Capacitor, Air Insulated

Aepinus

EM0938-001 Aepinus, Square Plates

Description:

This instrument is used to study the theory of capacitance and charge whilst using air as the insulation medium. The charge stored in a capacitor depends on the area of the capacitor plates, the distance between the plates and the dielectric material between them. To form an 'Air Capacitor', two large plates of known area are required to be positioned parallel to each other with air between them and the distance between the plates must be adjustable.

This Item Includes:

- 2pcs Flat Plate aluminium conductors, 200 x 200 mm square.
- 2pcs Flat Plate aluminium conductors, 283 x 283 mm square.
- 1pce Base with scale up to 160mm gap.
- 1 pce Acrylic plate, 3mm thick, 290x290mm
- 1 pce Glass plate, 3mm thick, 290x290mm

Length: 240mm	Width: 75mm	Height: 70mm	Weight: 420g

Use of the Instrument:

1) Push both sliders together and slide the pair as far as they can go. When being used, one slider remains against the end foot and the other slider is pulled back to slide over the scale.
2) Pull the front slide back along the scale so there is a big gap between the sliders. Take the pair of plates you require and notice the pillar fixed to the edge of the plate. Slide the pillar up the hole provided in the face of the sliders so that the two plates are facing each other. A strong magnet inside each slider will pull and hold the plates in position. Be sure the bottom edge of the plate is resting on the ledge provided. As the plate is pulled into position by the magnet in the slider, note the small metal pin that presses against the plate to make electrical contact. On the opposite end of each slider, away from the plates, a 4mm socket can be seen for accepting a 4mm banana plug.
3) Check that the plates are parallel to one another, fit a banana plug cable into the 4mm socket provided in each slider, connect to your power source and the instrument is now ready to use.

When the two sliders are pushed against each other, there should be no gap between the plates. The slider over the scale should be indicating zero.

NOTE: The holders for the plated have protection devices internally so the power supply is not short circuited by the touching of the plates.

As the slider is moved over the scale the gap between the plates increases and can be measured on the scale.

To remove the plates from the sliders, do not pull the plates from the sliders, but place the thumb and forefinger over the slider body so the fingers press against the rear face of the plate, then squeeze the fingers so they push the plate slightly forward. When the pin releases from the magnet in the slider, the plate can easily be removed.

The IEC 'Aepinus Air Capacitor':

Flat, rigid aluminium plates are mounted to face each other in a way that permits adjustment of the distance between their faces. Electrical connection to each disc is made by 4mm socket so that a high voltage Power Supply (IEC cat: LB2615-001) can be connected between the plates to deposit an electric charge and subsequently an Electrometer (IEC cat: LB1840-001) can be connected to measure the electric charge between them.

The plates are mounted to the sliders with excellent insulation. The plates are kept in accurate alignment and parallel with one another by the use of strong magnets pulling the plates against two flat and parallel surfaces on the faces of the sliders.

The base rail is fitted with a large and easy to read metric scale to measure the separation of up to 160mm between the two plates and a metal base provides stability on the bench during an experiment.

A sheet of glass and a sheet of acrylic are provided to place between the plates to compare the effect of different dielectric materials between the plates.

How To Use The Aepinus Capacitor:

After setting the plate area and the plate gap, a voltage is applied to the plates to fully charge the capacitor. Using the IEC 'coulomb meter', the amount of electric charge (coulombs) is measured which relates all the principles of the electric capacitor.

Performing an Experiment

The purpose of this apparatus is to study the relationship between the capacitance (in Farads), the area of capacitor plates (in sq.metres), the spacing between capacitor plates (in metres) and the medium between them (air, glass or acrylic plastic).

The relationship formula is: $C = K\,\varepsilon_0 \dfrac{A}{d}$

C = Capacitance (unit = Farads)

K = Dielectric Constant of the medium between the plates (no unit)

ε_0 = Permittivity (unit = Farad / metre)

A = Area of each plate (unit = m^2)

d = Distance between the plates (unit = m)

Permittivity:

In the case of a capacitor, permittivity Is the measurement of the difficulty of a material's ability to 'permit' an electric field to exist within it. It is a measurement of how much electric field can be created per unit Charge and it relates to the ability of charged particles in a medium to become polarised.

Inside a vacuum, the permittivity is 8.854×10^{-12} F/m (Farad / metre).

Each medium has a 'Dielectric Constant" which is a number that multiplies this Vacuum Permittivity to provide the permittivity value for that material.

Dielectric Constants of Various Materials:

Material		**Constant**
Vacuum		1
Air.		1.0006
Paraffin Paper	Used in commercial capacitors	2.3 – 3.5
Transformer oil	Used in high voltage industrial capacitors.	4
Mica.	Used in small high quality capacitors.	3 – 6
Glass	Often used in very high voltage capacitors.	5 – 10
Rubber	rarely used	2.5 – 35
Wood	rarely used	2.5 – 8
Porcelain	Some very high voltage capacitors	6
Glycerine	rarely used.	56
Pure Water (distilled)	rarely used	81

Capacitance	Usual Name
Basic name	Farad
Farad x 10^{-6}	Microfarad
Farad x 10^{-9}	Nanofarad
Farad x 10^{-12}	Picofarad

Example of Experiment: using the IEC 'Aepinus Capacitor' (Air Capacitor).

Refer to previous pages for information on how to fit and remove the plates and how to adjust the space between them. Adjust the slider to form a 10mm space between the 200mm square plates.

NOTE: The 283x283mm plate is double the area of the 200x200mm plate.

Calculate the capacitance of the system using $C = K\ \varepsilon_0\ A/d$

$C = 1.0006 \times (8.854 \times 10^{-12)}) \times (0.2 \times 0.2) / 0.01$

$C = 35.6 \times 10^{-12}$ Farads = 35.6 pF (picofarads)

Re-calculate using the 283mm square plates.

$C = 1.0006 \times (8.854 \times 10^{-12)}) \times (0.283 \times 0.283) / 0.01$

$C = 71.2 \times 10^{-12}$ Farads = 71.2 pF (picofarads)

Notice from the formula that if the plate area is doubled, the capacitance is doubled and if the space is doubled, the capacitance is halved.

Coulombs of charge = Capacitance x Voltage. $Q = C \times V$

Plug 2x cables into the 4mm socket holes provided. Momentarily touch the ends of the cables to a 100V.DC. power source so that the capacitor is charged to 100V. Using the IEC digital Coulomb Meter, discharge the Aepinus Capacitor into the coulomb meter and read the value of Nanocoulombs of electric charge.

Coulombs of charge should be 71.2 x 100 = 7120 picocoulomb or 7.120 nanocoulomb.

Try larger space between plates. Change the various factors of plate area, space between the plates and voltages applied. Predict and then prove the Coulombs of charge expected.

Change the Dielectric:

Place the glass sheet between the plates and slide the plates to press firmly against the glass medium. Using the formula above, re-calculate the charge and prove the result.

Change the dielectric to the Acrylic plastic and repeat the experiment, but, this time, measure the charge and, working in reverse, determine the Dielectric Constant of the Acrylic plastic.

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