

SQA Advanced unit specification

General information

Unit title: Marine Engineering: Mechanical Principles (SCQF Level 7)

Unit code: HW5J 47

Superclass: XQ

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Unit purpose

The purpose of this unit is to enable learners to further develop their knowledge and understanding of engineering mechanics. The engineering principles learnt here will enable the learner to understand how they apply to a marine engineering environment. This unit is designed for use in the training of Merchant Navy Officers.

This unit is designed to provide the learner with a clear path of progression onto the SQA Advanced Diploma in Marine Engineering mechanics units at SCQF level 8.

Outcomes

On successful completion of the unit the learner will be able to:

- 1 analyse linear and angular motion within an engineering environment
- 2 evaluate the forces and moments concerned with static equilibrium
- 3 evaluate the of strength of materials in a range of engineering environments
- 4 analyse simple machines and their uses within a marine engineering environment

Credit points and level

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

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Recommended entry to the unit

Entry onto this unit is at the discretion of the centre but it is recommended that the learner has completed the SCQF level 6 in Shipping and Maritime Operations.

Core skills

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 Critical Thinking at SCQF level 5

There are also opportunities to develop aspects of core skills which are highlighted in the support notes of this unit specification.

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.

The Assessment Support Pack (ASP) for this unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website.

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.

SQA Advanced unit specification: Statement of standards

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Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

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. Learners 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

Analyse linear and angular motion within an engineering environment

Knowledge and/or skills

- ◆ Displacement, velocity, speed and acceleration for linear motion
- ◆ Distance time graphs for constant velocity, linear motion
- ◆ Velocity time graphs for uniform acceleration, linear motion
- ◆ Linear and angular velocity equations
- ◆ Relationship between linear and angular motion
- ◆ Inertia
- ◆ Momentum

Outcome 2

Evaluate the forces and moments concerned with static equilibrium

Knowledge and/or skills

- ◆ Resolution of forces
- ◆ Vector and scalar quantities
- ◆ Equilibrium, resultant and equilibrant
- ◆ Moments of a force
- ◆ Work, power and energy
- ◆ Friction
- ◆ Bodies on a horizontal plane

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Outcome 3

Evaluate the strength of materials in a range of engineering environments

Knowledge and/or skills

- ◆ Stress and strain
- ◆ Modulus of elasticity
- ◆ Ultimate tensile stress and breaking stress
- ◆ Factor of safety
- ◆ Cantilever and simply supported beams
- ◆ Bending moment and shear force diagrams
- ◆ Bending moment equation
- ◆ Properties of a material

Outcome 4

Analyse simple machines and their uses within a marine engineering environment

Knowledge and/or skills

- ◆ Lifting machines
- ◆ Law of a machine
- ◆ Effort, load, velocity ratio, efficiency and mechanical advantage
- ◆ Simple and compound gear systems
- ◆ Vee belt power transmission

Evidence requirements for this unit

Outcomes 1–4 should be combined using holistic assessment that should last 2.5 hours. The assessment will be conducted under closed-book conditions however a formula sheet will be provided.

Learners are permitted to use a scientific calculator but not a programmable calculator.

Learners will need to provide evidence to demonstrate their knowledge and/or skills across all outcomes by showing that they can:

Outcome 1

Evidence for the knowledge and or skills in this outcome will be provided on a sample basis. Written and/or oral evidence based on a sample of **five from seven** knowledge and/or skills items should be provided in any assessment of this outcome.

In order to ensure that the learners will not be able to foresee what items they will be questioned on, a different sample of five out of seven knowledge and/or skills items is required each time the outcome is assessed.

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

- ◆ explain the terms displacement, velocity, speed and acceleration
- ◆ solve problems involving distance/time graphs to find velocity
- ◆ solve problems involving velocity/time graphs to find acceleration and distance travelled
- ◆ solve problems involving the equations for linear and angular motion
- ◆ explain the relationship between linear and angular motion and solve problems involving both linear and angular motion
- ◆ explain the term 'inertia' and apply it to a problem involving the acceleration/deceleration of a rotating disc
- ◆ explain the term momentum and solve a problem involving the linear momentum of colliding bodies

Outcome 2

Evidence for the knowledge and or skills in this outcome will be provided on a sample basis. Written and/or oral evidence based on a sample of **five from seven** knowledge and/or skills items should be provided in any assessment of this outcome.

In order to ensure that the learners will not be able to foresee what items they will be questioned on, a different sample of five out of seven knowledge and/or skills items is required each time the outcome is assessed.

