation. (End of guided reading)

Guided Reading Questions:

6. What are the three types of nuclear radiation?

7. How does radiation affect human cells?

8. In what ways is radiation helpful to society?

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Imagine

Instructions: What are some solutions to this challenge? Make sure to consider the following:

1. What tools measure radiation?
   https://www.youtube.com/watch?v=cwOPGfLkB7w (1:44 minutes)
2. Why do Geiger counters click?
   https://www.youtube.com/watch?v=qtvz8lH5zhk (3:07 minutes)
3. What are the components of a Geiger counter?
   https://www.youtube.com/results?search_query=how+does+a+geiger+Counter+work

Brainstorm ideas with your group and sketch those ideas below. Remember, all ideas are good at this stage!

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Plan

Instructions: As a group, you are going to construct a Geiger counter. First, review the Geiger Counter Instructions presentation, making sure to understand each component. Then make a drawing of your proposed Geiger counter prototype and list the materials that you will need.

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Create

Instructions: Follow your plan to build your Geiger counter prototype.

Test

Instructions:

1. Discuss which locations in the school will have the highest background radiation.
2. Search online resources to investigate normal background radiation.
3. Make your hypothesis:

4. Take your Arduino to different locations in the school and collect data for 15-30 minutes.
5. Record your results in the table below.
6. Answer the following questions.

DATA TABLE #1

	Location		
Time (min)	**Location #1:**	**Location #2:**	**Location #3:**
5			
10			
15			

7. What worked well with your Geiger counter prototype?

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8. What did not work well with your Geiger counter prototype?

9. How well did your Geiger counter measure background radiation?

10. What would you like to improve on your Geiger counter prototype?

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Improve

Instructions: Improve your Geiger counter prototype, retest it, and record your results in the table below.

1. Make changes to your Geiger counter prototype based on what worked and what did not work in your testing.
2. Retest your Geiger counter prototype.
3. Record your results at the times listed in the table below.
4. Answer the following questions.

DATA TABLE #2

	Location		
Time (min)	**Location #1:**	**Location #2:**	**Location #3:**
5			
10			
15			

5. What worked well with your Geiger counter prototype?

6. How did you improve your system?

7. Were your improvements successful?

8. Were you able to measure more background radiation? If so, how much more, and why do you think it measured more this time?

9. What would you like to improve on your updated Geiger counter prototype?

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Reflection Questions

Instructions: After testing and retesting your Geiger counter prototypes, answer the following questions:

1. What is the relationship between location and background radiation?

2. What would happen to a person who lived next to and was exposed to nuclear radiation?

3. How could you construct an infrastructure to contain nuclear radiation?

Summary

Instructions: Write a Radiation Report that includes the following:

- Background research (use answers from reading check)
- Challenge question/objective
- Hypothesis
- Methods
- Graph
- Analysis in CER paragraph format that states whether your hypothesis was supported or rejected, with justification using numerical evidence
- A discussion that includes improvements and further research ideas

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Conclusion
Instructions: Design a poster that could be shared on campus that teaches the community about the background radiation at different locations at school and the health effects of nuclear radiation. Include the strengths and limitations of the Geiger counter.