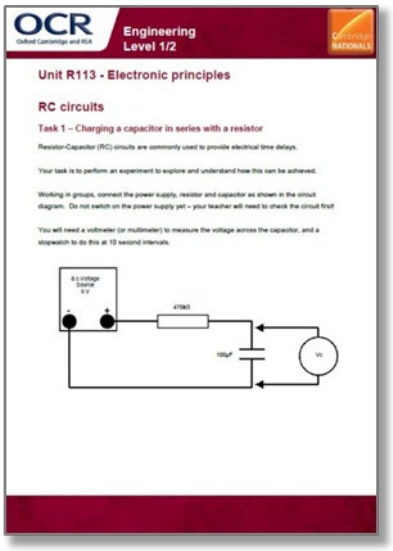
Unit R113 – Electronic principles

RC circuits

Instructions and answers for teachers

*These instructions should accompany the OCR resource **'RC circuits'** activity which supports OCR Cambridge Nationals in Engineering.*



The Activity:

This resource comprises of 2 tasks.

This activity offers an opportunity for maths skills development.

Associated materials:

'RC circuits' activity sheet
'Data examples' Excel file

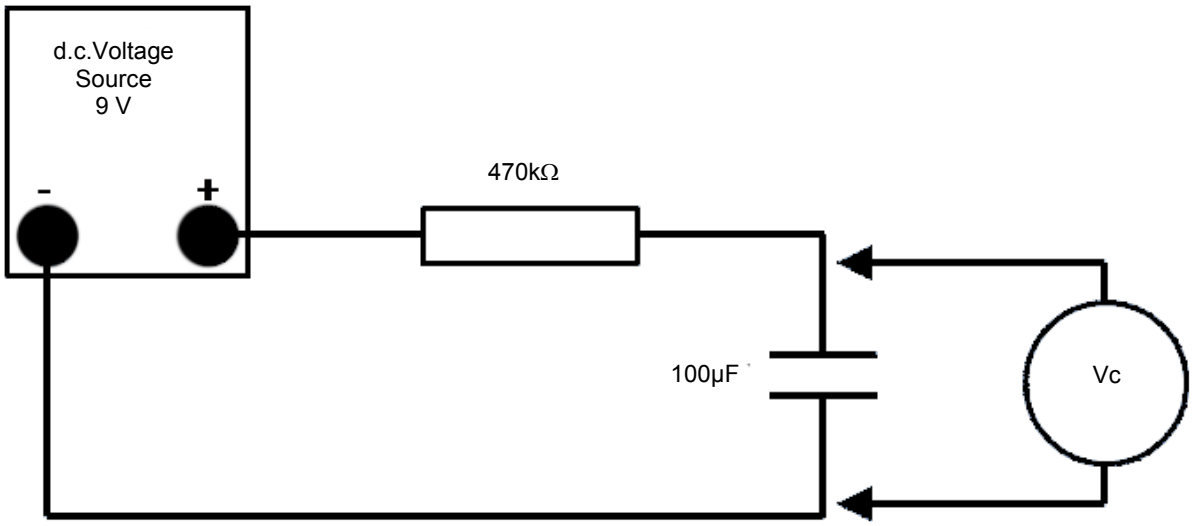
Suggested timings:

Tasks 1 and 2: 2 hours

Task 1 – Charging a capacitor in series with a resistor

The teacher could set the context of where RC circuits might be found in everyday electrical item to produce time delays. This could be in form of a group discussion. Typical applications might include security light time delays, bathroom fan timers or intermittent car wipers.
Before undertaking the Task learners will probably need an introduction to, and some background information on RC circuits. Internet sources may prove useful in showing the theory behind RC circuit including charging a capacitor and time constant.
For example: http://www.youtube.com/watch?v=pyfKKVkKngY

For Task 1 learners are required to work in groups to undertake a simple experiment using a voltage source, capacitor and resistor.



