Access to Higher Education Diploma
Physics
Subject Set
Rules of Combination and Unit Specifications
### Learning Outcomes

<table>
<thead>
<tr>
<th>The student should be able to</th>
<th>Assessment Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Understand simple mechanics</td>
<td>1.1 Define vectors and scalars; resolve 2D vectors and calculate resultants</td>
</tr>
<tr>
<td></td>
<td>1.2 Apply Newton’s Laws and equations of motion in 1D problems</td>
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<tr>
<td></td>
<td>1.3 Calculate work, energy and power; apply the rule of conservation of energy</td>
</tr>
<tr>
<td>2. Understand the behaviour of waves</td>
<td>2.1 Define properties of progressive waves</td>
</tr>
<tr>
<td></td>
<td>2.2 Analyse reflection and refraction at a plane surface</td>
</tr>
<tr>
<td>3. Understand the structure of matter</td>
<td>3.1 Describe the structure of the atom.</td>
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<tr>
<td></td>
<td>3.2 Analyse the structure of subatomic particles.</td>
</tr>
<tr>
<td>4. Understand simple concepts in electricity</td>
<td>4.1 Define key concepts in electricity.</td>
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<tr>
<td></td>
<td>4.2 Apply key concepts in electricity to simple DC circuits.</td>
</tr>
</tbody>
</table>

### Assessment Methodology

Assignment part or wholly undertaken under controlled conditions.

### Indicative Content

**Simple Mechanics**
- Scalars (quantity with magnitude), vectors (quantity with magnitude and direction), resolving horizontal and vertical components of vectors (force, velocity etc); application to find the resultant in simple vector diagram problems (trigonometry).
- Newton’s three laws in 1D mechanics problems (qualitative and quantitative); suvat in 1D, vertical or horizontal motion (free fall, simple 1D projectile problems etc).
- Work as the product of displacement and the force component in the direction of motion, and as the amount of energy transferred from one form into another; types of energy (electrical, GPE, KE, EPE, thermal etc); power as the rate at which work is done; conservation of energy; examples from mechanics, e.g. ramp, pendulum.

**Behaviour of Waves**
- Transverse waves (amplitude, frequency, period, wavelength, peak, trough); longitudinal waves (amplitude, frequency, period, wavelength, compression, rarefaction); similarities and differences between these types of wave; examples of each (seismic p and s waves, sound, music, classical light, etc)
- Law of reflection; Snell’s law and index of refraction; Huygens-Fresnel principle.
Structure of Matter
- Atomic Structure; nucleus (nucleons, protons, neutrons), electron states, electron cloud.
- Quarks (up, down, top, bottom, charm, strange); leptons (electron, muon, tau, associated neutrinos); antimatter (quarks, leptons); definition of meson and baryon; structure of proton (uud) and neutron (udd); calculate charge of simple mesons and baryons given a data table (kaon, pion, lambda, sigma etc).

Electrical Concepts
- Define: charge (fundamental property of matter), current (rate of flow of charge), voltage (energy per unit charge), resistance (components ability to inhibit current, energy per unit charge and per unit current), resistivity (materials ability to inhibit current), work (energy transferred by a component), power (rate of transfer of energy).
- Series and parallel circuits, combined series and parallel circuits, resistor networks, applying Kirchhoff’s laws of current and voltage, simple calculations of resistance from resistivity (vice versa).

Validation end date: 31 August 2019
# Medical Uses of Radioisotopes

## Learning Outcomes

The student should be able to:

<table>
<thead>
<tr>
<th>Learning Outcome</th>
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<tbody>
<tr>
<td>1</td>
<td>1.1 Define the terms 'radioisotope' and 'radiopharmaceutical'</td>
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<tr>
<td></td>
<td>1.2 Describe the production of radioisotopes for use in radiopharmaceuticals and imaging</td>
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<tr>
<td></td>
<td>1.3 Explain the key properties of radioisotopes that are intended for medical use</td>
</tr>
<tr>
<td>2</td>
<td>2.1 Explain the use of the gamma camera</td>
</tr>
<tr>
<td></td>
<td>2.2 Explain the use of radioisotopes in diagnostic imaging and give examples</td>
</tr>
<tr>
<td></td>
<td>2.3 Explain the advantages from the use of radiopharmaceuticals for treatment as opposed to irradiation using external sources of radiation</td>
</tr>
<tr>
<td>3</td>
<td>3.1 Describe the effects of different types of radiation on cells</td>
</tr>
<tr>
<td></td>
<td>3.2 Distinguish between the somatic and hereditary effects of radiation</td>
</tr>
<tr>
<td></td>
<td>3.3 Perform calculations involving absorbed dose, exposure, relative biological effect and effective dose</td>
</tr>
</tbody>
</table>

## Assessment Methodology

A controlled assignment or its equivalent on topics specific to this unit (i.e. short answer questions).

## Grading of this unit

The following grade descriptors will be applied to the assessment of this unit:

1. Understanding of the subject
2. Application of Knowledge
3. Application of Skills
4. Communication and Presentation
5. Quality

Please refer to the QAA Grade Descriptors for detail of the components of each descriptor.
Indicative Content

Please note that the indicative content supplied below is intended as a suggested guide only. It is not meant to be a prescriptive, exhaustive or fully delivered content list. If you would like more information about the indicative content please contact development@ascentis.co.uk.

