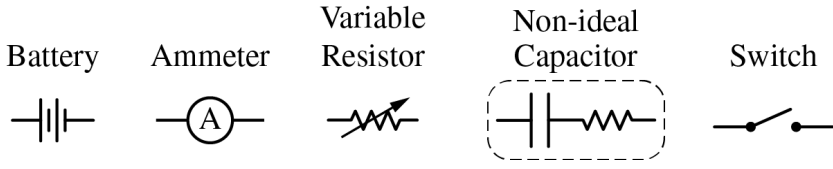


. A non-ideal capacitor has internal resistance that can be modeled as an ideal capacitor in series with a small resistor of resistance r_C . A group of students performs an experiment to determine the internal resistance of a capacitor. A circuit is to be constructed with the following available equipment: a single ideal battery of potential difference ΔV_0 , a single ammeter, a single variable resistor of resistance R , a single uncharged non-ideal capacitor of capacitance C , and one or more switches as needed.



(a) Using the symbols shown, draw a schematic diagram of a circuit that can charge the capacitor and may also be used to study the current through the capacitor as it discharges through the resistor.

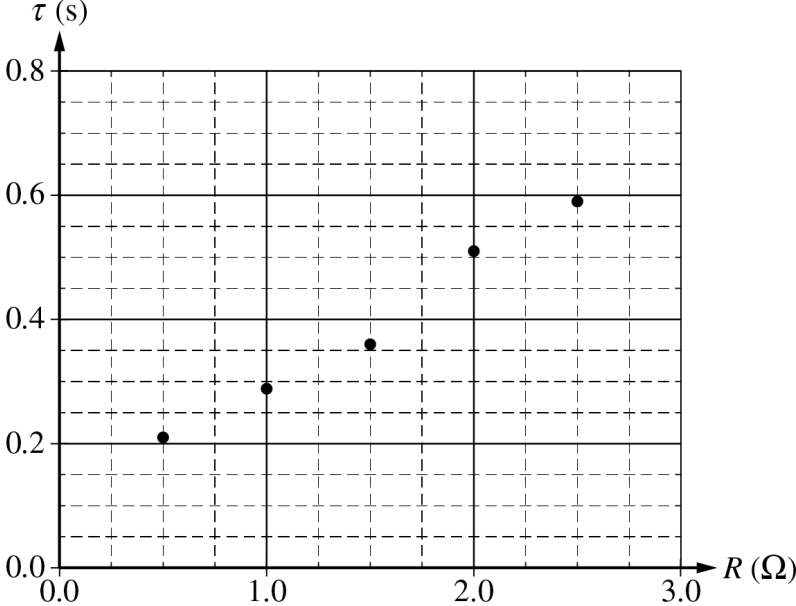
The capacitor is fully charged by the battery. At time $t = 0$, the capacitor starts discharging through the resistor.

(b) Show that the current I through the capacitor as a function of time t is $I(t) = I_0 e^{\frac{-t}{(R+r_C)C}}$ as the capacitor discharges.

GO ON TO THE NEXT PAGE.

Continue your response to **QUESTION 2** on this page.

(c) The students determine the time constant τ for the circuit as a function of the resistance R . The students' data are shown in the following graph.



- i. Draw the best-fit line for the data.
- ii. Using the best-fit line, calculate a value for the internal resistance r_C of the capacitor.

GO ON TO THE NEXT PAGE.

Continue your response to **QUESTION 2** on this page.

(d) The ammeter is found to be nonideal. Is the actual value for the internal resistance r_C for the capacitor greater than, less than, or equal to the experimental internal resistance of the capacitor calculated in part (c)?

___ Greater than ___ Less than ___ Equal to

Briefly justify your answer using features of the graph in part (c).

(e) The values of the variable resistor in the original experiment ranged from $0.5\ \Omega$ to $2.5\ \Omega$. The experiment is repeated with values ranging from $3.0\ \Omega$ to $6.0\ \Omega$. Would the slope of the best-fit line be more steep, be less steep, or remain unchanged compared to the graph in part (c)?

___ More steep ___ Less steep ___ Remain unchanged

Briefly justify your answer.

GO ON TO THE NEXT PAGE.