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

- ◆ solve problems involving the resolution of forces by calculating their vertical and horizontal components
- ◆ explain the terms 'vector' and 'scalar' and give examples of where they may be found on board ship
- ◆ explain the terms 'equilibrium', 'resultant' and 'equilibrant' and solve problems to find them in a given force system
- ◆ explain what the moment of a force is
- ◆ solve a problem involving work done, power and energy
- ◆ explain the term 'friction' and understand the difference between static and dynamic friction
- ◆ solve problems involving bodies on a horizontal plane

Outcome 3

Evidence for the knowledge and or skills in this outcome will be provided on a sample basis. Written and/or oral evidence based on a sample of **six from eight** knowledge and/or skills items should be provided in any assessment of this outcome.

In order to ensure that the learners will not be able to foresee what items they will be questioned on, a different sample of six out of eight knowledge and/or skills items is required each time the outcome is assessed.

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

- ◆ explain the terms stress and strain and solve a problem to find the stress and strain in an engineering component subject to loading
- ◆ explain the terms elasticity and modulus of elasticity 'E' and solve a problem involving elasticity and the modulus of elasticity
- ◆ solve a problem using the ultimate tensile stress and breaking stress of a material
- ◆ solve a problem incorporating factor of safety
- ◆ solve a problem for either a cantilever or simply supported beam with point loading and/or uniformly distributed load
- ◆ draw a bending moment and shear force diagram for a beam subject to point loads and/or uniformly distributed loads
- ◆ solve a problem for a simply supported beam made from either a solid square, solid rectangular, solid round or an annular cross sectional area using the bending moment equation
- ◆ explain the terms used to identify the properties of a material such as ductility, malleability, hardness and plasticity

Outcome 4

Evidence for the knowledge and or skills in this outcome will be provided on a sample basis. Written and/or oral evidence based on a sample of **three from five** knowledge and/or skills item should be provided in any assessment of this outcome.

In order to ensure that the learners will not be able to foresee what items they will be questioned on a different sample of three out of five knowledge and/or skills items is required each time the outcome is assessed.

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

- ◆ explain the concept of a lifting machine
- ◆ explain and derive the law of a machine
- ◆ explain the terms: effort, load, mechanical advantage (MA), velocity ratio (VR) and efficiency in respect of, a wheel and axle, differential wheel and axle, rope pulley block, differential rope pulley block, chain block, screw jack, Warwick screw, worm and wheel mechanisms and a hydraulic jack. Solve a problem related to a minimum of three aforementioned devices
- ◆ explain how power and torque is transmitted through simple and compound gearing systems. Solve a problem involving speed ratio, power and torque transmitted for a simple or compound gearing system.
- ◆ derive the torque transmitted in terms of belt tensions and solve a problem involving: speed ratios, power and torque transmitted for a belt drive system

SQA Advanced Unit Support Notes

Unit title: Marine Engineering: Mechanical Principles (SQCF Level 7)

Unit Support Notes are offered as guidance and 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 learners to develop knowledge, understanding and skills in the following areas:

- 1 Demonstrate a knowledge and understanding of linear and angular motion.
- 2 Demonstrate a knowledge and understanding of forces.
- 3 Demonstrate a knowledge and understanding of strength of materials.
- 4 Demonstrate a knowledge and understanding of simple machines.

In each section it is advised that the question set should relate to terminology used on board ship.

1 Demonstrate a knowledge and understanding of linear and angular motion (10 hours)

- ◆ Linear velocity problems of ships travelling at sea
- ◆ Angular velocity problems of rotating ships machinery such as crankshafts, flywheels, reciprocating pumps and pulleys
- ◆ Inertia problems of different constructions of engine flywheels

2 Demonstrate a knowledge and understanding of forces (10 hours)

- ◆ Forces generated in a two stroke engine mechanism
- ◆ Work done and power problems of specific marine machinery
- ◆ Force and mass problems of marine machinery or stores being hauled across horizontal inclined decks and problems involving engine room lifts and hoists.

3 Demonstrate a knowledge and understanding of strength of materials (10 hours)

- ◆ Stress and strain imposed on cylinder head studs, rivets and couplings
- ◆ Factor of safety with regards to marine machinery component materials
- ◆ Shear forces, bending moments, maximum bending moment and points of contraflexure of different types of cross sections of beams and frames as used in ship construction
- ◆ Selection of materials with regards to marine applications

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4 Demonstrate a knowledge and understanding of simple machines (10 hours)

- ◆ Lifting and jacking equipment as used in the maintenance and repair of specific machinery such as engines, pumps, compressors, steering gear, etc
- ◆ Belt drive systems as used for drives between electric motor and fridge compressor or air compressor or air conditioning unit or hydrophore pump
- ◆ Simple gear train systems as used for gangway hoist, crab winch, air winch gear box

This module is designed to fall in line with the requirements of the industry's IAMI Science A Syllabus at EOOW level.

