Qualification Requirement for the BTEC Higher Nationals in Applied Physics

This Qualification Requirement should be read in conjunction with overarching guidance from Edexcel.

Rationale

BTEC Higher Nationals using the title Applied Physics should be developed to provide:

- the education and training of physics technologists who are employed in a variety of types of technical work, in quality control, measurement, laboratory analysis, materials testing, research and development, education etc
- a standard national vocationally specific qualification at Level 4 linked to National Occupational Standards and professional body requirements.
- a nationally recognised vocationally specific qualification that will provide confidence to employers recruiting applied physics technologists that holders of the qualification possess the requisite knowledge, understanding, and skills
- a qualification that will be assessed to a national standard and thus provide confidence to those recruiting to more advanced higher education vocational qualifications such as a degree in Applied Physics or related area
- a programme of learning that ensures full understanding of the role of the applied physics technologist. This includes an understanding of the role at departmental/section level as well as an appreciation of how the role and that of the department/section fits within the overall structure of their organisation and within the scientific and local community.

Aims of the Qualification

Qualifications in Applied Physics meet the needs of the above rationale by:

- equipping individuals with knowledge, understanding and skills for success in employment in physics-based industries
- enabling progression to an undergraduate degree or further professional qualification in physics or related areas
- providing specialist studies relevant to individual vocations and professions in which students are working or intend to seek employment in the physical sciences and their related industries
- developing the learners ability in the physical sciences environment through effective use and combination of the knowledge and skills gained
- developing a range of skills and techniques, personal qualities and attributes essential for successful performance in working life and thereby enable learners to make an immediate contribution to employment

- providing flexibility, knowledge, skills and motivation as a basis for future studies and career development - an educational foundation for a range of careers in physical sciences and their related industries
- providing opportunities for learners to focus on the development of the higher level skills in a science and technological context
- providing opportunities for learners to develop a range of skills and techniques and attributes essential for successful performance in working life.

Mandatory Curriculum

Laboratory Management and Organisation: resource management; in-house and out-sourced services; laboratory management information systems; supervisory management; Health and Safety Management.

ICT and Management of Information: use sector specific physics/electronics based software packages for the management of information; collection; analysis and use of data; ICT skills used to obtain information from electronic sources and synthesise information.

Measurement Techniques: use of advanced modern instrumentation techniques to measure physical quantities; data logging. Students should be able to interpret and analyse data in a critical manner and be aware of the limitations of the use of the instruments used.

Scientific Project Management: use of project management skills; implement a project plan to investigate an unfamiliar situation and include a critical evaluation and review; importance of communications and presentation in project management; team working skills.

Numerical and Statistical Techniques: Use of numerical techniques to solve scientific problems; the types of errors and tolerances; evaluation of data obtained; including random, systematic and gross errors; accuracy and precision; linear and non-linear equations; constrained optimisation; differentiation and integration; differential equations.

Problem solving skills: Develop skills to solve physical problems that are of a practical and/or theoretical nature using appropriate techniques. Students should be able to analyse problems that involve unfamiliar information, synthesise information and summarise information in a critical manner. Conclusions should be presented for audiences at different levels who may or may not be familiar with the subject matter

Practical skills: Use a variety of equipment and practical techniques that can be used for investigations and/or physical applications. Students should be able to devise innovative experiments to investigate situations that are unfamiliar, analyse the results obtained in a critical manner and present conclusions in an acceptable format for audiences who may or may not be familiar with the subject. Calibrate equipment.

Optional Curriculum

Work-based Assignment: apply with a degree of autonomy and responsibility for own learning the knowledge, understanding and technical skills to a practical work-based assignment. This is for students employed within a physics electronics based industry

Nuclear Technology and Radiation Safety: develops an understanding of the physical principles that are used in the modern nuclear industry including the nature of isotopes and nuclear forces; radioactive decay and nuclear reactions; examples of application of nuclear technology; interaction of radiation with biological materials;
the hazards involved and the safety techniques that must be used to ensure that nuclear technology is applied safely. Candidates will assess the radiation dose uptake for a situation involving a radiation source.

