Unit 33: Physical Science for Health

Unit code: Y/600/8988

QCF Level 3: BTEC Nationals

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit aims to enable learners to gain knowledge of the electromagnetic spectrum, the atomic structure, radioactivity, sound waves, electricity and magnetism, and how these can be used in the health sector.

Unit introduction

This unit is designed to give learners a good understanding of the basic principles of physical science and how these principles may be applied within the health sector – both in terms of diagnostics and treatment/care.

Initially, learners will gain understanding of the electromagnetic spectrum and its applications in the health sector. They will then examine the principles of atomic structure and radioactivity, again considering uses within the health sector. Sound waves will also be explored, followed by electricity and magnetism, including their uses in health.

This unit will benefit learners who are considering a career in any aspect of the health sector, particularly in nursing or the allied health professions such as radiotherapy, physiotherapy or a laboratory-based profession. It will also be useful for learners who are considering roles such as health care assistants or clinical support workers.

Learning outcomes

On completion of this unit a learner should:

1 Know the electromagnetic spectrum

2 Know about atomic structure and radioactivity

3 Know about sound waves

4 Know about electricity and magnetism.

Unit content

1 Know the electromagnetic spectrum

Electromagnetic spectrum: radio waves, microwaves, infrared waves, visible light rays, ultraviolet waves, X-rays, gamma rays; ionising radiation, non-ionising radiation

Applications in health: diagnostic, eg X-rays, computed tomography (CT) scanners, contrast X-rays, magnetic resonance imaging (MRI), endoscopy, thermography; treatment, eg radiotherapy, uses of lasers; sterilisation

Light waves: speed, reflection, refraction, fibre optics; the focusing of light on the retina of the eye, the use of convex and concave lenses in correcting vision; colour vision, colour blindness

2 Know about atomic structure and radioactivity

Atomic structure: nucleus: neutrons, protons; electrons, electron shells; the periodic table; atomic number, mass number, isotopes

Radioactivity: radioactive isotopes, radioactive decay, half-life of radioactive materials, biological half-life; ionising radiation – alpha particles, beta particles, gamma rays, X-rays

Applications in health: tracers, radionuclide scanning, sterilising agents, use in cancer treatments

Health and safety: effects of ionising radiation on the body, eg dangers of mutations and increase in the occurrence of cancers; regulation, eg Health and Safety Executive (HSE), Environment Agency, legislative requirements and dose limits; use of film badges; use of protective equipment/clothing, eg lead aprons; procedures for reducing radiation hazards; remote handling equipment; issues surrounding the long-term storage of waste

3 Know about sound waves

Sound waves: how sound waves are produced, the speed of sound, echoes, frequencies, pitch, loudness; the function of the ear, range of human hearing, audiometers, hearing aids, induction loops and speech synthesisers

Applications in health: use of ultrasound for monitoring, eg blood flow rates, developing foetus; use of ultrasound for diagnostic purposes, eg narrowing of blood vessels

4 Know about electricity and magnetism

Electricity: current, voltage, resistance, power, electric circuits, conductors, insulators; fuses, transformers; electrical safety in care settings

Magnetism: magnetic fields, properties of magnets, theory of magnetism, magnetic induction, electromagnets

Applications: in health, eg defibrillation, electrocardiograph (ECG), electroencephalograph (EEG), instrumentation, eg measurement of blood pressure, mass spectrometry, magnetic resonance imaging

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 describe how the properties of the electromagnetic spectrum are used in the health sector [IE1; CT2]	**M1** explain how knowledge of the properties of light can be used to correct defects in vision	
P2 describe the properties of light [IE1; IE6; CT2; RL6; SM3]		
P3 describe how different types of ionising radiation can be applied in the health sector [IE1; IE6; CT2]	**M2** assess the dangers related to using ionising radiation	**D1** analyse precautions taken to minimise risk when using ionising radiation in the health sector
P4 describe how sound is used in the health sector [IE1; IE2; IE6; CT2; RL6; TW1; SM3; EP3]		
P5 describe how the properties of electricity and magnetism are used in the health sector. [IE1; IE2; IE6; CT2; RL6; TW1; SM3; EP3].	**M3** explain how knowledge of the properties of electricity and magnetism can be used to correct heart defects.	**D2** evaluate the use of physical science in diagnostics and treatments in the health sector.

