IGCSE Co-ordinated Sciences 0654
Unit 23: P16 Electrons, P17 Radioactivity, P20 Electronics

Recommended Prior Knowledge
Students should have some knowledge of atomic structure, including the location and nature of sub-atomic particles, and be able to construct simple electrical circuits.

Context
This Unit should be taught after Topics P7 and P8.

Outline
Thermionic emission and the properties of cathode rays are used as an introduction to the development of television. The nature of radioactivity is explored in terms of the properties of different types of radioactive emission, half life and the use of radio-isotopes. Simple electronic circuits are made and their applications considered.

AO	Learning outcomes	Suggested Teaching activities	Learning resources
AB	Appreciate that the behaviour of the thermionic diode can be interpreted in terms of negatively-charged particles given off from a heated tungsten wire.	Use a demonstration diode to show thermionic emission. Use a deflection tube and Helmholtz coils to demonstrate deflection of cathode rays in magnetic and electric fields.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 50. *IGCSE Study Guide for Physics* by Mike Folland Topic 4.
AB	Recognise that the electron, as a basic component of the atom, could be the particle carrying an electric current in a thermionic diode and also the particle responsible for carrying charge round an electric circuit.		Thermionic emission: http://www.answers.com
ABC	Appreciate that a flow of negatively charged particles (electrons) is the best solution in explaining the behaviour of a thermionic diode.	For students who are also following the extended curriculum, much of the work can be presented as a problem-solving activity: (i) solving the problem of how a television receiver can produce pictures,	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 50. *Teaching and Assessing Practical Skills in*

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		(ii) solving the problem presented by electron tubes which can apparently conduct an electric current through a vacuum. Even if equipment to demonstrate (ii) is not available, the observations can be described, or shown on video or film.	*Science* by Dave Hayward. *IGCSE Study Guide for Physics* by Mike Folland Topic 4.
AB	Understand how charges produced by friction can be understood in terms of an electron transfer.	Students following the extended curriculum can use the model of atoms which can gain or lose electrons to explain electrostatic phenomena encountered in P7. This model can also help students to understand the nature of positive and negative ions.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 37.
AB	Understand how the production of electrons from a heated wire has led to the cathode-ray oscilloscope and the possibility of television.	For students following only the core curriculum, it is probably sufficient to describe or demonstrate experiments with electron beam tubes. These observations can then be used to explain the inner workings of a television receiver. Lead on from the deflection tube (see above) to the c.r.o. and demonstrate its use (e.g. in displaying frequency and amplitude of sound waves, as in Waves unit). The first web site can be used by students to simulate using a c.r.o.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 50. This site enables students to control a wave on an oscilloscope screen. http://www.phy.ntnu.edu How does a TV work? http://www.wisegeek.com
AB	Appreciate that radiations from radioactive materials are capable of breaking up other atoms and molecules.	Use a Geiger tube to detect background radiation and a, b and g radiations. Emphasise that the radiations are emitted from the nucleus. Use a Geiger counter with suitable absorbers to show penetrating abilities.	IGCSE Physics by Tom Duncan & Heather Kennett Chapter 51. IGCSE Study Guide for Physics by Mike Folland Topic 4.
A	Understand the meaning of the term *ionising radiation.*	Students can research the history of the discovery of radioactivity using the website.	This site has an interesting history of Marie Curie. http://www.aip.org/history/curie/contents.htm
AB	Appreciate the link between ionisation and electric charge.	Use a diffusion type cloud chamber to show a particle tracks and lead to discussion of ionising effects. A spark counter could also be used.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 50.
AB	Know how radioactivity may be detected and measured.	Wherever possible, experiments should be demonstrated to show the sorts of detectors that are used to measure radioactivity and also to show how it may be absorbed and how it decays.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 51.

