Unit 13: The Underpinning Science for the Provision of Human Comfort in Buildings

Unit code: M/600/0296

QCF Level 3: BTEC Nationals

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit is designed to give learners knowledge of the factors that influence human comfort and an understanding of the principles for the provision of electric power. Learners will also develop skills in applying scientific principles to provide a comfortable internal environment and in performing calculations relating to fluids.

Unit introduction

Until quite recently, many buildings were too hot in summer, too cold in winter, draughty, poorly insulated, poorly lit and unhygienic. Today, a building must provide a comfortable, safe and hygienic internal environment. A clear understanding of the issues involved in achieving this is essential for everyone involved in the design and construction of buildings and the provision of building services.

Architects and builders, generally, are responsible for the internal environment of small buildings such as a house or apartment, but the services of a professional building services engineer would generally be required for larger and more complex buildings.

Learners will develop an understanding of the factors that affect human comfort, and of the principles that underpin the use of heating, ventilation, acoustics, lighting, electrical supply and the flow of water in both pipes and drains. They will develop knowledge and understanding of how each of these contributes to producing a desired internal environment, and will be able to use underpinning scientific knowledge and principles to support the design of the elements of a comfortable internal environment, including simple, safe and effective electrical and water installations.

Learning outcomes

On completion of this unit a learner should:

1. Know the factors that influence human comfort
2. Be able to apply scientific principles to provide a comfortable internal environment
3. Understand the generation, transmission and distribution of electrical power
4. Be able to perform calculations relating to fluids at rest and in motion.

Unit content

1 Know the factors that influence human comfort

Human comfort in the internal environment: heating and ventilation; acoustics; lighting

Heating and ventilation: physical factors (air temperature, mean radiant temperature, relative humidity, air movement); personal factors eg clothing, age, gender, activity, metabolism; integrated thermal comfort temperatures eg dry resultant, inside environmental, room centre comfort, apparent; methods used to measure each physical factor eg thermometer, globe thermometer, hygrometer, anemometer; acceptable comfort parameters

Acoustics: factors (sound reduction indices, reverberation times, noise criteria indices); sound level meter to measure each factor; acceptable comfort parameters

Lighting: factors (illuminance levels, daylight factors, glare indices); methods used to measure each factor eg light meter, daylight meter; acceptable comfort parameters

2 Be able to apply scientific principles to provide a comfortable internal environment

Heating and ventilation: principles of heat in buildings (U values, thermal bridges, air changes, fabric and ventilation heat losses, heat gains, heat balance); principles of condensation in buildings (sources of water vapour in buildings, structural temperature profiles, dew-point temperature profiles, prediction and prevention of condensation); standard calculations to support the above

Acoustics: principles of sound (standard units, addition and averaging of decibel levels, difference between sound and noise, techniques used to control noise, difference between sound insulation and sound absorption, difference between airborne and impact sound, issues associated with flanking transmission, techniques used to provide adequate sound insulation, sound absorption coefficients, reverberation, actual and optimum reverberation times); standard calculations to support the above

Lighting: principles of illumination (standard units, differences between natural and artificial light, advantages and disadvantages of each, inverse square law of illumination, cosine law of illumination, lumen method of design, daylight factor, components of daylight factor, desktop methods to determine daylight factor, control of glare for both artificial and natural light sources); standard calculations to support the above

3 Understand the generation, transmission and distribution of electrical power

Principles: nature of electricity; relationship between voltage, current, resistance and power; electromagnetic induction; alternating current wave form; power losses during transmission at different voltages; consequent need to transform AC voltages; nature of three-phase supply

Practices: practical generation of alternating current; standard sources of heat energy used to drive generators eg nuclear reaction or combustion of coal, oil or gas; transformation of alternating current; distribution of single-phase and three-phase electricity supplies to buildings

4 Be able to perform calculations relating to fluids at rest and in motion

Fluids at rest: properties (pressure at a given depth equal in all directions, always acts at right angles to any containing surface, magnitude affected by depth but not by volume or shape); standard calculations (actual pressure at a depth, force acting on a retaining wall, position of depth of centre of pressure)

Fluids in motion in pipes and channels: properties (difference between laminar flow and turbulent flow, total energy a constant); principles and uses of flow measurement devices, eg venturimeters, orifices, notches, weirs, Pitot tubes; standard calculations to support the above, eg volume flow rate, continuity equation, Bernoulli's theorem, Chezy formula for self-cleansing flow; D'Arcy formula for loss of head due to friction

