SCOTTISH QUALIFICATIONS AUTHORITY

Higher National Unit Specification

General information for centres

Unit title: Mathematics and Physics for Aviation

Unit code: DR0A 33

Unit purpose: This Unit is designed to allow candidates to acquire a foundation for understanding engineering mathematics, matter, statics, kinetics, dynamics, thermodynamics, optics, wave motion and sound as applied to aircraft maintenance engineering. It covers the knowledge about mathematics (module 1 of EASA Part 66 requirements) and physics (module 2 of EASA Part 66 requirements) required for EASA Part 66 B1 and B2 license.

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

1 Apply the skills and knowledge in arithmetic, algebra, geometry and trigonometry.
2 Demonstrate knowledge and understanding related to the theoretical fundamentals of statics, kinetics, and dynamics.
3 Demonstrate knowledge and understanding of the theoretical fundamentals of matter, thermodynamics and fluid dynamics.
4 Demonstrate knowledge and understanding of optics, wave motion and sound.

Credit points and level: 2 HN Credits at SCQF level 6: (16 SCQF credit points at SCQF level 6*)

**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. The Unit has no mandatory prerequisites, however it is recommended that candidates have Numeracy and Physics at Intermediate 2 level. This could be demonstrated by the achievement of the Numeracy National Units and Physics National Units at Intermediate 2 level.

Core skills: The achievement of this Unit gives automatic certification of 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.

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

General information for centres (cont)

Unit title: Mathematics and Physics for Aviation

In order to achieve this unit, candidates are required to present sufficient evidence that they have met all the requirements for each outcome within the evidence requirements specified. Details of these requirements are given for each outcome. The assessment instruments used should follow the general guidance offered by the Scottish Qualifications Authority (SQA) assessment model and an integrative approach to assessment is encouraged. (See references at the end of support notes).

Accurate records should be made of the assessment instruments used showing how evidence is generated for each outcome and giving marking schemes and/or checklists, etc. Records of candidates' achievements should be kept. These records will be available for external verification.

Higher National Unit specification: statement of standards

Unit title: Mathematics and Physics for Aviation

Unit code: DR0A 33

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.

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the 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 skill 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 skills and knowledge in arithmetic, algebra, geometry and trigonometry

Knowledge and/or skills

- Use of scientific/engineering notation, manipulation of numbers, numerical evaluation of expressions, changing of the subject of formulae, and solution of equations
- Construction and drawing of simple geometrical shapes, graphical representation of equations/functions, and calculations in trigonometry
- Limiting values and differentiation
- Integration

Evidence requirements

Evidence for the knowledge and/or skills in this Outcome will be provided by an examination taken as a single assessment lasting 40 minutes or by a single three hour assessment combining all four Outcomes, and carried out under supervised, closed-book, controlled conditions.

Where the knowledge is sampled, the sample should comprise at least three bullet points listed under knowledge and/or skills. In order to ensure that candidates will not be able to foresee the sample, the whole of the content listed must be taught and available for assessment. Moreover, a different sample is required each time the Outcome is assessed, to which candidates must give a satisfactory response. The evidence may be presented in responses to specific questions.

A candidate's response can be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate has correct understanding or skills in:

- arithmetical and algebraic expression — scientific notation, indices and powers, negative and fractional indices, binary and other applicable numbering systems, logarithms, arithmetical terms and signs, methods of multiplication and division, fractions and decimals, factors and multiples, weights, measures and conversion factors, ratio and proportion, averages and percentages, areas and volumes, squares, cubes, square and cube roots, evaluation of simple algebraic expressions, addition, subtraction, multiplication and division, use of brackets, simple algebraic fractions, linear equations and their solutions, simultaneous equations and second degree equations with one unknown
- graphical representation — parallel and vertical line, length of line, value of an angle, triangle and polygons, circle, evaluation of area and volume of a shape, rectangular coordinates, nature and uses of graphs, graphs of equations/functions, simple trigonometry, Pythagoras theorem, trigonometrical relationships, use of tables and polar coordinates
- differentiation — of polynomials, basic sine and cosine functions
- integration — of polynomials, basic sine and cosine functions

Assessment guidelines

This Outcome can be assessed by an examination taken as a single assessment lasting 40 minutes or by a single three hour assessment combining all four Outcomes, and 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.

