OCR A Physics A-Level

PAG 9.3

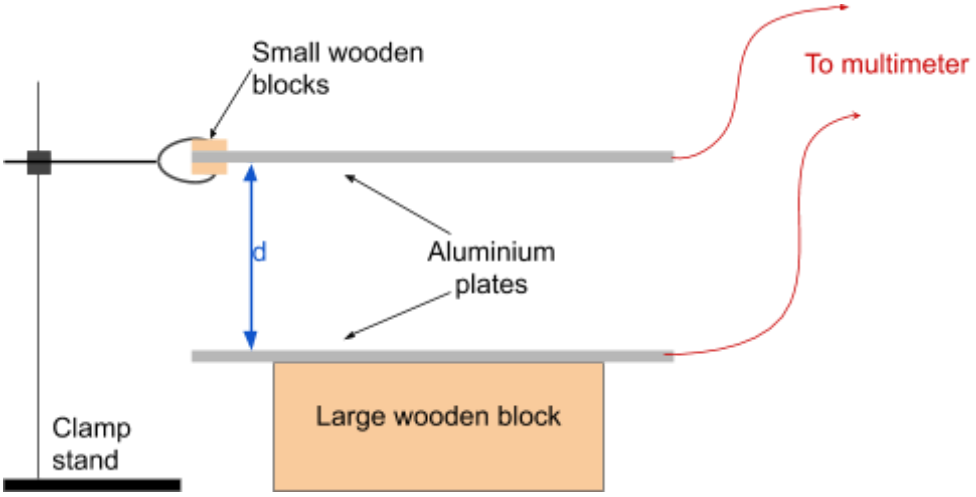
Investigating the factors affecting capacitance

Equipment

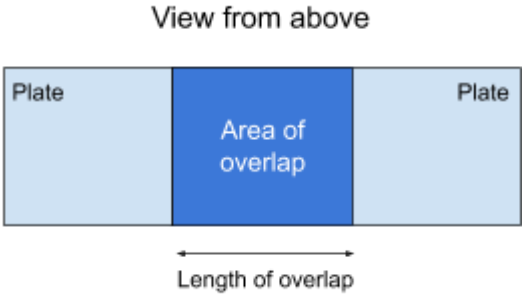
- Clamp stand
- Leads
- Multimeter
- Large aluminium plates
- Two small wooden blocks and one large wooden block
- Crocodile clips
- Metre ruler

Method

1. Set up the clamp stand and attach one of the aluminium plates to it, using the wooden blocks to insulate the aluminium plate as shown in the diagram below. Make sure the plate is parallel to the work bench.
2. Next, place the large wooden block below the aluminium plate and place the second plate on it, making sure both plates are perfectly aligned. You can do this by using a metre ruler to check the edges of the plates are in the same place.
3. Using the metre ruler, make sure the distance between the two plates (d) is 10 cm, and make sure this is kept constant throughout the experiment.



4. Measure the length and width by which the aluminium plates overlap using the metre ruler.
5. Using the crocodile clips and leads connect the two plates to a multimeter and record the capacitance.
6. Disconnect the circuit and move the large wooden block and the plate on top of it, to the right by 5 cm, making sure that the entire width of the plates still overlap.
7. Measure the new length by which the plates overlap, reconnect the circuit and measure the capacitance.
8. Repeat the last two steps until you have at least 7 readings.
9. Repeat the entire procedure twice more and find mean values of capacitance for each reading.



Calculations

- Find the area of overlap by multiplying each length by the width of the plates.
- Plot a graph of capacitance against the area of overlap (at each length of overlap), and draw a line of best fit.
- Your line of best fit should be a straight line passing through the origin, which shows that capacitance and area are directly proportional, as shown by the capacitance equation:

$$C = \frac{A\varepsilon_0\varepsilon_r}{d}$$

Where A is the area of overlap, ε_0 is the permittivity of free space, ε_r is the relative permittivity and d is the distance between the plates.

- Your line of best fit will have the equation y = mx, where y is the capacitance and x is the area, meaning that its gradient will be equal to $\frac{\varepsilon_0}{d}$ following the equation above (as the relative permittivity of air is 1).
- Therefore, you can find the value of ε_0 by multiplying the gradient of your line of best fit by the distance between the plates.

Notes

- If your line of best fit does not pass through the origin this may be because of a zero error caused by an uncalibrated multimeter or stray capacitance.
- You can investigate other factors by varying what is changed and what is kept constant in the procedure:
  - ➔ To investigate the distance between the plates (d) - vary d, and keep the area of overlap constant.
  - ➔ To investigate the relative permittivity between the plates (ε_r) - vary the insulator placed between the two plates whilst keeping the area of overlap and distance between the plates constant.