

SQA Advanced Unit Specification

General information for centres

Unit title: Petroleum Engineering: Physics, Mathematics and Chemistry

Unit code: HV4P 47

Unit purpose: On completion of the unit the candidate should be able to apply basic physics and chemistry fundamentals and perform calculations required for petroleum engineering.

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

- 1 explain the chemistry of hydrocarbons
- 2 explain the fundamentals of physics applied in petroleum engineering
- 3 perform relevant arithmetic, algebraic and geometric calculations

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: Access to this unit will be at the discretion of the centre.

Core Skills: There may be opportunities to gather evidence toward the core skills of *Numeracy*, *Communication* and *Information Technology* at SCQF level 5 in this unit, although there is no automatic certification of core skills or core skills components.

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: Candidates are assessed either on an outcome by outcome basis or by a single assessment combining all three outcomes. The assessments can be composed of an appropriate balance of short answer, restricted response and structured questions. Assessment could be carried out on a sample basis and under closed-book, supervised, controlled conditions.

SQA Advanced Unit Specification: statement of standards

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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

Explain the chemistry of hydrocarbons

Knowledge and/or skills

- ◆ The nature of matter
- ◆ Homologous nature of hydrocarbons
- ◆ Physical properties and combustion of hydrocarbons

Evidence requirements

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

- ◆ explain the nature of matter. Candidates must be able to explain how atomic structure relates to the physical and chemical properties of compounds.
- ◆ explain the homologous nature of hydrocarbons. In their explanation candidates must relate the physical properties to the lengths of carbon chain.
- ◆ explain the dangers of volatility and combustibility of hydrocarbons.

Assessment guidelines

This outcome could be assessed by an examination, taken as a single assessment lasting approximately 40 minutes, or by combining the assessment with those of Outcomes 2 and 3 into a single two-hour assessment. The assessment can be carried out under supervised, closed-book, controlled conditions.

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

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Outcome 2

Explain the fundamentals of physics applied in petroleum engineering

Knowledge and/or skills

- ◆ Fluid dynamics
- ◆ Heat transfer principles
- ◆ Gas laws
- ◆ Electrical principles

Evidence requirements

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

- ◆ explain the fundamental principles of fluid dynamics. Candidates must explain density and compressibility, viscosity, turbulent flow, boundary layers and fluid resistance.
- ◆ explain the principles of heat. Candidates must explain heat transfer, changes between states, and specific latent heat.
- ◆ explain the thermal expansion of solids, liquids and gases. Candidates must explain linear expansion, area expansion and volume expansion, ideal gases, the kinetic theories of gases in Boyle's Law and Charles's Law.
- ◆ solve problems and calculations involving electrical principles relating to current and voltage, Ohm's law and resistance, power and electrical energy calculations, simple circuits and series and parallel circuits.

Assessment guidelines

This outcome could be assessed by an examination, taken as a single assessment lasting 40 minutes, or by combining the assessment with those of Outcomes 1 and 3 in a single, two-hour assessment. The assessment could be carried out under supervised, closed-book, controlled conditions.

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

Outcome 3

Perform relevant arithmetic, algebraic and geometric calculations

Knowledge and/or skills

- ◆ Scientific and engineering notation
- ◆ Arithmetic and algebraic expressions
- ◆ Transposition of formulae
- ◆ Simple equations
- ◆ Simple geometric calculations

Evidence requirements

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can correctly:

- ◆ use scientific and engineering notation when performing arithmetic, algebraic and geometric calculations.
- ◆ evaluate arithmetic and algebraic expressions including those involving expansion of brackets and fractions.
- ◆ transpose formulae including those involving squares and square roots.
- ◆ solve simple equations.
- ◆ solve simple geometric calculations. Calculations must include volumes and surface areas of:
 - cylinders
 - spheres

Candidates must clearly show their workings throughout the process.

Assessment guidelines

This outcome could be assessed by an examination, taken as a single assessment lasting 40 minutes, or by combining the assessment with those of Outcomes 1 and 2 in a single two-hour assessment. The assessment could be carried out under supervised, closed-book, controlled conditions.

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

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Administrative information

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SQA Advanced Unit Specification: support notes

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 a mandatory unit within SQA Advanced Certificate and the SQA Advanced Diploma in Petroleum Engineering. It is designed to provide candidates with an understanding of the basic physics, chemistry, calculations and formulae required for petroleum engineering.

Outcome 1

Structure of matter, atoms and elements, molecules and compounds. Physical states, solid, liquid, gas, melting, and boiling points. Physical properties of alkanes and alkenes — combustion; trend in properties related to length of carbon chain, flammability, viscosity. Dangers of volatility and combustibility.

