Time Constants

Set up a series circuit consisting of a smooth DC supply, a resistance substitution box and an electrolytic capacitor (on a breadboard, see fig 1 below).
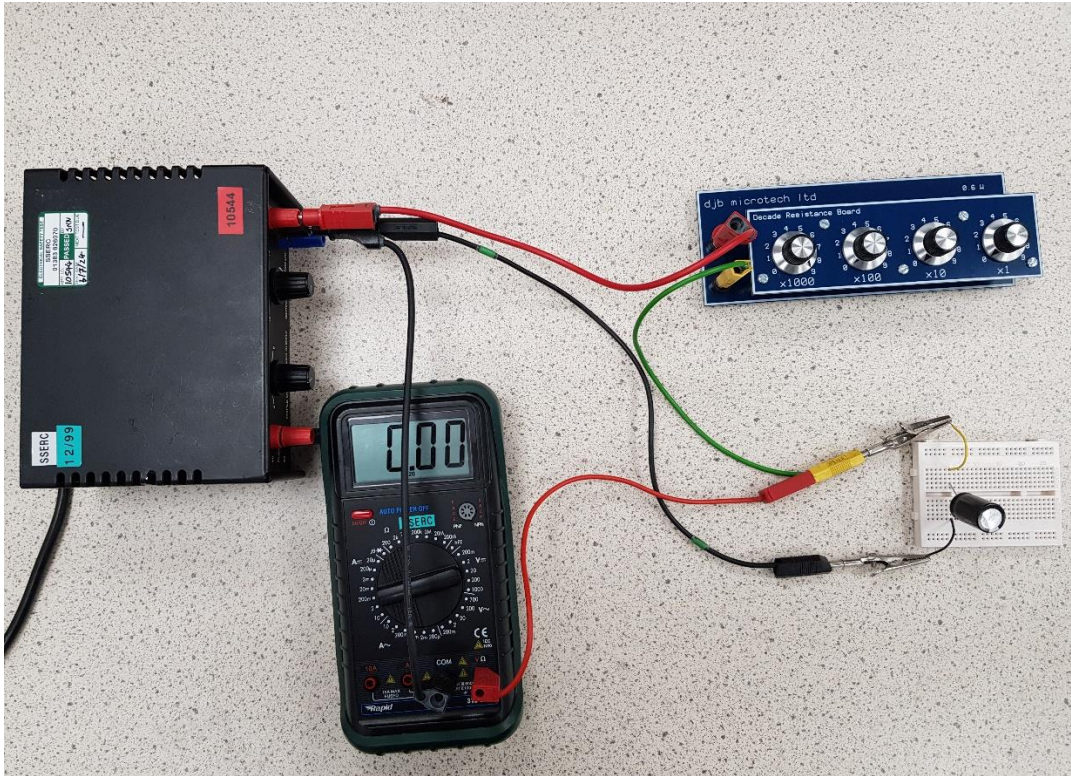

Fig 1 experimental set up

Use the multimeter to initially set the output voltage from the power supply to a known, accurate value. 12.0V in this example. Remove the voltmeter and reconnect it to measure the voltage across the capacitor. You will also need a stopwatch, timer or mobile phone with a stopwatch function.

With the power supply switched off short the capacitor briefly to ensure the voltmeter reads 0v.

Calculate 63% of the voltage you set the power supply to (in our case 7.56V). Switch on the power supply and simultaneously start the stopwatch. Stop the stopwatch when the voltmeter exceeds the 63% voltage calculated above. Note the value of the resistance from the decade box the value of the capacitor used and the time taken to reach the 63% voltage level.

Repeat this for other values of resistance (1000Ω - 9000Ω in our example).

Plot a graph of resistance on the x-axis v time on the y-axis (See fig 2).

This should result in a straight line with a gradient equal to the value of the capacitance in the circuit.