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills which are embedded in the assessment of this unit. By achieving the criteria, learners will have demonstrated effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

This unit needs to be delivered by appropriately qualified tutor/s and access to laboratory facilities will be necessary.

It would be helpful if the planning of the delivery of this unit could be in partnership with tutors responsible for delivering other scientific units within the programme. This will enable learners to apply theoretical knowledge of the physical sciences, and their application, to understanding in other units.

This unit involves a significant amount of underpinning knowledge, and tutors need to be aware that learners will have different degrees of prior knowledge of the physical sciences. Delivery needs to be as learner-centred as possible and include practical work, preferably in a laboratory, in order to bring the more theoretical aspects of the unit 'to life'.

Some learners may have limited previous knowledge and understanding of the physical sciences, and activities will initially need to be undertaken to address this for these learners. For example, the use of worksheets along with guidance on appropriate Level 2 textbooks, together with class discussions and clarification of basic principles, could help to lay the foundation for this unit.

Following this introduction, consideration of the electromagnetic spectrum could be used as a means of further building on learners' current knowledge and understanding. Some initial practical work could be carried out involving light waves.

It is not recommended that learners work in a practical arena with radioactive material, but practical investigations involving light, sound, electricity and magnetism would facilitate learning for this unit. Examples could include experiments with ray boxes and lenses to enable learners to appreciate the principles involved in the correction of defective vision, or the use of experiments with magnets to provide underpinning knowledge for understanding scanning techniques such as MRI.

Learners will benefit significantly from having access to health settings such as hospitals with radiology departments and laboratory diagnostic areas. Work experience placements in these settings could prove invaluable. Alternatively, local health authorities may organise career information days where a range of professional health sector workers are available to talk about their work and provide guided tours of the medical facilities. If these are not accessible, then the use of outside speakers such as radiologists, health and safety officers, optometrists, dentists, dental assistants and nurses would support learners in their understanding of how theoretical principles are put into practice.

Videos/DVDs could also be useful to support delivery of this unit.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Unit introduction.
Tutor input: introduction to the electromagnetic spectrum: diagram of the electromagnetic spectrum. Learner research: descriptions for each part of the spectrum.
Tutor input/group discussion: radiation – ionising and non-ionising radiation explained and the health implications of each discussed.
Practical activity: applications of the electromagnetic spectrum to health – X rays. Learners view some X-rays of parts of a human body. Computerised tomography – learners view CT scans from internet sites and research their use in the healthcare sector.
Assignment 1: Using the electromagnetic spectrum in the healthcare sector (P1, P2, M1)
Tutor input/practical activity: pictures of magnetic resonance imaging – purpose, advantages and disadvantages. Endoscopy – examples of what it is used to investigate – DVD or related programme showing the process of using an endoscope. Thermography – principles and examples of use, eg to diagnose early stages of breast cancer.
Tutor input/learner research: methods of patient treatment using the electromagnetic spectrum – radiotherapy for cancer treatment, use of lasers – eye surgery, cosmetic treatments.
Light wave theory and practical: learners use a light box and different prisms to refract and reflect light – learners draw the different paths of light as they pass through different prisms.
Practical activity: using convex and concave lenses to view objects – theory of how these lenses correct short and long sightedness. Eye tests to check learners' eye sight.
Tutor input: colour vision – theory of how the eye sees colour. Practical activity: learners view colour blind test sheets to see if they are able to see all colours.
Tutor input: structure of an atom – drawings and diagrams to show each part. Diagrams to show electronic shells and how the shell is filled from the centre outwards.
Practical activity: periodic table – each learner has a periodic table to view, element categories briefly discussed and how they are grouped in accordance with their outermost electronic shell. Atomic number and mass number explained. Learner research: learners determine the atomic number and mass number of a number of elements.
Tutor input: isotope – theory to explain what an isotope is and examples of different ones including radioactive isotopes. Learner research: an aspect of ionising radiation, alpha particles, beta particles, gamma rays or X-rays and feed back to the rest of the group.
Tutor input: half life – radioactive and biological half-life of different materials. Activity: worksheets and graphs plotting the half-life of different radioactive isotopes and biological half-life, eg alcohol in the body, prescription medicines, caffeine.