Outcome 2

Demonstrate knowledge and understanding related to the theoretical fundamentals of statics, kinetics, and dynamics

Knowledge and/or skills

- Statics and simple calculations in statics
- Kinetics and simple calculations in kinetics
- Dynamics and simple calculations in dynamics

Evidence requirements

Evidence for the knowledge and/or skills in this Outcome will be provided by an examination taken as a single assessment lasting 40 minutes or by a single three hour assessment combining all four Outcomes, and carried out under supervised, closed-book, controlled conditions.

Where the knowledge is sampled, the sample should comprise at least two bullet points listed under knowledge and/or skills. In order to ensure that candidates will not be able to foresee the sample, the whole of the content listed must be taught and available for assessment. Moreover, a different sample is required each time the Outcome is assessed, to which candidates must give a satisfactory response. The evidence may be presented in responses to specific questions.

A candidate's response can be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate has correct understanding or skills in:

- statics — forces, scalars and vectors; graphical method for force (vector) addition, subtraction and resolution; moments, levers, couples, centre of gravity of regular and irregular shapes; tension stress, compression stress, shear stress, torsion stress, strain and elasticity; pressure and buoyancy in liquids (barometers); velocity ratio, mechanical advantage and efficiency
- kinetics — uniform motion in a straight line, motion under constant acceleration (motion under gravity); uniform circular motion; pendular movement, periodic motion; simple theory of vibration, harmonics and resonance
- dynamics — mass; force and acceleration, centrifugal forces, centripetal forces, Newton's first, second and third laws, inertia, work, power, potential energy, kinetic energy, total energy, efficiency; momentum, conservation of momentum; Impulse; gyroscopic principles; friction: nature and effects, coefficient of friction (rolling resistance)

Assessment guidelines

This Outcome can be assessed by an examination taken as a single assessment lasting forty minutes or by a single three hour assessment combining all four Outcomes, and 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.

Outcome 3

Demonstrate knowledge and understanding of the theoretical fundamentals of matter, thermodynamics and fluid dynamics

Knowledge and/or skills

- The nature of matter
- The basic principles of fluid dynamics
- Bernoulli's theorem
- The principles of heat
- Thermodynamics

Evidence requirements

Evidence for the knowledge and/or skills in this Outcome will be provided by an examination taken as a single assessment event lasting 40 minutes or by a single three hour assessment combining all four Outcomes, and carried out under supervised, closed-book, controlled conditions.

Where the knowledge is sampled, the sample should comprise at least three bullet points listed under knowledge and/or skills. In order to ensure that candidates will not be able to foresee the sample, the whole of the content listed must be taught and available for assessment. Moreover, a different sample is required each time the outcome is assessed, to which candidates must give a satisfactory response. The evidence may be presented in responses to specific questions.

A candidate's response can be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate has correct understanding or skills in:

- nature of matter — the model of the atom, molecules; the chemical elements, chemical compounds; nature and properties of solid, fluid and gas; solid state, liquid state and gaseous state
- principles of fluid dynamics — density, and compressibility; viscosity, streamlining, turbulent flow, boundary layers, fluid resistance, reducing air resistance
- Bernoulli's Theorem, static pressure, dynamic pressure, total pressure, Venturi flow meter
- temperature and its measurement — Celsius, and Kelvin; heat, heat transfer, heat capacity, specific head capacity, latent heat, changes between states, thermal energy, calorific value of fuel
- 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; first and second law of thermodynamics; isothermal process, adiabatic process, isovolumetric process, isobaric process, heat engines

Assessment guidelines

This Outcome can be assessed by an examination taken as a single assessment lasting 40 minutes or by a single three hour assessment combining all four Outcomes, and 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.

