Institute for Apprenticeships & Technical Education

Construction: Building Services Engineering

T Level outline content: final version for inclusion in ITT

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Contents

Introduction 3

Outline content for T Levels:

Construction core content 8

Building Services Engineering pathway content 13

Occupational specialist content: 18

- Air Conditioning Engineering
- Electrical and electronic equipment engineering
- Electrotechnical Engineering
- Gas Engineering
- Heating Engineering
- Plumbing
- Protection Systems Engineering
- Refrigeration Engineering
- Ventilation

English, maths & digital skills 82

Introduction

T Levels are new, two-year, technical study programmes, designed with employers to give young people the skills that industry needs. T Levels will provide a mixture of:

- technical knowledge and skills specific to their chosen industry or occupation
- an industry placement of at least 45 days in their chosen industry or occupation
- relevant maths, English and digital skills.

T Levels will become one of three major options for students to study at level 3, alongside apprenticeships for those who wish to study and train for a specific occupation 'on the job', and A levels for students who wish to continue academic education.

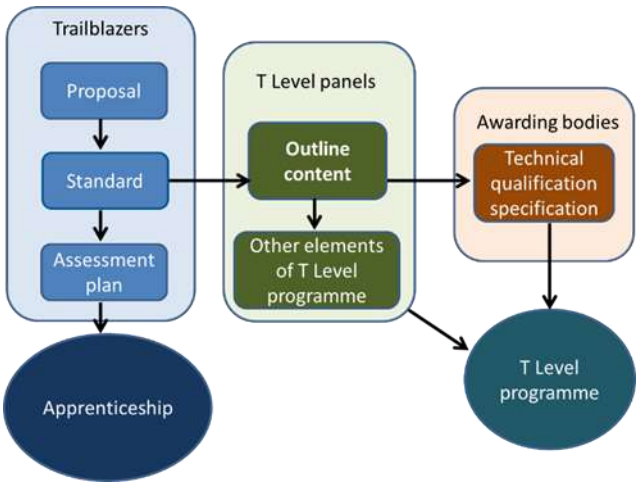
When they complete a T Level study programme, students will be able to choose between moving into a skilled occupation or further study, for example, a higher or degree level apprenticeship, or higher level technical study, including higher education.

Technical education has been categorised into fifteen different technical routes, according to occupational specialism. T Levels will be available across eleven of those routes, with occupations in the remaining four routes accessible through an apprenticeship only. Most routes have been split into a number of pathways; the T Level will broadly sit at pathway level. The occupations within scope for each T Level are set out in the Institute for Apprenticeships and Technical Education's occupational maps.

Outline content

This outline content has been produced by T Level panels of employers, professional bodies and providers, and is based on the same standards as those used for apprenticeships. The outline content will form the basis of the specifications for T Level Technical Qualifications, which will be developed by awarding organisations for approval by the Institute for Apprenticeships and Technical Education. One awarding organisation will be appointed to develop and deliver each Technical Qualification following a procurement process.

The diagram below demonstrates how the same standard created by employer-led Trailblazer groups is used for both apprenticeships, and as the basis for this outline content. It also shows that this outline content will be used by awarding organisations to develop the full Technical Qualification (TQ) specification.

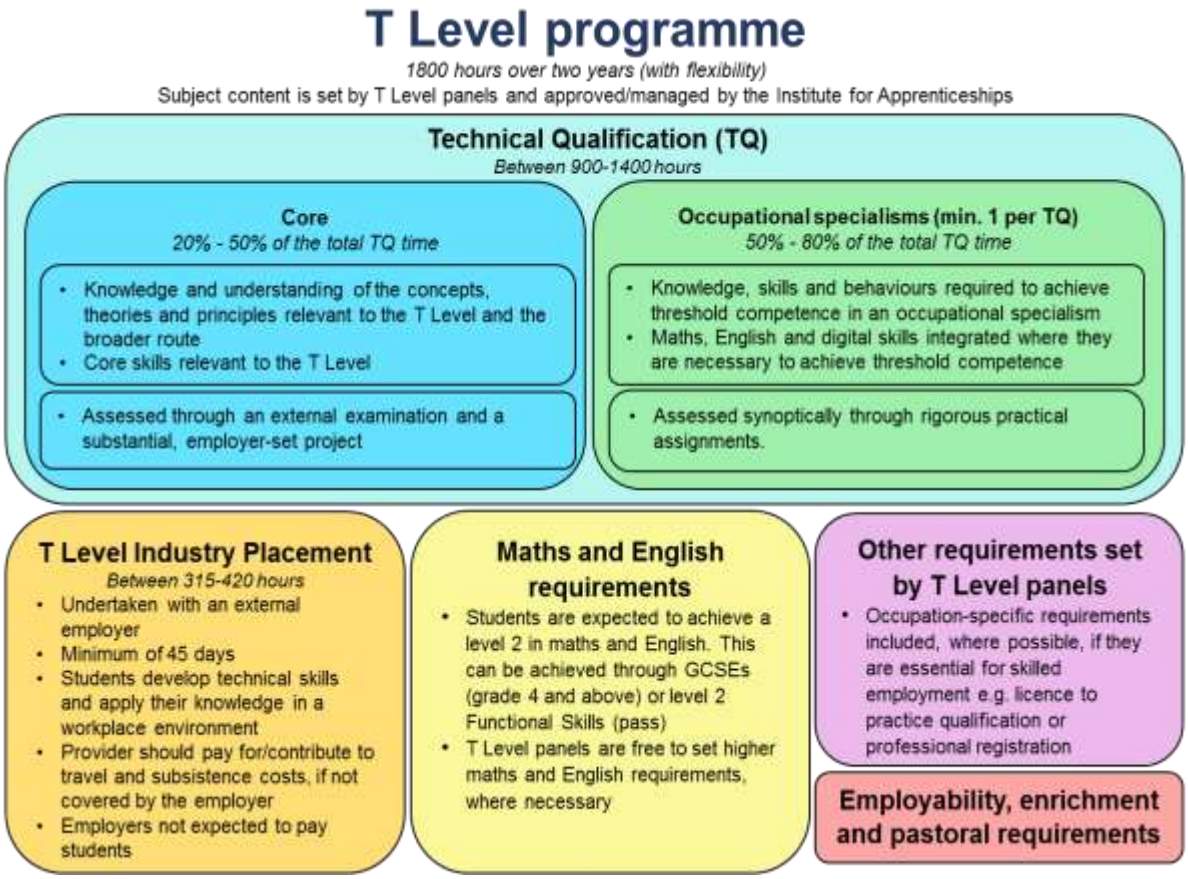


Colleges and other education and training providers will decide how to structure the T Level courses they offer, based on the qualification specifications. This will enable them to deliver the study programme's mandatory components in the most effective way for students.

T Level study programmes will include the following mandatory elements:

- a 'core' set of underpinning knowledge, concepts and skills, tailored for their chosen industry and occupation: 'core content'
- specialist content covering occupational or industry-specific skills: 'occupational specialist content'
- an industry placement with an employer, which will last for a minimum of 45 working days.

The diagram below demonstrates the different elements of a T Level programme. This outline content relates solely to the Technical Qualification part of a T Level programme.



Purpose Statement

Qualification Purpose

The purpose of the level 3 Technical Qualification is to ensure students have the knowledge and skills needed to progress into skilled employment or higher level technical training relevant to the T Level.[1]

To achieve this, each level 3 Technical Qualification must:

- provide reliable evidence of students' attainment in relation to:
    - the core knowledge and skills relevant to the route and occupational specialisms covered by the qualification
    - the knowledge and skills required for at least one occupational specialism relevant to the qualification.

- be up-to-date, providing the knowledge and skills needed for the occupations to have continued currency among employers and others.

- ensure that maths, English and digital skills are developed and applied where they are essential to achieve occupationally relevant outcomes.

- ensure that the minimum pass grade standard for occupational specialisms attests to competence, meets employer expectations, and is as close to full occupational competence as possible.

- allow the accurate identification of students' level of attainment and the effective differentiation of their performance.

- provide a clear and coherent basis for development of suitably demanding high-quality level 3 courses, which enable students to realise their potential.

- provide students with the opportunity to manage and improve their own performance.

- support fair access to attainment for all students who take the qualification, including those with special educational needs and disabilities (SEND).

[1] The Institute for Apprenticeships and Technical Education may only approve the qualification "if satisfied that by obtaining the qualification a person demonstrates that he or she has attained as many of the outcomes set out in the standards as may reasonably be expected to be attained by undertaking a course of education" (Technical and Further Education Act 2017).

Technical Qualification Design

T Level programmes will differ in length to reflect the requirements of different occupations, but are expected to last 1800 hours over two years (on average).

To accommodate legitimate differences in content across T Levels, we propose that the total time for the Technical Qualification:

- will fall within a defined range of between 900 and 1400 hours
- is no less than 50% of the time for the T level programme as a whole and
- is no more than 75% of the total time for the programme as a whole.

Component	Content	Assessment	Grading	Planned Hours
Core Students complete one component which covers all the core content	Knowledge and understanding of contexts, concepts, theories and principles relevant to the T Level Ability to apply core knowledge and skills, through a project, to meet employer-set requirements	Assessed through an externally set test and an employer-set project	Six point scale plus ungraded (U) A* – E and U	Between 20% and 50% of the qualification time
Occupational specialisms Students must complete at least one, or more depending on the minimum requirements specific to the qualification	The knowledge and skills required to achieve a level of competence needed to enter employment	Synoptic assessment of performance outcomes, to determine whether a student meets the minimum competence requirements	Three point scale plus ungraded (U) Distinction, Merit, Pass and Ungraded	Between 50% and 80% of qualification time

Construction: Building Services Engineering

Awarding organisations will need to ensure that students have an up-to-date knowledge of the legal and regulatory obligations relating to employment in the occupations relevant to the T Level, and understand the practical implication of these on their work.

In line with current industry expectations, those working in Building Services Engineering are required to deal with more than one system. As a result, it is expected that students will undertake a combination of at least two occupational specialisms to support their progression to the labour market on completion of the T Level.

Maths, English and Digital skills are set out in the final section of this document. Awarding organisations should integrate these within the qualification so that they are applied in occupationally relevant contexts. Other core skills and behaviours important for employability are already integrated within the content and must be clearly specified in the qualification specification.

Core content

The core content relates to the whole route, and the pathway that the Technical Qualification covers. This breadth of content will help to ensure students are able to apply their skills in a variety of contexts and for a variety of different purposes. The content will vary depending on the requirements of the route and the pathway or occupations covered by the scope of the Technical Qualification.

The core knowledge and understanding is assessed through an examination and core skills through a practical employer-set project.

The core knowledge and understanding focuses on the students' knowledge and understanding of contexts, concepts, theories and principles relevant to the T Level. This could include, where appropriate, assessment of knowledge and understanding relevant to the route and the pathway.

The employer-set project provides the opportunity to develop and apply a minimum range of core skills important for employability. Awarding organisations can integrate knowledge in the employer-set project, to contextualise core skills.

The allocation of content to each type of assessment will need to be approved by the Institute for Apprenticeships and Technical Education.

Construction core knowledge and understanding

Element	Content
Health and safety	• Legislation e.g. HASAWA, COSHH, Working at Height, Construction Design and Management regulations (CDM) including an overview of roles, responsibilities and enforcement. • Liability including public liability and employers liability. • Approved codes of practice, including Managing Health and Safety in Construction. • Implications of poor health and safety performance, including ethical, legal, environmental and financial. • Development of safe systems of work, including company management systems, risk assessments, method statements and permits to work. • Safety conscious behaviours e.g. following safe systems of work, reporting potential hazards and implications of poor housekeeping.
Science	Scientific principles, their applications, interaction between them to meet the purpose of the built environment and how their performance in the building is measured including: • Materials science, including material properties, chemical composition, degradation, failure and effects of environmental conditions. • Mechanical science, including the relationship between force, work, energy and power. • Electricity, including sources of power, generation, transformation, distribution and the relationship between voltage, current, resistance, electrical power, energy, efficiency and work done. • Structural science, including forces, loads, materials, and structural members. • Heat, including heat transfer, air temperature, air density humidity, condensation air movement, heat loss, thermal conductivity and resistance.

