

SQA Advanced Unit Specification

General information for centres

Unit title: Celestial Navigation (SCQF level 8)

Unit code: HW6M 48

Superclass: RE

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Version: 01

Unit purpose

This unit will support the learner as they develop their knowledge of the instruments, publications and processes required to successfully fix the ship's position and calculate compass errors using a range of celestial bodies. It will also introduce the learner to the theory and principles of celestial navigation so they develop their understanding of the reasoning behind the processes, thus allowing them to successfully apply their underpinning knowledge at sea.

This unit is primarily aimed at learners who intend to seek employment within the maritime industry.

Outcomes

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

- 1 Demonstrate the correct use and maintenance of relevant precision instruments.
- 2 Apply the principles and concepts of the celestial sphere to navigation techniques.
- 3 Evaluate the accuracy of gyro and magnetic compasses using celestial objects.
- 4 Determine the position of a ship using a range of celestial navigation techniques.

Credit points and level

2 SQA Credits at SCQF level 8: (16 SCQF credit points at SCQF level 8)

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Recommended entry to the unit

Access to this unit is at the discretion of the centre. However it would be beneficial if the learner had successfully completed the SQA Advanced unit *Navigational Mathematics and Science: An Introduction (F7HD 12)*.

Core Skills

Achievement of this Unit gives automatic certification of the following:

Complete Core Skill	Numeracy at SCQF level 6
Core Skill component	Critical Thinking at SCQF level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the support notes of the 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.

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

Demonstrate the use and maintenance of relevant precision instruments.

Knowledge and/or skills

- ◆ Using and maintaining the sextant
- ◆ Parts of the sextant, possible errors and methods of correction
- ◆ Sextant observations (vertical and horizontal)
- ◆ Use and maintenance of the chronometer
- ◆ Coordinated Universal Time (UTC), Greenwich Mean Time (GMT) and Chronometer Time
- ◆ Local Mean Time (LMT), Zone Time (ZT) and Standard Time (ST)

Outcome 2

Apply the principles and concepts of the celestial sphere to navigation techniques.

Knowledge and/or skills

- ◆ Key components of the celestial sphere
- ◆ Use of the nautical almanac to find the Greenwich Hour Angle (GHA), Local Hour Angle (LHA) and declination of sun stars and planets
- ◆ Use of nautical almanac altitude correction tables
- ◆ Predicting the time of twilight, meridian passage, sunrise and sunset
- ◆ Using UTC, GMT, LMT, ST and ZT
- ◆ Factors influencing the suitability of celestial bodies for sights
- ◆ Use of planet and star diagrams in the nautical almanac
- ◆ Star charts or short method tables to pre-compute altitudes and azimuths of stars to determine availability for position fixing
- ◆ NP323 star finder and identifier
- ◆ Star constellations
- ◆ Random and systematic errors
- ◆ Resolution of the cocked hat

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Outcome 3

Evaluate the accuracy of gyro and magnetic compasses using celestial objects.

Knowledge and/or skills

- ◆ Calculation of compass error and deviation by means of azimuths of celestial bodies and amplitude of the sun
- ◆ Calculation of compass error using polaris
- ◆ The reliability of compass errors obtained from celestial objects in relation to random and systematic errors

Outcome 4

Determine the position of a ship using a range of celestial navigation techniques.

Knowledge and/or skills

- ◆ Use of nautical almanac to find the time of meridian passage for the sun
- ◆ Application of TZD to declination to obtain latitude
- ◆ Correction of true altitude of polaris to obtain position line and latitude
- ◆ Marc St. Hilaire method (by calculation or short method tables) to obtain a position line and a point through which it passes
- ◆ Plotting position lines
- ◆ Fix the vessel's position by means of celestial observations

Evidence requirements for this unit

Written and/or oral evidence is required for Outcomes 1–4 under open-book supervised conditions.

Outcome 1 will be assessed on its own.

Outcome 2 will be combined for assessment with Outcomes 3 and 4.

For Outcome 1, learners will have access to a marine sextant and a nautical almanac

For Outcomes 2, 3 and 4, learners will be supplied with the relevant formulas, a nautical almanac and a set of nautical tables.

All knowledge and skills are assessed, however there is sampling within some of the knowledge and skills. When sampling takes place, a different sample should be used for each reassessment.

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Outcome 1

Learners will need to provide written/and or recorded oral evidence to demonstrate their knowledge and/or skills by showing that they can:

(a) Identify the parts of a marine sextant.

Learners must be able to identify the following:

- ◆ Index arm
- ◆ Index mirror
- ◆ Horizon mirror
- ◆ Sextant arc
- ◆ Vernier/micrometer scale
- ◆ Adjustment screws

(b) Describe the causes of errors in a marine sextant and their correction.

Learners should be able to describe the three correctable errors and how these are corrected plus all six non correctable errors.

(c) Measure angles using a sextant.

(d) Explain the use and care of a marine chronometer.

(e) Determine the correct UTC when given an approximate time, the chronometer reading (12 hr format) and chronometer error.

