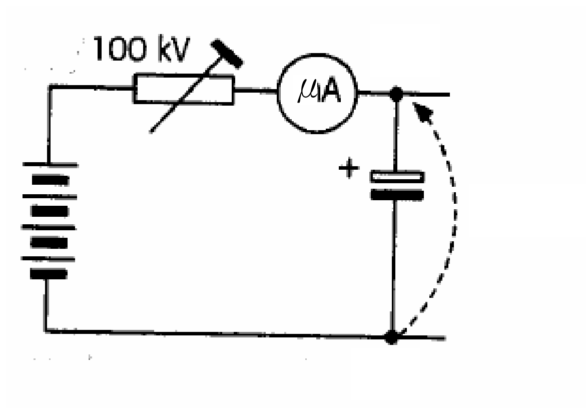
Mok Man Hin 7B (19)

C8 Study of charging capacitor at constant rate

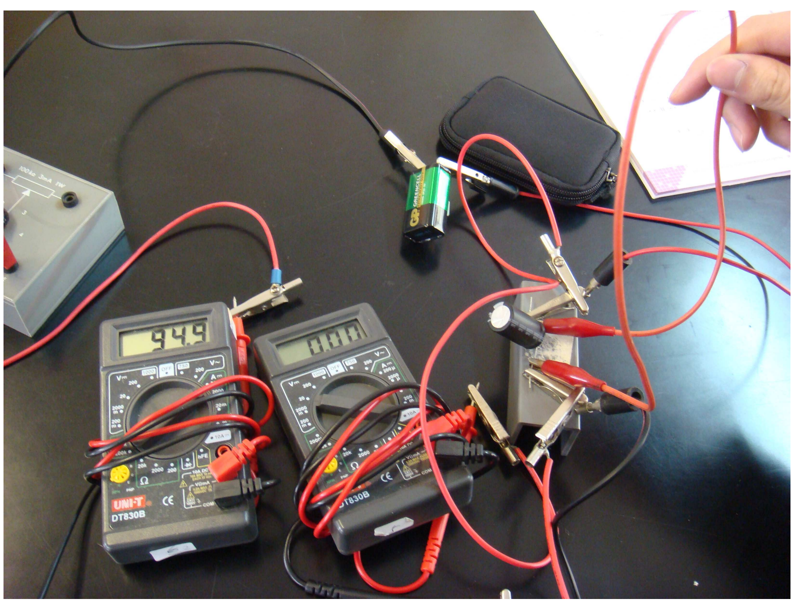
Procedure

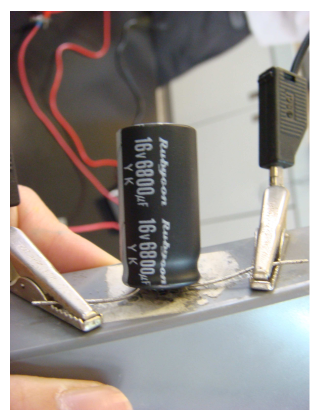
1. Connect the circuit as shown.



2. Connect a CRO across the capacitor in the circuit. Set the CRO to d.c. and the Y-gain to 1 V/DIV. Adjust its time base and Y-shift to obtain a steady horizontal trace on the bottom of the screen.
3. Connect both sides of the capacitor with a wire to short it. Adjust the potentiometer to obtain a suitable current, say 80 μA, shown by the microammeter. Record the current as I.