Outcome 2

Provides the underpinning knowledge of basic physics applied in petroleum engineering. Fluid dynamics: density, and compressibility; viscosity, turbulent flow, boundary layers, fluid resistance. Heat transfer: Celsius, and Kelvin; heat, heat transfer, specific heat capacity, changes between states, specific latent heat. Thermal expansion of solids, liquids, and gases: linear expansion, area expansion, and volume expansion; ideal gas, kinetic theory of gases, Boyle's Law, Charles's Law, Pressure Law, General Gas Law, Dalton's Law. The current and voltage in simple circuits and resistivity, Ohm's law and resistance should be studied. Problems and calculations involving series and parallel circuits. Power in an electric circuit and electrical energy calculations.

Outcome 3

Arithmetical and algebraic expression — scientific notation, indices and powers, logarithms, weights, measures and conversion factors, ratio and proportion, averages and percentages, evaluation of simple algebraic expressions, simple algebraic fractions, linear equations and their solutions, simultaneous equations, quadratic equations, angle measurement, data manipulation, evaluation and transposition of formulae.

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 petroleum engineering industries.

While the use of case study material is particularly recommended for both learning and teaching components of this unit, other suggested teaching and learning methods for this unit could include: the use of visual aids, information communication technology (ICT), group lectures and discussion, practical demonstrations, question and answer sessions, directed study, industrial/site visits.

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Formative work for this unit could include group discussion and role play emphasising workplace health and safety issues and events specific to petroleum engineering. Such an approach could be beneficial to those candidates without industrial experience.

Assessment strategies for this unit will either be three individual assessments for each of Outcomes 1, 2 and 3 or a single assessment covering all three outcomes. The total time for the single assessment model should not exceed the sum of the individual times for each outcome.

Opportunities for developing core skills

There are opportunities to develop the core skills of *Communication*, *Information Technology*, *Problem Solving* and *Numeracy* at SCQF level 5 in this unit, although there is no automatic certification of core skills or core skills components. This SCQF level 7 unit deals with information covering physics, chemistry and mathematics. The candidates will have to access a range of resources to support their learning. This will involve reading and interpreting information from textbooks as well as online resources. These learning, teaching approaches as well as the requirement for the assessment to contain some extended response questions will allow candidates to develop their *Information Technology* to at least SCQF level 5. The fact that much of the information will be in graphical form and that calculations will have to be carried out will ensure that candidates will be developing *Numeracy* at SCQF level 5.

Open learning

If this unit is delivered by open or distance learning methods, additional planning and resources may be required for candidate support, assessment and quality assurance. A combination of new and traditional authentication tools may have to be devised for assessment and re-assessment purposes.

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: Petroleum Engineering: Physics, Mathematics and Chemistry

Outcome 1

For this outcome you will be expected to describe: structure of matter, atoms and elements, molecules and compounds. Physical states, solid, liquid, gas, melting, and boiling points. Physical properties of alkanes and alkenes — combustion; trend in properties related to length of carbon chain, flammability, viscosity. Dangers of volatility and combustibility.

Outcome 2

For this outcome you should be able to apply basic physics in petroleum engineering. Fluid dynamics: density, and compressibility; viscosity, turbulent flow, boundary layers, fluid resistance. Heat transfer: Celsius, and Kelvin; heat, heat transfer, specific heat capacity, changes between states, specific latent heat. Thermal expansion of solids, liquids, and gases: linear expansion, area expansion, and volume expansion; ideal gas, kinetic theory of gases, Boyle's Law, Charles's Law, The current and voltage in simple circuits and resistivity, Ohm's law and resistance should be studied. Problems and calculations involving series and parallel circuits. Power in an electric circuit and electrical energy calculations.

Outcome 3

For this outcome you will be required to manipulate arithmetical and algebraic expression, using scientific and engineering notation when performing arithmetic, algebraic and geometric calculations. You will evaluate arithmetic and algebraic expressions including those involving expansion of brackets and fractions. You must transpose formulae including those involving squares and square roots. You will solve simple equations. You must solve simple geometric calculations. Calculations must include volumes and surface areas of cylinders and spheres

Assessments for this unit are likely to take the form of a closed-book assessment under supervised, controlled conditions. The assessment papers could be composed of an appropriate balance of short answer, restricted response and structured questions. You will be assessed either on an outcome by outcome basis or by a single, three-hour holistic assessment combining all three outcomes.