Learners will require:

- 9v d.c. supply (could be a battery)
- 470kΩ resistor
- 100 μF capacitor
- Voltmeter (or multimeter on voltage range)
- Connecting wire
- Stopwatch or timer

The experiment requires learners to:

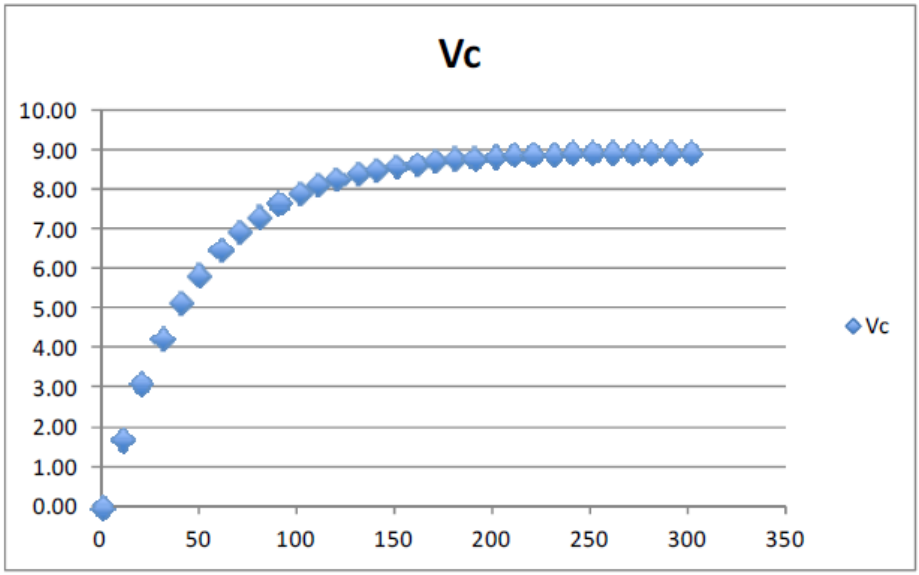
- Tabulate and plot (charging) voltage across the capacitor
- Comment on the shape of the graph – an exponential
- Determine the circuit time constant – given by RxC
- Determine in how many time-constant periods the capacitor can be considered fully charged

The teacher should check that the circuit is correctly connected before the learner connects the supply.

Learners can plot the graph using graph paper, or use software such as Microsoft Excel. This will develop learners' ICT skills.

1. What do you notice about the shape of the graph?

The graph will be an exponential function (curve):



2. What is the time constant for the circuit (given by C x R)?

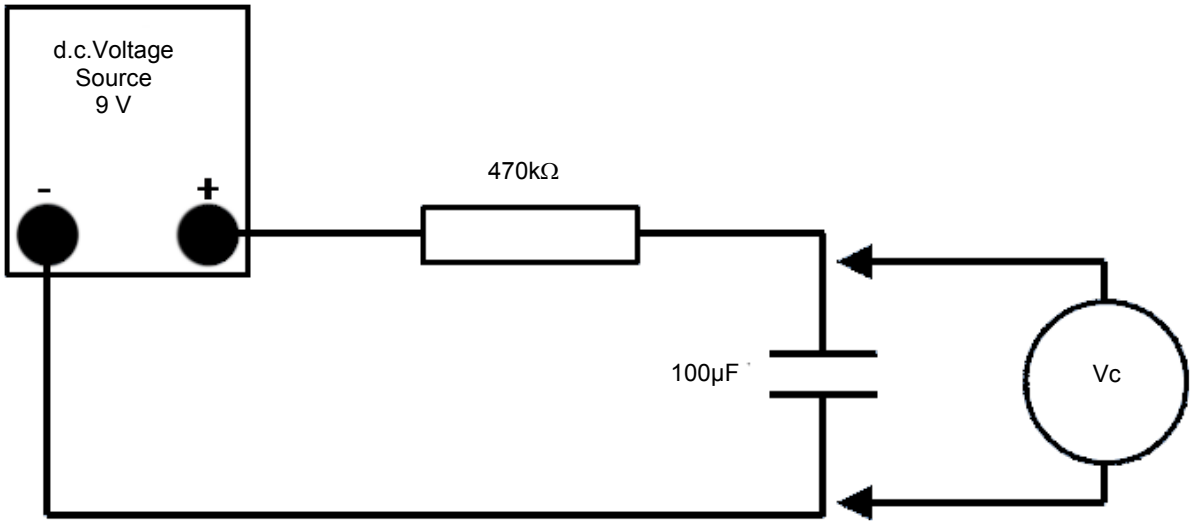
The time constant for the circuit is C x R (learners will need to know that resistance is in kiloohms and capacitance is in microfarads in order to calculate this). The time constant is 47 seconds.