Topic and suggested assignments/activities and/assessment
Assignment 2: Using radiation in the healthcare sector (P3, M2, D1)
Learner research: applications of radioactive materials in health – use of internet and DVD footage showing the use of radioactive tracers being used by healthcare professionals.
Discussion: problems associated with using ionising radiation on the body: dangers of mutations and increase in the occurrence of cancers, problems associated with the storage of waste materials from radiation treatments.
Tutor input and worksheets: methods of controlling the problems associated with radiation: bodies and legislation to help control the use of radioactive materials. Procedures for reducing radiation hazards – protective clothing and equipment. Problems associated with the storage of waste materials from radiation treatments.
Group discussion: advantages and disadvantages of using ionisation radiation in the healthcare sector.
Tutor input and practical sessions: sound waves. Buzz groups: how sound waves travel. Workshop – listening to sound waves with different frequencies, pitch and loudness.
Tutor input: the ear – diagrams to show the structure of the ear – the function is then explained. Guest speaker: a healthcare professional could deliver a talk on human hearing, with equipment to demonstrate the range of audiometers, hearing aids, induction loops and speech synthesisers.
Group visit: applications of sound waves in health: a visit to a healthcare provider could demonstrate the use of ultrasound for diagnostic purposes, eg monitoring, blood flow rates or a programme can be shown to show how ultrasound scans are used to view a developing foetus.
Tutor input and practical activity: learners are taught the principles of electricity and then design circuit boards using a power source, voltmeters and ammeters to measure current, voltage and resistance. Group discussion: insulators and their use in circuits. Practical demonstration: a transformer and its use in power supplies of appliances, ground fault circuit interrupters etc.
Assignment 3: Using sound, electricity and magnetism in the healthcare sector (P4, P5, M3, D2)
Tutor input: electrical safety in care settings – methods of ensuring the safety of electrical appliances and sources of electricity are protected – eg logbooks, socket protectors, not overloading sockets.
Tutor input and practical activity: explanation and demonstration of magnets and magnetism. Practical experiment: demonstrate magnetic induction and making electromagnets.
Tutor input: applications of electricity in health – defibrillation, application and principal of defibrillation. Practical activity: observation of an ECG trace, or, if possible, learners can have an ECG reading taken from themselves to examine. Electroencephalograph (EEG) traces examined and explained.
Unit review and assessment.

Assessment

For P1, learners will need to describe the range of different frequencies on the electromagnetic spectrum, the characteristics of each type of region on the spectrum and how each of these can be applied in the health sector. For P2, learners will need to describe the different properties of light which can partly be covered by a lab report from an investigation into light travelling through prisms and different types of lens. The report can be extended to an explanation of how the properties of light can be used to correct defects in vision to allow learners to meet M1.

For P3, knowledge of the atomic structure will be required in order to help learners describe different types of ionising radiation. Learners will also need to describe how ionising radiation can be applied in the health sector – where possible, learners should be encouraged to explore the area they would like to work in. M2 requires learners to assess the dangers associated with using ionising radiation. To achieve D1, learners will need to analyse precautions taken to minimise risk when using ionising radiation in the health sector.

For P4, learners will need to describe the properties of sound waves including how a person can hear these sound waves. Learners will also need to state how sound is applied in the health sector.

For P5, learners could write up a lab report from their practical investigation into the properties of electricity and magnetism. They can then describe how electricity and magnetism can be applied in the health sector. For M3, learners will take this further to explain how the properties of electricity and magnetism can be used for a specific purpose.

