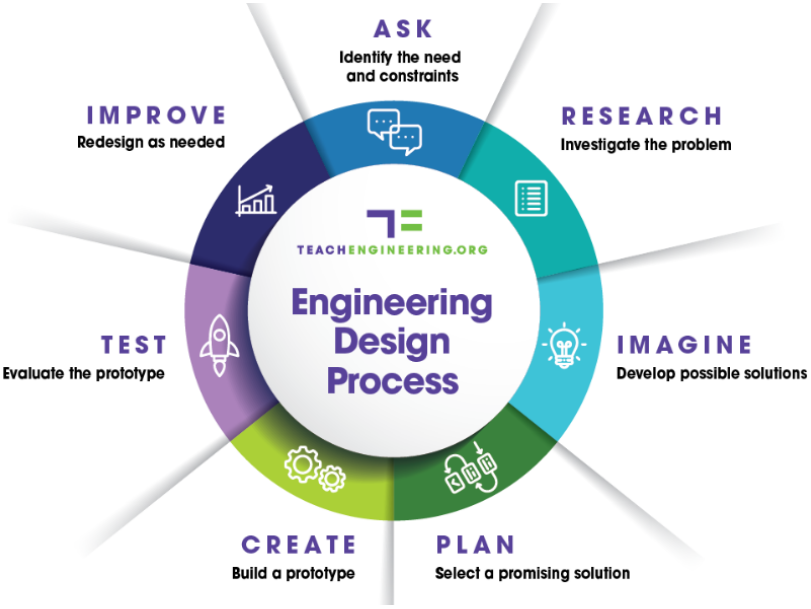
Name: Date: Class:

Create a Capacitor Engineering Design Process Packet



Ask: Define the Problem
Instructions: Write complete answers to the following questions.

1. In your own words, describe the task you are trying to accomplish. *(What are you being asked to design, and why?)*

2. What are the variables or parameters that you can change in your design?*(Think about materials, measurements, spacing, etc.)*

3. How do you predict changing these parameters will affect the capacitance? Why do you think so? *(Use evidence from your prior learning or observations.)*

Name: **Date:** **Class:**

Research: Learn about the Problem

Instructions: Complete the table using your own words.

Term	Definition (In Your Own Words)
capacitor	
electric charge	
electron	
voltage (V)	
current	
capacitance (C)	
farad (F)	
electrode	
plate area	
plate separation distance	
dielectric	
electrolyte	
electric field	
discharge	
LCR meter	
multimeter	

Name: **Date:** **Class:**

Research: Construct a Capacitor

Instructions: Gather the appropriate materials and then follow the directions below to construct a capacitor.

Materials:

- 2 cups
- 1 ruler
- 1 tape (masking or clear)
- 1 scissors
- aluminum foil (30 cm × 30 cm)
- 2 metals from the class supply area
- 2 electrolyte solutions from class supply area
- (optional) 1 small wooden block
- (optional) 1 small rock

Part 1: Constructing the Capacitor

1. Wrap aluminum foil around one cup so that it completely covers the outside in a single layer.
    a. Use scissors to trim the foil to fit neatly.
    b. Remove the foil, lay it flat, and measure its length and width.
    c. Record your measurements in your data table.
2. Re-wrap the foil around the cup. Secure it with tape if needed.
3. Fill the cup 75-90% with one of the electrolyte solutions.
4. Record which electrolyte you used in your data table.
5. Prepare your second metal electrode:
    a. If using foil, wrap it around a wooden block. Cut it to size, then measure and record its length and width.
    b. If using a cylinder, measure and record its diameter and height.
    c. If using a rectangular strip, measure and record its length and width.
6. Once measured, place the metal electrode in the center of the cup, making sure it does not touch the aluminum foil.

Part 2: Measuring Capacitance

7. Measure the distance between the outer foil and the center metal electrode. Record this value.
8. Use the LCR meter to measure the capacitance of your capacitor. Record your measurement.

Part 3: Reflecting and Revising

9. Choose one parameter to change (area, distance, or electrolyte material).
    a. Make a prediction about how this change will affect capacitance.
    b. Record your prediction in your data table.
    c. Change only one variable at a time.
10. Perform at least two trials for each parameter you choose to change.

Name: **Date:** **Class:**

Imagine: Develop Potential Solutions

Instructions: Based on your experimental data, propose design solutions that could maximize capacitance. You may use available materials, modify them, or create new design components.

Sketch **FOUR** different design solutions below. Make sure to label parts and materials.

Name: **Date:** **Class:**

Plan: Select a Solution

Instructions: Have each team member share their brainstormed design ideas. As a team, select ONE solution that you believe will store the greatest amount of electrical charge (i.e., maximize capacitance).

In the space below, draw and label your team's final design. Be sure to include:

- Clearly labeled parts and materials.
- Predicted measurements (before building).
- Final measured values (after building).

Name: **Date:** **Class:**

Create: Build the Prototype

Instructions: Use your final design plan to construct your optimized capacitor. Update the plan above with the prototype's final measured values.

Test: Measure Capacitance and Collect Data

Instructions: Test the capacitance of your prototype using the same procedure as before.

1. Set up your capacitor for testing
   a. Connect the two leads of your LCR meter (or multimeter with capacitance function) to the capacitor plates.
   b. Make sure the inner metal electrode does not touch the outer foil.
2. Measure capacitance
   a. Record the capacitance in the table below.
   b. Repeat the measurement at least two times to ensure accuracy.

Dielectric Used: _____

Metal Identity	Length or Diameter	Width or Height	Surface Area	Separation Distance	Capacitance

Analyze: Reflect on performance and compare to predictions

Instructions: Answer the following questions.

1. Does your capacitor perform as expected?

2. Did the measured capacitance match your predictions?

3. Identify any design factors that might improve performance.

Reflect & Redesign: Iterate to improve the design

Instructions: Answer the following questions.

4. What changes could you make to further increase capacitance?

5. Draw or describe a modified design and explain why you think it would work better.