Performance Task: Investigating Capacitance in Real-Life Circuits

Title:

Design, Construct, and Analyze a Simple Capacitor-Based Energy Storage System

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I. Overview / Task Description

Capacitors are essential components in many real-world technologies—from camera flashes and power supplies to touch screens and electric vehicles. In this performance task, you will **design and build a working model** that demonstrates how capacitors store and release electrical energy. You will analyze the behavior of your capacitor system based on measurable data and relate your findings to capacitance formulas and theoretical principles.

You may choose **one** of the following applications

1. **Camera Flash Simulator** – charging a capacitor with a battery and discharging through an LED.
2. **Touch Sensor Model** – observing changes in capacitance when a conductive plate is touched.
3. **RC Charging/Discharging Circuit** – building a resistor-capacitor circuit and measuring charging curves.
4. **Mini Power Backup System** – using capacitors to keep an LED lit when power is removed.

II. Learning Competencies

By completing this task, you should be able to:

- Explain capacitance and the factors affecting it (plate area, distance, dielectric).
- Apply the formula $C=\varepsilon A/d$.
- Analyze the charging and discharging of a capacitor using graphs.
- Compute stored energy in a capacitor using $E=\frac{1}{2}CV^2$.
- Design an investigation related to capacitors and interpret results.
- Communicate scientific findings clearly and effectively.

III. Materials (may vary depending on chosen project)

- Capacitors (10 μF – 1000 μF)

- Resistors (100–1000 Ω)
- Breadboard
- LED and 9V or 3V battery
- Wires
- Switch (optional)
- Foil sheets / cardboard (for homemade capacitors)
- Multimeter (for voltage measurement)
- Phone timer / stopwatch

IV. Task Instructions

PART A – Design

1. Identify the capacitor application you want to model.
2. Draw a labeled circuit diagram.
3. Predict how the capacitor will behave (charging time, brightness changes, etc.).
4. Write your hypothesis and expected data trend.

PART B – Construction

1. Assemble the circuit based on your design.
2. Double-check connections for safety.
3. Show your prototype to your teacher for approval.

PART C – Data Collection

Using a multimeter or sensor:

- Measure voltage across the capacitor every **1 second during charging** until it reaches maximum.
- Then measure voltage **every second during discharging**.
- Record all data in a table.

You must provide at least:

- Charging graph (Voltage vs. Time)
- Discharging graph (Voltage vs. Time)

PART D – Computation & Analysis

Answer the following:

1. Compute the **capacitance** using the RC time constant
   τ=RC\tau = RCτ=RC.
2. Compare the calculated capacitance with the labeled value.
3. Compute stored energy:
   E=12CV2E = \frac{1}{2}CV^2E=21CV2.
4. Explain why the capacitor behaves the way it does based on physics principles.
5. Discuss sources of error.

PART E – Output

Submit a **Performance Task Report** containing:

- Title and group members
- Purpose of the activity
- Circuit diagram
- Procedure and materials
- Data tables and graphs
- Calculations
- Analysis and conclusion
- Photo(s) of your prototype
- Reflection: “What did I learn about capacitors?”

V. Scoring Rubric (Total = 40 points)

Criteria	Description	Poins
Design & Planning	Clarity, accuracy of circuit diagram, hypothesis	**8**
Construction & Functionality	Circuit works as intended, safe assembly	**8**

Data Collection	Complete, accurate measurements; organized tables	**8**
Analysis & Calculations	Correct graphs, formulas, and explanation	**10**
Presentation & Reflection	Clear reporting, creativity, insights	**6**
