Higher National Unit specification

General information

Unit title: Physics: Light and Optics (SCQF level 8)

Unit code: H93J 35

Superclass: RC

Publication date: May 2015

Source: Scottish Qualifications Authority

Version: 03

Unit purpose

This Unit is designed to enable learners to understand key aspects of light and optics. Learners will also develop practical skills in techniques relevant to light and optics. The Unit is suitable for learners studying at HNC level, and will provide the necessary underpinning knowledge and skills to enable progression to further study of physics at HND level or to seek employment in science based industries.

Outcomes

On successful completion of the Unit the learner will be able to:

1 Describe and explain aspects and principles of the science of light.
2 Describe and explain different light sources and spectrums.
3 Describe polarisation, interference and diffraction.
4 Perform a practical experiment related to light and optics.

Credit points and level

1 Higher National Unit credit at SCQF level 8: (8 SCQF credit points at SCQF level 8)

Recommended entry to the Unit

Entry is at the discretion of the centre, however it is recommended that learners should have completed the HN Units H93D 33 *Physics 1* and H8XP 33 *Mathematics for Science 1* or equivalent, or have experience of Physics and Mathematics at Higher level.

Higher National Unit specification: General information (cont)

Unit title: Physics: Light and Optics (SCQF level 8)

Core Skills

Achievement of this Unit gives automatic certification of the following Core Skills component:

Complete Core Skill	None
Core Skill component	Critical Thinking at SCQF level 6 Using Number at SCQF level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of this Unit specification.

Context for delivery

If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

The Assessment Support Pack (ASP) for this Unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website **www.sqa.org.uk/sqa/46233.2769.html**.

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**.

Higher National Unit specification: Statement of standards

Unit title: Physics: Light and Optics (SCQF level 8)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the Knowledge and/or Skills section must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Describe and explain aspects and principles of the science of light.

Knowledge and/or Skills

- Straight-line propagation, reflection and refraction of light
- Light as a wave phenomenon
- Total internal reflection
- Optical dispersion

Outcome 2

Describe and explain different light sources and spectrums.

Knowledge and/or Skills

- The electromagnetic spectrum
- Spectrum emission and absorption
- Blackbody radiation
- Hydrogen spectrum: Lyman series, Balmer series, Paschen series, Brackett series
- Energy levels

Outcome 3

Describe polarisation, interference and diffraction.

Knowledge and/or Skills

- Polarisation: linear, circular, natural
- Interference: Young's experiment, fringe spacing, diffraction gratings, Lloyd's mirror and holograms, Michelson interferometer
- Diffraction: The Huygens–Fresnel–Kirchhoff theory, Fraunhofer diffraction
- Photonics: photoelectric effect
- Imaging

Unit title: Physics: Light and Optics (SCQF level 8)

Outcome 4

Perform a practical experiment related to light and optics.

Knowledge and/or Skills

- Light and optics experiment
- Working safely, within current health and safety regulations
- Consistent and accurate results
- Recording observations and results
- Evaluation skills
- Result analysis and conclusions

Higher National Unit specification: Statement of standards (cont)

Unit title: Physics: Light and Optics (SCQF level 8)

Evidence Requirements for this Unit

Written and/or oral recorded evidence for Outcomes 1−3 should be assessed using a holistic closed-book assessment under supervised conditions. The assessment will use a sampling approach to the Knowledge and/or Skills as detailed below. It is recommended that the assessment be completed within 90 minutes. Learners can only have access to the *SQA Databook for HN Physics* or any suitable replacement when sitting the assessment.

Written and/or oral recorded evidence for Outcome 4 should be assessed by production of a full laboratory report. An assessor's observation checklist could be used to record performance evidence of the practical experiment.

Outcome 1

The assessment will sample 3 of the 4 Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- Describe the differences between light rays, pencils and beams; apply the principles of reflection and refraction to determine what will happen to the light at an interface of two materials; apply Snell's law to calculate angles and direction of light.
- Explain one of the following: Huygen's principle, optical path length, propagation time, Fermat's principle.
- Apply the principles of total internal reflection to a prism and fibre optics to explain one of the following: the evanescent wave, frustrated total internal reflection, total internal reflection fluorescence.
- Explain optical dispersion; perform calculations to determine the Abbe number, using information from a dispersion curve.