	• Light, including refraction, difference in artificial and natural light, glare, directed and reflected light, flow of light energy and daylight factor. • Acoustics, including frequencies, reverberation, decibels, comfort levels and privacy. • Earth science, including physical geography, hydrology, geology, earth forces, natural phenomenon (e.g. earthquakes) and weather.
Design	• Benefits of good design including within budget, of good design to product performance e.g. on budget, over specified, difficult to assemble/build. • Design principles e.g. buildability and integration of services. • Role of different disciplines (e.g. contractor, architect) involved in design. • Design process from conception to completion. Human factors e.g. inclusivity,heat, acoustics, lighting and air quality. • Understanding of the whole building, including life cycle assessment.
Construction & the built environment industry	• Structure of the construction industry. • How the construction industry serves the economy as a whole. • Integration of the supply chain through partnering and collaborative practices. • How projects are procured within the construction sector e.g. tenders and supply chain. • Roles and responsibilities of the construction professions e.g. surveyor, carpenter, heating engineer. • The role of CPD in developing the knowledge and skills of those working in the sector and those that may provide it e.g. through professional bodies, accreditation, certification bodies.

	• Building information modelling, including Digital Plan of Works (DPoW), Employer's Information Requirements (EIR), Common Data Environment (CDE), information exchange and the effect on project delivery. • How current examples of PESTLE factors may impact the industry e.g. post Grenfell, tax changes for self-employed, augmented reality.
Sustainability	• Importance of sustainability when planning and delivering a construction project e.g. environmental protection. • Types of sustainable solutions e.g. social, environmental, economic and human. • Obligations under environmental legislation e.g. Clean Air Act and Water Act. • Environmental policies and initiatives and how they impact on design and construction. • Environmental performance measures e.g. water use, radioactive waste. • Principles of heritage and conservation e.g. listed buildings, traditional buildings and maintenance of existing stock. • Lean construction including reduce, repurpose and recycle. • Waste management including types of materials that require specific actions e.g. asbestos and the measures in place by construction organisations. • Energy production and energy use (including embodied energy).
Measurement	• The benefits of accurate and appropriate measurement on built environment performance e.g. accurate reporting. • Types of measurement, including standard units of measurement and mensuration techniques. • Measurement standards, guidance and practice including measurement rules.

Building Technology	• Construction methods, including traditional and modern methods e.g. on and off-site construction and robotics. • Forms of construction, built environment and civil engineering structures, sub-structures, superstructures, foundations and external works. • Building regulations and their purpose in construction including renovation. • Building standards and their purpose in renovation and construction including ISO, British and industry. • Manufacturers' instructions and their purpose in renovation and construction. • Internet of things e.g. data capture in a completed building, utilising data for manufacture and delivery and machine to machine learning.
Information and data	• Key elements of data, including accuracy, generalisation, interoperability, level of detail and metadata. • Purpose of information standards, regulation, and guidance and practice. • Sources of information e.g. product data and manufacturer's specifications. • Data management and confidentiality, including data protection legislation and typical organisational procedures.
Relationship Management	• Types of stakeholders e.g. client, team and end user. • Roles, expectations and interrelationships of different stakeholders throughout the construction project delivery e.g. at design stage, through construction, to handover and in use. • The importance of a collaborative approach to project delivery and reporting, and how this is applied in practice. • Customer service principles e.g. product knowledge, time and communication.

	• The importance of team work to team and project performance. • Team dynamics, including what is expected of a team member, what qualities are needed and how these qualities are demonstrated. • Equality, diversity and representation including related legislation. • Negotiation techniques e.g. win-win. • Conflict management techniques e.g. mediation. • Methods (e.g. verbal, non-verbal) and styles (e.g. formal, informal) of communication and suitability for different situations that may arise throughout a construction project. • Employment rights and responsibilities of the employer and employee e.g. health and safety. • Ethics and ethical behaviour e.g. honesty, fairness. • How sources of information, including social networking contribute to knowledge sharing.
Digital Technology	• Internet of things e.g. crowd sourcing digital data to assist just in time asset management, information interdependencies. • Digital engineering techniques e.g. simulation, animation. • Opportunities for the use of technology used in other industries and contexts and adapting for use in construction and the built environment.
Commercial/Business	• Business structures e.g. community interest companies and SMEs. • Business objectives e.g. financial and social. • Business values e.g. care for life, ethical and transparent, commit to customer and better together. • Principles and examples of corporate social responsibility e.g. community design, local recruitment.

	• Principles of entrepreneurship and innovation e.g. vision, research, finance. • How businesses measure success e.g. benchmarking, KPIs and target setting. • Principles of project management e.g. clear goals and objectives, defined roles, milestones. • Quality management and techniques used in business.

Core knowledge and understanding across Building Services Engineering

Element	Content
Health and safety	• How to inspect a work environment and ensure it is safe, including sensory inspection. • Implications of health and safety legislation to employers and those working with BSE systems, including Provision and Use of Work Equipment Regulations (PUWER), Electricity at Work Regulations, Control of Noise at Work Regulations, Control of Vibrations at Work Regulations and additional guidance (including lone working). • Safe working practices for the safe isolation of systems including electrotechnical. • Implications of poor health and safety on building performance and individual stakeholders. • Recording and reporting of safety incidents and near misses. • Emergency procedures for unsafe situations e.g. gas products. • Types of PPE and the risks they help to mitigate.
Legislation, regulations and standards	• Relevant UK and international standards and regulations, approved codes of practice (ACOPs) and how they apply to Building Services Engineering systems including Legionnaires Disease: The control of legionella bacteria in water systems, Control of

	Asbestos Regulations, Hazardous Waste Regulations, 18th Edition Wiring Regulations. • Key requirements of environmental legislation e.g. Climate Change Act, Control on Ozone Depleting Substances. • Key requirements of waste management legislation e.g. Waste, Electronic and Electrical Equipment (WEEE) requirements including which materials may contain hazardous substances. • Key content and required notifications of Building Regulations and Approved Documents e.g. Part P, Part L and how they are applied to Building Services Engineering systems. • Industry codes of practice and other sources of information and advice on technical safety and legislative aspects e.g. Charted Institute of Building Services Engineers (CIBSE), Building Engineering Services Association (BESA).
Building services engineering (BSE) systems	• Purpose and characteristics of Building Services Engineering systems (including air conditioning, electrotechnical, gas, heating, plumbing, protection, refrigeration, ventilation) and key differences in operation. • The potential effect of the installation and decommissioning of a Building Services Engineering system on other systems and building performance e.g. clean air. • Mechanical principles including components (e.g. fans, pumps), their characteristics, function within the system and implications to the system of component failure. • Electrotechnical principles including components (e.g. cabling, terminations), their characteristics, function within the system and implications to the system of component failure. • Types of control systems (digital, mechanical), their purposes, components, similarities and differences.

	• Monitoring systems and how they collect and transmit data. • How to identify different types of electrical supply e.g. phasing, voltage and the implications for Building Services Engineering system installation and maintenance • How to identify different earthing arrangements e.g. TT, TN and the implications for Building Services Engineering system installation and maintenance. • Cable types and sizes, accessories and equipment used in older electrical installations and the implications for Building Services Engineering system installation and maintenance. • Types of pipework and ductwork, components and distribution systems and how they affect the performance of the Building Services Engineering system.
Maintenance principles	• Types of maintenance e.g. planned, reactive etc and their suitability for different situations. • Maintenance plans, their content and typical tasks for Building Services Engineering systems. • Typical timeframes to complete maintenance tasks. • Documentation required for maintenance and verification of maintenance activities e.g. manufacturers' instructions, maintenance checklists. • Types of actions required when faults cannot be rectified and implications to customer and business including time and costs.
Information and data	• Drawings, circuit diagrams and schematics etc. and the conventions, symbols and terminology needed to aid interpretation. • Data storage, security and protection e.g. prevention of cyber attacks, malware, Trojans etc. • Programming and set up of digital systems using various IT resources e.g. computer, mobile technologies.

	• How to store, retrieve, manipulate, transmit and receive data in digital form across ICT applications e.g. broadband.
Sustainability	• Energy efficiency, renewable energy and emerging technology measures that could be utilised along with new Building Services Engineering installations including insulation materials, control and monitoring systems, Internet of Things (IoT), environmental technologies, patterns of usage, innovative products and services, improved designs.
Building technology	• Types of building structure and fabric and implications for application, installation and maintenance of Building Services Engineering systems. • Procedures and processes for penetrating building structure and fabric and their suitability for different situations e.g. fire, sound and weatherproofing.
Tools, equipment and materials	• How to ensure tools, equipment and materials are fit for purpose e.g. calibration checks, cleanliness checks. • Importance of maintenance and how to maintain tools, equipment and materials e.g. storage, greasing, sharpening etc.
Measurement	• International System of Units (SI) e.g. luminous intensity, flow rates. • Derived SI units, including those associated with area, volume, weight, power, energy and force.

Employer-set project

The employer-set project ensures students have the opportunity to combine core knowledge and skills to develop a substantial piece of work in response to an employer-set brief.

To ensure consistency in project scope and demand, awarding organisations will develop assessment objectives which require students to:

- plan their approach to meeting the brief
- apply core knowledge and skills as appropriate
- select relevant techniques and resources to meet the brief
- use maths, English and digital skills as appropriate
- realise a project outcome and review how well the outcome meets the brief.

The awarding organisation will work with a relevant employer or employers to devise a set brief that:

- ensures a motivating starting point for students' projects, for example, a real-world problem to solve
- ensures students can generate evidence that covers the assessment objectives
- is manageable for providers to deliver
- is officially approved by the awarding organisation and employer.

For Building Services Engineering in achieving the assessment objectives and meeting the brief students must demonstrate the following core skills:

- communication e.g. providing information and advice to customers and / or wider stakeholders on the potential risks of a change to an industrial system, or making a presentation to a stakeholder on the implications of change
- work collaboratively with other team members and stakeholderes e.g. to develop content to bid for a construction project
- applying a logical approach to solving problems, identifying issues and proposing solutions e.g. through setting criteria for successful implementation of a system, using cost / benefit analysis of the introduction of new procedures or equipment
- primary research e.g. obtaining measurements related to a design and / or customer requirements.

Occupational Specialist Content

Specialist content is structured into different occupational specialisms, which correspond to the apprenticeship standards listed on the occupational map covered by the T Level. Occupational specialisms ensure students develop the knowledge and skills necessary to achieve a level of competence needed to enter employment in the occupational specialism.

Achievement of this minimum level of competence signals that a student is well-placed to develop full occupational competence, with further support and development, once in work (including an apprenticeship). The knowledge and skills listed are required to achieve one or more ‘performance outcomes’. These indicate what the student will be able to do as a result of learning and applying the specified knowledge and skills.

In essence, each performance outcome describes, at a high level, what the student ‘can do’ to have met minimum competence requirements in an occupational specialism.

Core skills and behaviours are specified in occupational specialism(s) only where they are essential to achieving the given performance outcome. Although the behaviours maybe assessed implicitly through application of skills, they must be clearly specified in the qualification specification to support effective application of those skills.

Occupational Specialism: Air conditioning engineering

Performance Outcome 1: Install air conditioning systems

Knowledge Specific to Performance Outcome	Skills
Air conditioning systems • The function and operation of air conditioning systems (e.g. centralised plant, Air Handling Units (AHUs), fan coils, chilled beams) and how they interact in a range of different systems and applications. • The many uses of air conditioning, refrigeration and ventilation in a modern economy. **Air conditioning science** • Sound understanding of principles of thermodynamics, gas laws, psychrometrics, fluid flow, electricity, filtration, heat transfer, properties of refrigerant fluids and lubricants. • Understanding comfort in terms of temperature, humidity, carbon monoxide, metabolism etc. • Measurements, diagrams, calculations, tools, charts, tables and formulae and apply them as appropriate. **Legislation, Regulations and Standards** • Relevant UK and international standards, Approved Codes of Practice (ACOPS) and how they are applied to air conditioning systems including indoor air quality, bacteria in water and asbestos. **Sustainability**	• Sequence and prioritise tasks e.g. plan execution of programme of works. • Identify information requirements for the task e.g. drawings, manufacturer's specifications. • Gather information required for the task e.g. manufacturer's instructions, non-domestic building services compliance guide. • Produce written report to stakeholders about work completed. • Measure and mark out installation requirements e.g. on filters, ancillary components. • Connect components e.g. heating and cooling coils. • Fill and purge heating and cooling circuits. • Insert components into system e.g. heat exchangers, ancillary parts. • Adjust components e.g. belts, dampers. • Connect control systems including sensors and programmers. • Apply final settings e.g. from manufacturer's instructions. • Confirm system is ready to commission e.g. run 'pre-flight check'.