   Current (I) = **95.0** μA



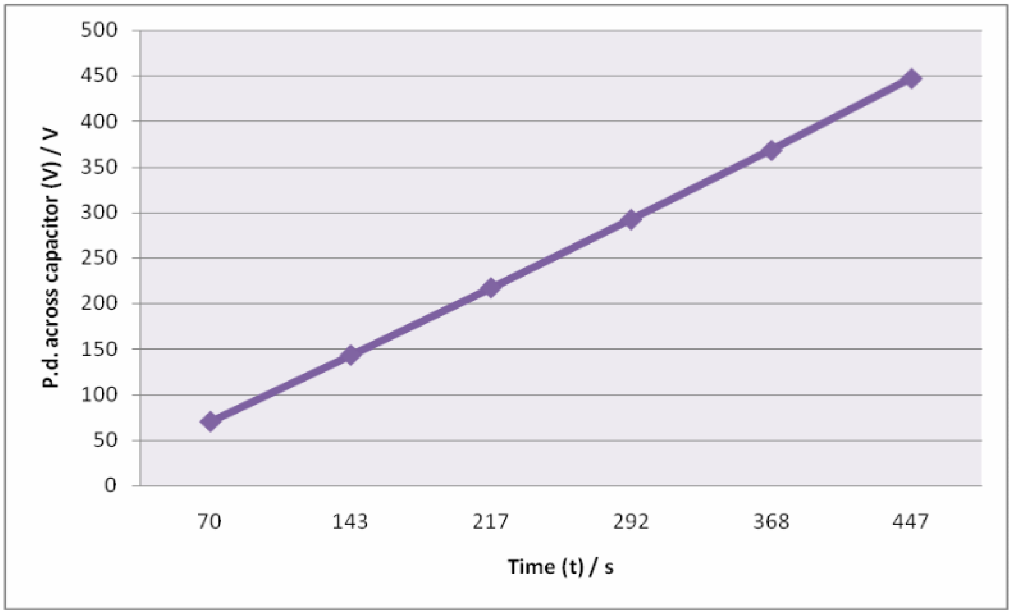


4. Disconnect the wire across the capacitor to let it charge up.
5. Repeat steps 3 and 4 but this time keep the charging current constant as I in step 3 by adjusting the potentiometer continuously. Record the time (t) for the CRO trace to rise in

steps of 1 V by using a stop watch. Tabulate the results.

P.d. across capacitor (*V*) / V	**1.0**	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**
Time (*t*) / s	**70**	**143**	**217**	**292**	**368**	**447**

6. Plot a graph of potential difference (*V*) across the capacitor against time (*t*). Find the slope of the graph.



Slope = V/t = 6/447 = 0.0134 A/F

Apparatus:

Multimeter x 2	Camera x 1
Battery x 1	Clips & wires x1
6800μF capacitor x 1	Variable resistor x 1

Theory

The charge stored (Q) on a capacitor: Q = CV

Definition of current: I = dQ/dt

I = C (dV/dt)

Since I = constant, C is charged at a constant rate.

Results and Discussion

1. From the *V*-*t* graph in step 6, determine the relationship between the potential difference across the capacitor and the time.

   The potential difference across the capacitor increases is proportional to the increases of time.

2. What does the slope of the *V-t* graph represent?

   C = Q/V where Q = It

   C = It/C

   V/t = I/C

   Slope of the graph represent the current per unit capacitance, 6/447 = 0.0134 A/F.

3. Compare the measured capacitance of the capacitor with the value marked on it. Calculate the percentage error.

   Marked capacitance: 6800 μF

   Measured capacitance: Slope = I/C

   0.0134 A/F =95.0 μA /C

   C= 7077.5 μF

   Percentage error: (7077.5 – 6800)/ 6800 x 100% = 4.08%

4. Determine the relationship between the charge stored in the capacitor and the potential difference across it when the charging current is a constant.

   When the charging current is a constant at 95.0 μA, the potential difference across the capacitor decreases as the capacitance increases in accordance with Q = CV.

5. State the sources of error and suggest improvements for this experiment.

   - The current is not kept at constant, hence takes the middle part of the data for plotting graph to obtain a more reliable straight line because the charge up would be faster in the end.
   - In order to completely discharge the capacitor, the capacitor is shorted with a wire.
   - The time constant affects the rate of charging of a capacitor. It takes infinite time to have completed charging of the capacitor theoretically, but practically capacitor is approximately charged up after 5 time constant. Therefore, appropriate value of capacitance should be chosen.
   - We should set the correct unit for the multimeter, otherwise the meter will be burst.
   - The resistance in wires, is extremely small by comparing with the variable resistor, can be neglect.
   - Multimeter may charge up the capacitance.
   - Take a video for easily obtaining data.