Outcome 4

Understand the knowledge of optics, wave motion and sound

Knowledge and/or skills

- Wave motion
- The nature of sound
- The nature of light
- Reflection and refraction

Higher National Unit specification: statement of standards (cont)

Unit title: Mathematics and Physics for Aviation

Evidence requirements

Evidence for the knowledge and/or skills in this Outcome will be provided by an examination taken as a single assessment lasting 40 minutes or by a single three hour assessment combining all four Outcomes, and carried out under supervised, closed-book, controlled conditions.

Where the knowledge is sampled, the sample should comprise at least two bullet points listed under knowledge and/or skills. In order to ensure that candidates will not be able to foresee the sample, the whole of the content listed must be taught and available for assessment. Moreover, a different sample is required each time the outcome is assessed, to which candidates must give a satisfactory response. The evidence may be presented in responses to specific questions.

A candidate's response can be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate has correct understanding or skills in:

- mechanical waves, sinusoidal wave, stationary waves, transverse waves, wavelength, frequency, period, phase, amplitude, intensity, polarisation, longitudinal waves, interference and diffraction
- speed of sound, factors affecting the speed of sound, production of sound, intensity, pitch and quality, Doppler effect
- speed of light, the electromagnetic spectrum, wave properties of light
- laws of reflection — image formation by a plane surfaces, image formation by spherical mirrors; laws of refraction: lenses, formation of images by lenses, focal length, linear magnification; fibre optics, internal reflection, type of optical fibre

Assessment guidelines

This Outcome can be assessed by an examination taken as a single assessment lasting 40 minutes or by a single three hour assessment combining all four Outcomes, and 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.

Administrative Information

Unit code: DR0A 33

Unit title: Mathematics and Physics for Aviation

Superclass category: RC

Original date of publication: August 2005

Version: 02

History of changes:

Version	Description of change	Date
02	Core Skills section update	April 2007

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: Mathematics and Physics for Aviation

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 80 hours.

Guidance on the content and context for this Unit

This Unit is designed to allow candidates to acquire a foundation for understanding engineering mathematics, matter, statics, kinetics, dynamics, thermodynamics, optics, wave motion and sound as applied to aircraft maintenance engineering. Throughout the Unit it is recommended that problems are set in an aircraft engineering context. The use of a scientific calculator with trigonometric functions and scientific notation is advised.

Corresponding to Outcomes:

1 Data manipulation. Evaluation of formulae

e.g. $Z = \sqrt{R^2 + \left(2\pi fL - \frac{1}{2\pi fC}\right)^2}$ or $Y = A \cdot \log_3\left(\frac{1}{X}\right)$

Scientific notation, indices and power, negative and fractional indices, binary, octal and hexadecimal numbers. Changing subject of formulae

eg $f_0 = \frac{1}{2\pi\sqrt{LC}}$ to $L = \frac{1}{(2\pi f_0)^2 C}$

Linear and quadratic equations. Simultaneous linear equations in two unknowns.

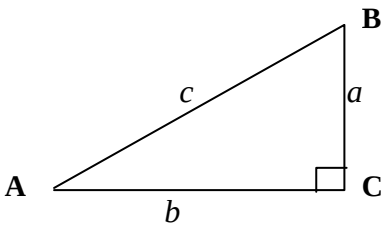
Degree and radians. Circle, triangle and polygon. Sphere, pyramid, prism and cone. Area and volume of regular shape.

