Higher National Unit Specification

General information for centres

Unit title: Fluid Mechanics: Theory and Practice

Unit code: F3XB 34

Unit purpose: This Unit is designed to provide candidates with a theoretical and practical introduction to fluid mechanics. It is intended primarily for those who are working towards the HNC and HND in Chemical Engineering and Chemical Process Technology.

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

1 Apply the theory of fluid mechanics to the measurement of pressure and flow in fluids.
2 Estimate energy requirements and specify equipment for fluid transfer operations.
3 Perform practical procedures for the measurement of flow and friction losses in fluids.

Credit points and level: 1 HN 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 Access 1 to Doctorates.*

Recommended prior knowledge and skills: Access to this Unit will be at the discretion of the centre, though it is recommended that candidates have prior knowledge of physics and/or mathematics at SCQF level 6, or equivalent.

Core Skills: There are opportunities to develop the Core Skills of *Numeracy*, *Problem Solving* and *Working with Others*, and the component Written Communication, all at SCQF level 6 in this Unit.

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

Complete Core Skill	None
Core Skill component	Using Number at 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.

Higher National Unit specification: statement of standards

Unit title: Fluid Mechanics: Theory and Practice

Unit code: F3XB 34

Assessment: Outcomes 1 and 2 could be assessed individually or by a combined assessment covering both Outcomes. Assessment could be composed of an appropriate balance of short answer, restricted response and structured questions. Outcome 3 will be an assessment of practical skills supported by a report of a practical procedure. All assessment should be carried out under supervised conditions.

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

Apply the theory of fluid mechanics to the measurement of pressure and flow in fluids

Knowledge and/or Skills

- Fluid statics theory
- Manometric methods
- The fluid energy equation
- Constriction flowmeters and the Pitot tube

Evidence Requirements

Evidence for this Outcome will be provided on a sample basis with candidates being required to provide evidence for three of the four Knowledge and/or Skills items. Assessment must be carried out under supervised conditions.

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- apply fluid statics theory to measure the pressure of liquids and gases by use of vertical and inclined tube manometers
- estimate liquid level in process vessels by measurement of pressure and differential pressure
- apply the fluid energy equation to the measurement of fluid flow and measure the flowrate of liquids and gases by use of the orifice-plate meter and the Venturi meter
- estimate the velocity of liquids and gases by use of the Pitot tube

Where calculations are performed, the candidate must:

- apply appropriate formulae.
- apply the principles of the calculation.
- Show all working through a calculation.
- provide reasonable answers to the questions asked. The answer should derive from the application of the formulae and correct application of the principles of the calculation.

Assessment Guidelines

Outcome 1 could be assessed by a single assessment or combined with Outcome 2. The assessment could be composed of an appropriate balance of short answer, restricted response and structured questions.

Outcome 2

Estimate energy requirements and specify equipment for fluid transfer operations

Knowledge and/or Skills

- Energy requirements for fluid transfer operations
- Frictional energy losses in pipelines and pipe fittings.
- Velocity profiles in laminar and turbulent flow regimes
- Pump and compressor equipment for fluid transfer operations

Evidence Requirements

Evidence for this Outcome will be provided on a sample basis with candidates being required to provide evidence for three of the four Knowledge and/or Skills items. Assessment must be carried out under supervised conditions.

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- estimate the energy requirements for fluid transfer operations involving changes in fluid pressure, fluid elevation and fluid pressure
- estimate frictional energy losses in pipelines and pipe fittings using empirical equations and friction charts
- describe velocity profiles in laminar and turbulent flow regimes and predict flow regime in fluid transfer operations
- identify pump and compressor equipment for fluid transfer operations

Where calculations are performed, the candidate must:

- apply appropriate formulae.
- apply the principles of the calculation.
- show all working through a calculation.
- provide reasonable answers to the questions asked. The answer should derive from the application of the formulae and correct application of the principles of the calculation.

Assessment Guidelines

Outcome 2 could be assessed by a single or combined with Outcome 1. The assessment could be composed of an appropriate balance of short answer, restricted response and structured questions.

Outcome 3

Perform practical procedures for the measurement of flow and friction in fluids

Knowledge and/or Skills

- Fluid flow equipment
- Health and safety regulations
- Experimental error and estimate errors as appropriate

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- describe the fluid flow equipment used and its method of operation.
- prepare and operate fluid flow equipment.
- perform an appropriate fluid flow experiment and produce a laboratory report for the experiment. The laboratory report must record accurately the results of the experiment and provide calculations and conclusions drawn. Sources of experimental and estimate errors must be included.