(f) Use UTC and longitude to determine Local Mean Time (LMT) or Zone Time (ZT), or use UTC and the Nautical Almanac to determine Standard Time (ST).

(g) Use LMT and longitude or ST and the Nautical Almanac to determine UTC.

For (e), (f) and (g), a different sample of times should be used on each assessment occasion.

Outcome 2

Learners will need to provide written/and or recorded oral evidence to demonstrate their knowledge and/or skills by showing that they can discuss a sample of two of the following concepts:

- ◆ The celestial sphere
- ◆ Use of publications
- ◆ Potential instrument errors
- ◆ Time conversions
- ◆ Suitability of celestial bodies
- ◆ Potential user errors
- ◆ Comparison of calculation methods
- ◆ Plotting accuracy

A different sample of concepts and topics should be used on each assessment occasion.

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Outcome 3

Learners will need to provide written/and or recorded oral evidence to demonstrate their knowledge and/or skills by showing that they can provide evidence for the following:

- (a) Given the vessel's position and the UTC determine the GHA, LHA and declination of any celestial body.
- (b) Using a method acceptable to the UK Maritime and Coastguard Agency, determine the azimuth and hence true bearing of any celestial object at any time.

In (a) and (b), learners must produce evidence from a sample of two of the following:

- ◆ Venus
- ◆ Mars
- ◆ Jupiter/Saturn
- ◆ Sun or any star

A different sample should be used on each assessment occasion.

- (c) Use the polaris tables in the nautical almanac to determine the true bearing of polaris at any time.
- (d) Using the amplitude formula, determine the true bearing of the sun when rising or setting.

Learners should also comment on the accuracy of the calculation.

In each of (b), (c) or (d), compare the true bearing of the celestial body with the observed magnetic and gyrocompass bearing and hence determine the error of the compass. Given the variation, calculate the deviation of the magnetic compass.

Outcome 4

Learners will need to provide written and/or recorded oral evidence to demonstrate their knowledge and/or skills by showing that they can:

- (a) Determine the true altitude of any celestial object from a sample of one of the following:
 - ◆ Sun
 - ◆ Star
 - ◆ Planet
- (b) Describe the relationship between true altitude and a position circle or position line.
- (c) Calculate the observed latitude from an observation of a heavenly body on the observers meridian from a sample of one of the following:
 - ◆ Sun
 - ◆ Star
 - ◆ Planet

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(d) Calculate the direction of the position line and a point through which it passes from a sample of one of the following:

- ◆ Sun
- ◆ Star
- ◆ Planet

The Marc St Hilaire method of sight reduction or other method acceptable to the UK Maritime and Coastguard Agency may be used in the above calculation.

(e) Calculate the direction of the position line and a point through which it passes from an observation of polaris.

In (c) and (d) above the object chosen for (c) must be different from that chosen in (d).

In each calculation, only the following information should be given to the learner:

- ◆ The date and year
- ◆ The approximate time at the vessel, the chronometer reading (12 hr format) and chronometer error; or the UTC
- ◆ The Dead Reckoning (DR) or Estimated (EP) position of the vessel
- ◆ The sextant altitude of the object
- ◆ The index error of the sextant

(f) Determine the position of the vessel, at a given time, by plotting at least two position lines on graph paper or an appropriate plotting sheet.

In producing evidence for (f) one of the following situations should be sampled:

- (i) two sights with a run in between
- (ii) two simultaneous sights
- (iii) three or more stars involving transferring two or more position lines

SQA Advanced Unit support notes

Unit title: Celestial Navigation (SCQF level 8)

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 80 hours.

Guidance on the content and context for this unit

The knowledge and skills contained within the unit cover all the requirements as laid down by Standards for Training and Certification of Watchkeepers (STCW) at the operational level aboard ship.

Completion of the unit will also ensure that the learner complies with the requirements laid down by the UK Maritime and Coastguard Agency (MCA) for the issue of an Officer of the Watch Unlimited Certificate of Competency as a Deck Officer. The required knowledge and skills for MCA certification can be found in a document detailing the requirements for the issue of an Education and Training Certificate (A&B), which is available from the MNTB.

The following notes give additional information on the knowledge and skills for each of the four outcomes.

Outcome 1

To practically apply the concepts within this unit, the learner must have the skills required to use the instruments. This outcome focusses on the practical use of the sextant and the chronometer, including its care and maintenance. It also provides the knowledge and skills required to apply corrections to the instruments or calculations, based on identified errors. Conversion of time using longitude and the nautical almanac is also included as it provides the learner with a link between the use of the instruments and the theories and calculations within the other outcomes.

Outcome 2

This outcome allows the learner to develop an understanding of the principles and concepts behind the calculations and processes used within the other outcomes. It provides an opportunity to consider the reasons behind actions and the options available to the learner when using celestial navigation techniques at sea.

Outcome 3

This outcome provides the learner with the knowledge and skills required to ascertain the accuracy of the magnetic and gyro compasses by comparing the true bearing of a celestial object with the bearing taken from the compass. The learner will apply these methods at sea to ensure that any errors are identified and corrections applied.