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 four physical factors that influence human comfort in the internal environment [IE1, IE2, IE4, IE6]	**M1**	compare three integrated thermal comfort temperatures in general use		
P2	describe four personal factors that influence human comfort in the internal environment [IE1, IE2, IE4, IE6]				
P3	describe four methods used to measure factors that affect human comfort [IE1, IE2, IE4, IE6, TW1, TW6]				
P4	identify acceptable comfort parameters [IE1, IE2, IE4, IE6]				
P5	describe the scientific principles that underpin heating, ventilation, acoustics and lighting [IE1, IE2, IE4, IE6, CT2, CT3, RL3, RL4]				
P6	perform four separate calculations associated with the provision of a comfortable internal environment [IE1, IE2, IE4, IE6, CT5, RL3, SM3]	**M2**	assess the effect of varying standard design options on the provision of heating, ventilation, acoustics and lighting, and on the prevention of condensation		

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:	
P7	explain the generation, transmission and distribution of electricity using appropriate principles and practices [IE1, IE2, IE4, IE6, CT2, CT3, RL3, RL4]	**M3**	explain why electricity is transformed for distribution by using alternating current	**D1**	justify the use of single-phase and three-phase distribution systems
P8	differentiate between the properties of fluids at rest and in motion [IE1, IE2, IE4, IE6, CT2, CT3, RL3, RL4]	**M4**	apply appropriate formulae to solve two problems in fluid mechanics and one in flow measurement.	**D2**	compare two different flow measurement devices in terms of accuracy, measurement approach and ease of use.
P9	produce analytical solutions to problems relating to fluids. [IE1, IE2, IE4, IE6, CT5, RL3, SM3]				

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

Tutors have the opportunity to use a wide range of techniques to deliver this unit. Lectures, discussions, seminar presentations, site visits, supervised practicals, research using the internet and/or library resources and use of personal and/or industrial experience are all suitable. Delivery should stimulate, motivate, educate and enthuse learners. Visiting expert speakers could add to the relevance of the subject.

Learning outcomes 1 and 2 are linked and form a logical, consistent and progressive structure. Learning outcomes 3 and 4 are not linked, either to each other or to learning outcomes 1 and 2. This implies three broad areas of delivery, each leading to a separate assessment instrument.

Teaching and learning strategies designed to support delivery of learning outcomes 1 and 2 should take an integrated, learner-centred approach. This would involve learners in taking readings, consulting standards, making decisions and suggesting alternatives.

For learning outcome 1, delivery should emphasise the physical comfort of humans in the interior of buildings. This includes the various factors that comprise a comfortable internal environment, the parameters within which a given person will feel comfortable, the commonly accepted methods of measuring such factors, the importance of using the correct units, and any indices used to integrate the various factors. Underpinning principles are not a requirement at this stage.

For learning outcome 2, delivery should focus on the links between the knowledge and understanding of basic science gained at Key Stage 4, and the extension and application of those principles to the provision of a comfortable internal environment. The 'hard science' only needs to be of sufficient depth to support practical application of the scientific principles. A quantitative approach should be adopted to support understanding of the basic principles.

The unit should not, however, be seen as a mathematical exercise. Calculations used to support the delivery process should always reflect real-life and standard practices. For example, calculations on the lumen method of design should determine the number of fittings needed to give a design level of illumination, rather than the level of illumination provided by a given number of fittings. This principle applies to each of the broad areas that comprise the unit.

Standard spreadsheet applications will allow learners to assess the effect of altering window to wall ratios, the number of air changes/hour, the U value of components, or the replacement of single glazed windows by double glazing. They could also be used to construct and interpret structural and dew-point temperature profiles, to determine actual and optimum reverberation times, and much more.

The effect of varying design options on heating, ventilation, acoustics and lighting should be considered for some or all of the following: sheltered sites, deep building shapes, narrow building plans, heavy building materials, increased window areas and the use of small sealed windows. These are, however, suggestions only and the list is not exclusive nor comprehensive.

Mention may be made of the 2006 changes to *Approved Documents F and L of the Building Regulations*, and the uses of standard assessment procedures (SAP) where time allows, but a thorough treatment of these topics is more appropriate for learners at Higher National or degree level. There is no requirement to deal with these topics in this unit, or to assess them.