Outcome 2

The assessment will sample 3 of the 5 Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- Explain the relationship between frequency and wavelength; perform calculations to determine the appropriate region of the electromagnetic spectrum.
- Explain that energy is absorbed and re-radiated as light in discrete bundles called quanta and is dependent on the frequency of light; perform calculations to determine the frequency of light for absorption and emission spectrums.
- Explain blackbody radiation; perform calculations using the Wien displacement law and the Stefan–Boltzmann law.
- Explain the hydrogen spectrum and the three series of spectra lines: Lyman, Balmer and Paschen; perform calculations to determine the energy and wavelength for the three series of spectra lines, and from these values calculate the wave frequency and identify the region of the electromagnetic spectrum.
- Explain the energy levels related to the absorbed and emission spectrum.

Higher National Unit specification: Statement of standards (cont)

Unit title: Physics: Light and Optics (SCQF level 8)

Outcome 3

The assessment will sample 3 of the 5 Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- ♦ Explain linear, circular and natural polarisation and their applications; perform calculations to determine the Brewster angle.
- ♦ Explain the different types of interference; explain the effect of using diffraction gratings; perform calculations on the Young's experiment using the produced spectrum, irradiance of the interference fringe pattern and the irradiance of light.
- ♦ Explain diffraction and the Huygens–Fresnel–Kirchhoff theory.
- ♦ Explain the photoelectric effect and its different applications.
- ♦ Explain the production of images; perform calculations to determine the power, focal length and focal point of a lens; describe one application of imaging.

Outcome 4

Learners will perform a minimum of one practical experiment, the content of which will be related to Outcomes 1−3. A learner's response will be judged satisfactory where the evidence shows that the learner can achieve all of the following:

- ♦ Follow instructions to perform an experiment related to light and optics.
- ♦ Work in a safe manner regarding current health and safety regulations.
- ♦ Achieve consistent and accurate results.
- ♦ Record experimental observations and results clearly and accurately.
- ♦ Evaluate validity of results in terms of sources of and values of experimental errors.
- ♦ Analyse results correctly and state valid conclusions.

An assessor observation checklist will be used to record the learner's performance of the practical work in line with given instructions and health and safety requirements.

Learners must report results by production of a full laboratory report. Where a learner does not perform an assessed practical experiment to the required standard, they will be given the chance to either reattempt the same practical experiment, or to undertake a different practical experiment of similar complexity. Where a laboratory report does not meet required standard, then the learner will be given a single opportunity to re-draft. If the required standard is still not attained, then an alternative practical experiment will be set.

Higher National Unit Support Notes

Unit title: Physics: Light and Optics (SCQF level 8)

Unit Support Notes are offered as guidance and are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

This Unit is intended as part of the framework for HNC/HND Applied Sciences but may be suitable for inclusion in other HN Science awards. It is designed to introduce learners to the theoretical and practical aspects of light and optics.

Outcome 1 — Describe and explain aspects and principles of the science of light

- The fundamentals of this section are straight-line propagation, reflection and refraction of light. A ray of light is the direction of propagation of light energy, a pencil of light is a bundle of rays coming from a single point source of light and limited by some aperture. If the source of the light is a great distance away, infinity, the pencil of light from the source is a parallel pencil. A beam of light is a collection of pencils from an extended source. Reflection of light is how light reflects at the same angle as the angle of incidence at the normal, with the incident ray, normal and reflected ray are in the same plane. The reflection of light can be used to look at optical levers, location of an image. Refraction is the bending of light at an interface between two media. Snell's law can be used to determine the refractive index of a material.
- Waves are a dynamic moving phenomena, they occur in space and time. A sine wave can be used when looking at variation of a wave with position and time, $y = A\sin(k\theta - \omega t)$. In 2 and 3 dimensions the lines of maxima (or any well-defined phase) define the wave fronts of the wave, and they typically have a characteristic shape like expanding circles in 2D and spheres in 3D, or for waves travelling uniformly in one direction they are simply planes.