Outcome 4

The final outcome provides the learner with the knowledge and skills required to determine the position of the vessel using celestial navigation. The learner calculates intercepts and bearings, using an approved method, then plots position lines to determine a position. A range of situations are used to provide the learner with the skills required to apply the techniques at various times and using various celestial bodies.

Guidance on approaches to delivery of this unit

This unit is designed to introduce learners to the main concepts of celestial navigation and the use of celestial navigation for checking the accuracy of the ship's compass and for fixing the ship's position, both as a check on the accuracy of the electronic navigation aids or as a primary means of navigation where the navigation aids have failed. It is beneficial for the learner to have completed *Navigational Maths and Science (HW6E 47)* prior to starting this unit as they will have developed their knowledge and skills in trigonometry and geometry.

Learners will be introduced to the main publications and sources of information used for celestial navigation such as the nautical almanac, nories (or other) nautical tables, short method tables, tools to assist in deciding which bodies to use for position fixing, and charts and plotting sheets used to determine the ship's position from the position lines obtained.

It will also introduce the learners to the sextant and chronometer and explain what they are, their role in celestial navigation, then show the learners how to read and use the sextant and chronometer, check their accuracy, correct or apply any errors found, and use the information they provide.

It seeks to show the learners how to use the information from nautical equipment and publications to determine the error of the ship's compass, and apply that error. The learner is introduced to the nautical almanac and the information that it contains, and how to use that information to complete calculations involving the true bearings of celestial bodies.

As the unit covers topics which may not be familiar to the learner, the method of delivery will start with basic principles and application of theory. It will then progress into demonstration and use of equipment and culminates in determining fixes using the methods which have been gradually introduced and practiced. Where possible, sextant angles and compass bearings should be obtained using actual landmarks or celestial bodies. This information can then be used to generate tasks based on real-time data.

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.

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Written and/or oral evidence is required for Outcomes 1–4 under open-book supervised conditions.

Outcome 1 will be assessed on its own.

Outcome 2 will be combined for assessment with Outcomes 3 and 4.

For Outcome 1, learners will have access to a marine sextant and a nautical almanac.

For Outcomes 2, 3 and 4, learners will be supplied with the relevant formulas, a nautical almanac and a set of nautical tables.

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For Outcome 1, the learner should complete a series of tasks based on the evidence requirements. The assessor may wish to collate the evidence in the form of a centre approved task list. The assessor should vary the method of time conversion and the times used.

The assessor should incorporate the evidence requirements for Outcome 2 into the evidence requirements for Outcomes 3 and 4. This gives the learner an opportunity to perform calculations, generate a solution and then evaluate their actions, based on the principles and concepts. Where possible, the assessor should generate an assessment which encourages the learner to apply the knowledge and skills from the three outcomes in an integrated manner.

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

This Unit has the Core Skill of Numeracy embedded in it, so when learners achieve this Unit their Core Skills profile will be updated to show that they have achieved Numeracy at SCQF level 6.

This unit also has 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 Critical Thinking at SCQF level 6.

The unit also provides learners with the opportunity to develop the Core Skills of:

Communication: Writing, Reading at SCQF level 5. Learners will develop the use of both by having to read and extract information in the nautical almanac and nautical tables and then present this information in a clear and concise format in a written assessment.

Communication: Oral at SCQF level 6 can be developed through the learner having to demonstrate and explain the causes of errors in the marine sextant and their correction. Learners will have to use the correct nautical terminology and their explanation will need to be clear and concise when carrying out the correction procedure.

History of changes to unit

Version	Description of change	Date

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General information for learners

Unit title: Celestial Navigation (SCQF level 8)

In this unit you will learn about the practice of using observations of celestial bodies to identify your position and check for compass errors; it includes using a sextant to measure the altitude of celestial bodies, and the chronometer to obtain the time of such observations.

The unit will also provide you with the principles and concepts behind celestial navigation techniques. This will allow you to develop a more comprehensive perspective on the application of the techniques and resolve potential difficulties when using these methods at sea.

To successfully complete this unit, you will need to provide evidence of a satisfactory level of achievement in each assessment. Wherever possible the concepts that you encounter in this unit will be related to the actual practice that you are likely to encounter on board the ship.

The aim of the unit is to provide you with the skills required to step onto the bridge wing, take a sight and a bearing of a celestial body and determine your position and any errors within the equipment being used. In order to provide the best possible opportunity to achieve this aim, the delivery will mix theory and its application, as would be required when using the skills as an OOW. The assessments will also be created to provide theoretical, practical, written and/or oral evidence.

This Unit has the Core Skill of Numeracy embedded in it, so when you achieve this Unit your Core Skills profile will be updated to show that you have achieved Numeracy at SCQF level 6.

This unit also has 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 Critical Thinking at SCQF level 6.

There are opportunities to develop the following Core Skills in this unit, although there is no automatic certification.

- ◆ *Communication: Writing and Reading* at SCQF level 5
- ◆ *Communication: Oral* at SCQF level 6