• Environmental technologies employed in the sector (e.g. heat recovery) which can be used to reduce heat gain, cooling load or energy use. • Supply and storage of energy from renewable resources e.g. ground, water. • Reducing environmental impact of air conditioning systems through circular economics and low impact refrigerants. **System installation** • How to check multiple circuits and systems for leakages. • Location methods for air handling system installation including types of tools and equipment needed. • Types of ductwork and pipework, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.	

Performance Outcome 2: Commission air conditioning systems

Knowledge Specific to Performance Outcome	**Skills**
Air conditioning systems • The function and operation of air conditioning systems (e.g. centralised plant, Air Handling Units (AHUs), fan coils, chilled beams) and how they interact in a range of different systems and applications. • The many uses of air conditioning, refrigeration and ventilation in a modern economy. **Air conditioning science**	• Interpret a risk assessment e.g. apply required controls. • Interpret information provided e.g. BS/EN/ISO Standards or manufacturer's instructions including tabular and graphical information. • Interpret commissioning data including determining design parameters have been met. • Explore requirements of the task using open questioning and listening e.g. energy efficiency requirements. • Visually inspect system installation e.g. cleanliness, secure, as per specification. • Establish a steady state operation.

• Sound understanding of principles of thermodynamics, gas laws, psychrometrics, fluid flow, electricity, filtration, heat transfer, properties of refrigerant fluids and lubricants. • Understanding comfort in terms of temperature, humidity, carbon monoxide, metabolism etc. • Measurements, diagrams, calculations, tools, charts, tables and formulae and apply them as appropriate. **Legislation, Regulations and Standards** • Relevant UK and international standards, Approved Codes of Practice (ACOPS) and how they are applied to air conditioning systems including indoor air quality, bacteria in water and asbestos. **Sustainability** • Environmental technologies employed in the sector (e.g. heat recovery) which can be used to reduce heat gain, cooling load or energy use. • Supply and storage of energy from renewable resources e.g. ground, water. • Reducing environmental impact of air conditioning systems through circular economics and low impact refrigerants. **System commissioning** • System operation requirements to be checked for commissioning including after a long period of non-use. • How to carry out a visual inspection of an air conditioning system. • Expectations of a steady state operation for air conditioning systems.	• Collect data from control system e.g. flow rates, temperatures, humidity and filtration/air quality levels. • Record data from commissioning instrumentation e.g. air quality, differential pressure, wet and dry temperature. • Check function of system against design specification. • Adjust system to comfortable ambient conditions to ensure maximum performance and efficiency.

Performance Outcome 3: Maintain air conditioning systems

Knowledge Specific to Performance Outcome	Skills
Air conditioning systems • The function and operation of air conditioning systems (e.g. centralised plant, Air Handling Units (AHUs), fan coils, chilled beams) and how they interact in a range of different systems and applications. • The many uses of air conditioning, refrigeration and ventilation in a modern economy. **Air conditioning science** • Sound understanding of principles of thermodynamics, gas laws, psychrometrics, fluid flow, electricity, filtration, heat transfer, properties of refrigerant fluids and lubricants. • Understanding comfort in terms of temperature, humidity, carbon monoxide, metabolism etc. • Measurements, diagrams, calculations, tools, charts, tables and formulae and apply them as appropriate. **Legislation, Regulations and Standards** • Relevant UK and international standards, Approved Codes of Practice (ACOPS) and how they are applied to air conditioning systems including indoor air quality, bacteria in water and asbestos. **Sustainability** • Environmental technologies employed in the sector (e.g. heat recovery) which can be used to reduce heat gain, cooling load or energy use.	• Produce a method statement. • Assess the suitability of information available e.g. sufficiency, accuracy. • Calculate resource requirements for servicing the system e.g. lubricants, filters, cleaning agents. • Complete documentation e.g. maintenance plan, maintenance report. • Visually inspect systems e.g. for corrosion, damage, loose screws or connectors. • Clean system e.g. drain pans, filters. • Tighten loose components e.g. screws, electrical connectors. • Adjust components e.g. dampers, belts. • Lubricate bearings and other moving parts e.g. pulleys, heat recovery wheels. • Check unit is running according to optimum settings. • Review system against minimal risks from legionella and other potential health hazards e.g. sick building syndrome (SBS). • Assess system risks for long term performance e.g. components reaching end of life. • Report on maintenance activities. • Investigate system operation to identify faults. • Rectify system.

• Supply and storage of energy from renewable resources e.g. ground, water. • Reducing environmental impact of air conditioning systems through circular economics and low impact refrigerants. **System maintenance** • Types of fault finding techniques, their suitability for different situations and how they are applied in practice. • Cleaning: which components and how to clean without compromising system, tools, equipment and materials to do that. • Disassembly techniques. • Fault finding techniques. • How techniques vary according to use and operation of system. • When a F-gas or other specialist is required to work on the system.	

Occupational Specialism: Electrical and electronic equipment engineering

Performance Outcome 1: Install electrical and electronic equipment systems

Knowledge Specific to Performance Outcome	Skills
Health and safety • Tests required, including portable appliance testing (PAT) to ensure products meet national and international safety standards. **Tools, equipment and materials** • Tools, equipment and materials used for installation (e.g. general hand tools, specific tools for termination of cables or connection of pipework) and their purpose. • Operation and handling requirements e.g. how to use a screwdriver correctly. **Systems and products** • Requirements of utilities in meeting product and system operations. • Characteristics, types and purpose of different types of electrical and electronic equipment, including related software, and their suitability for the installation location. • How components operate within a system and integrate to enable the product and system to operate effectively including different types of connectivity and wireless systems available e.g. Wi-Fi, Bluetooth. • Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted, including different types of wireless systems available. • Different types of AV equipment e.g. optical media, display screen, infra-red transmitter.	• Assess risk associated with tasks. • Identify information required to complete tasks. • Review information to ensure its accuracy and validity, including suitability of equipment being installed. • Select tools, equipment and materials to complete task. • Inspect the suitability of resources for use, including tools, materials and equipment. • Mark out the position of electrical and electronic equipment. • Analyse situations to identify potential causes for delays and errors e.g. the work site not being ready. • Think creatively to adapt designs as appropriate e.g. where site conditions are different to information provided. • Use tools and equipment to carry out tasks e.g. to fit brackets and supports, connect equipment. • Handle materials e.g. metal and plastic containment systems and cable types. • Make systems safe to work on including safe isolation and discharging stored charge as well as isolation of water services. • Connect electrical and electronic equipment to the installed systems e.g. wiring, plumbing, ducting. • Install cable and cable containment systems. • Terminate cables. • Connect conductors e.g. terminate into relevant terminals using appropriate tools. • Connect to existing building services engineering systems e.g. plumbing, ventilation. • Apply techniques to move products including lifting, stowage, removal of protective components and packaging.

System installation • How to install cable and wiring system supports. • How to terminate cables e.g. coax, control wiring, data cabling. • How to identify the electrical supply, including AC single and poly-phase circuits up to 1000V AC. • Electrical circuit types e.g. radial and ring final circuits. • Ways to terminate and connect conductors e.g. screwed, crimped and push fit connections. • How to connect plumbing and drainage to existing installations to equipment e.g. push fit, compression and soldered joints. • Backflow prevention in plumbing systems e.g. the use of check valves. • Broadband requirements and how to assess suitability. • How to install ventilation and ducting equipment e.g. solid and flexible ductwork. • Manufacturer's installation requirements e.g. ventilation, building strength, viewing distance. Existing systems and implications for new installations, including: • Cable types and sizes. • Electrical accessories and equipment. • Plumbing systems e.g. lead pipework. • Drainage systems. Decommissioning of existing systems in preparation for new installations including: • How to make existing products and systems • safe to decommission before installation of new products e.g. isolate electrical and plumbing supplies.	• Remove electrical, electronic and mechanical equipment e.g. remove redundant wiring and plumbing / drainage systems and equipment.

• How to identify potential issues before decommissioning a system.	

Performance Outcome 2: Commission electrical and electronic equipment

Knowledge Specific to Performance Outcome	Skills
Health and safety • Tests required, including portable appliance testing (PAT) to ensure products meet national and international safety standards. **Tools, equipment and materials** • Tools, equipment and materials used for installation (e.g. general hand tools, specific tools for termination of cables or connection of pipework) and their purpose. • Operation and handling requirements e.g. how to use a screwdriver correctly. **Systems and products** • Requirements of utilities in meeting product and system operations. • Characteristics, types and purpose of different types of electrical and electronic equipment, including related software, and their suitability for the installation location. • How components operate within a system and integrate to enable the product and system to operate effectively including different types of connectivity and wireless systems available e.g. Wi-Fi, Bluetooth. • Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted including different types of wireless systems available.	• Inspect electrical and electronic equipment e.g. visual inspection. • Test electrical, electronic and mechanical equipment systems e.g. polarity, earth fault loop impedance, continuity. • Analyse and interpret test information and data. • Complete the required documents for the task e.g. warranty card, commissioning certificate. • Identify inadequate installations. • Demonstrate product to customer. • Present information to the customer including energy saving practices and environmentally friendly purchases, recall registration requirements. • Setup connection including network and router. • Review performance in relation to customer network, including performance relating to speed..

• Different types of AV equipment e.g. optical media, display screen, infra-red transmitter. **System commissioning** • How to undertake inspections for electrical and electronic equipment before putting them into service e.g. correct electrical / plumbing connections. • How to undertake testing for electrical, electronic and plumbing equipment e.g. polarity, earth fault loop impedance. • How to adjust equipment as required by installation standards to ensure correct function.	

Performance Outcome 3: Maintain electrical and electronic equipment

Knowledge Specific to Performance Outcome	Skills
Health and safety • Tests required, including portable appliance testing (PAT) to ensure products meet national and international safety standards. **Tools, equipment and materials** • Tools, equipment and matrials used (e.g. general hand tools, specific tools for termination of cables or connection of pipework) and their purpose. • Operation and handling requirements e.g. how to use a screwdriver correctly. **Systems and products** • Requirements of utilities in meeting product and system operations.	• Sequence activities required to complete task including planning to isolate electrical and mechanical supplies and informing relevant people. • Allocate time and resources to complete the task. • Collect system data e.g. data from any integrated monitoring systems. • Question the user to understand the issue. • Record system data. • Use software to analyse data from work activity e.g. system generated diagnostic reports. • Provide technical advice and guidance. • Test electrical equipment to ensure it is safe to work on e.g. remove stored charge (Electrostatic Discharge). • Propose solutions for equipment faults e.g. contingency plans for equipment that is no longer manufactured.

• Characteristics, types and purpose of different types of electrical and electronic equipment, including related software, and their suitability for the installation location.
• How components operate within a system and integrate to enable the product and system to operate effectively including different types of connectivity and wireless systems available e.g. Wi-Fi, Bluetooth.
• Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted including different types of wireless systems available.
• Different types of AV equipment e.g. optical media, display screen, infra-red transmitter.
 	
System maintenance
• Fault finding techniques e.g. testing and questioning.
• Use of technology for fault finding and diagnostic work as well as software / firmware updates.
• Principles and examination of:
  ○ The operating principles and products operating sequence.
  ○ The importance of van stock maintenance.
  ○ Anti-static protection requirements for sensitive equipment.
	• Replace component equipment, ensuring fitness for purpose.
	• Test equipment to ensure safe to use e.g. ‘PAT Testing’.
	• Reinstate software.