- Total internal reflection is a phenomenon that can take place when light travels from a material of lower refractive index to one of higher refractive index, from glass into air. This phenomenon only happens at angles greater than the critical angle. Optical fibres can be investigated looking at the coherent bundles for the transmitting of images and incoherent for the transmitting of light signals. The evanescent wave, when total internal reflection is taking place, a wave field extends into the low refractive index medium. The wave field does not propagate perpendicular to the surface but decreases exponentially. If a second surface is brought close to the totally internally reflected surface, into the evanescent wavefield, then the total internal reflection is frustrated. Some energy crosses the narrow gap and propagation resumes in the neighbouring medium. Total internal reflection fluorescence is a technique used to detect very small concentrations of biological molecules, which may be proteins, single strand DNA or drugs. A thin layer of the specific sensor is coated on the inside of an optical slide and an aqueous solution containing the biological molecules with fluorescent labels attached is allowed to flow across the optical slide. The slide is illuminated by total internal reflected light from the outside with a wavelength which excites the fluorescence. The evanescent wave extends for a few hundred nano-metres over the sample surface that is coated. By measuring the fluorescence signal, the effectiveness of the binding can be studied and the concentration of molecules in the solution inferred.
- Dispersion is the phenomenon of splitting white light into its constituent colours. Optical dispersion is the variation of refractive index with wavelength. The dispersion curve can be formed, dispersion increases more rapidly at shorter wavelengths, resulting in the plot of refractive index versus wavelength, the Cauchy empirical formula is the best reasonably simple scaling for the dispersion curve.

$$n\lambda = n_0 + \frac{A}{\lambda^2}\left(+ \frac{B}{\lambda^2} + ...\right)$$

The Abbe number is a single parameter measurement of dispersion. The larger the dispersion, the smaller the Abbe number. Glass catalogues quote n_λ = at certain standard wavelengths of selected Fraunhofer spectral lines. The following are particularly relevant.

Fraunhofer letter	Origin	Wavelength (nm)
C	H red	656.27
D	Na Yellow	589.4
D	He yellow	587.56
F	H Blue	486.13

The Abbe number $V_d = \dfrac{n_d - 1}{n_F - n_C}$

Unit title: Physics: Light and Optics (SCQF level 8)

Outcome 2 — Describe and explain different light sources and spectrums

- An overview of the different parts of the electromagnetic spectrum. The two tiny parts of the spectrum which we experience, light and heat radiation, should be expended to discuss complete spectrum, looking at the energy, frequency and wavelength and the application of the different parts of the spectrum.
- All bodies emit electromagnetic radiation over a wide range of wavelengths. The spectrum of emitted radiation will not depend on what the body is made of, metallic, ceramic, or the age of the body, but on the temperature of the body. Consider how all objects in a kiln glow with the same red colour.
- Blackbody radiation is emitted from an ideal radiating body. The body radiates by the maximum amount possible and will also absorb incident radiation by the maximum amount possible. If a body is not glowing in the visible wavelength range it will appear black. The sun is a 'blackbody' on this definition. The total rate of radiation energy, per unit surface area, is proportional to the 4th power of the absolute temperature. The total irradiance emitted from the surface of an ideal radiator at absolute temperature is given by the Stefan–Boltzmann law, $I = \sigma T^4$ where σ is a fundamental physical constant called the Stefan–Boltzmann constant. The power is not uniformly distributed over all wavelengths, as the temperature rises the peak on a plot of Irradiance (λ) versus wavelength (μm) will increase and it shifts to shorter wavelengths. This rule is the Wien displacement law.
- Hydrogen is the most common element in the sun, and the universe. A hydrogen atom is the simplest of all atoms and it has the simplest spectrum, having just four lines in the Balmer series. Hydrogen emission spectrum has bright lines at just the same frequencies as the hydrogen absorption lines.
- Electrons in atoms occupy discrete energy levels. These levels are labelled by quantum numbers. It is this quantum number that determines the energy of the electron in hydrogen. When the electron drops from one level to a lower level, it emits the surplus energy as electromagnetic radiation. This section should include the Paschen series, Balmer series and Lyman series.