For D1, learners will need to have given a considered evaluation of how the use of physical sciences has impacted, in both a positive and a negative way, on the health sector, particularly for diagnosis and treatment of diseases and physiological defects.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1	Using the electromagnetic spectrum in the healthcare sector	You are about to start a work with an ophthalmic optician. You have been asked to prepare for your placement by finding out about the properties of the electromagnetic spectrum so that you can have a better idea of how this knowledge can be applied in the health sector.	Visual display and lab report.
P3, M2, D1	Using radiation in the healthcare sector	A group of senior citizens in your care have concerns over some treatment that they have been receiving that requires ionising radiation. To help put their minds at rest, you have been asked to prepare a presentation that examines the use of radiation and the health and safety precautions that are in place.	Presentation.
P4, P5, M3, D2	Using sound, electricity and magnetism in the healthcare sector	As a healthcare professional you will need to know how the physical sciences can be used to diagnose and treat patients who are suffering from acute or chronic disorders.	Practical investigation – write up lab report.

Links to National Occupational Standards (NOS), other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Health and Social Care sector suite (see *Appendix A*) and has links with units from other qualifications in that suite. See *Appendix E* for NOS links and *Appendix G* for a mapping of the NHS Knowledge and Skills Framework against particular units in this qualification.

Essential resources

The following resources are essential for delivery of this unit:

- an appropriately qualified tutor
- access to laboratory facilities to support practical work
- library resources with key texts and other reference materials.

In addition, the following resources are considered to be highly valuable:

- work experience placements
- popular science journals and magazines as these often have articles on current scanning procedures and health and safety
- medical images can be obtained from the Department of Medical Physics at University College London
- audio and visual records
- local hospitals.

Employer engagement and vocational contexts

Taking advantage of opportunities to visit relevant workplaces or to invite guest speakers from the sector would greatly enhance delivery of this unit. In particular, contacts within nursing, radiotherapy, physiotherapy or physics departments at universities would be beneficial.

Indicative reading for learners

Textbooks

Adams S and Allday J – *Advanced Physics (Advanced Science)* (Oxford University Press, 2000) ISBN 978019914680 2

Honeywill C – *Make the Grade: AS and A Level Physics* (Nelson Thornes, 2002) ISBN 9780174482802

Johnson K, Hewett S, Holt S and Miller J – *Advanced Physics for You* (Nelson Thornes, 2000) ISBN 9780748752966

Stretch B and Whitehouse M – *BTEC Level 3 Nationals in Health and Social Care Student Book 1* (Pearson, 2010) ISBN 9781846907663

Stretch B and Whitehouse M – *BTEC Level 3 Nationals in Health and Social Care Student Book 2* (Pearson, 2010) ISBN 9781846907470

Journals and magazines

New Scientist

Nursing Times

Physics Review

Popular Science

School Science Review

Websites

www.omni.ac.uk	Resources in health and medicine
www.planet-science.com	Free science resources
www.teaching-biomed.man.ac.uk	Faculty of Medicine, Dentistry, Nursing and Pharmacy, University of Manchester
www.xray2000.co.uk	Nicks X-ray

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	[IE1] identifying questions to answer when researching properties of physical science [IE2] planning and carrying out research and practical investigations into sound, electricity and magnetism [IE6] supporting conclusions about how properties of physical science are applied in the health sector
Creative thinkers	[CT2] asking questions to extend their thinking about different properties of physical science
Reflective learners	[RL6] communicating their learning in different ways for different audiences, depending on the assignment brief
Team workers	[TW1] collaborating with others when carrying out practical work
Self-managers	[SM3] organising time and resources when carrying out practical work or preparing written assignments
Effective participators	[EP3] proposing practical ways forward when carrying out practical work.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	using a variety of ICT systems for research, manipulation of text and images and for transferring information
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	using a variety of sources when researching ionising radiation
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	searching for information on ionising radiation and evaluating its validity and suitability
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	entering information using ICT, and developing new information from this
Present information in ways that are fit for purpose and audience	presenting information on physical science techniques used in the healthcare sector, in a variety of formats depending on its purpose
Mathematics	
Select and apply a range of skills to find solutions	selecting and using the correct calculations when describing the electromagnetic spectrum
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	interpreting the results of calculations related to the electromagnetic spectrum, presenting findings
Draw conclusions and provide mathematical justifications	justifying methods used
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	taking part in discussions about ionising radiation and its application in the health sector listening to, and interacting with, guest speakers
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	reading and synthesising information from a variety of texts related to the properties of electricity and magnetism and their use in the health sector
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	writing different types of documents, eg a laboratory report and a presentation.