Occupational Specialism: Electrotechnical engineering

Performance Outcome 1: Install electrotechnical systems

Knowledge Specific to Performance Outcome	Skills
Tools, equipment and materials • Tools and equipment used for installation (e.g. general hand tools and specific tools for termination of cables etc.) and their purpose. • Operation and handling requirements e.g. how to use a screwdriver correctly. **Electrical installations** • Fundamental Principles of national standards. • Special Locations specified in national standards. • Special Installations specified in national standards. • How to select and install wiring systems e.g. armoured, insulated and sheathed cable types etc. • How to erect an electrical installation e.g. selection and erection of equipment etc. **System installation** • How to install cable installation and wiring system supports. • How to terminate cables e.g. armoured cable glands, coax, control wiring and data cabling. • Ways to terminate and connect conductors e.g. screwed, crimped and push fit connections. • The principles and practices for terminating and connecting cords in electrical systems.	• Assess risk associated with tasks e.g. is any specialist equipment needed etc. • Identify information required to complete tasks, including manufacturer's installations instructions. • Collect and collate information e.g. drawings and plans etc. • Review information to ensure its accuracy and validity, including suitability of equipment being installed. • Select tools, equipment and materials to complete task e.g. cable type, hand tools etc. • Inspect the suitability of resources for use, including tools, materials and equipment. • Mark out the position of electrical equipment e.g. accessories location. • Analyse situations to identify potential causes for delays and errors e.g. the work site not being ready, incorrect drawings, insufficient materials etc. • Use tools and equipment to carry out tasks e.g. to connect equipment, to install wiring and containment systems etc. • Handle materials e.g. metal and plastic containment systems and cable types etc. • Connect electrical equipment to the installed wiring systems e.g. luminaires, accessories etc. • Install cable containment systems e.g. conduit, trunking, basket and tray etc. • Install cabling e.g. single core cables, armoured cables, insulated and sheathed flat cables etc.

	• Terminate cables e.g. armoured, insulated and sheathed flat cables etc. • Connect conductors e.g. terminate into relevant terminals using appropriate tools etc. • Update digital building information management system software.

Performance Outcome 2: Commission electrotechnical systems

Knowledge Specific to Performance Outcome	**Skills**
Tools, equipment and materials • Tools and equipment used for installation (e.g. general hand tools and specific tools for termination of cables etc) and their purpose. • Operation and handling requirements e.g. how to use a screwdriver correctly. **Electrical installations** • Fundamental Principles of national standards. • Special Locations specified in national standards. • Special Installations specified in national standards. • How to select and install wiring systems e.g. armoured, insulated and sheathed cable types etc. • How to erect an electrical installation e.g. selection and erection of equipment etc. **System commissioning** • How to undertake inspections for initial verification of electrotechnical systems. • How to undertake testing for electrotechnical systems e.g. continuity of conductors, insulation resistance, polarity, earth fault loop impedance etc.	• Inspect electrotechnical systems e.g. visual inspection etc. • Test electrotechnical systems e.g. continuity of conductors, insulation resistance, polarity, earth fault loop impedance. • Analyse and interpret information and data e.g. from testing electrotechnical systems etc. • Complete commissioning documentation e.g. Electrical Installation Certificate etc.

• How to adjust equipment as required by installation standards to ensure correct function e.g. adjust settings of sensors where required etc.	

Performance Outcome 3: Maintain electrotechnical systems

Knowledge Specific to Performance Outcome	**Skills**
Tools, equipment and materials • Tools and equipment used for installation (e.g. general hand tools and specific tools for termination of cables etc) and their purpose. • Operation and handling requirements e.g. how to use a screwdriver correctly. **Electrical installations** • Fundamental Principles of national standards. • Special Locations specified in national standards. • Special Installations specified in national standards. • How to select and install wiring systems e.g. armoured, insulated and sheathed cable types etc. • How to erect an electrical installation e.g. selection and erection of equipment etc. **System maintenance** • Fault finding techniques e.g. testing and questioning. • Different requirements for each building types e.g. hospitals, chemical plants, paint stores.	• Communicate orally health and safety risks to stakeholders e.g. explain unsafe situations and the risks associated with them etc. • Sequence activities required to complete task including planning to isolate electrical supplies and informing relevant people. • Allocate time and resources to complete the task including materials required for the task. • Collect system data e.g. data from any integrated monitoring systems etc. • Record system data e.g. on work records or equipment maintenance sheets etc. • Analyse data from work activity e.g. system generated diagnostic reports. • Provide technical advice and guidance (e.g. safety advice, energy efficiency etc.) to technical and non-technical stakeholders. • Test electrical equipment to ensure it is safe to work on e.g. stored charge etc. • Analyse information to identify potential faults e.g. feedback from system users etc. • Think creatively to propose solutions for installation faults e.g. insulation resistance readings deteriorating over time,

	contingency plans for equipment that is no longer manufactured etc. • Replace components of electro-technical systems e.g. lamps and tubes, broken accessories etc.

Performance Outcome 4: Decommission electrotechnical systems

Knowledge Specific to Performance Outcome	**Skills**
Tools, equipment and materials • Tools and equipment used for installation (e.g. general hand tools and specific tools for termination of cables etc) and their purpose. • Operation and handling requirements e.g. how to use a screwdriver correctly. **Electrical installations** • Fundamental Principles of national standards. • Special Locations specified in national standards. • Special Installations specified in national standards. • How to select and install wiring systems e.g. armoured, insulated and sheathed cable types etc. • How to erect an electrical installation e.g. selection and erection of equipment etc. **System decommissioning** • How to make systems safe to decommission. • How to identify potential issues before decommissioning a system.	• Make systems safe to work on including safe isolation and discharging stored charge. • Communicate with relevant stakeholders to ensure required information is available to undertake the task using electronic communication. • Remove electrotechnical systems e.g. remove redundant wiring systems and equipment etc.

Occupational Specialism: Gas engineering

Performance Outcome 1: Install gas systems

Knowledge Specific to Performance Outcome	Skills
Health and safety • Typical hazards and risks associated with working with gas systems. • Safe working practices associated with working with gas systems. • Emergency procedures, including gas escapes, report of fumes and for unsafe situations. **Tools, equipment and materials** • Types of tools, equipment and materials used for access, measuring when working on gas systems, their characteristics, properties, purpose and suitability for tasks. • Operation and handling requirements of tools, equipment and materials. **Gas systems** • Characteristics, types and purpose of different types of components and their suitability for different types of systems including Liquid Petroleum Gas (LPG) and Natural Gas, domestic and commercial. • How components operate within a system and integrate to enable the system to operate effectively e.g. pressures etc. • Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location e.g. gas council number etc.	• Interpret information from a risk assessment. • Use tools in accordance with good working practice. • Install pipework relevant to the type of gas being conveyed. • Install clips/brackets to various substrates. • Install flues/chimneys to facilitate a range of gas appliances and equipment e.g. LPG closed flue to commercial warm air units etc. • Install ventilators to facilitate the correct combustible air requirements for appliances installed in a variety of locations/buildings e.g. LPG to commercial catering etc. • Install appliances. • Install components into appliances. • Install controls into systems. • Install thermal installation materials. • Install seals appropriate to the gas appliance. • Check gas components are in accordance with design parameters. • Check gas components are registered Gas Council (GC). • Analyse information to identify requirements for gas installation e.g. flueing requirements. • Communicate system requirements to allied trades e.g. electrical requirements etc. • Establish safe working environment to conduct gas installation. • Ensure no ingress of foreign objects within gas system and components.

• Waste and waste products including types of systems, attributes (e.g. Magnetite, corrosion smells, bacteria etc.), hazards to user, interaction with other parties, environmental impact. • Safety devices applicable to gas systems, their characteristics and operation. • Gas and the combustion process including combustion analysis, carbon monoxide (CO), types of burners and interaction with other devices e.g. ventilators and Mechanical Heat Ventilation Recovery (MHVR) etc. • Types of flues in relation to gas and the combustion process, their correct operation, safe operation and suitability for different types of system. • Types of ventilation in relation to gas and the combustion process and their suitability for different requirements. • Types of gas appliances and their system requirements. **Gas engineering science** Scientific principles and concepts as applied to gas engineering including: • Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft. **Pipework technology** • Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.	• Update relevant line diagrams/installation plans. • Complete a method statement for installation identifying any potential delays. • Adapt on-site specific gas system installation changes e.g. LPG to natural gas etc. • Gather relevant gas system component part information. • Update digital building information management system software.

• Flow rates and their relationship to pipework and system design. • How to apply different techniques for forming and bending pipework. **Legislation and industry guidance** Implications of legislation and additional guidance to employers and those working with gas systems including Gas Safety (Installation and Use) Regulations. **Building technology** • Types of fixtures and suitability for different building fabrics. **System installation** • Bending techniques e.g. machine, scissor, hand etc. • Connection techniques e.g. threading, soldering etc.	

Performance Outcome 2: Commission gas systems

Knowledge Specific to Performance Outcome	**Skills**
Health and safety • Typical hazards and risks associated with working with gas systems. • Safe working practices associated with working with gas systems. • Emergency procedures, including gas escapes, report of fumes and for unsafe situations. **Tools, equipment and materials**	• Assess risks associated with completing the activities. • Test all gas rates and pressures are within regulatory requirements. • Ensure any tools/equipment are calibrated correctly. • Calculate correct purge in accordance with gas installation. • Purge system correctly. • Visually inspect installation is compliant with Gas Safety and Use Regulations 1998.

• Types of tools, equipment and materials used for access, measuring when working on gas systems, their characteristics, properties, purpose and suitability for tasks. • Operation and handling requirements of tools, equipment and materials. **Gas systems** • Characteristics, types and purpose of different types of components and their suitability for different types of systems including Liquid Petroleum Gas (LPG) and Natural Gas, domestic and commercial. • How components operate within a system and integrate to enable the system to operate effectively e.g. pressures etc. • Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location e.g. gas council number etc. • Waste and waste products including types of systems, attributes (e.g. Magnetite, corrosion smells, bacteria etc.), hazards to user, interaction with other parties, environmental impact. • Safety devices applicable to gas systems, their characteristics and operation. • Gas and the combustion process including combustion analysis, carbon monoxide (CO), types of burners and interaction with other devices e.g. ventilators and Mechanical Heat Ventilation Recovery (MHVR) etc. • Types of flues in relation to gas and the combustion process, their correct operation, safe operation and suitability for different types of system. • Types of ventilation in relation to gas and the combustion process and their suitability for different requirements.	• Complete gas system handover documentation to end user e.g. manufacturer's commissioning log etc. • Demonstrate safe operation of gas appliance and controls to the end user. • Visually check gas system installation conforms to original design requirements. • Set gas system parameters to commission in accordance with manufacturer's instructions and Gas Safety and Use Regulations 1998. • Record commissioning results. • Analyse commissioning results to determine correct gas installation in accordance with original design.

• Types of gas appliances and their system requirements. **Gas engineering science** Scientific principles and concepts as applied to gas engineering including: • Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft. **Pipework technology** • Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required. • Flow rates and their relationship to pipework and system design. • How to apply different techniques for forming and bending pipework. **Legislation and industry guidance** Implications of legislation and additional guidance to employers and those working with gas systems including Gas Safety (Installation and Use) Regulations. **Building technology** • Types of fixtures and suitability for different building fabrics. **System commissioning** • Inspection techniques and how they are applied in commissioning systems e.g. visual measurement etc.	

• Factors to inspect during commissioning (e.g. flow rate, temperature etc.) and how expected standards are defined. • Testing of installation e.g. tightness, flue flow and spillage etc. • Safe storage and supply of fuel source.	

Performance Outcome 3: Maintain gas systems

Knowledge Specific to Performance Outcome	Skills
Health and safety • Typical hazards and risks associated with working with gas systems. • Safe working practices associated with working with gas systems. • Emergency procedures, including gas escapes, report of fumes and for unsafe situations. **Tools, equipment and materials** • Types of tools, equipment and materials used for access, measuring when working on gas systems, their characteristics, properties, purpose and suitability for tasks. • Operation and handling requirements of tools, equipment and materials. **Gas systems** • Characteristics, types and purpose of different types of components and their suitability for different types of systems including Liquid Petroleum Gas (LPG) and Natural Gas, domestic and commercial. • How components operate within a system and integrate to enable the system to operate effectively e.g. pressures etc.	• Question end user to identify any gas installation and user concerns. • Identify the correct replacement parts relevant to the appliance from a selection of similar parts e.g. correct multifunctional valve etc. • Calculate maintenance downtime. • Safe handling of all gas components when conducting maintenance e.g. smart meters etc. • Identify potential gas installation system errors. • Test system in accordance with end user requirements. • Remove and replace faulty gas system components. • Repair faulty gas system components e.g. a thermocouple within a multifunctional valve etc.

• Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location e.g. gas council number etc. • Waste and waste products including types of systems, attributes (e.g. Magnetite, corrosion smells, bacteria etc.), hazards to user, interaction with other parties, environmental impact. • Safety devices applicable to gas systems, their characteristics and operation. • Gas and the combustion process including combustion analysis, carbon monoxide (CO), types of burners and interaction with other devices e.g. ventilators and Mechanical Heat Ventilation Recovery (MHVR) etc. • Types of flues in relation to gas and the combustion process, their correct operation, safe operation and suitability for different types of system. • Types of ventilation in relation to gas and the combustion process and their suitability for different requirements. • Types of gas appliances and their system requirements. **Gas engineering science** Scientific principles and concepts as applied to gas engineering including: • Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft. **Pipework technology** • Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of	

materials, their suitability for different situations and tools and equipment (including fixings) required. • Flow rates and their relationship to pipework and system design. • How to apply different techniques for forming and bending pipework. **Legislation and industry guidance** Implications of legislation and additional guidance to employers and those working with gas systems including Gas Safety (Installation and Use) Regulations. **Building technology** • Types of fixtures and suitability for different building fabrics. **System maintenance** • Fault finding techniques, their suitability for different situations and how they are applied in practice. • How to clean components without compromising the system and associated tools, equipment and materials.	

Performance Outcome 4: Decommission gas systems

Knowledge Specific to Performance Outcome	**Skills**
Health and safety • Typical hazards and risks associated with working with gas systems. • Safe working practices associated with working with gas systems.	• Enable control mechanism from a risk assessment prior to working. • Establishing consumer needs when decommissioning any gas installation e.g. maintaining temporary heating system etc.

• Emergency procedures, including gas escapes, report of fumes and for unsafe situations. **Tools, equipment and materials** • Types of tools, equipment and materials used for access, measuring when working on gas systems, their characteristics, properties, purpose and suitability for tasks. • Operation and handling requirements of tools, equipment and materials. **Gas systems** • Characteristics, types and purpose of different types of components and their suitability for different types of systems including Liquid Petroleum Gas (LPG) and Natural Gas, domestic and commercial. • How components operate within a system and integrate to enable the system to operate effectively e.g. pressures etc. • Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location e.g. gas council number etc. • Waste and waste products including types of systems, attributes (e.g. Magnetite, corrosion smells, bacteria etc.), hazards to user, interaction with other parties, environmental impact. • Safety devices applicable to gas systems, their characteristics and operation. • Gas and the combustion process including combustion analysis, carbon monoxide (CO), types of burners and interaction with other devices e.g. ventilators and Mechanical Heat Ventilation Recovery (MHVR) etc.	• Safely isolate the gas system prior to decommissioning e.g. Emergency Control valve (ECV) and Electrical etc. • Extract gas equipment and components from installation with appropriate handling techniques. • Reinstate appropriate service post decommissioning e.g. re-pressurise heating system following a replacement part etc. • Maintain safe working area. • Return clean installation to end user. • Safe disposal of waste products when decommissioning gas system.

• Types of flues in relation to gas and the combustion process, their correct operation, safe operation and suitability for different types of system. • Types of ventilation in relation to gas and the combustion process and their suitability for different requirements. • Types of gas appliances and their system requirements. **Gas engineering science** Scientific principles and concepts as applied to gas engineering including: • Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft. **Pipework technology** • Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required. • Flow rates and their relationship to pipework and system design. • How to apply different techniques for forming and bending pipework. **Legislation and industry guidance** Implications of legislation and additional guidance to employers and those working with gas systems including Gas Safety (Installation and Use) Regulations. **Building technology**	

• Types of fixtures and suitability for different building fabrics. **Decommissioning** • Procedures involved in decommissioning. • Requirements for recording, labelling and reporting decommissioned systems including warning notices and labels to prevent use of decommissioned appliances.	

Occupational Specialism: Heating engineering

Performance Outcome 1: Install heating systems

Knowledge Specific to Performance Outcome	Skills
Health and safety • Typical hazards and risks associated with heating systems (e.g. burns, dust etc.) and the controls that need to be in place. **Tools, equipment and materials** • Types of tools, equipment and materials used for access, measuring when working on heating systems, their characteristics, properties, purpose and suitability for tasks. • Operation and handling requirements of tools, equipment and materials. **Heating systems** • Components used in heating systems (e.g. thermostats, valves etc.), their characteristics, effect of type of energy source e.g. oil, solid fuel, function within the system and how they work together to support the operation of the system.	• Install pipework relevant to the type of system. • Install clips/brackets to different types of building fabric. • Install flues/chimneys. • Install ventilators. • Install appliances. • Install heat emitting devices. • Install components into appliances. • Install controls into a range of systems. • Install thermal installation materials. • Install seals for heat emitting devices. • Check heating products are in accordance with design parameters. • Install control systems for the system. • Prepare a safe working environment to conduct heating system installation. • Update line diagrams/installation plans.

• Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location.
• Appliances supported by heating systems including limitations, operating parameters, legal requirements.
• Waste and waste products, types of systems, attributes (e.g. magnetite, corrosion etc.), hazards to user, interaction with other parties including the consumers.
• Safety devices applicable to heating systems, their characteristics and operation.
 	
Heating engineering science
Applications of scientific principles and concepts to heating engineering including:
• Combustion including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft.
• Heating Systems and the combustion process including:
  ○ Combustion analysis
  ○ Carbon monoxide (CO)
  ○ Types of burners
  ○ Interaction with other devices e.g. ventilators and MVHR etc.
• Flues in relation to gas and the combustion process the following:
  ○ Various Types
  ○ Correct Operation
  ○ Safe Operation
  ○ Sizes.
• Ventilation in relation to gas and the combustion process the following:
	• Use hand and power tools when penetrating a range of building fabrics.
	• Update digital building information management system software.

○ Requirements ○ Types ○ Methods. **Pipework technology** • Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required. • Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics. **Regulations, legislation and industry guidance** • Implications of legislation and additional guidance to employers and those working with heating systems including: ○ Gas Safety (Installation and Use) Regulations ○ CIBSE Domestic Heating Design Guide ○ Building Standards ○ Gas Industry Unsafe Situations Procedure ○ Environmental legislation. **System installation** • Bending techniques e.g. machine, scissor, hand etc. • Connection techniques e.g. threading, soldering etc.	

Performance Outcome 2: Commission heating systems

Knowledge Specific to Performance Outcome	**Skills**

Health and safety • Typical hazards and risks associated with heating systems (e.g. burns, dust etc.) and the controls that need to be in place. **Tools, equipment and materials** • Types of tools, equipment and materials used for access, measuring when working on heating systems, their characteristics, properties, purpose and suitability for tasks. • Operation and handling requirements of tools, equipment and materials. **Heating systems** • Components used in heating systems (e.g. thermostats, valves etc.), their characteristics, effect of type of energy source e.g. oil, solid fuel, function within the system and how they work together to support the operation of the system. • Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location. • Appliances supported by heating systems including limitations, operating parameters, legal requirements. • Waste and waste products, types of systems, attributes (e.g. magnetite, corrosion etc.), hazards to user, interaction with other parties including the consumers. • Safety devices applicable to heating systems, their characteristics and operation. **Heating engineering science** Applications of scientific principles and concepts to heating engineering including:	• Assess risks associated with completing the activities and take appropriate safety precautions e.g. prevention of scalding from hot water etc. • Set heating controls and parameters in accordance with manufacturer's instructions. • Verify fitness for purpose of tools/equipment e.g. calibrate against a known source etc. • Complete heating system handover documentation to end user. • Test heating system installation conforms to original design requirements. • Adjusting heating system parameters to commission in accordance with manufacturer's instructions. • Test heating system. • Record commissioning results e.g. temperature of primary pipework etc. • Visually inspect correct equipment is utilised in the heating system. • Compare commissioning results against design parameters to determine correct installation in accordance with original design.

• Combustion including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft.
• Heating Systems and the combustion process including:
  ○ Combustion analysis
  ○ Carbon monoxide (CO)
  ○ Types of burners
  ○ Interaction with other devices e.g. ventilators and MVHR etc.
• Flues in relation to gas and the combustion process the following:
  ○ Various Types
  ○ Correct Operation
  ○ Safe Operation
  ○ Sizes.
• Ventilation in relation to gas and the combustion process the following:
  ○ Requirements
  ○ Types
  ○ Methods.
 	
Pipework technology
• Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.
• Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics.
 	
Regulations, legislation and industry guidance	

• Implications of legislation and additional guidance to employers and those working with heating systems including:
  ○ Gas Safety (Installation and Use) Regulations
  ○ CIBSE Domestic Heating Design Guide
  ○ Building Standards
  ○ Gas Industry Unsafe Situations Procedure
  ○ Environmental legislation.
 	
System commissioning
 	
• Inspection techniques and how they are applied in commissioning systems e.g. visual measurement etc.
• Factors to inspect during commissioning (e.g. flow rate, temperature etc.) and how expected standards are defined.
• Testing techniques (e.g. pressure test, safety valve operations etc.) and their application.	

Performance Outcome 3: Maintain heating systems

Knowledge Specific to Performance Outcome	**Skills**
Health and safety • Typical hazards and risks associated with heating systems (e.g. burns, dust etc.) and the controls that need to be in place. **Tools, equipment and materials** • Types of tools, equipment and materials used for access, measuring when working on heating systems, their characteristics, properties, purpose and suitability for tasks. • Operation and handling requirements of tools, equipment and materials.	• Use active listening and questioning to identify any end user concerns around system operation e.g. correct times of operation etc. • Calculate maintenance downtime prior to deactivating. • Conduct fault finding in a methodical manner using a range of techniques. • Engineer corrective measures to rectify fault e.g. change a selection of pipework etc. • Assemble system components. • Disassemble system components when conducting maintenance.

Heating systems
• Components used in heating systems (e.g. thermostats, valves etc.), their characteristics, effect of type of energy source e.g. oil, solid fuel, function within the system and how they work together to support the operation of the system.
• Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location.
• Appliances supported by heating systems including limitations, operating parameters, legal requirements.
• Waste and waste products, types of systems, attributes (e.g. magnetite, corrosion etc.), hazards to user, interaction with other parties including the consumers.
• Safety devices applicable to heating systems, their characteristics and operation.
 	
Heating engineering science
Applications of scientific principles and concepts to heating engineering including:
• Combustion including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft.
• Heating Systems and the combustion process including:
  ○ Combustion analysis
  ○ Carbon monoxide (CO)
  ○ Types of burners
  ○ Interaction with other devices e.g. ventilators and MVHR etc.
• Flues in relation to gas and the combustion process the following:
	• Repair faulty heating system components as identified e.g. cylinder thermostat etc.
	• Classify waste for disposal and recycling.

○ Various Types ○ Correct Operation ○ Safe Operation ○ Sizes. • Ventilation in relation to gas and the combustion process the following: ○ Requirements ○ Types ○ Methods. **Pipework technology** • Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required. • Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics. **Regulations, legislation and industry guidance** • Implications of legislation and additional guidance to employers and those working with heating systems including: ○ Gas Safety (Installation and Use) Regulations ○ CIBSE Domestic Heating Design Guide ○ Building Standards ○ Gas Industry Unsafe Situations Procedure ○ Environmental legislation. **System maintenance** • Fault finding techniques and their application. • Typical faults in heating systems and how they are caused • Types of actions required when faults cannot be rectified and implications to customer and business including time and costs.	