Outcome 3 — Describe polarisation, interference and diffraction

- Polarisation is due to the direction of the electric field associated with light. The existence of polarisation phenomena is a direct consequence of light being a transverse wave, or nearly so. Light propagating through some solids may not be purely transverse. In linear polarisation the direction of the electric field stays constant at a point in space. So the orientation does not vary with time, though the electric field itself varies sinusoidally with time. With circular polarisation, the x and y amplitudes of the electric field are both equal but there is a phase difference of π/2 between them. The following equations define right circularly polarised light, whose rotation is clockwise when looking backwards towards the light.

$$E_x = E_0 \cos(kz - \omega t)$$
$$E_y = E_0 \cos(kz - \omega t - \pi/2) \qquad = E_0 \sin(kz - \omega t)$$

Left circularly polarised light has the equations

$$E_x = E_0 \cos(kz - \omega t)$$
$$E_y = E_0 \cos(kz - \omega t + \pi/2) \qquad = -E_0 \sin(kz - \omega t)$$

Natural polarisation (unpolarised light) consists of light where the direction of the electric field varies at random between successive measurements at one point. Any direction is equally likely. Unpolarised light can be considered as a combination of equal amounts of linear polarisation in two directions at right angles, where the two components are incoherent. Unpolarised light can be partially polarised by reflection with an explanation of the polarisation angle. Unpolarised light can be partially polarised by reflection. Calculations should include the polarisation angle and Brewster's law.

$$\tan\theta = \frac{n_b}{n_a}$$

- Constructive and destructive interference and intermediate phases shifts. Visibility of an interference pattern is controlled by the ratio of the maximum to minimum irradiance in the pattern. This leads to the definition of the visibility V, as a percentage, given by
  $$V = \frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}} \times 100.$$
- Explain Young's experiment, calculate the distance between the slits in a diffraction grating and the distance between neighbouring fringes and the irradiance of the interference fringe pattern and the phase difference between the two waves.
- Explain diffraction of light and the Huygens–Fresnel–Kirchhoff theory. Fraunhofer diffraction looks at the diffraction of light from a very faraway source effectively 'at infinity' or at the image on a screen being 'at infinity'. The implications of these two special circumstances are that the phase change in the received light from across the aperture varies linearly with the coordinates across the aperture. If the distance from the aperture is y then in Fraunhofer differentiation the phase change varies in proportion to y. Mathematically, the total electric field, E_p, at a point on the screen is given

  by, $E_p \; \alpha \int_{aperture} \cos(kr - \omega t)\, dA$

  As always the irradiance will depend on the square of the electric field.

- Photoelectric effect is the emission of electrons from a material when it is bombarded by light or, more generally, electromagnetic radiation. Calculate the work function and the velocity of the released electrons. Explain applications, eg the photomultiplier, image intensifiers and CCD detectors.
- Each point on an object sends out light in many directions. To see the object we intercept a narrow pencil of light coming from a point. The object appears at the apex of the observed cone of light. Explain the concept of converging and divergence of pencil rays. The effect of a lens, a reflecting surface at the aperture alters the vergence of an incident wave by the power of the lens. Images are formed independently by each separate part of the image forming surface, explain how this can give a blurred image.

- Look at the effect of a spherical surface where the calculations of the power must include the radius of the sphere. All measurements are made from the vertex of the surface, the point where the surface intersects the axis of the optical system. The focal point and focal length of lens and the determination of where the image will be formed. Imaging for a thin lens where the image on the first surface is taken as the object for the second surface. Calculation of where the image can be observed and magnification. Look at the applications, ie telescopes and microscopes.

Outcome 4 — Perform a practical experiment related to light and optics

Guidance on suitable practical experiments for assessment purposes is given elsewhere in this document. However, it is envisaged that learners will also participate in a range of other practical experiments which will both develop their laboratory skills and support the theory covered in Outcomes 1−3.

In carrying out such experiments, learners should follow Good Laboratory Practice and carry out or be familiar with the risk on all procedures undertaken. Opportunities should be taken to develop awareness of the sources of experimental error and of the accuracy of measurements, with quantification of errors where possible.

Guidance on approaches to delivery of this Unit

There is no particular order in which Outcomes 1−3 would be best delivered. It is envisaged that laboratory work and demonstrations will feature across the delivery of each of the Outcomes, and that the assessed practical experiments will be undertaken in a similar timeframe to the underpinning theory.

