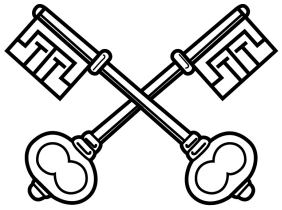
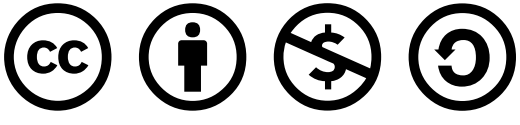


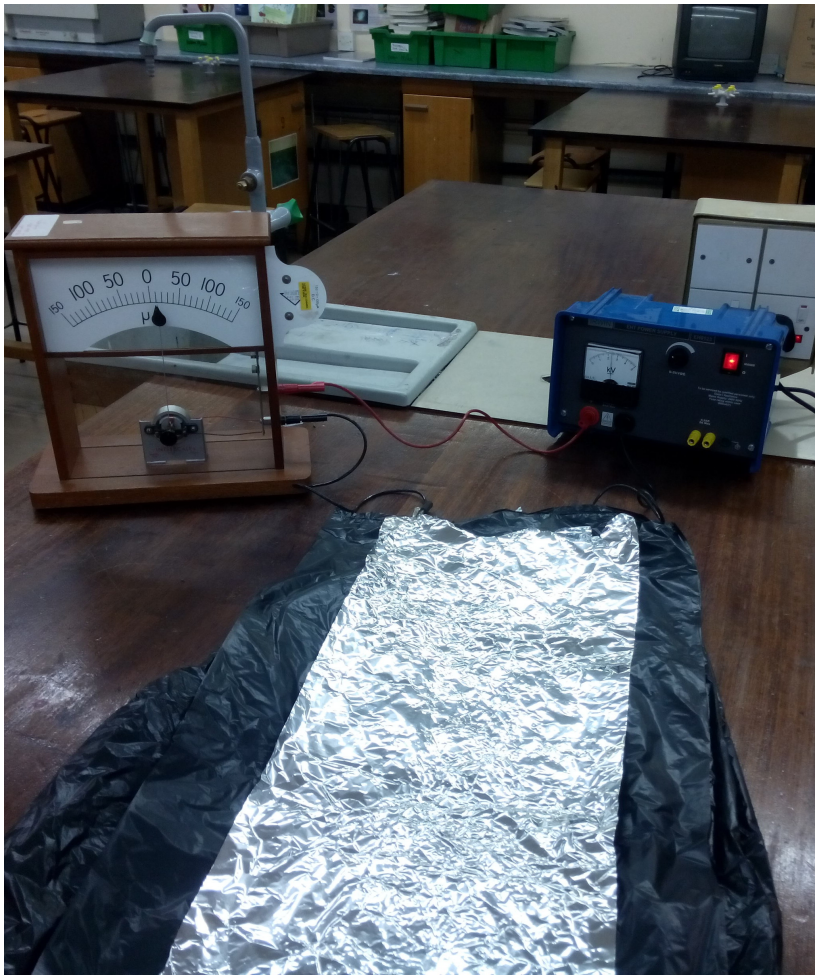
RADLEY

Capacitors

A.C. Norman



The bin bag capacitor



- Is the circuit complete?
- Will current flow when it is switched on?

RADLEY

Lesson Objectives

1. Know what a capacitor is and how it stores charge
2. Understand how capacitance is defined and its dimensions
3. Be able to work out the charge stored on a capacitor using $Q = CV$

Textbook p. 94–95

REMINDER: Office hours are week 2 Tuesdays 3.45–5.0 p.m. in room 19.