Performance Outcome 4: Decommission heating systems

Knowledge Specific to Performance Outcome	Skills
Health and safety • Typical hazards and risks associated with heating systems (e.g. burns, dust etc.) and the controls that need to be in place. **Tools, equipment and materials** • Types of tools, equipment and materials used for access, measuring when working on heating systems, their characteristics, properties, purpose and suitability for tasks. • Operation and handling requirements of tools, equipment and materials. **Heating systems** • Components used in heating systems (e.g. thermostats, valves etc.), their characteristics, effect of type of energy source e.g. oil, solid fuel, function within the system and how they work together to support the operation of the system. • Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location. • Appliances supported by heating systems including limitations, operating parameters, legal requirements.	• Apply control mechanisms from a risk assessment prior to working e.g. safe disposal of heating system fluids etc. • Communicate with user to establish needs when decommissioning heating e.g. temporary heating requirements etc. • Safely electrically isolate the heating system prior to decommissioning. • Extract old heating equipment from installation. • Make good building fabric post system removal. • Reinstate appropriate service post decommissioning e.g. fuel supply etc. • Safe disposal of waste products when decommissioning heating systems

• Waste and waste products, types of systems, attributes (e.g. magnetite, corrosion etc.), hazards to user, interaction with other parties including the consumers.
• Safety devices applicable to heating systems, their characteristics and operation.
 	
Heating engineering science
Applications of scientific principles and concepts to heating engineering including:
• Combustion including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft.
• Heating Systems and the combustion process including:
  ○ Combustion analysis
  ○ Carbon monoxide (CO)
  ○ Types of burners
  ○ Interaction with other devices e.g. ventilators and MVHR etc.
• Flues in relation to gas and the combustion process the following:
  ○ Various Types
  ○ Correct Operation
  ○ Safe Operation
  ○ Sizes.
• Ventilation in relation to gas and the combustion process the following:
  ○ Requirements
  ○ Types
  ○ Methods.
 	
Pipework technology	

• Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.
• Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics.
 	
Regulations, legislation and industry guidance
• Implications of legislation and additional guidance to employers and those working with heating systems including:
  ○ Gas Safety (Installation and Use) Regulations
  ○ CIBSE Domestic Heating Design Guide
  ○ Building Standards
  ○ Gas Industry Unsafe Situations Procedure
  ○ Environmental legislation.
 	
System decommissioning
• Procedures involved in decommissioning.
• Requirements for recording, labelling and reporting decommissioned systems including warning notices and labels to prevent use of decommissioned appliances.	

Occupational Specialism: Plumbing

Performance Outcome 1: Install plumbing systems

Knowledge Specific to Performance Outcome	Skills
Health and safety • Key requirements of Codes of Practice (CoP) including Water Bylaws, Hazardous Waste Regulations, Waste Regulations Advisory Service (WRAS) and Building Standards • Typical hazards and risks associated with plumbing systems and the controls that need to be in place. **Tools, equipment and materials** • Tools, equipment and materials used for installation (e.g. benders, soldering equipment etc.) and their purpose. • Operation and handling requirements for tools and equipment. **Plumbing systems** • Plumbing systems including above ground drainage and rainwater capture. • Components used in plumbing systems (e.g. valves, syphons etc.), their characteristics, function within the system and how they work together to support the operation of the system. • Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location. • Types of control systems required for plumbing systems (including digital controls), their characteristics, operation and suitability for different situations.	• Interpret risk assessments. • Select tools, equipment and materials e.g. pipe slice, soldering equipment, plastic pipe etc. • Measure site requirements and materials. • Mark out requirements e.g. joist notching's, depths, pipe lengths etc. • Use tools including hand and power tools. • Bend pipes including 90° and offset angles. • Cut pipes including leaving chamfered edge. • Connect materials. • Fix pipework to structures. • Position and secure components in plumbing system. • Interpret information provided including drawings, specifications, local site considerations. • Update digital building information management system software.

• Appliances supported by plumbing systems including limitations, operating parameters, waste outputs, fluid categories including compressed air and steam. • Waste and waste products types of systems, attributes (e.g. smells, bacteria etc.), hazards to user, interaction with other parties including the undertaker, treatment. • The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage. **Plumbing science** Scientific principles, their applications, interaction between them to meet the purpose of the system and how their performance in the system is measured including: • Types of water, properties and chemical states, sources and storage, water quality (including pH) and treatments, behaviour under different temperatures. • Relationship between flow and pressure including Boyle's and Charles' Law. • Relationship between mass/volume and specific heat capacity. • Types of insulation materials, their properties including relevant standards and their suitability for different systems. • Electrolyte qualities of materials and the periodic table, relationship to flow rates. **Pipework technology** • Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of materials, their suitability for different situations and tools and equipment required.	

• Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics. **Information and data** • Plumbing drawing symbols and markings. • Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc. **Measurement** • Metric and imperial dimensions of height, weight and length. **System installation** • Bending techniques e.g. machine, scissor, hand etc. • Connection techniques e.g. threading, soldering etc. • Potential impact of installation activities on customer essential services and how these can be minimised e.g. isolation of services, preparation of temporary services etc.	

Performance Outcome 2: Commission plumbing systems

Knowledge Specific to Performance Outcome	**Skills**
Health and safety • Key requirements of Codes of Practice (CoP) including Water Bylaws, Hazardous Waste Regulations, Waste Regulations Advisory Service (WRAS) and Building Standards • Typical hazards and risks associated with plumbing systems and the controls that need to be in place. **Tools, equipment and materials**	• Assess risks associated with completing activities. • Interpret information and data including from visual and other sources e.g. manufacturer's instructions, drawings, BS and EN standards etc. • Inspect the installation of components. • Ensure accuracy and compliance with intended outcomes e.g. flow rate, temperature etc. • Test system e.g. pressure test, safety valve operations etc. • Record data e.g. flow rate, temperature etc.

• Tools, equipment and materials used for installation (e.g. benders, soldering equipment etc.) and their purpose. • Operation and handling requirements for tools and equipment. **Plumbing systems** • Plumbing systems including above ground drainage and rainwater capture. • Components used in plumbing systems (e.g. valves, syphons etc.), their characteristics, function within the system and how they work together to support the operation of the system. • Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location. • Types of control systems required for plumbing systems (including digital controls), their characteristics, operation and suitability for different situations. • Appliances supported by plumbing systems including limitations, operating parameters, waste outputs, fluid categories including compressed air and steam. • Waste and waste products types of systems, attributes (e.g. smells, bacteria etc.), hazards to user, interaction with other parties including the undertaker, treatment. • The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage. **Plumbing science** Scientific principles, their applications, interaction between them to meet the purpose of the system and how their performance in the system is measured including:	• Complete required documentation e.g. service sheet, commissioning record etc. • Present technical information orally for different stakeholders.

• Types of water, properties and chemical states, sources and storage, water quality (including pH) and treatments, behaviour under different temperatures. • Relationship between flow and pressure including Boyle's and Charles' Law. • Relationship between mass/volume and specific heat capacity. • Types of insulation materials, their properties including relevant standards and their suitability for different systems. • Electrolyte qualities of materials and the periodic table, relationship to flow rates. **Pipework technology** • Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of materials, their suitability for different situations and tools and equipment required. • Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics. **Information and data** • Plumbing drawing symbols and markings. • Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc. **Measurement** • Metric and imperial dimensions of height, weight and length. **System commissioning** • Inspection techniques and how they are applied in commissioning systems e.g. visual measurement etc.	

• Factors to inspect during commissioning (e.g. flow rate, temperature etc.) and how expected standards are defined. • Testing techniques (e.g. pressure test, safety valve operations etc.) and their application. • Documentation required for commissioning and verification of commissioning e.g. service sheet, commissioning record etc. • Technical information required for use by different stakeholders.	

Performance Outcome 3: Maintain plumbing systems

Knowledge Specific to Performance Outcome	**Skills**
Health and safety • Key requirements of Codes of Practice (CoP) including Water Bylaws, Hazardous Waste Regulations, Waste Regulations Advisory Service (WRAS) and Building Standards. • Typical hazards and risks associated with plumbing systems and the controls that need to be in place. **Tools, equipment and materials** • Tools, equipment and materials used for installation (e.g. benders, soldering equipment etc.) and their purpose. • Operation and handling requirements for tools and equipment. **Plumbing systems** • Plumbing systems including above ground drainage and rainwater capture. • Components used in plumbing systems (e.g. valves, syphons etc.), their characteristics, function within the system and how they work together to support the operation of the system.	• Identify information requirements from a brief e.g. expected system flow rates, water pressures, water temperatures, vessel pressures etc. • Explore user requirements using open questioning and listening. • Estimate and calculate time and resources. • Analyse situations to identify potential causes for delays and errors. • Inspect the suitability of materials, tools and equipment e.g. adjustable spanners, copper pipe etc. • Analyse situations to identify potential faults. • Repair components in systems e.g. tap washer and cartridges etc. • Disassemble parts of a system. • Replace components within a system.

• Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location. • Types of control systems required for plumbing systems (including digital controls), their characteristics, operation and suitability for different situations. • Appliances supported by plumbing systems including limitations, operating parameters, waste outputs, fluid categories including compressed air and steam. • Waste and waste products types of systems, attributes (e.g. smells, bacteria etc.), hazards to user, interaction with other parties including the undertaker, treatment. • The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage. **Plumbing science** Scientific principles, their applications, interaction between them to meet the purpose of the system and how their performance in the system is measured including: • Types of water, properties and chemical states, sources and storage, water quality (including pH) and treatments, behaviour under different temperatures. • Relationship between flow and pressure including Boyle's and Charles' Law. • Relationship between mass/volume and specific heat capacity. • Types of insulation materials, their properties including relevant standards and their suitability for different systems. • Electrolyte qualities of materials and the periodic table, relationship to flow rates.	

Pipework technology • Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of materials, their suitability for different situations and tools and equipment required. • Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics. **Information and data** • Plumbing drawing symbols and markings. • Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc. **Measurement** • Metric and imperial dimensions of height, weight and length. **System maintenance** • Fault finding techniques and their application. • Typical faults in plumbing systems and how they are caused. • Documentation required for maintenance and verification of maintenance activities e.g. manufacturer's instruction, maintenance checklists etc. • Types of actions required when faults cannot be rectified and implications to customer and business including time and costs.	

Performance Outcome 4: Decommission plumbing systems

Knowledge Specific to Performance Outcome	**Skills**

Health and safety • Key requirements of Codes of Practice (CoP) including Water Bylaws, Hazardous Waste Regulations, Waste Regulations Advisory Service (WRAS) and Building Standards. • Typical hazards and risks associated with plumbing systems and the controls that need to be in place. **Tools, equipment and materials** • Tools, equipment and materials used for installation (e.g. benders, soldering equipment etc.) and their purpose. • Operation and handling requirements for tools and equipment. **Plumbing systems** • Plumbing systems including above ground drainage and rainwater capture. • Components used in plumbing systems (e.g. valves, syphons etc.), their characteristics, function within the system and how they work together to support the operation of the system. • Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location. • Types of control systems required for plumbing systems (including digital controls), their characteristics, operation and suitability for different situations. • Appliances supported by plumbing systems including limitations, operating parameters, waste outputs, fluid categories including compressed air and steam. • Waste and waste products types of systems, attributes (e.g. smells, bacteria etc.), hazards to user, interaction with other parties including the undertaker, treatment.	• Safely isolate electrical and other services. • Handle materials to protect their integrity and safety e.g. copper pipe, plastics etc. • Extract components from a system. • Reconfigure system. • Categorise waste e.g. for recycling, disposal etc. • Make good the building fabric.

• The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage. **Plumbing science** Scientific principles, their applications, interaction between them to meet the purpose of the system and how their performance in the system is measured including: • Types of water, properties and chemical states, sources and storage, water quality (including pH) and treatments, behaviour under different temperatures. • Relationship between flow and pressure including Boyle's and Charles' Law. • Relationship between mass/volume and specific heat capacity. • Types of insulation materials, their properties including relevant standards and their suitability for different systems. • Electrolyte qualities of materials and the periodic table, relationship to flow rates. **Pipework technology** • Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of materials, their suitability for different situations and tools and equipment required. • Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics. **Information and data** • Plumbing drawing symbols and markings. • Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.	