It is envisaged that delivery of Outcome 1 could commence with coverage of the basic description of light and the principles of reflection and refraction using Snell’s law. Continuing with aspects of wave phenomena, waves varying in position and time, Huygen’s principle, optical path length, propagation time and Fermat’s principle. The principles of total internal reflection through a prism and fibre optics with explanations of the evanescent wave, frustrated total internal reflection and total internal reflection fluorescence. The Outcome could be completed with dispersion curves and the Abbe number.

Outcome 2 will cover different light sources and spectrums, this will include looking at the relationship between frequency and wavelength using the relationship to determine the appropriate region of the electromagnetic spectrum. Delivery could then focus on energy absorbed or re-radiated giving the absorption and emission spectra before covering blackbody radiation and making calculations using Wien displacement law and Stefan–Boltzmann law. The Outcome could be completed with the hydrogen spectrum and the Lyman, Balmer and Paschen series.

Outcome 3 could commence with linear, circular and natural polarisation and their applications before covering interference and the effect of using diffraction gratings. Delivery could then focus on diffraction and the Huygens–Fresnel–Kirchhoff theory with learners performing calculations to determine irradiance of light. The photoelectric effect and its applications should also be covered. The Outcome could be completed with the production of images, calculations on the focal length and the focal point of a lens and applications such as telescopes and microscopes.

Unit title: Physics: Light and Optics (SCQF level 8)

It is envisaged that Outcome 4 will be delivered alongside the theoretical based Outcomes 1−3. A range of practical experiments could be utilised to both support understanding of the underlying theory and to prepare learners for undertaking the assessed practical experiment. Aspects suitable for experimental investigation might include Snell's law, focal length of a concave lens using a convex lens, determination of the refractive index from a measurement of the Brewster angle and the production and detection of plane polarised light.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Outcomes 1−3 could be assessed by a single holistic closed-book assessment with an appropriate cut-off score that covers the sampling requirements as detailed in the Evidence Requirements. Assessment should be carried out in supervised conditions, and it is recommended that the assessment be completed within 90 minutes. Learners can only have access to the *SQA Databook for HN Physics* or any suitable replacement when sitting the assessment.

Where evidence of Outcomes 1−3 is assessed by sampling, the whole of the content listed in the Knowledge and/or Skills must be taught and available for assessments. Learners should not know in advance the items on which they will be assessed, and different items should be sampled on each assessment occasion. Any items not sampled in the first assessment, must be included in the alternate (re-sit) assessment.

In Outcome 4 learners are required to undertake one assessed practical experiment, the content of which will be related to Outcomes 1−3. Examples of suitable experiments are given below. However, this list is not prescriptive, and other practical experiments of similar complexity may be used by the centre.

Suitable practical experiments for Outcome 1 are:

- Snell's law, refraction of light through a glass block.
- Wavelength of light.

Suitable practical experiments for Outcome 2 are:

- Dividing the amplitude of laser light.
- Focal length of a concave lens using a convex lens.

Suitable practical experiments for Outcome 3 are:

- Investigating diffraction at a single slit.
- Calculating the wavelength in two-slit interference.
- Determination of the refractive index from a measurement of the Brewster angle.
- Production and detection of plane polarised light.
- Measuring the refractive index of air using a Michelson interferometer.

Unit title: Physics: Light and Optics (SCQF level 8)

It is envisaged that the assessed practical experiment will usually be performed individually. However, there may be some experiments that are suitable to be undertaken in pairs or small groups, but if this is the case then the assessor should ensure that all participants are actively involved and are able to adequately demonstrate the required skills.

An exemplar instrument of assessment with marking guidelines has been produced to indicate the national standard of achievement at SCQF level 8.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at **www.sqa.org.uk/e-assessment**.

Opportunities for developing Core and other essential skills

The delivery and assessment of this Unit will provide learners with the opportunity to develop the Core Skills of *Numeracy* and *Problem Solving* at SCQF level 6, and *Information and Communication Technology (ICT)* at SCQF level 4.

Numeracy — Using Number at SCQF level 6

Learners will be required to decide on the steps and operations to solve complex problems, carrying out sustained and complex calculations, eg performing calculations related to polarisation of light, or the phase change across an aperture.