For learning outcome 3, learners must be made aware that all power stations generate electrical energy using electromagnetic induction and that this always involves moving a coil through a magnetic field to produce an electro-motive force. Delivery needs be no deeper than that, and there is no requirement for a more advanced understanding of the basic physics, such as Faraday's laws or Lenz's law.

Learners should understand that the difference between coal-fired, oil-fired, gas-fired and nuclear power stations lies in how the heat needed to drive the turbines is obtained. Learners do not need to develop a detailed practical understanding of generators. Learners should, however, be made aware that the methods in general use today consume valuable fossil fuels at an unacceptable rate, and that this is a matter of some concern. A description of alternative energy techniques is not required at this stage in the unit.

Learners must know that an electrical current is simply a flow of electrons in a conductor, that power = voltage × current and voltage = current × resistance. They will need this knowledge and understanding to explain why we need to transform electricity during transmission. Learners must be aware that it is possible to use three separate coils, each displaced from the other by 120°, in the same generator, and that this forms the basis of the standard form of three-phase, four-wire AC supply.

For learning outcome 4, learners must develop an understanding of what is meant by fluid pressure, fluid flow, friction losses in pipes and self-cleansing flow. They should be aware of the difference between laminar and turbulent flow but any treatment of turbulent flow, transitional flow or Reynolds number is not required and all flow can be considered to be laminar at this stage.

Delivery should include coverage of a variety of calculations designed to support all aspects of the unit content. Learners must be able to perform calculations relating to the flow of fluids in pipes and drains and use at least one flow measurement device. It will, however, be necessary to identify, describe and compare at least two flow measurement devices in order to meet the assessment requirements. The more different these are, the easier they will be to compare. The actual construction of these devices is not relevant at this stage.

Broad reference should be made to the Building Regulations wherever necessary. Learners should be encouraged to see how buildings have developed over the last 30 years and how construction of a new building is different from the maintenance and adaptation of an older property. Wherever possible, links should be made with the industry, in particular house building companies, as this will provide an opportunity for learners to relate to buildings they are familiar with, and to use this to inform their study of the design of the internal environment.

Group activities are permissible, but tutors will need to ensure that individual learners have equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken before practical activities are taken. Centres are advised to read the *Delivery approach* section in the specification, and *Annexe H: Provision and Use of Work Equipment Regulations 1998 (PUWER).*

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
Introduction
Human comfort Whole-class, tutor-led discussion of factors that affect human comfort Small-group activity to measure factors using appropriate equipment. Each group to be allocated a different factor and the equipment used to measure the magnitude of that factor Followed by small-group research into underpinning scientific principles and acceptable values for each factor Each group to present their findings to the class with a Q&A session led and controlled by the tutor
Calculations relating to human comfort Tutor to explain the above and lead the class through exemplar calculations and the use of any relevant graphs and tables Learners practise calculations in preparation for assignment.
Assignment 1: Human Comfort
Electrical power Whole-class, tutor-led discussion of generation, transmission and distribution of electrical power. Emphasis on the fact that it is alternating current (AC) that is always generated in power stations and transmitted through the National Grid. A clear description of the AC waveform and the relationship between voltage, current, resistance and power will be required A site visit to a power station or sub-station and a conducted tour of electrical services within the centre Class divided into three groups. One to research generation, another transformation and the last distribution. Each group to present their findings to the class. Tutor to provide a comprehensive handout to support the presentations **after** the presentations. Discussion of presentations in light of tutor handout Whole-class, tutor-led discussion of single-phase and three-phase supply, and advantages of latter
Assignment 2: Electrical Power
Fluids Properties of fluids at rest through simple demonstrations by tutor, practical work where equipment is available; $P = h\rho g$, depth of centre of pressure, force acting on wall Properties of fluids in motion through simple demonstrations by tutor, practical work where equipment is available; Bernoulli, Chezy, D'Arcy formulae; venturimeter, orifice plate, Pitot tubes and similar Tutor to explain the above and lead the class through exemplar calculations and the use of any relevant graphs and tables. Learners to practise typical calculations.
Assignment 3: Fluids
Review of unit and assignment feedback

Assessment

Evidence for this unit may be gathered from a variety of sources, including well-planned investigative assignments, case studies or reports of practical assignments.