3. How does the time for the capacitor to fully charge (to approximately 9v) relate to the time constant C x R?

Learners should be able to identify that it takes approximately 235 seconds for the capacitor to charge fully, and this is approximately 5 x time constants.

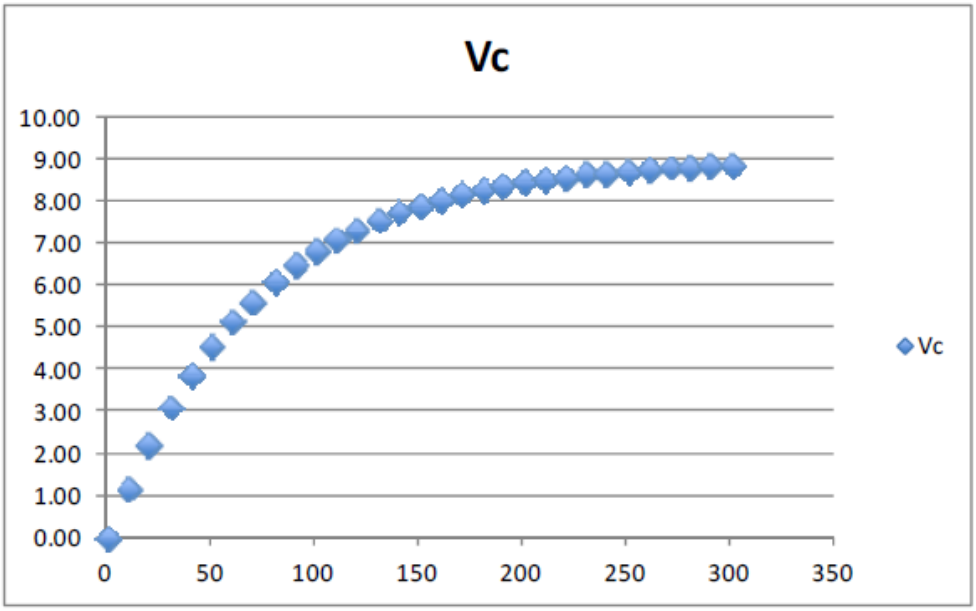
Task 2 – Effects of varying the value of C in the circuit

In Task 2, learners will repeat the experiment from Task 1 this time with a larger value capacitor (150 µF).



1. What do you notice about the shape of the graph this time – how has it changed from that plotted in Task 1?

The shape of the graph is still an exponential function (curve) – but in this case the capacitor takes longer to charge up.



2. What has been the effect on the circuit time constant by making the value of C bigger?

The time constant for this circuit is 70.5 seconds.

3. Does the capacitor charge fully (to approximately 9v) in 300 seconds – and if not how long will it take?

Following on from Task 1 – the capacitor can be considered charged in 5 x time constants, which is 352.5 seconds. The capacitor does not fully charge in 300 seconds.

4. If the value of the capacitor cannot be changed, what is another way of changing the circuit time constant?

If C cannot be changed in the circuit then another way of altering the time constant is by varying R. This is what is typically what is done in everyday appliances discussed at the start of the lesson, where a variable resistor is used to alter the time delay.

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