Optical Technology: develops an understanding of principles that underlie key devices used in current optical technology including the physical principles of light sources used; the operation of optical fibres; single and multi-element detector systems. The knowledge gained should enable the candidate to evaluate the properties of an optoelectronic imaging system.

Materials Science and Technology: develops an understanding and knowledge of structure-property relationships for a range of different materials; how properties of materials can be modified; materials characterisation and testing techniques.

Microcontrollers: develops an understanding of the structure and features of a PIC microcontroller; develops the skills to produce assembler programs for a PIC microcontroller and debug a PIC microcontroller program. The skills that are developed are employed in the production of a mini-project involving a PIC microcontroller.

Microelectronics: develops and applies a knowledge and understanding of semiconductor theory. This includes the process of conduction in semiconductors; the Hall effect; extrinsic semiconductor energy diagrams; potential barriers and the effect of bias on p-n junctions; the physical construction of bipolar transistors and MOSFETS; the fabrication of silicon ICs and devices. Practical work is used to relate device characteristics to the physics of the device.

Interfacing and Data Acquisition: develops and applies the knowledge and understanding of the fundamentals of interfacing computers to sensors, transducers and instruments. The unit includes an introduction to a programming language for the presentation of data; the operation of sensors and transducers; PC interface cards for digital I/O operations; how ADCs and DACs are interfaced to a computer; industrial standards used for instrument interfacing. A mini-project is included in which students apply the skills they have developed to acquiring data from a laboratory experiment.

Applications of Thermodynamic Concepts: develops and applies the knowledge and understanding of thermodynamic principles that underlie key technological applications including temperature and equilibrium; the first and second laws of thermodynamics; the nature of thermal properties and processes that includes thermal expansion and the transfer of thermal energy.

Vacuum Science and Technology: develops an understanding of the key physical factors that determine how various levels of vacuum are achieved; techniques used for the creation of a vacuum; measuring vacuum levels and detecting leaks; two applications of vacuum technology.

Digital Imaging Techniques: develops an understanding of the basics of digital imaging techniques including the nature of the digital image; capture of digital images; image processing; practical applications of digital imaging.

Mathematics For Science: develops and applies the knowledge and understanding of statistical and mathematical principles including graphs for exponential, logarithmic and trigonometric functions; derivatives and integrals of standard functions; complex numbers; vectors in two and three dimensions; solutions to ordinary differential equations; partial derivatives of a function of two variables

Links to Professional Body

Students studying an HNC/D in Applied Physics may apply to become an Affiliate Member of the Institute of Physics. On obtaining an HNC/D in Applied Physics and a number of years (usually between 3 – 5 years) of post HNC/D experience in the applied physics industry, they are able to apply for 'Associate Membership' of the Institute of Physics.

Links to National Standards
There is the opportunity for programmes in Applied Physics to provide some of the underpinning knowledge, understanding and skills for the Level 4 NVQ in Laboratory and Associated Technical Activities.

Higher Level Skills and Abilities

Learners will be expected to develop the following skills during the programme of study:

- the ability to work as an individual and in teams for successful performance in a physics based industrial environment
- the ability to be flexible and respond to the changing climate within the scientific community
- the ability to communicate effectively and appropriately
- the ability to use ICT and Management Information Systems in a physics based environment
- supervisory management responsibilities in an appropriate context
- personal qualities and attributes essential for successful performance in working life
- analysing, synthesising and summarising information critically
- the ability to read and use appropriate scientific literature with a full and critical understanding
- the ability to solve problems applying subject knowledge and understanding to address familiar and unfamiliar problems
- the ability to think laterally and be innovative and creative in relevant contexts
- the ability to think independently, take responsibility for their own learning and recognise their own learning style
- designing, planning, conducting and reporting on investigations
- undertaking laboratory investigations in a responsible, safe and ethical manner
- recognising the moral and ethical issues of scientific enquiry and experimentation and appreciating the need for ethical standards and professional codes of conduct
- develop an appreciation of the interdisciplinary nature of science, the capacity to give a clear and accurate account of a subject, marshal arguments in a mature way, and engage in debate and dialogue both with specialists and non-specialists.

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