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AB	Understand the meaning of the term *background radiation.*		IGCSE Study Guide for Physics by Mike Folland Topic 5.
AB	Be able to relate radioactivity to the structure of an atom.	Nuclear reactions and decay series could be discussed to provide a focus for this section.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 51.
AB	Appreciate why radioactivity can be dangerous to living things but be able to put these hazards into perspective.	The safe handling of radioactive materials should arise naturally from the teacher demonstrations and is best integrated within the unit as a whole, extending discussion to cover industrial and medical issues.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 51. *IGCSE Study Guide for Physics* by Mike Folland Topic 5.
A	Appreciate the differences between alpha, beta, and gamma radiations.	Emphasise the links between the properties (penetration, ionisation, deflection by magnetic or electric fields) and the nature (charge, relative size, particles/e-m radiation).	Web link looking at alpha, beta and gamma: http://www.ewart.org.uk
ABC	Appreciate how radioactivity changes with time and understand the concept of *half-life.*	Use a radioactive decay simulation exercise and if possible an experiment with a Geiger counter and short half-life isotope to plot decay curves. Radioactive decay gives an opportunity for more graph plotting and recognition of the need to draw trend lines through points. Extend to work from data involving long half-lives. The website can be used to illustrate the meaning of the term 'half-life'.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 51. *IGCSE Study Guide for Physics* by Mike Folland Topic 5. *Teaching and Assessing Practical Skills in Science* by Dave Hayward This site has a good presentation to explain the meaning of the term 'half-life'. http://www.colorado.edu On the left-hand side click on Table of Contents. Scroll down to the bottom of the page and click on 'Meaning of half-life'. There is also a useful half-life simulation – a graph is plotted as an isotope decays (a variety of isotopes can be chosen). Click on Half-life.

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AB	Appreciate some of the uses to which radioactivity has been put.	Use many examples, concentrating on those that students will know something about, e.g. medical treatment and diagnosis, smoke alarms etc. Students can use this and other websites to prepare either a written or oral presentation on the uses of radioactivity.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 51. This site has useful information on medical imaging, radioactive dating and detection of radioactivity. http://library.thinkquest.org
ABC	Appreciate the idea of randomness in the decay process and relate this to half-life.	Students following the extended curriculum can explore the random nature of radioactivity and see how it leads to the law of radioactive decay. Experiments throwing dice can give a good simulation of the decay process.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 51. *Teaching and Assessing Practical Skills in Science* by Dave Hayward
ABC ABC	Understand that electronics is an extension of the study of electricity. Appreciate that knowledge of changes in resistance can be used to produce detectors which can respond to changes in the environment.	Links should be made to work from topics P7 Using electricity and P8 Energy and electricity. The intention is that this section of work should be almost entirely practical. As such, it tries not to be too specific about the sort of electronic circuits a student might make. The websites give details of suitable electronic experiments for class practicals.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 53. *Teaching and Assessing Practical Skills in Science* by Dave Hayward Electronics experiments: http://www.faqs.org http://www.picotech.com/experiments/experimentsbytype.html (scroll down the page to the relevant section).
ABC	Understand how a reed relay can be used to operate devices which need larger currents than detectors can pass.	The electromagnetic relay is used to introduce the concept of the electronic gate. A reed relay is only a small-scale version of larger relays, using small currents and voltages. A larger one could be used instead. Its essential purpose is to show how a controlling circuit can be separated from, yet control, the operating circuit. Once this is understood, the relay can be replaced by an electronic gate (NOR gates are simplest to use).	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 53. *Teaching and Assessing Practical Skills in Science* by Dave Hayward Relays: http://www.kpsec.freeuk.com

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ABC	Appreciate how electronics can be used to solve simple problems in everyday life.	Electronic gates have the virtue of requiring very small currents and voltages to operate. This leads to the use of sensors (devices that respond to changes in the environment) to provide the controlling signals. Students can construct examples such as light-operated switches, temperature-operated switches and time-operated switches.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 53. *Teaching and Assessing Practical Skills in Science* by Dave Hayward
ABC	Appreciate that integrated circuits, called microprocessors, are the control units of many devices in everyday use -appreciate how AND, NOT and OR gates are used.	Finally, students should have the opportunity to see how control circuits can be combined to carry out quite complex operations - whether domestically or industrially.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 53. *IGCSE Study Guide for Physics* by Mike Folland Topic 4. *Teaching and Assessing Practical Skills in Science* by Dave Hayward Logic gates: http://www.kpsec.freeuk.com http://www.ee.surrey.ac.uk