

Storing charge and energy between two plates

AP Physics 2 (algebra-based) · Lab answers

The sample data give a gradient of $3.54 \times 10^{-13} \text{ F}\cdot\text{m}$ and ϵ_0 near $8.85 \times 10^{-12} \text{ F/m}$. If your values are different, check that your graph is straight and that you converted units, and state how large the stray capacitance was.

Level: AP Physics 2 (algebra-based) · **Curriculum:** AP P2 Unit 10

Question 1 Calculate 1/d

$d = 1.0, 2.0, 3.0, 4.0$ and 5.0 mm gives $1/d = \mathbf{1000, 500, 333, 250}$ and $\mathbf{200 \text{ m}^{-1}}$.

Question 2 Graph and gradient

Gradient = $(362 - 79) \text{ pF} / (1000 - 200) \text{ m}^{-1} = 0.354 \text{ pF}\cdot\text{m} = \mathbf{3.54 \times 10^{-13} \text{ F}\cdot\text{m}}$. The graph is straight, so C is proportional to $1/d$ plus a constant.

Question 3 Value of ϵ_0

Gradient = $\epsilon_0 A$, so $\epsilon_0 = 3.54 \times 10^{-13} / 0.040 = \mathbf{8.85 \times 10^{-12} \text{ F/m}}$, in line with the accepted value.

Question 4 The intercept

The line is $C = 0.354 \times (1/d) + c$, and at $1/d = 200$ we have $79 = 70.8 + c$, so $c \approx \mathbf{8 \text{ pF}}$. This is stray capacitance from the leads and the meter.

Question 5 Dielectric constant

$\kappa = (410 - 8) / (126 - 8) = 402 / 118 = \mathbf{3.4}$.

Question 6 Uncertainty in d

1.0 mm : $0.05/1.0 = \mathbf{5 \%}$. 5.0 mm : $0.05/5.0 = \mathbf{1 \%}$. Small gaps give the largest uncertainty, so errors affect the left of the graph most.

Question 7 Prediction

At $1/d = 100 \text{ m}^{-1}$, $C = 0.354 \times 100 + 8 = \mathbf{43 \text{ pF}}$. If the sheets bend, the real gap varies and the effective d is smaller than measured, so C reads high.