Measurement • Metric and imperial dimensions of height, weight and length. **System decommissioning** • Procedures involved in decommissioning. • Waste management procedures e.g. transport of licenced waste, materials that can be recycled etc. • How to safely remove different types of waste from the working area including asbestos lagging, contaminated water. • Documentation required for decommissioning and verification of decommissioning activities, their content and purpose. • Requirements for recording, labelling and reporting decommissioned systems including warning notices and labels to prevent use of decommissioned appliances.	

Occupational Specialism: Protection Systems Engineering

Performance Outcome 1: Install Protection Systems

Knowledge Specific to Performance Outcome	Skills
Health and safety • Safe working practices specific to work on protection systems e.g. safe isolation and Personal Protective Equipment (PPE) required when undertaking electrical testing etc. **Tools, equipment and materials** • Tools and equipment used when working with protection systems (e.g. general hand tools and specific tools for termination of cables), their purpose and suitability for different task etc. • Operation and handling requirements e.g. how to use a screwdriver correctly. **Protection systems** • Fire Detection Systems fire and smoke patterns in and around buildings in relation to Fire Detection Systems. • Security Systems, including access control, video surveillance and intruder, hold up alarm systems.. • Emergency Lighting Systems. • The relationship of fire detection and security alarms to the fire and security industry and the requirement and implementation of security risk assessments. **System and installation** • How to install cable installation and wiring system supports • How to terminate cables e.g. armoured cable glands, coax, control wiring and data cabling etc.	• Assess risk associated with tasks e.g. is any specialist equipment needed etc. • Identify information required to complete tasks, including manufacturer's installations instructions. • Collect and collate information e.g. drawings and plans etc. • Review information to ensure its accuracy and validity, including suitability of equipment being installed. • Select tools, equipment and materials to complete task e.g. cable type, hand tools etc. • Inspect the suitability of resources for use, including tools, materials and equipment. • Mark out the position of equipment e.g. detection and monitoring equipment location etc. • Analyse formal and informal information to identify potential causes for delays and errors e.g. the work site not being ready, incorrect drawings, insufficient materials etc. • Think creatively to adapt designs as appropriate e.g. where site conditions are different to information provided. Use tools and equipment to carry out tasks e.g. to connect equipment, to install wiring and containment systems etc. • Handle materials e.g. metal and plastic containment systems and cable types etc. • Connect equipment to the installed wiring systems e.g. call points, detectors etc. • Install cable containment systems e.g. conduit, trunking, basket and tray etc.

• Ways to terminate and connect conductors e.g. screwed, crimped and push fit connections etc.	• Install cabling e.g. armoured cables, insulated and sheathed flat cables etc. • Terminate cables e.g. armoured, insulated, coax and data cables etc. • Connect conductors e.g. terminate into relevant terminals using appropriate tools etc.

Performance Outcome 2: Commission Protection Systems

Knowledge Specific to Performance Outcome	**Skills**
Health and safety • Safe working practices specific to work on protection systems e.g. safe isolation and Personal Protective Equipment (PPE) required when undertaking electrical testing etc. **Tools, equipment and materials** • Tools and equipment used when working with protection systems (e.g. general hand tools and specific tools for termination of cables), their purpose and suitability for different task etc. • Operation and handling requirements e.g. how to use a screwdriver correctly. **Protection systems** • Fire Detection Systems fire and smoke patterns in and around buildings in relation to Fire Detection Systems. • Security Systems, including access control and video surveillance. • Emergency Lighting Systems. • The relationship of fire detection and security alarms to the fire and security industry and the requirement and implementation of security risk assessments.	• Inspect protection systems e.g. visual inspection etc. • Test protection systems e.g. continuity of conductors, functional operation etc. • Analyse and interpret information and data from ICT applications e.g. computer, digital transmission over IP, email, mobile communication technology etc. • Complete the documentation for the task e.g. Commissioning Certificate etc. • Use oral and non-verbal communication skills to demonstrate system operation. • Adjust protection systems equipment as required by installation standards e.g. adjust settings of sensors where required etc. • Update digital building information management system software.

System commissioning • How to undertake inspections for initial verification of protection systems e.g. visual inspection. • How to undertake testing for protection systems e.g. continuity of conductors and functional testing.	

Performance Outcome 3: Maintain Protection Systems

Knowledge Specific to Performance Outcome	Skills
Health and safety • Safe working practices specific to work on protection systems e.g. safe isolation and Personal Protective Equipment (PPE) required when undertaking electrical testing etc. **Tools, equipment and materials** • Tools and equipment used when working with protection systems (e.g. general hand tools and specific tools for termination of cables), their purpose and suitability for different task etc. • Operation and handling requirements e.g. how to use a screwdriver correctly. **Protection systems** • Fire Detection Systems fire and smoke patterns in and around buildings in relation to Fire Detection Systems. • Security Systems, including access control and video surveillance. • Emergency Lighting Systems.	• Communicate orally health and safety risks to stakeholders e.g. explain unsafe situations and the risks associated with them etc. • Sequence activities required to complete task including planning to isolate electrical supplies and informing relevant people where required. • Allocate time and resources to complete the task including materials required for the task. • Collect system data from ICT applications e.g. computer, digital transmission over IP, email, mobile communication technology etc. • Record system data e.g. on work records or equipment maintenance sheets etc. • Communicate written technical advice and guidance to technical and non-technical stakeholders e.g. safety advice, to stakeholders etc. • Test equipment to ensure it is safe to work on e.g. stored charge etc. • Analyse information to identify potential faults e.g. feedback from system users etc. • Think creatively to propose solutions for installation faults e.g. insulation resistance readings deteriorating over time,

• The relationship of fire detection and security alarms to the fire and security industry and the requirement and implementation of security risk assessments. **System maintenance** • Fault finding techniques e.g. testing and questioning. • Different requirements for each building types e.g. hospitals, chemical plants, paint stores. • Older systems and installations e.g. 230V fire systems, mechanical sounders, cable types no longer used but maybe still installed.	contingency plans for equipment that is no longer manufactured etc. • Replace components of protection systems e.g. sensors, detectors and monitoring equipment etc.

Performance Outcome 4: Decommission Protection Systems

Knowledge Specific to Performance Outcome	**Skills**
Health and safety • Safe working practices specific to work on protection systems e.g. safe isolation and Personal Protective Equipment (PPE) required when undertaking electrical testing etc. **Tools, equipment and materials** • Tools and equipment used when working with protection systems (e.g. general hand tools and specific tools for termination of cables), their purpose and suitability for different task etc. • Operation and handling requirements e.g. how to use a screwdriver correctly. **Protection systems** • Fire Detection Systems fire and smoke patterns in and around buildings in relation to Fire Detection Systems.	• Make systems safe to work on including safe isolation and discharging stored charge. • Communicate with stakeholders to ensure required information is available to undertake the task using electronic communication. • Remove protection systems e.g. remove redundant equipment and wiring systems etc.

• Security Systems, including access control and video surveillance. • Emergency Lighting Systems. • The relationship of fire detection and security alarms to the fire and security industry and the requirement and implementation of security risk assessments. **System decommissioning** • How to make systems safe to decommission. • How to identify potential issues before decommissioning a system.	

Occupational Specialism: Refrigeration engineering

Performance Outcome 1: Install refrigeration systems

Knowledge Specific to Performance Outcome	Skills
Tools, equipment and materials • Types of fluids including liquids and gases, how they flow and the effect of different pipe sizes on flow. • The safe recovery, recycling and disposal of equipment and hazardous waste transfer. **Legislation, Regulations and Standards** • Key requirements of environmental legislation relating to refrigeration systems e.g. Climate Change Act, Control on Ozone-Depleting Substances etc. **Refrigeration systems** • Components of refrigeration cycles, pressures and temperatures of different points on a circuit. • Performance requirements for running a refrigeration cycle. • The function and operation of refrigeration system components and how they interact in a range of different systems and applications to operate effectively. • The suitability of different types of components for refrigeration systems operating in different situations to meet differing client needs. **Refrigeration engineering sience** • How to apply gas laws when adaptations to a refrigeration system are needed. • How to show a refrigeration cycle on pressure-enthalpy charts.	• Sequence and prioritise tasks e.g. plan and execute programme of works etc. • Identify information requirements from a brief e.g. scale of installation required, appropriate hardware etc. • Gather required information e.g. manufacturer's instructions & power requirements etc. • Interpret information and data. • Calculate data required e.g. heat loss, cooling loads, unit sizes etc. • Produce written reports to different types of stakeholder (e.g. end user, construction project manager etc.) about work completed. • Measure and mark out installation requirements e.g. on components, surfaces etc. • Drill holes for fixings in various substrates. • Position units (including indoor and outdoor) including levelling and squaring. • Insert protective materials into drilled holes e.g. conduit, fireproof insulation, intumescent mastic etc. • Cut pipework (including conduit) to required dimensions. • Manually bend microbore pipework. • Assemble pipework including swaging and brazing. • Permanently fix indoor and outdoor units and supports including pipework and cabling. • Leak test system with a vacuum.

• How to interpret pressure-enthalpy charts. • Properties of refrigerant fluids and lubricants and implications for their use in refrigeration systems. • Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted including different types of wireless systems available. **Sustainability** • Environmental impact of refrigerants and their Ozone Depletion Potential (ODP) and their Global Warming Potential (GWP). • New developments in refrigeration (e.g. low GWP refrigerants etc.) and their potential uses in refrigeration systems and associated toxicity and fire risks. • How to maximise efficient refrigeration system performance including mitigation of direct and indirect carbon emissions. **System installation** • How to check for refrigeration system leakages. • Types of substrates and implications for refrigeration system installation including types of tools and equipment needed. • Types of protective materials, their properties and how to ensure the material operates effectively. • Types of pipework including prefabricated and modularised components and distribution systems, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.	

Performance Outcome 2: Commission refrigeration systems

Knowledge Specific to Performance Outcome	**Skills**

Tools, equipmenet and materials • Types of fluids including liquids and gases, how they flow and the effect of different pipe sizes on flow. • The safe recovery, recycling and disposal of equipment and hazardous waste transfer. **Legislation, Regulations and Standards** • Key requirements of environmental legislation relating to refrigeration systems e.g. Climate Change Act, Control on Ozone-Depleting Substances etc. **Refrigeration systems** • Components of refrigeration cycles, pressures and temperatures of different points on a circuit. • Performance requirements for running a refrigeration cycle. • The function and operation of refrigeration system components and how they interact in a range of different systems and applications to operate effectively. • The suitability of different types of components for refrigeration systems operating in different situations to meet differing client needs. **Refrigeration engineering sience** • How to apply gas laws when adaptations to a refrigeration system are needed. • How to show a refrigeration cycle on pressure-enthalpy charts. • How to interpret pressure-enthalpy charts. • Properties of refrigerant fluids and lubricants and implications for their use in refrigeration systems.	• Interpret a risk assessment e.g. apply stated control measures etc. • Interpret information provided e.g. drawings, manufacturer's specifications etc. • Collect data from control system e.g. flow rates, temperature etc. • Interpret commissioning data collected e.g. have design parameters been met etc. • Discuss requirements with stakeholders (e.g. end user, client etc.) using open questioning and listening techniques. • Inspect system installation e.g. cleanliness, secure etc. • Establish a steady state operation. • Adjust system for optimum performance. • Establish comfortable ambient conditions. • Record test results.

• Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted including different types of wireless systems available. **Sustainability** • Environmental impact of refrigerants and their Ozone Depletion Potential (ODP) and their Global Warming Potential (GWP). • New developments in refrigeration (e.g. low GWP refrigerants etc.) and their potential uses in refrigeration systems and associated toxicity and fire risks. • How to maximise efficient refrigeration system performance including mitigation of direct and indirect carbon emissions. **System commissioning** • System operation requirements to be checked for commissioning including after a long period of non-use. • How to carry out a visual inspection of a refrigeration system. • Expectations of a steady state operation for refrigeration system.	

Performance Outcome 3: Maintain refrigeration systems

Knowledge Specific to Performance Outcome	**Skills**
Tools, equipment and materials • Types of fluids including liquids and gases, how they flow and the effect of different pipe sizes on flow. • The safe recovery, recycling and disposal of equipment and hazardous waste transfer. **Legislation, Regulations and Standards**	• Produce a method statement including risk assessment (RAMS). • Assess suitability of information provided e.g. sufficiency, currency etc. • Calculate resource requirements e.g. how much refrigerant required for size of system etc. • Complete documentation e.g. maintenance plan (O&M manual) etc.