Assessment must be carried out under supervised conditions.

Assessment Guidelines

Outcome 3 could be assessed by completion at least one laboratory experiment, supported by a laboratory report and an observational checklist covering the health and safety aspects.

Administrative Information

Unit code: F3XB 34

Unit title: Fluid Mechanics: Theory and Practice

Superclass category: RC

Original date of publication: August 2008

Version: 02

History of Changes:

Version	Description of change	Date
02	Embedded Core Skills of Using Number at SCQF level 6 been added.	24/02/166

Source: SQA

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of Higher National qualifications.

Additional copies of this Unit specification can be purchased from the Scottish Qualifications Authority. Please contact the Customer Contact Centre for further details, telephone 0845 279 1000.

Higher National Unit specification: support notes

Unit title: Fluid Mechanics: Theory and Practice

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 is part of the HNC/HND in Chemistry/Chemical Process Technology and HNC in Chemical Engineering and provides candidates with a theoretical and practical introduction to fluid mechanics.

The following could be covered in the delivery of this Unit.

Outcome 1

The fluid static pressure equation and its application to the measurement of pressure in fluids by manometric methods:

- The Torricelli vacuum
- Static pressure in liquid columns
- The U-tube, the inclined tube and the single-tube manometer
- Manometry using immiscible liquids

Other common methods of pressure measurement and the use of pressure to determine liquid levels in process vessels:

- The Bourdon-tube pressure gauge
- The electronic strain gauge and the differential pressure cell
- Pressure gauges as level indicators
- Errors from atmospheric pressure variations
- Differential pressure cells as level indicators

The fluid energy equation and its application to the measurement of fluid flow:

- The fluid energy (Bernoulli) equation
- Solutions of the fluid energy equation for the constriction flow meter and the Pitot tube
- The orifice-plate meter and the Venturi meter
- Calibration of constriction flow meters
- The variable-area flow meter
- Applications of the Pitot tube

Higher National Unit specification: support notes (cont)

Unit title: Fluid Mechanics: Theory and Practice

Outcome 2

The use of the fluid energy equation to determine energy requirements for fluid transfer operations involving changes in the height, pressure and velocity of the transferred fluid:

- Calculation of potential, kinetic and pressure energy changes
- Relative contributions of potential, kinetic and pressure energy changes

The description of laminar, transitional and turbulent flow regimes and the use of the Reynolds number for the prediction of flow regimes:

- Friction in fluids and fluid viscosity
- Velocity profiles in laminar flow regimes
- Turbulent and transitional flow regimes
- Dimensionless numbers and the Reynolds number
- Prediction of flow regimes using the Reynolds number
- The implications of flow regime for fluid transfer operations

Empirical methods for the estimation of frictional energy losses in pipelines and pipe fittings:

- The force balance in a flowing fluid
- Frictional energy losses as pressure losses
- The dimensionless friction factor and its relation to the Reynolds number
- Empirical methods for determination of the friction factor
- Friction charts
- Frictional energy losses in laminar, turbulent and transitional flow
- The effect of surface roughness

The types of pump and compressor equipment in use for fluid transfer operations in the oil refining and chemicals industries and their principal operating characteristics:

- Centrifugal pumps and compressors and their operating characteristics
- Positive displacement pumps and compressors and their operating characteristics
- Reciprocating pumps and compressors
- The Monod pump, the peristaltic pump and other specialised designs

Outcome 3

The use of plant or laboratory fluid transfer equipment to demonstrate the principles of constriction flow measurement and the estimation of frictional energy losses in pipes and fittings:

- Preparation and operation of equipment in accordance with instructions
- Measurement of pressure using manometric and electronic methods
- Calibration of the orifice-plate meter and the Venturi meter
- Estimation of energy losses caused by friction in pipes and pipe fittings
- Recording and presenting of data in tabular and graphical forms
- Standard formats for the presentation of reports

Higher National Unit specification: support notes (cont)

Unit title: Fluid Mechanics: Theory and Practice

Guidance on the delivery and assessment of this Unit

This Unit will probably be delivered as part of a Group Award designed to provide candidates with technical knowledge and skills for employment in the oil refining and chemicals manufacturing industries. If possible, it is recommended that the Unit is delivered in the early part of the Group Award.