There are many suitable forms of assessment that could be used. Some example assessment approaches are suggested below. However, these are not intended to be prescriptive or restrictive, and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used, suitable evidence would be observation records or witness statements. Guidance on the use of these is provided on the Edexcel website.

The structure of the unit suggests that the grading criteria could be addressed fully by using three assignments. The first of these would cover P1, P2, P3, P4, P5, P6, M1 and M2, the second would cover P7, M3 and D1, and the third P8, M4 and D2.

To achieve a pass grade learners must meet the nine pass criteria listed in the grading grid.

For P1, learners must describe four physical factors that influence human comfort in the internal environment. They must use the correct units for each variable. Evidence could be a presentation, a report or through oral questioning based on a tutor provided case study.

For P2, learners must describe four personal factors that influence human comfort in the internal environment. They must use the correct units for each variable. Evidence could be a presentation, a report or through oral questioning based on a tutor provided case study.

For P3, learners must describe four methods used to measure factors that affect human comfort. They should be able to describe the instruments, meters and methods used to measure the physical variables that influence human comfort. This could include thermometers, hygrometers, anemometers, sound level meters and light meters. Although there are obvious benefits in learners having opportunities to use such equipment, there is no formal requirement for them to produce practical results to support evidence of this and the use of secondary sources is acceptable. Evidence could be in the same format as for P1.

For P4, learners must identify acceptable comfort parameters. They should be able to quantify acceptable values for comfort parameters. These should be taken from air temperature, mean radiant temperature, relative humidity, air speed, rates of air change for a variety of rooms, airborne and impact sound reduction indices, reverberation times, illumination levels and daylight factors. Evidence should take the form of a report supported by images, tables, charts and calculations as appropriate.

For P5, learners must describe the basic scientific principles that underpin the factors selected for P1 and P2. These should be taken from air temperature, mean radiant temperature, relative humidity, air speed, rates of air change for a variety of rooms, airborne and impact sound reduction indices, reverberation times, illumination levels and daylight factors. Evidence should take the form of a report supported by images, tables, charts and calculations as appropriate.

For P6, learners must perform four calculations associated with the provision of a comfortable internal environment. At least one calculation should relate to the prevention of condensation. The answers to the calculations should be substantially correct, but small errors are acceptable if they are corrected after feedback from the tutor. Such calculations should refer to the determination of U values from first principles, changes to the U values of existing structures, the calculation of fabric and ventilation heat losses and hence total heat losses.

Learners should refer to the production of structural and dew-point temperature profiles, the addition and averaging of sound levels in dB, the determination of both actual and optimum reverberation times of an enclosure, and the inverse and cosine laws of illumination for point sources of light.

Reference should also be made to the lumen method of design for luminaires mounted in a regular pattern, the use of daylight factors and basic exercises to determine the daylight factor for a room of rectangular plan with only one window. Evidence could be in the same format as for P5.

For P7, learners must explain the generation, transmission and distribution of electricity using appropriate principles and practices. Learners must also produce a diagram of a typical alternating current (AC) output and use this to support an explanation of why AC constantly changes and reverses. Evidence could be in the same format as for P5.

For P8, learners must differentiate between the properties of fluids at rest and in motion. This could be expressed in terms of which form of energy is involved in each case. Evidence could be in the same format as for P1.

For P9, learners must produce analytical solutions to problems relating to fluids. Problems should be set in a vocational context. Learners should select and apply appropriate formulae to solve fluid problems. The answers to the calculations should be substantially correct, but small errors are acceptable if they are corrected after feedback from the tutor.

To achieve a merit grade learners must meet all of the pass grade criteria and the four merit grade criteria.

For M1, learners must compare three integrated thermal comfort temperatures in general use. They must cover the advantages and disadvantages for each of the integrated thermal comfort temperatures. This should indicate clearly which variables have been incorporated into each index and how this influences the accuracy and usefulness of each index. Evidence could be in the same format as for P1.

For M2, learners must assess the effect of varying standard design options on the provision of heating, ventilation, acoustics and lighting, and on the prevention of condensation. Indicative examples are given in the *Delivery* section, but learners should feel free to devise their own design options. This part of the assessment is designed to be open ended, but any reasoning used must be logical and any recommended procedures, methods or techniques must be practicable.

