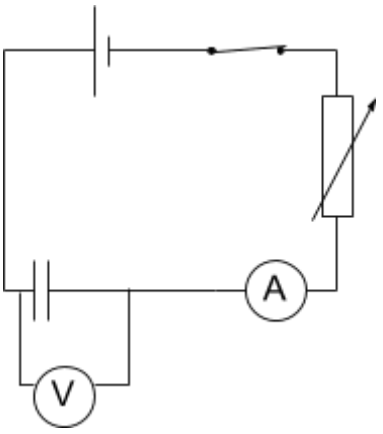
OCR A Physics A-Level

PAG 9.2

Investigating capacitors in series and parallel combinations using ammeters and voltmeters

Equipment

- Capacitors x 2
- Cell
- Voltmeter
- Ammeter
- Switch
- Variable resistor
- Stopwatch

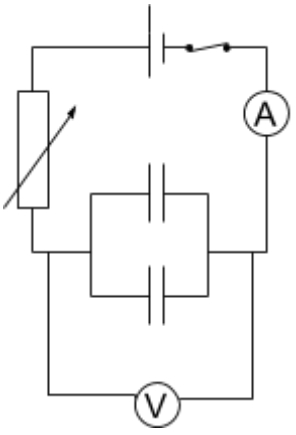


Method (Part 1)

- Set up the circuit as shown to charge the capacitor which is represented by the 2 parallel lines of equal length.
- Closing the switch allows current to flow, adjust the variable resistor to keep the current constant for as long as possible.
- Record the value of the constant current as well as the potential difference and the time since closing the switch in a table.

Calculations

- To calculate the charge (C) across the capacitor, multiply the fixed charging current (A) value by the time in seconds since the switch was closed.
- Plot a graph of charge (C) against voltage (V) and draw a line of best fit.
- Find the gradient of the line of best fit, this is the capacitance of the capacitor in farads.

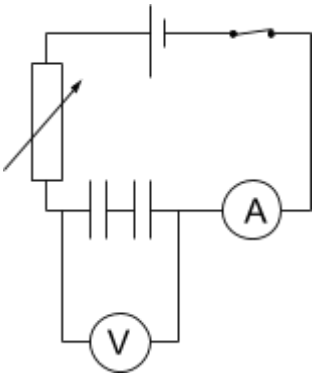


Method (Part 2)

- Set up the circuit as shown to charge the 2 capacitors in parallel.
- Repeat the procedure from above, once again recording the time since the switch was closed and the corresponding voltage and current at this point.

Calculations

- Once again, plot a graph of charge against voltage for each time and calculate the gradient to find the combined capacitance of the 2 capacitors.
- You should find the combined capacitance of the 2 capacitors in parallel is the sum of their individual capacitances.



Method (part 3)

- Set up the circuit as shown to charge the two capacitors in series.
- Repeat the previous steps of charging at a constant current and recording voltage and time since the switch was closed.

Calculations

- Calculate the charge (Q) stored by the capacitor using Q=It for each time (where I is the constant current and t is the time since the switch was closed).
- Plot a graph of charge against voltage and calculate the gradient to find the combined capacitance of the two capacitors.
- You should find that if the capacitors are of the same capacitance then the combined capacitance is half the capacitance of one.
- This is because the combined capacitance (C) for capacitors in series is given by: $\mathbf{1/C = 1/C_1 + 1/C_2 + \ldots 1/C_n}$

Notes

- Using a data logger to record voltage and current will be more efficient and convenient as the data logger can calculate the charge (Q=It) in real time and plot a real-time graph of charge against voltage.
- It will be impossible to keep the current constant once the capacitor is fully charged, only use the values for which current is approximately constant when drawing your graph.
- Check before closing the switch that there is no systematic error in the voltmeter or ammeter.