

Capacitors, energy storage and dielectrics

AP Physics C (Mechanics and E&M, calculus-based) · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test lasts 45 minutes and is marked out of 20. Show each step, give answers with units and write explanations in full sentences. Use $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$. Data not given in a question must not be assumed.

Level: AP Physics C (Mechanics and E&M, calculus-based) · **Curriculum:** AP PC:E&M Unit 10

Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Capacitance and charge (2 marks)

State what capacitance measures, and explain why storing more charge does not change a capacitor's capacitance.

Question 2 Parallel plate capacitor (3 marks)

A capacitor has plates of area 0.050 m^2 separated by 1.0 mm of air and is charged to 9.0 V . Calculate its capacitance and the charge stored.

Question 3 Energy stored (3 marks)

A $220 \mu\text{F}$ capacitor is charged to 30 V . Calculate the energy stored and the average power if it discharges completely in 0.50 ms .

Question 4 Dielectric inserted (3 marks)

A 100 pF capacitor is charged to 50 V and isolated. A slab of $\kappa = 2.5$ is inserted. Calculate the new potential difference and the final energy.

Question 5 Why the field falls (2 marks)

Explain, using bound charge, why the field between plates falls when a dielectric is inserted at constant free charge.

Question 6 Coaxial capacitor (3 marks)

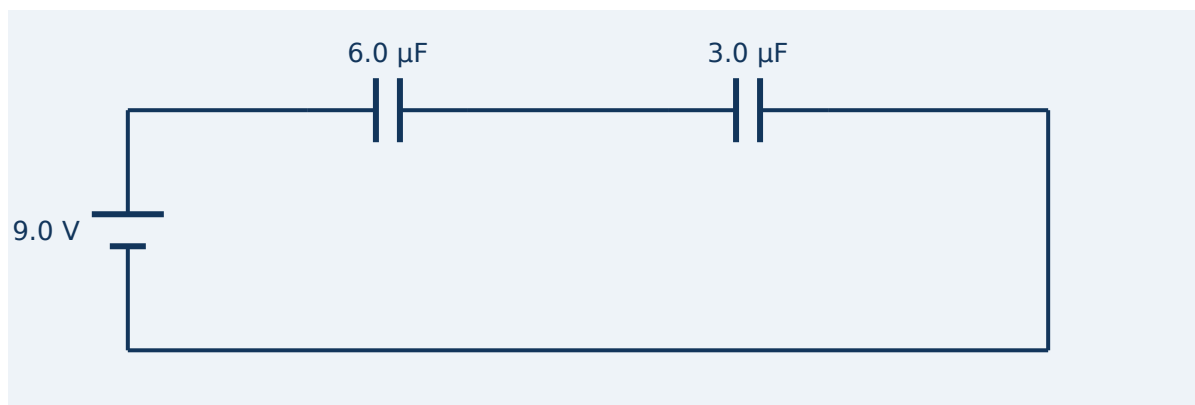
A coaxial capacitor has $a = 1.0 \text{ mm}$, $b = 4.0 \text{ mm}$ and $L = 2.0 \text{ m}$. Calculate its capacitance.

Question 7 Energy density (2 marks)

Calculate the energy density in air where the electric field is $1.2 \times 10^4 \text{ V/m}$.

Question 8 Series pair (2 marks)

The diagram shows two capacitors in series.



Series capacitors across 9.0 V.

- Calculate the equivalent capacitance. (1 mark)
- Calculate the voltage across the $3.0 \mu\text{F}$ capacitor. (1 mark)