For M3, learners must explain why electricity is transformed for distribution. Learners must explain how a transformer works, the importance of the alternating magnetic field in the core and the difference between step-up and step-down transformers. This should be supported by diagrams and simple calculations and should include the reasons for using alternating current.

For M4, learners must apply appropriate formulae to solve two problems in fluid mechanics and one in flow measurement. The answers to the calculations should be substantially correct, but small errors are acceptable if they are corrected after feedback from the tutor. Learners must include calculations relating to the flow of fluids in pipes and drains and the use of at least one flow measurement device.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria and the two distinction grade criteria.

For D1, learners must justify the use of single-phase and three-phase distribution systems. The justification should include both theoretical and practical considerations. They must be able to explain why the use of a three-phase supply reduces the number of cables required, and justify how a four-wire supply is used to deliver both 240V and 415V to buildings. There is no requirement for any understanding of star and delta connections at this stage. Evidence could be in the same format as for P1.

For D2, learners must compare two different flow measurement devices in terms of accuracy, measurement approach and ease of use. This information should then be used to compare the various devices in terms of the advantages and disadvantages of each, how accurate the results are, which formula and/or approach is used and how easy each is to use. This can be related to M4 where learners have applied the principles and formulae. This should not be confused with problems associated with the construction of these measurement devices, which is not a consideration at this stage. Evidence could be in the same format as for P1.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading criteria. 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, P3, P4, P5, P6, M1, M2	Human Comfort	A property developer wishes to convert an old farm into a health centre. She wants the centre to be the 'last word' in comfort but has no idea what 'comfort' means in this context. As a consultant, you have been asked to help improve her understanding of this topic.	Presentation or report, to include text supported by diagrams, calculations, graphs, tables, charts and practical results as appropriate.
P7, M3, D1	Electrical Power	The farm is isolated and is not connected to a mains supply. As an electrician, you have been asked to investigate how this could be carried out and what is implied in terms of generation, transformation and distribution.	Report, to include diagrams, calculations, graphs, tables and charts as appropriate.
P8, P9, M4, D2	Fluids	The farm is isolated and is not connected to the mains drainage or a clean drinking water supply. As a fluid engineer, you have been asked to research the basic principles that underpin working with fluids before commencing any design of the water supply or the drainage for the health farm.	Practical reports including calculations, graphs and conclusions as appropriate. Standard design calculations.

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

This unit forms part of the BTEC Construction and the Built Environment sector suite. This unit has particular links with the following unit titles in the Construction and the Built Environment suite:

Level 1	Level 2	Level 3
	Use of Science and Mathematics in Construction	Science and Materials in Construction and the Built Environment
		Mechanical and Electrical Services in Construction
		Building Services Science

Essential resources

Resources should include the equipment needed to measure factors associated with human comfort including thermometers (mercury-in-air, globe, Kata), hygrometers, anemometers, sound level meters and light meters. This equipment should be used to demonstrate the standard range of acceptable values and underpinning concepts, principles and theories.

In general, instruments and items of equipment are available at a realistic cost and centres do not need to buy the best available equipment in order for learners to achieve the learning outcomes. Relatively low cost meters, of reasonable accuracy, that combine the measurement of temperature, relative humidity, sound levels and light levels in a single instrument are available from specialist electrical suppliers.

Equipment such as avometers, dynamos, generators and transformers will help support delivery of learning outcome 3, either as sectioned models, demountable kit or live installations.

Hydraulic benches, venturimeters, pipe friction apparatus, and so on, will assist the delivery of learning outcome 4, where they can be used to demonstrate underpinning concepts, principles and theories.

Spreadsheets will be useful in the teaching and learning strategies designed to address learning outcomes 2 and 4 and this implies the need for learner access to an ICT resource. The use of industry recognised software would be advantageous, where available, but is not essential.

Health, safety and welfare issues must be considered at all times and risk assessments should be undertaken for all demonstrations and experiments used in the delivery or assessment of the unit.