Specification Requirement

Capacitance

Definition of capacitance; $C = \frac{Q}{V}$

[AQA GCE AS and A Level Specification Physics A, 2009/10 onwards]

A simple capacitor

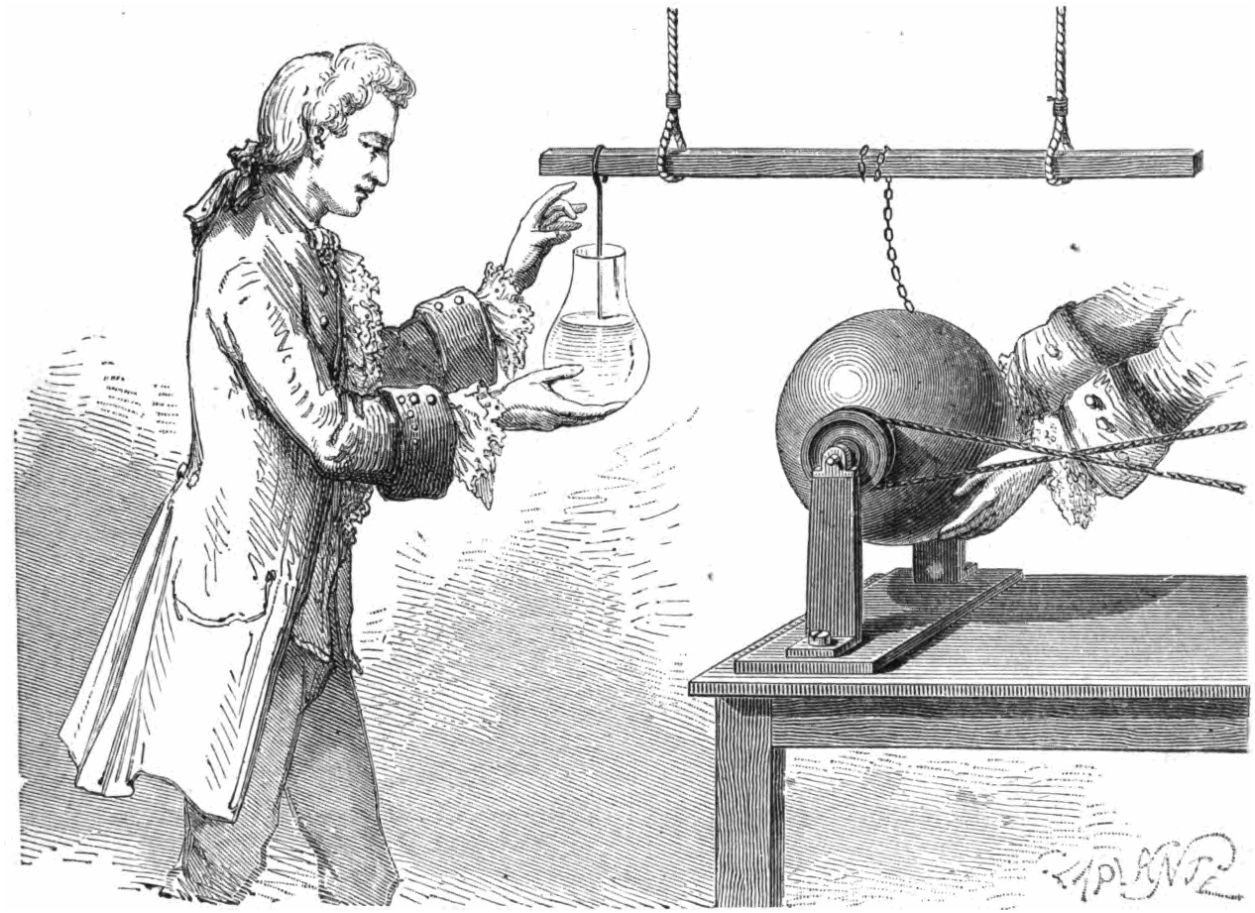
Capacitor notes

A capacitor stores .
Electrons are forced onto the plate and pulled off the plate by the power supply.
After the supply is diconnected, the capacitor can be used to supply (a bit like a battery).

Capacitor notes

A capacitor stores charge.
Electrons are forced onto the negative plate and pulled off the positive plate by the power supply.
After the supply is diconnected, the capacitor can be used to supply charge (a bit like a battery).

The first capacitor was discovered in 1745



[Image: Laplante (Public domain)]

Calculations

1. Think carefully about what you saw in the experiment. **Estimate** an upper limit for the amount of charge that is stored on each plate of the capacitor.
2. If your previous answer was the charged stored on the capacitor at 2000 V, how much charge do you think could be stored at 500 V?

