SQA Advanced Unit specification

General information for centres

Unit title: Thermofluids

Unit code: HT7C 47

Unit purpose: This Unit is designed to enable candidates to develop the knowledge and understanding required to apply the basic principles of thermofluids to the solution of problems within engineering systems. The Unit will also provide the candidate with a base from which future advanced work in Mechanical Engineering may be undertaken.

On completion of the Unit the candidate should be able to:

1 Evaluate properties, changes and energy transfers of state for perfect gases.
2 Evaluate properties, changes and energy transfers of state for vapours.
3 Apply energy, continuity and momentum principles to steady flow processes.

Credit points and level: 1 SQA Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7*)

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to Doctorates.*

Recommended prior knowledge and skills: It would be an advantage if candidates had a knowledge and understanding of basic thermodynamics. This can be evidenced by possession of a Higher in Mechanical Engineering or the following NQ Units: Introduction to Thermofluids or Thermofluids.

Core skills: There may be opportunities to gather evidence towards the following listed Core Skill components in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Use of Numbers	SCQF level 6
Critical Thinking	SCQF level 6

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

Assessment: The assessment for all three Outcomes should be combined together into one assessment paper which candidates should sit at one single assessment event lasting no more than two hours. Assessment should be conducted under controlled, supervised conditions.

SQA Advanced Unit specification: statement of standards

Unit title: Thermofluids

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The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

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

Outcome 1

Evaluate properties, changes and energy transfers of state for perfect gases

Knowledge and/or skills

- the ideal gas laws (Boyle's law; Charles' law)
- combined gas law
- characteristic gas equation
- universal gas constant
- use of process diagrams
- specific heat capacities of gases
- internal energy and enthalpy
- tables of properties
- relationship between the Celsius and Kelvin temperature scales
- relationship between absolute, atmospheric and gauge pressure
- relationship between heat and work
- conservation of energy
- open and closed thermodynamic systems
- thermodynamic processes:
  - flow and non-flow processes
  - constant volume; constant pressure; isothermal; polytropic and adiabatic
  - energy transfers

Evidence requirements

Evidence for the knowledge and/or skills items in Outcome 1 should be provided on a sample basis. The evidence may be presented in responses to specific questions. Each candidate will need to demonstrate that they can answer correctly questions based on a sample of the knowledge and/or skills items listed in the Outcome. In any assessment of this Outcome, **eight out of fourteen** knowledge and/or skills items should be sampled. In all assessments the knowledge/skills item thermodynamic processes must be sampled.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of eight out of fourteen knowledge and/or skills items are required each time the Unit is assessed, which must include the thermodynamic processes knowledge and skills item. Candidates must provide a satisfactory response to all items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing the candidate is able to:

- calculate gas properties using the gas laws:
  - Boyle's law;
  - Charles' law,
  - Combined gas law
  - Characteristic gas equation
- draw process diagrams
- solve problems relating to internal energy and enthalpy
- use tables of properties
- calculate problems involving heat and work transfer
- solve problems for thermodynamic processes including:
  - flow and non-flow processes
  - constant volume; constant pressure; isothermal; polytropic and adiabatic
  - energy transfers

Assessment guidelines

The assessment of this Outcome should be combined together with that for Outcomes 2 and 3 to form a single assessment paper, details of which are given under the Evidence Requirements for Outcome 3.

Outcome 2

Evaluate properties, changes and energy transfers of state for vapours

Knowledge and/or skills

- use of process diagrams
- specific heat capacities of vapours
- internal energy and enthalpy
- tables of properties
- mass and volumetric flow rates
- the steady flow energy equation
- energy transfer principles for:
  - boilers
  - superheaters
  - condensers
  - turbines
- basic steam terminology:
  - dry steam
  - wet steam
  - superheated steam
  - specific volume
  - internal energy
  - dryness fraction
  - degree of superheat

Evidence requirements

Evidence for the knowledge and/or skills items in Outcome 2 will be provided on a sample basis. The evidence may be presented in responses to specific questions. Each candidate will need to demonstrate that they can correctly answer questions based on a sample of the knowledge and skills items listed in the Outcome. In any assessment of this Outcome, **six out of eight** knowledge and/or skills items should be sampled which must include the knowledge/skills items steady flow energy equation and apply energy principles to thermodynamic systems.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of six from eight knowledge and/or skills items are required each time the Unit is assessed which must include the steady flow energy equation and apply energy principles to thermodynamic systems knowledge and/skills items. Candidates must provide a satisfactory response to all items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing the candidate is able to:

- draw process diagrams
- calculate specific heat capacities of vapours
- calculate internal energy and enthalpy
- use tables of properties
- solve problems involving energy transfers
- solve problems involving mass and volumetric flow rates
- solve problems involving the steady flow energy equation
- apply energy principles to thermodynamic systems for boilers, condensers and turbines
- describe basic steam terminology (dry steam; wet steam; superheated steam and specific volume internal energy)
- determine dryness fraction
- determine the degree of superheat

Assessment guidelines

The assessment of this Outcome should be combined together with that for Outcomes 1 and 3 to form a single assessment paper, details of which are given under the Evidence Requirements for Outcome 3.