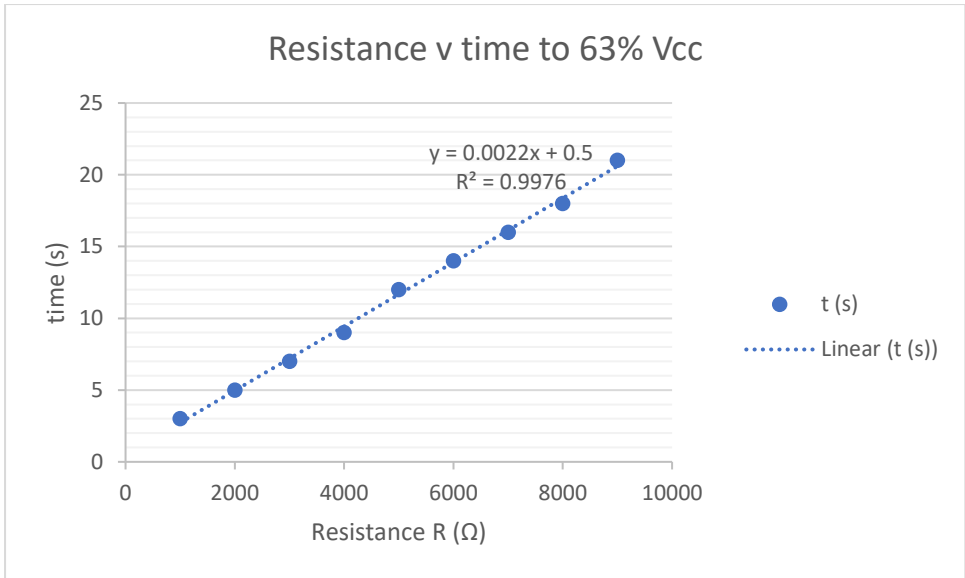Fig 3 shows the capacitor used indicating the stated value.
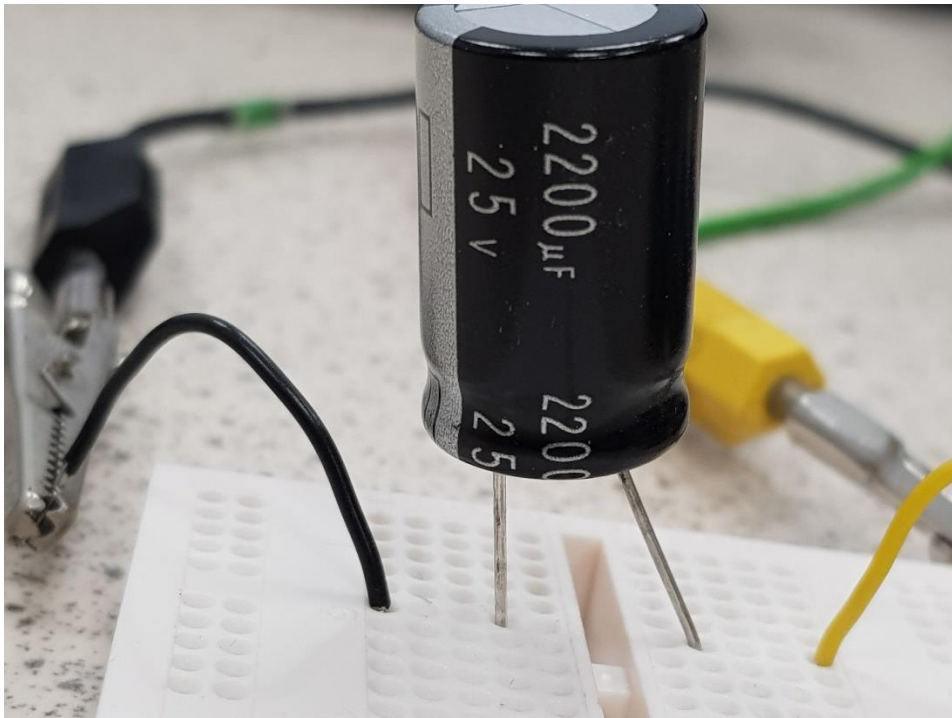
Fig 2 Resistance v time graph

Fig 3 Capacitor used.