Employer engagement and vocational contexts

Support to enable centres to initiate and establish links to industry, and to networks arranging visits to industry and from property practitioners is below:

- Learning and Skills Network – www.vocationallearning.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- The Royal Institution of Chartered Surveyors – www.rics.org
- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI University of Warwick) – www.warwick.ac.uk/wie/cei/

Indicative reading for learners

Textbooks

Burberry P – *Environment and Services, 9th Edition* (Longman, 2007) ISBN 0582432324

McMullan R – *Environmental Science in Building, 6th Edition* (Palgrave Macmillan, 2007) ISBN 0230525369

Journals

Building Engineer – Association of Building Engineers

Websites

www.aepuk.com	Association of Electricity Producers
www.bre.co.uk	Building Research Establishment Limited
www.buildingcentre.co.uk	The Building Centre
www.cibse.org	The Chartered Institution of Building Services Engineers
www.energysavingtrust.org.uk	The Energy Saving Trust
www.noisenet.org	NoiseNet.org Ltd
www.water.org.uk	Water UK

Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS that have been included within the assessment criteria of this unit:

Skill	When learners are …
Independent enquirers	identifying questions to answer and problems to resolve, planning and carrying out research, analysing and evaluating information, supporting conclusions using reasoned arguments and evidence, as they: • identify four physical and four personal factors that influence human comfort in the internal environment • describe four physical and four personal factors that influence human comfort in the internal environment • describe the basic scientific principles that underpin human comfort • describe four methods used to measure factors that affect human comfort • identify acceptable comfort parameters • perform four separate calculations associated with the provision of a comfortable internal environment and the prevention of condensation • explain the safe and effective generation, transmission and distribution of electricity in terms of underpinning principles • differentiate between the properties of fluids at rest and in motion • select appropriate formulae to solve problems relating to fluids • apply appropriate formulae to solve problems relating to fluids
Creative thinkers	asking questions to extend their thinking, connecting their own and others' ideas and experiences in inventive ways and adapting ideas as circumstances change, as they: • describe the basic scientific principles that underpin human comfort • perform four separate calculations associated with the provision of a comfortable internal environment and the prevention of condensation • explain the safe and effective generation, transmission and distribution of electricity in terms of underpinning principles • differentiate between the properties of fluids at rest and in motion • select appropriate formulae to solve problems relating to fluids • apply appropriate formulae to solve problems relating to fluids

Skill	When learners are …
Reflective learners	reviewing progress, acting on the outcomes, inviting feedback and dealing positively with praise, setbacks and criticism, as they: • describe the basic scientific principles that underpin human comfort • perform four separate calculations associated with the provision of a comfortable internal environment and the prevention of condensation • explain the safe and effective generation, transmission and distribution of electricity in terms of underpinning principles • differentiate between the properties of fluids at rest and in motion • select appropriate formulae to solve problems relating to fluids • apply appropriate formulae to solve problems relating to fluids
Team workers	collaborating with others to work towards common goals and providing constructive support and feedback to others, as they: • describe four methods used to measure factors that affect human comfort
Self-managers	organising time and resources and prioritising actions, as they: • perform four separate calculations associated with the provision of a comfortable internal environment and the prevention of condensation • select appropriate formulae to solve problems relating to fluids • apply appropriate formulae to solve problems relating to fluids

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 wide range of ICT applications, especially the internet, to research for projects and presentation related to human comfort in the internal environment
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	
Manage information storage to enable efficient retrieval	
Follow and understand the need for safety and security practices	
Troubleshoot	
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	using a wide range of ICT applications, especially the internet, to research for projects and presentation related to human comfort in the internal environment
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	
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	producing reports and presentations for other learners, tutors and assessment purposes related to human comfort in the internal environment
Bring together information to suit content and purpose	
Present information in ways that are fit for purpose and audience	
Evaluate the selection and use of ICT tools and facilities used to present information	
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	communicating with other learners and the tutor by email and sending, opening and saving attachments

Skill	When learners are …
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	performing calculations, drawing graphs, checking results and communicating results and conclusions using mathematical techniques related to human comfort in the internal environment
Identify the situation or problem and the mathematical methods needed to tackle it	
Select and apply a range of skills to find solutions	
Use appropriate checking procedures and evaluate their effectiveness at each stage	
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	
Draw conclusions and provide mathematical justifications	
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	discussing research findings related to human comfort in the internal environment in small groups and communicating findings to other learners and the tutor using a variety of presentations
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching information related to human comfort in the internal environment from books, journals, CD ROMs and websites
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	presenting the results of their research related to human comfort in the internal environment in report format using clear and accurate English