Since the Unit is introductory, it should be assumed that candidates have no previous knowledge of Fluid Mechanics.

It is recommended that the understanding of principles rather than memorisation of complex formulae is emphasised in the delivery of Outcomes 1 and 2.

In support of this emphasis, assessments of Outcomes 1 and 2 may be appropriate in which candidates have access to their own course materials, provided that the problems set do not appear explicitly in the course materials.

Assessments of Outcomes 1 and 2 should be supervised and conferring between candidates excluded. Supervision of the report writing element of the Outcome 3 assessment is probably not practical and the assessor should confirm that the reports presented by each candidate are authentic.

A note on the Evidence Requirements

The Evidence Requirements state that candidates 'must provide a satisfactory response' which includes reasonable answers derived 'from the application of the formula and correct application of the principles of the calculation'. This allows for acknowledgement of the correct working and application of formulae, even where candidates' final answer may be inaccurate.

The statement allows for the eventuality where a single error at one stage in an extended calculation sequence has a cumulative effect on the final answer, even though working/formulae are otherwise correctly applied. Acknowledgement of the correct working should be given in such cases.

Opportunities for developing Core Skills

There are opportunities to develop the Core Skills of *Numeracy, Problem Solving* and *Working with Others,* and the component Written Communication, all at SCQF level 6 in this Unit.

Throughout this Unit candidates are required to perform calculations, manage formulae and use equations, providing the opportunity to develop the Core Skill of *Numeracy*. In Outcome 1 candidates will also be required to interpret and plot graphs, developing *Numeracy* skills.

The use of problems in assessments that candidates require to interpret and work through will develop the Critical Thinking component of *Problem Solving* at SCQF level 6, as will the laboratory aspect of Outcome 2. This work will also allow for development of Written Communication skills and through the negotiation of laboratory space, shared facilities and the potential team working, the Core Skill of *Working with Others*.

Higher National Unit specification: support notes (cont)

Unit title: Fluid Mechanics: Theory and Practice

This unit has the Using Number component of Numeracy embedded in it. This means that when learners achieve the Unit, their Core Skills profile will also be updated to show they have achieved Numeracy at SCQF level 6.

Open learning

Outcomes 1 and 2 of this Unit would be suitable for delivery by distance learning provided that the centre made appropriate arrangements for materials and assessment:

Outcome 3 may not be suitable for delivery or assessment by distance learning because the supervised practical activity is mandatory.

Candidates with disabilities and/or additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering alternative Outcomes for Units. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* **(www.sqa.org.uk)**.

General information for candidates

Unit title: Fluid Mechanics: Theory and Practice

Whilst this Unit may be taken on a standalone basis, it is intended primarily for candidates who are working towards the HNC Chemical Engineering and HNC/HND Chemical Process Technology.

The Unit introduces the theory of Fluid Mechanics and its practical applications at a level which should be useful to you in pursuing a career in the chemicals processing/oil refining industries. In addition, the Unit is may help you furthering study of chemical engineering at second or third year degree level.

On completion of the Unit, you should be able to:

1 Understand the methods used to measure pressure, level and rate of flow in fluids.
2 Estimate energy requirements and select equipment for fluid transfer operations.
3 Perform practical procedures in the laboratory for the measurement of pressure, flow and friction in fluids.

To complete the Unit successfully, you must provide solutions to a number of problems in fluid mechanics. To solve these problems, you must apply fluid mechanics theory and perform calculations correctly, without conferring. Assessment may be conducted over two assessment periods, each lasting approximately one hour, though this is at the discretion of your centre.

In addition, you must perform at least one practical procedure in the laboratory and prepare a report of this procedure to a satisfactory standard.

You will have the opportunity to develop Core Skills in *Numeracy, Problem Solving* and *Communication* and *Working with Others* at SCQF level 6.

The practical focus of the Unit will require you to interpret and work through set problems that will also develop Critical Thinking in skills, with the laboratory aspect of Outcome 2 also provides the opportunity to develop Written Communication and skills and W*orking with Others*.

This unit has the Using Number component of Numeracy embedded in it. This means that when you achieve the Unit, your Core Skills profile will also be updated to show you have achieved Numeracy at SCQF level 6.