

Storing charge and energy between two plates

AP Physics 2 (algebra-based) · Lab

Name: _____ Date: _____ Class: _____

How does the capacitance of two parallel plates change as they are moved apart, and what does a dielectric do? You build a capacitor from aluminium sheets, measure its capacitance at several separations, plot C against $1/d$, and use the gradient to find the permittivity of free space.

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

Aim

To investigate how the capacitance of a parallel-plate capacitor depends on the plate separation, to estimate ϵ_0 , and to find the dielectric constant of acrylic.

Equipment

- Two aluminium sheets 0.20 m × 0.20 m, stiff and flat
- Plastic or wooden spacers of thickness 1.0, 2.0, 3.0, 4.0 and 5.0 mm
- Digital multimeter with a capacitance range (or a dedicated capacitance meter)
- Acrylic sheet 3.0 mm thick, same size
- Callipers, tape and short leads

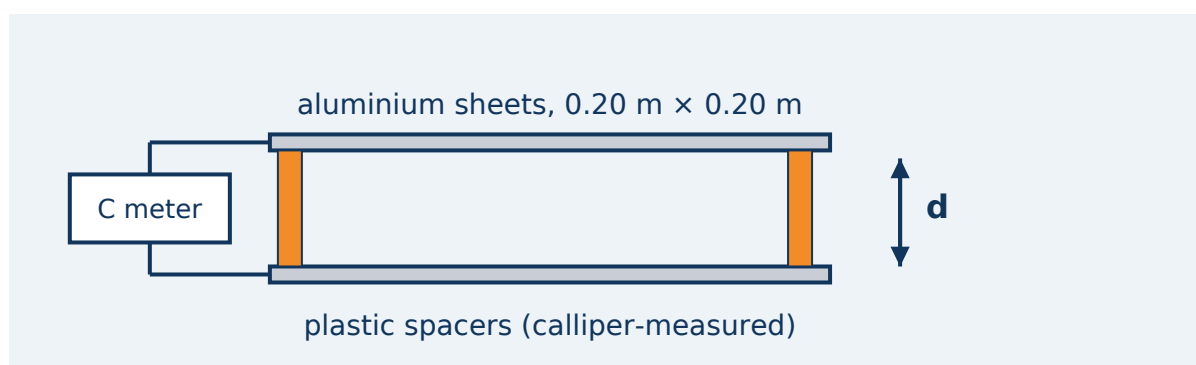
Safety

Safety

The meter supplies only a tiny test voltage, so there is no shock risk, but never connect the sheets to a mains socket or a battery with high voltage. Press the foil edges flat so that they cannot cut your fingers, and keep the sheets dry.

Method

1. Measure each spacer thickness with callipers and record it as d .
2. Lay one sheet flat, place spacers of thickness d at the corners, and lay the second sheet on top, aligned exactly.
3. Connect the meter to the two sheets, press gently on top, and read the capacitance.
4. Repeat for the other four spacer thicknesses.
5. Fill the 3.0 mm gap completely with the acrylic sheet and record the capacitance.



Two aluminium sheets, separated by spacers, form the capacitor. A meter reads its capacitance directly.

Results

Sample readings from Chiamaka's group in Lagos, with the area $A = 0.040 \text{ m}^2$, are shown.

d (mm)	1.0	2.0	3.0	4.0	5.0	3.0 with acrylic
C (pF)	362	185	126	97	79	410

Analysis questions

Question 1 Calculate $1/d$

Convert d to metres and calculate $1/d$ for each air reading.

Question 2 Graph and gradient

Plot C (vertical) against $1/d$ and find the gradient using the first and last points.

Question 3 Value of ϵ_0

Use the gradient and $A = 0.040 \text{ m}^2$ to calculate ϵ_0 .

Question 4 The intercept

Find the intercept on the C axis and suggest what it represents.

Question 5 Dielectric constant

Use the 3.0 mm results to find κ for acrylic, correcting for stray capacitance.

Question 6 Uncertainty in d

The spacers are measured with callipers to $\pm 0.05 \text{ mm}$. Find the percentage uncertainty in d for the 1.0 mm and 5.0 mm spacers.

Question 7 Prediction

Predict the reading for $d = 10 \text{ mm}$ using your line, and explain why the sheets must be flat.