Module 6: Capacitors

This section introduces the basic properties of capacitors and how they are used in electrical circuits. The use of capacitors as a source of electrical energy is then developed. This section introduces the mathematics of exponential decay, which is also required for the decay of radioactive nuclei in 6.4. This section provides knowledge and understanding of capacitors and exponential decay. Experimental work provides an excellent way to understand the behaviour of capacitors in electrical circuits and the management of safety and risks when using power supplies (HSW4). There are many opportunities for learners to use spreadsheets in the analysis and presentation of data (HSW3). The varied uses of capacitors give the opportunity for the consideration of their use in many practical applications (HSW2, 5, 6, 9).

| Specification reference | Checklist questions |
| --- | --- |
| 6.1.1 a | Can you explain capacitance, *C* = ? |  |
| 6.1.1 a | Can you define the unit farad? |  |
| 6.1.1 b | Can you describe charging and discharging of capacitors in terms of the flow of electrons? |  |
| 6.1.1 c | Can you demonstrate the total capacitance of capacitors in series, …? |  |
| 6.1.1 d | Can you demonstrate the total capacitance of capacitors in parallel, *C* = *C*1 + *C*2 + …? |  |
| 6.1.1 e i | Can you describe an analysis of circuits containing capacitors? |  |
| 6.1.1 e ii | Can you understand an investigation of circuits containing capacitors? |  |
| 6.1.2 a | Can you understand p.d.–charge graphs for capacitors? |  |
| 6.1.2 b | Can you describe how energy is stored by capacitors? |  |
| 6.1.2 b | Can you demonstrate that *W* =  *QV* = *V2C*? |  |
| 6.1.2 c | Can you describe the use of capacitors to store energy? |  |
| 6.1.3 a i | Can you describe discharging a capacitor through a resistor? |  |
| 6.1.3 a ii | Can you investigate the charge and the discharge of a capacitor? |  |
| 6.1.3 b | Can you explain the time constant *CR* of a capacitor–resistor circuit? |  |
| 6.1.3 c | Can you demonstrate *x* = *x0* and *x* = *x0* (1 – ) for capacitor–resistor circuits? |  |
| 6.1.3 d | Can you demonstrate the modelling of the equation  for a discharging capacitor? |  |
| 6.1.3 e | Can you explain exponential decay and the constant-ratio property of decay graphs? |  |

**Homework and Independent Study**

HW: Assessed past-paper questions. Kerboodle online task(s)

Revision: As part of Module 6.1 – 6.3 topic test (*Capacitors, Electric Fields and Electromagnetism*)

IS: Textbook summary questions on each sub-topic, to self-assess.

Zig-zag module 6 booklets for revision and IS. *Answers distributed at end of topic.*

Use of online resources including physicandmathstutor.com, Seneca Learning and Kerboodle textbook, Chapter 21. Practise past-paper questions at the end of topic (textbook pages 443-45).

**Key Terms**

**Capacitance**: The charge stored per unit pd in a capacitor.

**Capacitor**: An electrical component that stores charge. A parallel-plate capacitor is made of two parallel conducting plates with an insulator between them (dielectric).

**Capacitors in Parallel**: When capacitors are connected in parallel, their individual capacitances are summed to give the total capacitance.

**Capacitors in Series**: When capacitors are connected in series, the total capacitance is equal to the inverse of the sum of the inverses of the individual capacitances.

**Energy Stored by a Capacitor**: Equal to half the product of the charge stored and the capacitance. This can be found from the area under a charge-voltage graph.

**Farad**: The unit of capacitance.

**Time Constant**: The product of the circuit resistance and capacitance. It is the time taken for the voltage to discharge to 1/e (or 36.8%) of its initial charge.