Problem Solving — Reviewing and Evaluating at SCQF level 6

Following the assessed practical experiment learners will be required to review and evaluate the effectiveness of the exercise with a thorough interpretation of random and systematic sources of error. Learners will be required to reach sound conclusions on the basis of the data collected and the inherent errors.

Unit title: Physics: Light and Optics (SCQF level 8)

***Information and Communication Technology (ICT)* — Providing/Creating Information at SCQF level 4**

Learners will make effective and appropriate use of ICT packages to produce a laboratory report in an appropriate format. Packages used will likely include word processing, spreadsheets and the use of ray drawing software.

This Unit has the Critical Thinking components of Problem Solving and Using Number components of Numeracy embedded in it. This means that when candidates achieve the Unit, their Core Skills profile will also be updated to show they have achieved Critical Thinking at SCQF level 6 and Using Number at SCQF level 6.

History of changes to Unit

Version	Description of change	Date
03	Duration of assessment for Outcomes 1-3 changed from 120 minutes to 90 minutes.	18/03/2016
02	Core Skills Components Critical Thinking and Using Number at SCQF level 6 embedded.	28/07/2015

Additional copies of this Unit specification can be purchased from the Scottish Qualifications Authority. Please contact the Business Development and Customer Support team, telephone 0303 333 0330.

General information for learners

Unit title: Physics: Light and Optics (SCQF level 8)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This is a 1 credit Unit at SCQF level 8, which you are likely to be studying as part of the first year of an HNC/HND Science programme. Before progressing to this Unit it would be beneficial to have completed the HN Unit H93D 33 *Physics 1* and H8XP 33 *Mathematics for Science 1*, where you will have learned underpinning aspects of light, the required mathematics and developed your practical skills. There will be a strong emphasis on the importance of experimental data in understanding optical principles, and on the applications of knowledge of light waves in practical situations.

On completion of the Unit you should be able to:

1 Describe and explain aspects and principles of the science of light.
2 Describe and explain different light sources and spectrums.
3 Describe polarisation, interference and diffraction.
4 Perform a practical experiment related to light and optics.

Outcome 1

In this Outcome you will cover fundamentals of light, in particular the difference between light rays, pencils and beams, looking at the principles of reflection and refraction.

You will learn about light as wave, looking at how waves vary with time, position and optical path length, and the principles of total internal reflection through a prism, fibre optic and fluorescence. How different materials with different refractive indexes disperse light by different degrees will also be covered.

Outcome 2

In this Outcome you will learn about the different parts of the electromagnetic spectrum and the relationship between wavelength and frequency. You will examine the emission and absorption spectrum and you will learn to perform calculations on the frequency of light and energy levels. You will learn about blackbody radiations using the Wien displacement law and the Stefen–Boltzmann law, and you will examine the hydrogen spectrum and the three different spectrum series.

Outcome 3

In this Outcome you will look at the different types of polarisation: linear, circular and natural, and the applications of polarisation. You will learn about different experiments which split light into fringe patterns, and you will learn about diffraction of light through different shaped apertures. The photoelectric effect and the different applications it is used for will be covered, and you will learn about the production of images and how to perform calculations on the focal length and focal point of lens. You will also cover applications, ie telescopes and microscopes.

General information for learners (cont)

Unit title: Physics: Light and Optics (SCQF level 8)

Outcome 4

In this Outcome you will undertake a practical experiment, based on the content of Outcomes 1-3.

During this practical work, you will also be expected to develop good laboratory practices as well as improve your skills of manipulation, observation and measurement. You will be encouraged to develop safe working practices and to strive constantly to improve the accuracy and reliability of your results. The reporting and analysis of experimental data is an important aspect of the practical sessions.

Assessment

For Outcomes 1−3 you will take a closed-book, end of Unit assessment.

Outcome 4 will be assessed after you have learned the necessary practical skills, and will take the form of one practical experiment, for which you will report your results in a full laboratory report.

Core Skills

You will have opportunities to develop the Core Skills of *Numeracy* and *Problem Solving* at SCQF level 6, and *Information and Communication Technology (ICT)* at SCQF level 4.