Learners will be provided with opportunities to learn about:

- Distinguishing the radioactive isotopes of an element and understanding their properties.
- Identifying alpha \((\alpha)\) beta \((\beta)\) and gamma \((\gamma)\) products of decay and knowing their effects.
- The significance of the radioactive decay rate and half-life for sources and of half value thickness for screening materials.
- The health hazards from using ionising radiation and the precautions needed for safe handling and application of radioactive materials.
- The production of radioisotopes for medical uses, including the technetium generator (“moly cow”) and the production of iodine isotopes by the use of accelerators and nuclear reactors.
- Key biological properties, including iodine concentration in the thyroid, the non toxic nature of technetium and excretion of radioactive material from the body.
- Key radiological properties, including the half life and types of radiation produced for the typical isotopes used.
- The design of the gamma camera (choice of sources, detectors and collimators) and its use in scintigraphy.
- The use of radioisotopes in diagnostic imaging for various types of nuclear scanning, choice of isotope in relation to organ involved, Positron Emission Tomography (PET) scanning, etc.
- The treatment of patients with a radiopharmaceutical in cases unsuitable for external beam therapy, such as for multiple small tumours or in cases of proximity to a radiosensitive organ.
- The possible effects of different types of radiation on living cells, dosimetric methods and instruments for monitoring radiation exposure, units of measurement for radiation.
- The distinguishing of damage by radiation to germline cells in reproductive organs (involving hereditary effects) and of damage to somatic cells in other organs.
- The calculation of the effect of radiation exposure in terms of absorbed dose, relative biological effect (weighting factor), equivalent dose and effective dose.

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<tr>
<td><strong>The student should be able to</strong></td>
<td><strong>The student can</strong></td>
</tr>
<tr>
<td>1 Understand the principles and practices involved in X-ray radiography</td>
<td>1.1 Explain key terminology used in radiography and the types of radiographic equipment available</td>
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<tr>
<td></td>
<td>1.2 Explain the process of radiography, how radiation is detected and how radiographic images are produced and processed</td>
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<td>1.3 Explain how X-ray techniques are used in diagnosis</td>
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<td>1.4 Describe how a CT scan can produce coronal and sagittal images of the body in two or three dimensions</td>
</tr>
<tr>
<td>2 Understand the principles and practices involved in Ultrasonography and MRI</td>
<td>2.1 Assess the applicability, benefits and limitations of ultra-sound imaging techniques and discuss their use in diagnosis</td>
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<tr>
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<td>2.2 State the general principles involved in MRI and explain the benefits and limitations of the technique</td>
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<tr>
<td>3 Understand the procedures used in radiology and patient care</td>
<td>3.1 State the hazards associated with radiation and explain concepts and methods of radiation protection</td>
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<td></td>
<td>3.2 Calculate the effective radiation dose in a given case</td>
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<td></td>
<td>3.3 Explain relevant health risks to a patient</td>
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<td>3.4 Evaluate, for the patient and clinician, methods of:</td>
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<tr>
<td></td>
<td>• record keeping procedures</td>
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<td></td>
<td>• medical exposure control</td>
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<td></td>
<td>• radiation safety</td>
</tr>
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<td></td>
<td>• infection control</td>
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</tbody>
</table>

**Assessment Methodology**

A time constrained assignment.
### Grading of this unit

The following grade descriptors will be applied to the assessment of this unit:

1. Understanding of the subject
2. Application of knowledge
3. Application of skills
4. Communication and presentation
5. Quality

Please refer to the QAA Grade Descriptors for detail of the components of each descriptor.

### Indicative Content

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**Radiation**
- the sub-atomic components of an atom.
- beta (β) and gamma (γ) radiation decay equations using a periodic table
- the mechanism of gamma (γ) rays indirect ionisation.
- characteristic radioactive decay curves and the "spin-spin" interaction.
- calculations of decay rates, values of half-lives and of half value thickness for absorption.
- the health hazards of using ionising radiation.

**Use of X-rays**
- labelling the structure of an x-ray tube.
- detecting and measuring radiation intensity via photographic film, via the ionising effect of radiation detected electronically and via scintillation caused by chemical fluorescence.
- suitable techniques of image processing for diagnostic and dosimetric evaluations.
- Comparing and contrasting the use of 2D tomography to computed 3D tomography.
- how the CT scan can produce coronal and sagittal images of the body.
- how CT scanning can be used in diagnosis.

**Use of Ultra-sound**
- sound waves and how they are reflected from an object.
- speed/time/distance calculations and acoustic impedance equations for ultrasound.
- the applicability, benefits and limitations of ultra-sonography techniques.
- the use of ultra-sonography to develop 3D images of baby tissue in a mother’s womb.

**Use of Magnetic Resonance Imaging**
- how strong magnetic fields can be used to align atomic nuclei.
- how radio waves can be used to disturb the axis of rotation of aligned atomic nuclei.
- the Larmor frequency for resonance induction utilising the gyromagnetic process.
- how the radio frequency emission generated by disturbed nuclei returning to their baseline states can be collected and used to generate an image.
- the effectiveness, benefits and limitations of using MRI.

### Safety and Procedures

- assessing the health implications of using ionising radiation.
- methods of radiation safety and infection control for both the patient and the clinician.
- calculating the effective radiation dose for a patient in a given case.
- the health risks to a patient from undergoing treatment such as a CT scan.
- evaluation of methods for record keeping and procedures used for safety precautions.