This module provides a progression path onto the Marine Engineering SQA Advanced Diploma in Mechanics modules.

Guidance on approaches to delivery of this unit

Practical demonstration and realistic problem solving should support the application of mechanical principles and concepts. Computer software could be made available where appropriate and learners should be encouraged to take a logical problem solving approach throughout.

The unit has been written such that there is sufficient time built in for learners to practise what they have learnt through appropriate formative assessment exercises. Additionally, the unit has been designed to incorporate time for experimental work and computer simulations so that learners have an opportunity to confirm theories in practice. Whilst, it is recognised that computer simulation can be a valuable tool in confirming mechanical theories, it is nevertheless felt important that learners do some practical laboratory work so that they can gain experience in using test equipment and analysing the results of experiments.

As this unit provides core dynamics and principles which underpin much of the studies done in other areas of the SQA Advanced Certificate and SQA Advanced Diploma in Marine Engineering awards it is recommended that the unit be delivered towards the start of these awards.

Guidance on approaches to assessment of this unit

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

The assessment for all four outcomes of this unit should be combined together into one assessment paper. This paper could be taken by learners at one single assessment event that should last 2.5 hours. Assessment should be conducted under closed-book, controlled and supervised conditions. Learners are permitted to use a scientific calculator but not a programmable calculator. Where sampling is used an alternative sample should be used when reassessing learners. Assessment should take place under invigilated conditions and follow the assessment centres examination policy.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the evidence requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at www.sqa.org.uk/e-assessment.

Opportunities for developing core and other essential skills

In all outcomes each of the assessments requires the learner to be able to solve problems involving statics. This will give the learner the opportunity to develop the component 'Using Number' of the Core Skill Numeracy at SCQF level 6. The specific core skill elements that the learner will have to complete are 'Work confidently to solve a numerical problem' and 'Carry out a number of sustained, complex calculations'.

The assessment of this unit may also contribute towards the component 'Written Communication (writing)' of the Core Skill Communication at SCQF level 6. Learners may have to structure their responses, which could include varying structure and presenting essential information in a logical manner. The specific core skill elements that learners may have to complete are 'Present all essential ideas/information and supporting detail in a logical and effective order' and 'Vary sentence structure, paragraphing, and vocabulary to suit the purpose and target audience'.

In Outcome 1 learners have an opportunity to apply graphical skills when interpreting and presenting information. This will give the learner the opportunity to develop the component 'Using graphical information' of the Core Skill Numeracy at SCQF level 6. In the drawing of linear motion graphs learners will develop the specific core skill elements 'Extract, analyse, and interpret graphical information' and 'Select an appropriate form of complex table, chart, diagram, or qualitative form and communicate complex information in that form'.

This unit has the Using Number component of Numeracy and the Critical Thinking component of Problem Solving embedded in it. This means that when learners achieve the unit, their core skills profile will also be updated to show they have achieved Using Number at SCQF level 6 and Critical Thinking at SCQF level 5.

History of changes to unit

Version	Description of change	Date

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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](#).

General information for learners

Unit title: Marine Engineering: Mechanical Principles (SQCF Level 7)

This section will help you decide whether this is the unit for you by explaining what the unit is about, what you should know or be able to do before you start, what you will need to do during the unit and opportunities for further learning and employment.

This unit has been designed to allow you to develop knowledge, understanding and skills in mechanical concepts and theorems that underpin so much of more advanced studies in Marine Engineering. If you have studied these subjects before the early parts of this unit it will provide you with an opportunity to revise the concepts and theorems you have learnt in previous courses.

It always enhances your learning when you can apply the theoretical knowledge to a practical marine engineering environment. It may be the case that during the unit you will have the opportunity to relate this theory to practice by use of computer simulation. The learner will also be able to apply the theories learnt to a practical situation when on board ship as part of your training programme.

By the end of this unit you will be expected to sit an assessment covering all the learning outcomes where you will be tested on the concepts and theorems you have learned. The assessment will last 2.5 hours and will be conducted under closed-book conditions. A formula sheet will be provided within the assessment.

In order to be successful in this module you will need to apply the engineering theories learned across the four learning outcomes to real engineering environments. You will be assessed on the level of your knowledge and understanding of engineering processes and your ability to perform sometimes complex calculations to a high degree of accuracy.

This unit will contribute to the graded unit for learners studying towards and SQA Advanced Certificate or SQA Advanced Diploma in Marine Engineering.

This unit has the Using Number component of Numeracy and the Critical Thinking component of Problem Solving embedded in it. This means that when you achieve the unit, your core skills profile will also be updated to show you have achieved Using Number at SCQF level 6 and Critical Thinking at SCQF level 5.