• Key requirements of environmental legislation relating to refrigeration systems e.g. Climate Change Act, Control on Ozone-Depleting Substances etc. **Refrigeration systems** • Components of refrigeration cycles, pressures and temperatures of different points on a circuit. • Performance requirements for running a refrigeration cycle. • The function and operation of refrigeration system components and how they interact in a range of different systems and applications to operate effectively. • The suitability of different types of components for refrigeration systems operating in different situations to meet differing client needs. **Refrigeration engineering sience** • How to apply gas laws when adaptations to a refrigeration system are needed. • How to show a refrigeration cycle on pressure-enthalpy charts. • How to interpret pressure-enthalpy charts. • Properties of refrigerant fluids and lubricants and implications for their use in refrigeration systems. • Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted including different types of wireless systems available. **Sustainability** • Environmental impact of refrigerants and their Ozone Depletion Potential (ODP) and their Global Warming Potential (GWP).	• Produce technical reports e.g. maintenance reports etc. • Visually inspect the system e.g. security of pipework, vibration mounts etc. • Clean system e.g. clearing leaves and other debris from outdoor units, washing filters and gauzes etc. • Extract components from the system. • Apply fault finding techniques to identify faults e.g. data analysis, testing etc. • Rectify faults e.g. poorly fitted insulation, broken condensate drain, incorrectly set controls etc. • Report on maintenance concerns e.g. hot running compressor, evidence of leaks etc. • Classify waste for disposal and recycling.

• New developments in refrigeration (e.g. low GWP refrigerants etc.) and their potential uses in refrigeration systems and associated toxicity and fire risks. • How to maximise efficient refrigeration system performance including mitigation of direct and indirect carbon emissions. **System maintenance** • Types of fault finding techniques, their suitability for different situations and how they are applied in practice. • Cleaning: which components require cleaning and how to clean without compromising system, tools, equipment and materials to do that. • Disassembly techniques. • How to extract refrigerant and manage and handle it when extracted.	

Occupational Specialism: Ventilation

Performance Outcome 1: Install ventilation systems

Knowledge Specific to Performance Outcome	Skills
Health and safety • Typical hazards and safe systems of work specific to ventilation engineering e.g. Risk Assessment and Method Statement (RAMS) etc. **Ventilation systems** • Types of systems (e.g. general supply and extract ventilation, kitchen extraction ventilation and Local Exhaust Ventilation etc.) their purposes, similarities and differences in operation. • Mechanical components (e.g. fans, anti-vibration mounts etc.), their characteristics, function within the system and implications to the system of component failure. • Electrotechnical components (e.g. inverters, actuators etc.) their characteristics, function within the system and implications to the system of component failure. • Types of control system Building Management System (BMS) or standalone), their purposes, components, similarities and differences. • The importance of system cleanliness and cleanliness standards and requirements and how to achieve these. **Tools, equipment and materials** • Tools, equipment and materials (e.g. portable access equipment, drills, hand tools etc.) and their purpose. • Operation and handling requirements, including protection of ductwork from fabrication location to site delivery address (Pre-Delivery and Installation (PDI) levels).	• Interpret a risk assessment e.g. apply controls where required etc. • Interpret information provided e.g. specification, drawing, local site considerations etc. • Calculate installation requirements e.g. positive and negative static pressure, air velocity, structural load bearing and support tolerances etc. • Measure ductwork requirements e.g. location of fixings, lengths etc. • Mark out required measurements e.g. on building fabric, on ductwork. • Prepare work areas for installation activities. • Position, fix, insert and secure ventilation ductwork (including ceiling, floor mounted, riser, access doors) to modular air handling system components. • Apply internal ventilation ductwork coatings and linings. • Test for air leakages and make corrections. • Update digital building information management system software.

Ductwork science • Types of ductwork and in-line system components and their suitability for different systems. • Types of linings, coatings and identification labels and their suitability for different systems. • Types of ductwork materials, their properties (e.g. fire ratings, thickness gauges etc.) and their suitability for different systems. • Types of thermal insulation materials, their properties including relevant standards and their suitability for different systems. • Types of support, fittings and fixings and their suitability for different systems. **Information and data** • The contents and importance of the asbestos register and legionella control log book. • Indoor air quality requirements for different situations. • Types of documentation produced, their content and purpose e.g. commissioning certificates, manufacturer's data sheets, asset lists etc.	

Performance Outcome 2: Commission ventilation systems

Knowledge Specific to Performance Outcome	**Skills**
Health and safety • Typical hazards and safe systems of work specific to ventilation engineering e.g. Risk Assessment and Method Statement (RAMS) etc. **Ventilation systems**	• Produce a method statement including risk assessment (RAMS). • Assess suitability of information provided e.g. for sufficiency, accuracy etc. • Interpret collected data e.g. determine data parameters, whether system meets design parameters etc. • Test system including load testing, air leakage, particulate testing, system balancing.

• Types of systems (e.g. general supply and extract ventilation, kitchen extraction ventilation and Local Exhaust Ventilation etc.) their purposes, similarities and differences in operation. • Mechanical components (e.g. fans, anti-vibration mounts etc.), their characteristics, function within the system and implications to the system of component failure. • Electrotechnical components (e.g. inverters, actuators etc.) their characteristics, function within the system and implications to the system of component failure. • Types of control system Building Management System (BMS) or standalone), their purposes, components, similarities and differences. • The importance of system cleanliness and cleanliness standards and requirements and how to achieve these. **Tools, equipment and materials** • Tools, equipment and materials (e.g. portable access equipment, drills, hand tools etc.) and their purpose. • Operation and handling requirements, including protection of ductwork from fabrication location to site delivery address (Pre-Delivery and Installation (PDI) levels). **Ductwork science** • Types of ductwork and in-line system components and their suitability for different systems. • Types of linings, coatings and identification labels and their suitability for different systems. • Types of ductwork materials, their properties (e.g. fire ratings, thickness gauges etc.) and their suitability for different systems. • Types of thermal insulation materials, their properties including relevant standards and their suitability for different systems. • Types of support, fittings and fixings and their suitability for different systems.	• Record test results. • Annotate system profile and layout drawings reflecting system adaptions. • Update building information systems. • Produce handover documentation e.g. asset list, air testing results, fan details etc.

Information and data • The contents and importance of the asbestos register and legionella control log book. • Indoor air quality requirements for different situations. • Types of documentation produced, their content and purpose e.g. commissioning certificates, manufacturer's data sheets, asset lists etc. **System commissioning** • Positive and negative pressure classification and system balancing. • Types of tests, their purpose and techniques to be applied including system balance and set to work, airflows, volume, pressure, BMS point to point and functional tests, post clean vacuum testing.	

Performance Outcome 3: Maintain ventilation systems

Knowledge Specific to Performance Outcome	**Skills**
Health and safety • Typical hazards and safe systems of work specific to ventilation engineering e.g. Risk Assessment and Method Statement (RAMS) etc. **Ventilation systems** • Types of systems (e.g. general supply and extract ventilation, kitchen extraction ventilation and Local Exhaust Ventilation etc.) their purposes, similarities and differences in operation.	• Sequence and prioritise tasks. • Identify information requirements e.g. from a maintenance plan etc. • Gather required information e.g. manufacturer's specifications, handover materials, site registers etc. • Calculate maintenance downtime. • Convert imperial measurements to metric. • Calculate resource and equipment requirements. • Discuss with client the effectiveness and efficient status of the installation using open questioning and listening. • Clean system including pre-clean and post-clean testing.

• Mechanical components (e.g. fans, anti-vibration mounts etc.), their characteristics, function within the system and implications to the system of component failure. • Electrotechnical components (e.g. inverters, actuators etc.) their characteristics, function within the system and implications to the system of component failure. • Types of control system Building Management System (BMS) or standalone), their purposes, components, similarities and differences. • The importance of system cleanliness and cleanliness standards and requirements and how to achieve these. **Tools, equipment and materials** • Tools, equipment and materials (e.g. portable access equipment, drills, hand tools etc.) and their purpose. • Operation and handling requirements, including protection of ductwork from fabrication location to site delivery address (Pre-Delivery and Installation (PDI) levels). **Ductwork science** • Types of ductwork and in-line system components and their suitability for different systems. • Types of linings, coatings and identification labels and their suitability for different systems. • Types of ductwork materials, their properties (e.g. fire ratings, thickness gauges etc.) and their suitability for different systems. • Types of thermal insulation materials, their properties including relevant standards and their suitability for different systems. • Types of support, fittings and fixings and their suitability for different systems. **Information and data**	• Handle materials to maintain their integrity and that of the system including the use of aggressive chemicals. • Identify root cause of faults. • Apply fault finding techniques to rectify system operation. • Measure ductwork dimensions e.g. for transformation section etc. • Cut ductwork e.g. using shears, portable electrical equipment such as nibblers etc. • Join ductwork using mechanical techniques. • Disassemble parts of a system. Reinstall components within a system.

• The contents and importance of the asbestos register and legionella control log book. • Indoor air quality requirements for different situations. • Types of documentation produced, their content and purpose e.g. commissioning certificates, manufacturer's data sheets, asset lists etc. **System maintenance** • Cutting techniques and how they are applied including resources needed. • Mechanical joining techniques and how they are applied including resources needed. • Assembly and disassembly techniques and how they are applied. • Fault finding techniques, how they are applied and suitability for different situations. • Regulations and procedures for waste management of decontaminated ductwork and associated components.	

Integrating maths, English and digital skills

Maths

The completion of a level 2 mathematics qualification (GCSE mathematics or Functional Skills) is a minimum exit requirement for all T Levels. This will ensure that all students have demonstrated fluency and competence in mathematics, and are able to recognise the importance of mathematics in their own lives, in work and to society. Achievement of a level 2 mathematics qualification will also provide the foundation to access mathematics at a higher level, if required.

Technical Qualifications should contain sufficient and appropriate maths to help students reach the minimum required competence in their chosen specialism(s). The following General Maths Competencies (GMCs) have been developed with input from the Royal Society Advisory Committee on Maths Education (ACME), and awarding organisations will need to embed these, and the underpinning maths, into the specifications and assessments being developed as part of the Technical Qualification.

The GMCs below are relevant to this particular Technical Qualification:

- Communicate using mathematics
- Cost a project
- Estimate, calculate and error-spot
- Measure with precision
- Optimise work processes
- Process data
- Represent with mathematical diagrams
- Understand data
- Use rules and formulae
- Work with proportion.

Awarding organisations that are awarded an exclusive licence will need to integrate these into the Technical Qualification specification and assessments, drawing upon a more detailed framework of maths that underpins the GMCs, currently being developed in association with the Royal Society ACME.

English

The completion of a level 2 English qualification (English language GCSE or Functional Skills) is a minimum exit requirement for all T Levels. This will ensure that all students have demonstrated that they can read fluently, communicate and write effectively, and demonstrate a confident control of Standard English.

The specification for a Technical Qualification should ensure that students acquire the technical vocabulary, and gain the practical communication skills (written and oral), needed to achieve competence in their chosen occupational specialism(s).

The assessments for Technical Qualifications should ensure that students:

- Know the correct technical vocabulary and use it appropriately

- Apply their communication skills (written and oral) appropriately, using Standard English
- Use accurate spelling, punctuation and grammar.

Digital

Technical Qualifications should contain sufficient and appropriate digital skills to help students reach competence in their chosen specialism(s).

This Technical Qualification should support students to develop the digital knowledge and skills needed in order to:

- Adopt professional approaches to using digital communications and social media
- Collate, manage, access and use digital data in spreadsheets, databases and other formats
- Design and create new digital artefacts and materials such as digital writing, digital imaging, digital audio and video, digital code, apps and interfaces and web pages
- Follow licensing guidelines, using only approved and licensed software applications
- Gather and organise information from different digital sources
- Make use of standard analytical tools in applications to better interpret information.

Awarding organisations that are awarded an exclusive licence will need to integrate these into the Technical Qualification specification and assessments.