Replace the decade resistance box with a fixed value resistor (20kΩ) and plug in different values of electrolytic capacitor (see figs 4&5) and repeat the experiment noting the value of the capacitor, the value of the fixed resistance and the time to reach the 63% voltage level.
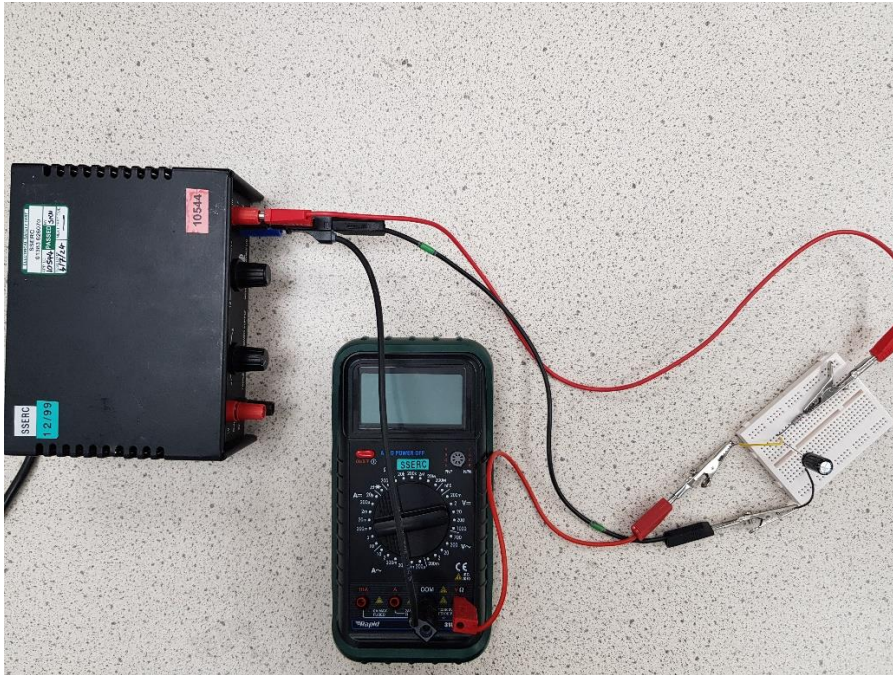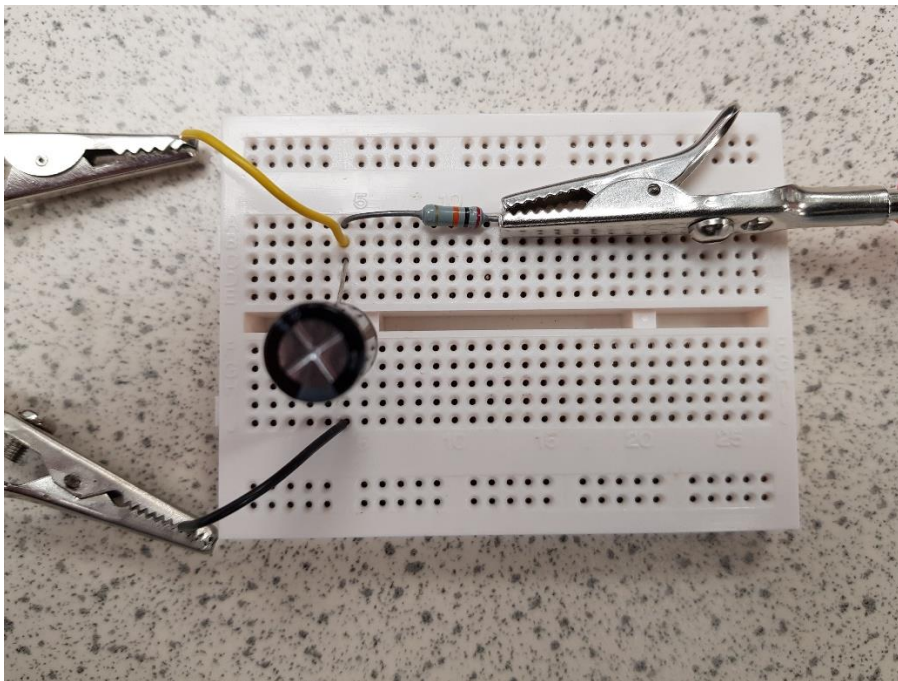
Fig 4

Fig 5 showing a fixed 20kΩ resistor being used

Plot the value of the capacitance used on the x-axis and the time on the y-axis (see fig 4 below). The gradient of this graph should equal the value of the fixed resistor. In fig 6 below the gradient is 20290 as the capacitance is plotted in μF.