Higher National Unit specification: support notes (cont)

Unit title: Mathematics and Physics for Aviation

Pythagoras theorem, simple trigonometry, trigonometrical relationship

eg



$c^2 = a^2 + b^2$

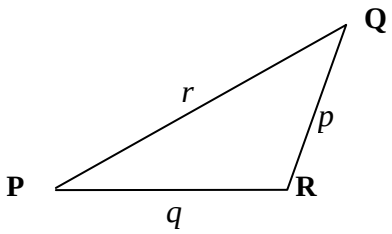
$\sin A = \frac{a}{c}$ $\sin B = \frac{b}{c}$

$\cos A = \frac{b}{c}$ $\cos B = \frac{a}{c}$

$\tan A = \frac{a}{b}$ $\tan B = \frac{b}{a}$

$\tan A = \frac{\sin A}{\cos A}$

$\sin^2 A + \cos^2 A = 1$



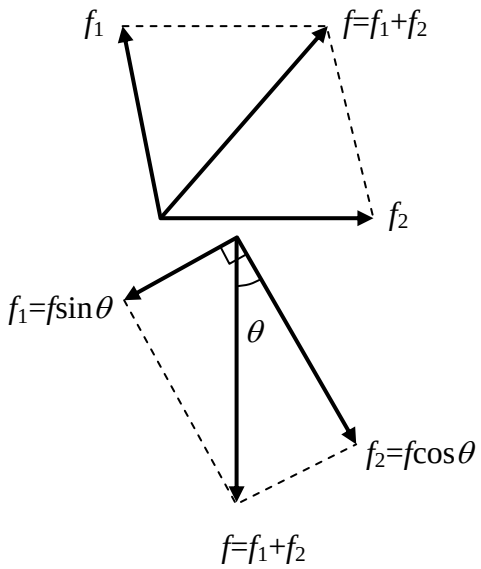
$r^2 = p^2 + q^2 - 2pq\cos R$

Rectangular coordinates, polar coordinates, graphical representation, graphs of linear and quadratic functions, y-intercept and gradient of straight line, graphs of sine-wave

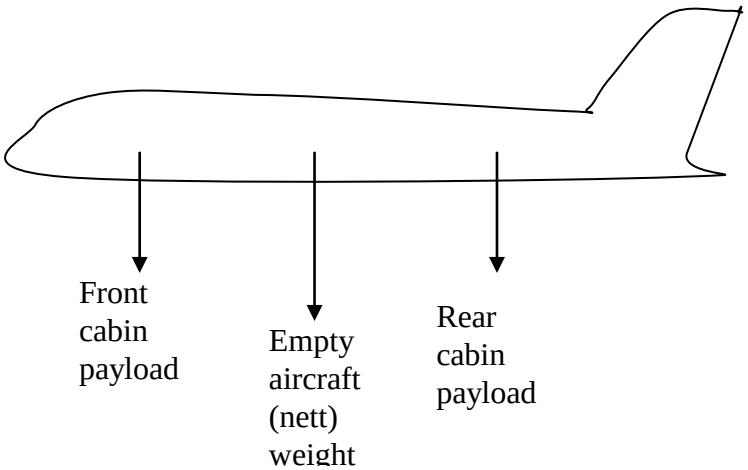
$y = A\sin(\omega t + \phi)$

2 Measuring forces, vectors and scalars, adding forces, resolving forces

eg



Moments, level, couples. Centre of gravity, the change of the centre of gravity of an aircraft due to fuel and pay—load.



Stress, strain and elasticity, tension and compression, shear and torsion. Force and pressure, pressure in a liquid, eg $P=\rho gh$, and buoyancy in a liquid. The concept of hydraulic machines which use liquid pressure to transfer energy from one place to another. Pressure measurement, a Mercury barometer. Velocity ratio, mechanical advantage and efficiency.

Uniform motion in a straight line, speed and velocity, motion under constant acceleration (motion under gravity), distance — time, velocity — time, and acceleration — time graphs.

Mass; force and acceleration, Newton's first, second and third laws, inertia, work, power, potential energy, kinetic energy, total energy.

