UE3010800 VOLTAGE ON A PLATE CAPACITOR

EXPERIMENT PROCEDURE

- **Measuring the electrostatic voltage on a plate capacitor as a function of the distance between the plates.**
- **Confirming the proportionality between the voltage and the distance between the plates for small plate distances.**

OBJECTIVE

Measure the electrostatic voltage as a function of the distance between the plates.

SUMMARY

To increase the distance between the charged plates of a plate capacitor after removing their external connections, mechanical work must be performed. This can be demonstrated by measuring the resulting increase of the voltage between the plates using an electrostatic voltmeter.

REQUIRED APPARATUS

Quantity	Description	Number	
1	Electric Field Meter (230 V, 50/60 Hz)	**1001030**	or
	Electric Field Meter (115 V, 50/60 Hz)	**1001029**	
1	Plate Capacitor D	**1006798**	
1	DC Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)	**1003312**	or
	DC Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)	**1003311**	
1	Analogue Multimeter AM50	**1003073**	
1	Set of 15 Experiment Leads, 75 cm 2.5 mm²	**1002841**	

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BASIC PRINCIPLES

The charged plates of a plate capacitor exert an attractive force on each other. Therefore, to increase the distance between the plates of a capacitor that has been charged and its external connections removed, mechanical work must be performed. The additional energy supplied to the capacitor in this way can be measured as an increase of the voltage between the plates, provided that no current flows between the plates during the measurement.

A more precise description of this relation is obtained by considering the homogeneous electric field E between the plates of the capacitor, which carry the charges Q und $-Q$. The electric field strength is:

(1) $$E = \frac{1}{\varepsilon_0} \cdot \frac{Q}{A}$$

A: Area of each plate,

$$\varepsilon_0 = 8.85 \cdot 10^{-12} \frac{\mathrm{V \cdot s}}{\mathrm{A \cdot m}}$$: Permittivity of free space

If no current can flow if the plate distance d is changed, the charge Q and thus also the electric field E remain unchanged.

For small distances, for which the electric field can be assumed to be homogeneous, the voltage U on the capacitor and the electric field E are given by:

(2) $$U = E \cdot d$$

d: Distance between the plates.

Thus, the voltage U is proportional to the distance between the plates d. In the experiment, this relationship is tested by using the electric field meter as an electrostatic voltmeter. This method ensures that no current can flow through the voltmeter between the capacitor plates and the charge Q on the plates remains unchanged.

EVALUATION

From Equation 2, a plot of U against d will give a straight line passing through the origin and through the measurement points, with a gradient corresponding to the constant electric field E. Deviations can be attributed to the fact that the electric field can no longer be assumed to be homogeneous with an increasing distance between the plates.

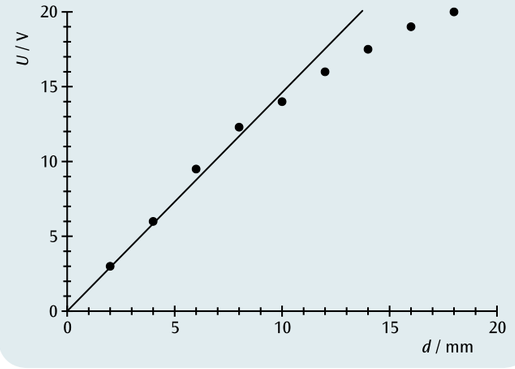

Fig. 1: Voltage U on the plate capacitor as a function of distance d between the plates.