Answers

1 $\approx 2 \times 10^{-6}\,\mathrm{C} = 2\,\mu\mathrm{C}$

2 $\approx 5 \times 10^{-7}\,\mathrm{C} = 0.5\,\mu\mathrm{C}$

Voltage and charge stored

To answer the last question, you made an assumption that charge stored is directly proportional to voltage.

$$Q \propto V$$

In fact, this is always true for a capacitor, so we can write

$$Q = CV,$$

where C is a constant of proportionality called the *capacitance*.

Capacitance

From the equation $Q = CV$, what can you say about the units of capacitance?

Capacitance

From the equation $Q = CV$, what can you say about the units of capacitance?

- We can rearrange $Q = CV$ to $C = \frac{Q}{V}$.
- This means the capacitance is the charge stored (coulombs) per volt

Capacitance

From the equation $Q = CV$, what can you say about the units of capacitance?

- We can rearrange $Q = CV$ to $C = \frac{Q}{V}$.
- This means the capacitance is the charge stored (coulombs) per volt
- We give this unit ($\mathrm{C\,V^{-1}}$) a special name: *Farad* (F)
- The 1 F is rather a large capacitance (like 1 C is a large charge) so normally we shall meet capacitances in μF.

Capacitor dissection

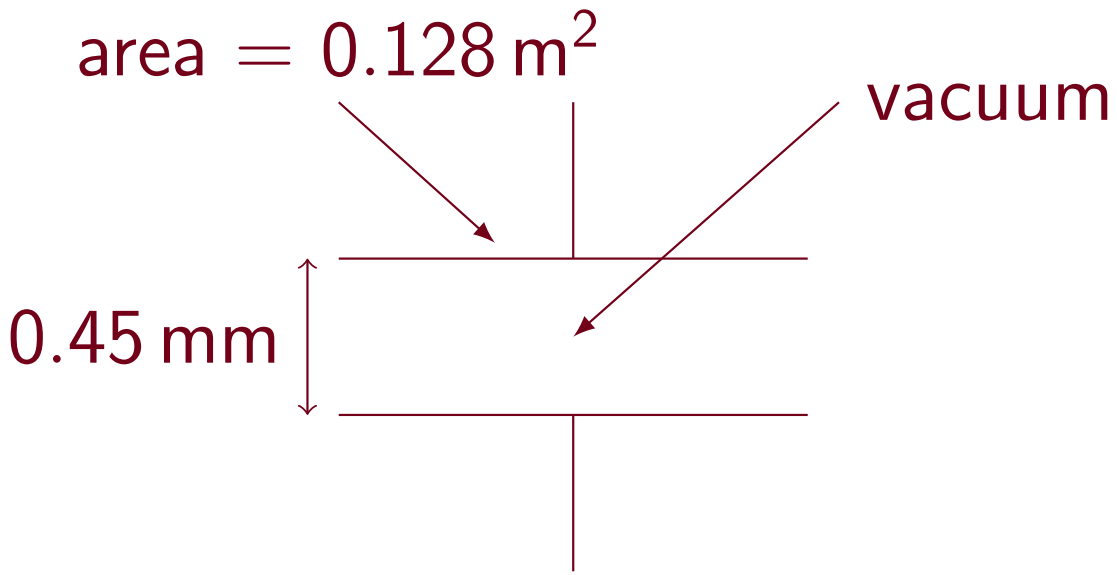
- Very similar to the bin bag capacitor
- Typical values are 10–100 µF

Uses of capacitors

- Smoothing circuits, e.g. in rectification of a.c. to make d.c.
- Back-up power supplies, e.g. for when there is a power cut
- Filtering electronic signals by frequency, e.g. in tuning a radio
- Timing circuits (more details next lesson)

Warm-up question

Calculate the capacitance of the capacitor shown



Warm-up question

Calculate the capacitance of the capacitor shown

$$
\begin{aligned}
C &= \frac{\varepsilon_0 A}{d} \\
&= \frac{8.85 \times 10^{-12}\,\mathrm{F\,m^{-1}} \times 0.128\,\mathrm{m^2}}{0.45 \times 10^{-3}\,\mathrm{m}} \\
&= 2.52\,\mathrm{nF}.
\end{aligned}
$$

Tip

- Expect your answer to be in mF at the very largest!