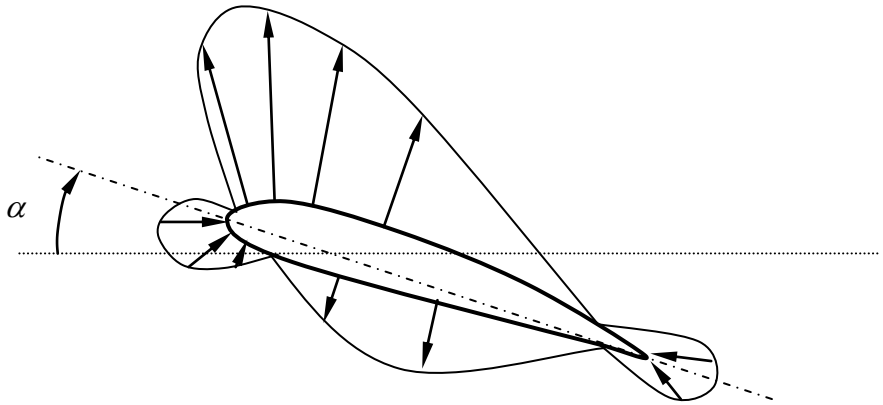
Uniform circular motion, centrifugal forces, centripetal forces; pendular movement, periodic motion; simple theory of vibration, harmonics and resonance.

Momentum, conservation of momentum; Impulse; gyroscopic principles; friction: nature and effects, coefficient of friction (rolling resistance).

3 Structure of matter, atoms and elements, molecules and compounds. Physical states, solid, liquid, gas, melting, boiling.

Density, compressibility and specific gravity; viscosity, streamlining, turbulent flow, boundary layers, airflow around an aerofoil, fluid resistance, reducing air resistance.

Bernoulli's Theorem, static pressure, dynamic pressure, total pressure, Venturi flow meter, lift generated by an aerofoil in a low speed airflow.



Celsius, and Kelvin; heat, heat transfer, heat capacity, specific head capacity, latent heats, thermal energy, calorific value of fuel.

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; first and second law of thermodynamics; isothermal process, adiabatic process, isovolumetric process, isobaric process, heat engines.

4 Mechanical waves, sinusoidal wave, stationary waves, transverse waves, wavelength, frequency, period, phase, amplitude, intensity, polarisation, longitudinal waves, interference and diffraction.

Speed of sound, factors affecting the speed of sound, production of sound, intensity, pitch and quality, Doppler effect.

Speed of light, the electromagnetic spectrum, wave properties of light.

Laws of reflection: image formation by a plane surfaces, image formation by spherical mirrors; laws of refraction: lenses, formation of images by lenses, focal length, linear magnification; fibre optics, internal reflection, type of optical fibre.

Guidance on the delivery and assessment of this Unit

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skill 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.

It is possible to assess candidates either on an Outcome by Outcome basis or by a single three hour assessment combining all four Outcomes. The assessment papers could be composed of an appropriate balance of short answer, restricted response and structured questions. Assessment should be carried out under closed—book, supervised, controlled conditions.

Opportunities for developing Core Skills

There are no opportunities to develop Core Skills in this Unit.

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.

For further information and advice, please see *Assessment and Quality Assurance for Open and Distance Learning* (SQA, February 2001, publication code A1030).

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: Mathematics and Physics for Aviation

In this Unit you will build a foundation for understanding engineering mathematics, matter, statics, kinetics, dynamics, thermodynamics, optics, wave motion and sound as applied to aircraft maintenance engineering. It covers the knowledge about mathematics (module 1 of EASA Part 66 requirements) and physics (module 2 of EASA Part 66 requirements) required for EASA Part 66 B1 and B2 license. There are four Outcomes:

1 Apply the skills and knowledge in arithmetic, algebra, geometry and trigonometry.
2 Demonstrate knowledge and understanding related to the theoretical fundamentals of statics, kinetics, and dynamics.
3 Demonstrate knowledge and understanding of the theoretical fundamentals of matter, thermodynamics and fluid dynamics.
4 Demonstrate knowledge and understanding of optics, wave motion and sound.

This Unit will be beneficial if you are interested in aircraft engineering or are doing an aircraft engineering course.

You will be assessed either on an outcome by outcome basis or by a single three hour holistic assessment combining all four Outcomes. The assessment papers could be composed of an appropriate balance of short answer, restricted response and structured questions. Assessment should be carried out under closed-book, supervised, controlled conditions.