Outcome 3

Apply energy, continuity and momentum principles to steady flow processes

Knowledge and/or skills

- Bernoulli equation
- flow through pipes and vanes

Evidence requirements

All knowledge and/or skills items in this Outcome must be assessed.

Candidate response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing the candidate is able to:

- solve problems involving Bernoulli's equation in pipes of constant and varying cross section and involving change of height
- solve problems involving Bernoulli's equation on inclined planes
- solve problems involving motion in pipe bends, stationary flat plates and stationary curved vanes

Assessment guidelines

The assessment of this Outcome should be combined together with that for Outcomes 1 and 2 to form a single assessment paper. This single assessment paper should be taken at a single assessment event lasting two hours and carried out under supervised, controlled conditions.

Assessment should be conducted under closed-book conditions and as such candidates should not be allowed to bring any textbooks, handouts or notes to the assessment. Candidates will be permitted to use scientific calculators during the assessment.

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions.

Administrative Information

Unit code: HT7C 47

Unit title: Thermofluids

Superclass category: XH

Date of publication: August 2017

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History of changes:

Version	Description of change	Date

Source: SQA

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

SQA Advanced Unit specification: support notes

Unit title: Thermofluids

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

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

Guidance on the content and context for this Unit

This Unit has been written in order to allow candidates to develop skills, knowledge and understanding of the principles of thermofluids in the following areas:-

1 Evaluate properties, changes and energy transfers of state for perfect gases (20 hours)

This should include solving problems for a variety of different perfect gases and thermodynamic processes. The characteristic gas equation and a standard table of thermodynamic formulae should be used.

Areas for practical work may include, but not be limited to, the following:

- confirmation of Boyle's law and Charles' law by experiment

2 Evaluate properties, changes and energy transfers of state for vapours (10 hours)

This should include solving problems for vapours and thermodynamic processes. This will involve the use of wet and dry steam including superheated steam and boilers and associated ancillary equipment. Problems should involve the use of the steady flow energy equation.

3 Apply energy, continuity and momentum principles to steady flow processes (10 hours)

This should involve solving problems for flow through pipes of varying sections, inclination and bends using Bernoulli's equation and vector analysis.

Guidance on the delivery and assessment of this Unit

This Unit should be delivered by a combination of whole class teaching, tutorial work and practical laboratory work. The latter is seen as particularly important as it provides candidates with an opportunity to relate theoretical knowledge to a practical mechanical context. The Unit has been designed to incorporate sufficient time to allow lecturers to teach all the core thermodynamic principles in the Unit.

As this Unit provides core mechanical principles that underpin much of the studies in other areas of the SQA Advanced Certificate/Diploma in Mechanical Engineering, it is recommended that the Unit be delivered towards the start of these awards.

Where this Unit is incorporated into other group awards it is recommended that it be delivered in the context of the specific occupational area(s) that the award is designed to cover.

The Unit has been written such that there is sufficient time built in to allow candidates to practise what they have learnt through appropriate formative assessments.

Details on the approaches to assessment are given under Evidence Requirements and Assessment Guidelines in Outcome 3 of the SQA Advanced Unit specification: statement of standards section. It is recommended that this section is read carefully before proceeding with assessment of candidates.

It is strongly recommended that any lecturer delivering this Unit studies the Unit Assessment Exemplar to determine the standard of assessment expected by the Unit writers.

Opportunities for developing Core Skills

There may be opportunities to gather evidence towards the following listed Core Skill components in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Use of Numbers	SCQF level 6
Critical Thinking	SCQF level 6

Open learning

This Unit could be delivered by distance learning, which may incorporate some degree of on-line support. However, with regard to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangement would be required to be put in place to ensure that the assessment, which is required to be sat at a single event, was conducted under controlled, supervised conditions.

For information on normal open learning arrangements, please refer to the SQA guide *Assessment and Quality Assurance of Open and Distance Learning (SQA 2000).*

Equality and inclusion

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

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

General information for candidates

Unit title: Thermofluids

This Unit has been designed to allow you to develop knowledge, skills and understanding in basic thermofluids principles and concepts.

This Unit will also provide you with an opportunity to study the relationships that exist between pressure, volume and temperature as well as evaluate properties and changes of state for perfect gases and vapours.

This Unit will also allow you the opportunity to develop the necessary knowledge and skills to evaluate energy transfers for perfect gases and vapours. This evaluation is the basis for applying thermofluids principles to specified thermodynamic systems e.g. boilers, condensers, turbines, compressors as well as nozzles and throttles.

You will also learn to apply energy, continuity and momentum principles to steady flow processes i.e. in pipes of varying cross section and inclination, pipe bends, stationary flat plates and stationary curved vanes.

It is good to gain sound theoretical knowledge and understanding but it is also important that you are able to set your theoretical knowledge within a practical Mechanical context. Thus, it is likely during the Unit you will be provided with the opportunity to relate theory to practice by doing practical experiments.

The formal assessment for this Unit will consist of a single assessment paper lasting no more than two hours. The assessment will be conducted under closed-book conditions in which you will not be allowed to take notes, textbooks etc into the assessment. However, you will be allowed to use a scientific calculator. You will sit this assessment paper at the end of the Unit.