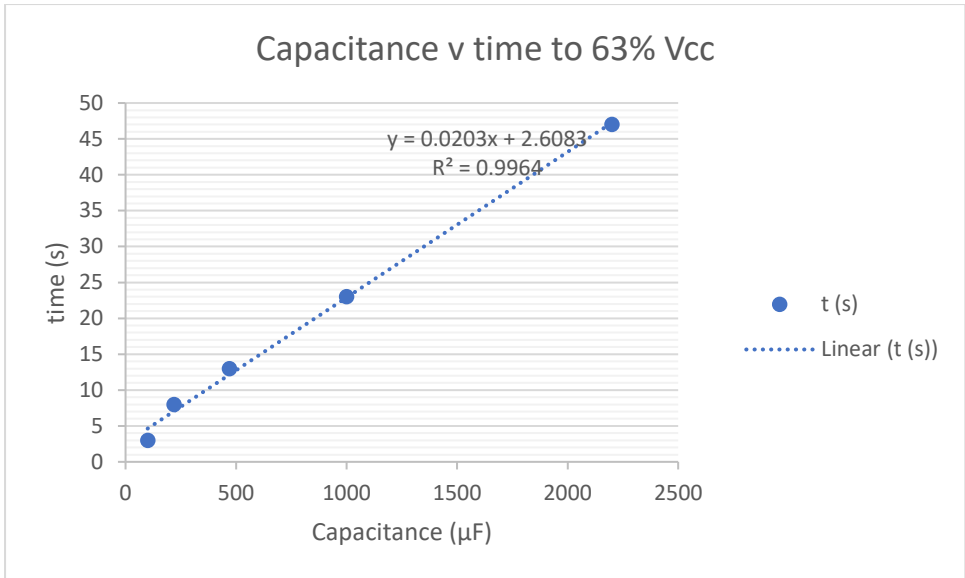This is within the stated tolerance of the 20kΩ resistor used.

Fig 6 Capacitance v time graph

Some typical results from this experiment are shown in the screenshot of the spreadsheet as shown in Fig 7 below.
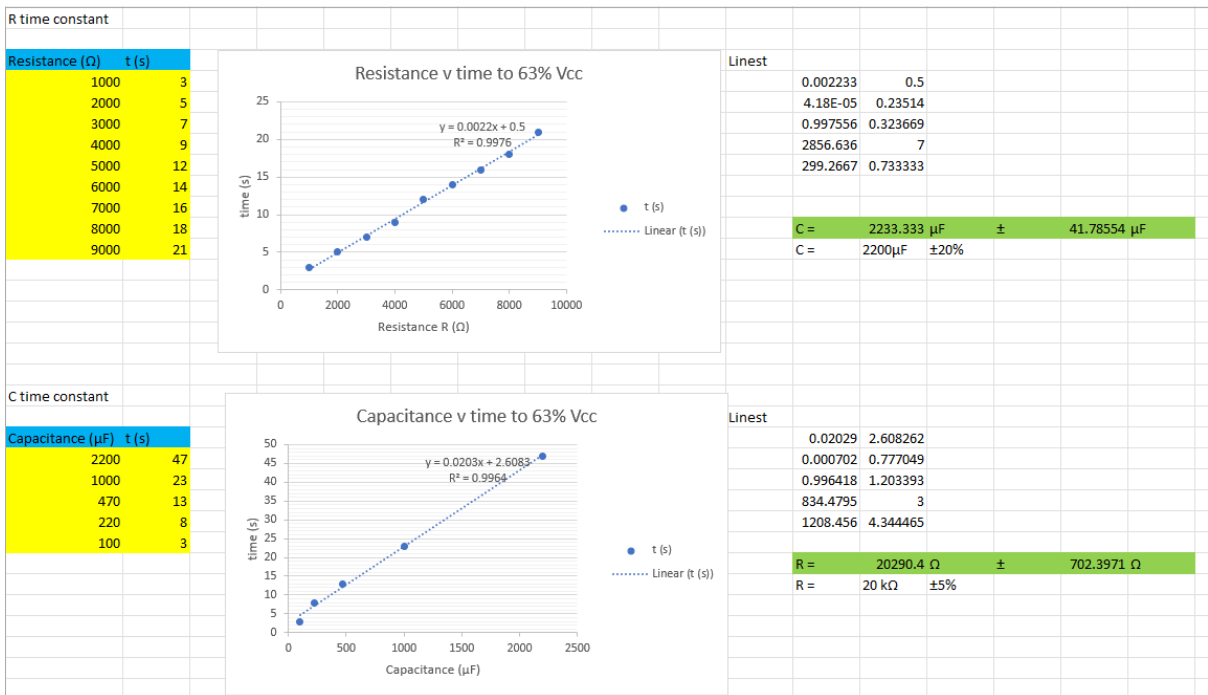

Fig 7 Typical results.