CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business

R101, R102, R103, R104

A comprehensive 99 page overview of how the following qualifications match to the Learning Outcomes for Cambridge Nationals in Engineering, Principles in Engineering and Engineering Business showing opportunities for holistic teaching.

21st Century Physics A 2012 J245

21st Century Science A 2012 J241

21st Century Additional Science A 2012 J242

Gateway Additional Science B 2012 J262

Gateway Physics B 2012 J265

Gateway Science B 2012 J261

GCSE Mathematics B J567 Foundation Bronze

GCSE Mathematics B J567 Foundation Gold

GCSE Mathematics B J567 Foundation Initial

GCSE Mathematics B J567 Foundation Silver

GCSE Mathematics B J567 Higher Silver

Cambridge National ICT Level 1/2 J800/J810/J820

The suggested matches in this document are not definitive. They are examples of where Maths, Science and ICT can be applied in Cambridge Nationals in Engineering, Principles in Engineering and Engineering Business.

You can navigate this pdf by clicking on any of the outer tabs on the unit pages. The Home button will return you to the Contents page.

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CAMBRIDGE NATIONAL IN ENGINEERING

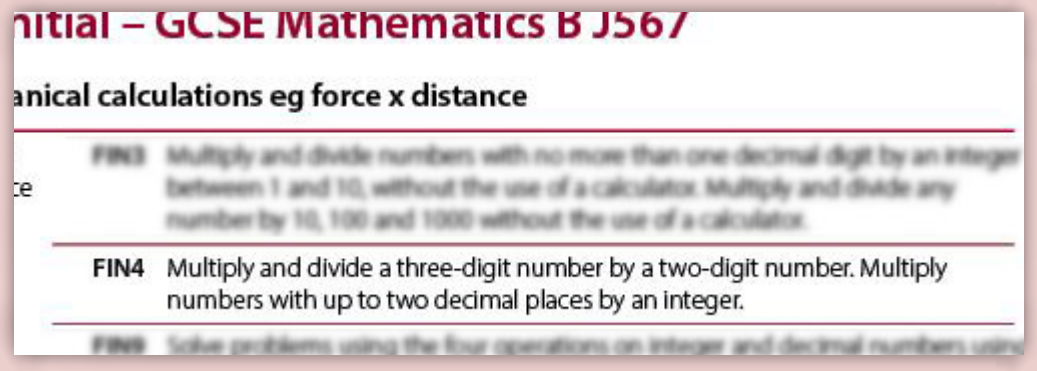
Principles in Engineering and Engineering Business – Maths, Science and ICT in Engineering

Cambridge Nationals in Engineering - Mapping to (maths) and science

This document will help you plan your curriculum and assist you in delivering related subjects such as maths, science and ICT when teaching your Cambridge Nationals in Engineering.

The mapping of R101 LO1 to maths foundation – initial and bronze

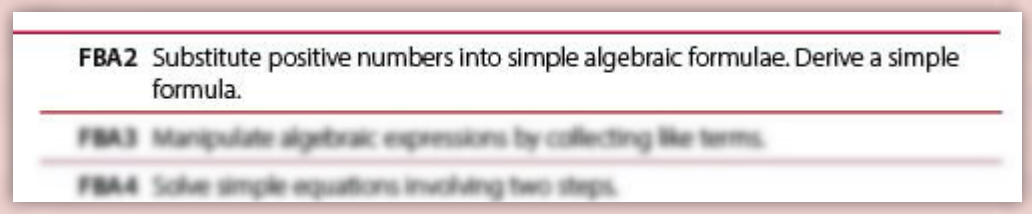
The example below is an extract from this mapping document and suggests how GCSE maths could be taught and then applied to develop skills in evaluating market data necessary for LO1.



nitial – GCSE Mathematics B J567

anical calculations eg force x distance

FIN3	Multiply and divide numbers with no more than one decimal digit by an integer between 1 and 10, without the use of a calculator. Multiply and divide any number by 10, 100 and 1000 without the use of a calculator.
FIN4	Multiply and divide a three-digit number by a two-digit number. Multiply numbers with up to two decimal places by an integer.
FIN9	Solve problems using the four operations on integer and decimal numbers using



FBA2	Substitute positive numbers into simple algebraic formulae. Derive a simple formula.
FBA3	Manipulate algebraic expressions by collecting like terms.
FBA4	Solve simple equations involving two steps.

Learners are required to interpret and develop calculations of pulleys and gears (R101) which will require them to understand how applied force and distance from a fulcrum applies to gear/pulley ratios. In maths, (FIN4) learners are required to multiply and divide a three-digit number by a two-digit number, then multiply numbers with up to two decimal places by an integer. They need to substitute positive numbers into simple algebraic formulae (FBA2) and derive a simple formula. In maths, learners could explore how force could be negative as well as positive which could be represented by integers. Simple algebraic formula could be used when solving compound gear and pulley ratios of speed and torque. Joining these two requirements together makes the learning experience much more relevant to learners and should ultimately increase their interest.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Contents

Click on any of the Learning Outcomes to navigate to the page.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO1: Understand physical properties and mechanical principles

Learners must be taught:

- **physical properties ie**
  - energy
    - forms (mechanical; electrical; chemical; light; sound; heat)
    - potential
    - kinetic
    - conversion
- **mechanical principles ie**
  - power, work and efficiency
    - mechanical advantage (levers; gears; pulleys)
  - forces and torque
  - mechanical efficiency
    - velocity and acceleration (m/s; m/s^2)
    - units and measurement
  - watt; joule; Nm; newton; gram; second; meter; pascal
- **mechanical principles using calculation of:**
  - levers (Class 1, 2 and 3)
    - pulleys and gears (simple and compound)
    - static and moving bodies

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial – GCSE Mathematics B J567

Fundamental mechanical calculations eg force x distance

Fundamental mechanical calculations (torque = force x distance, efficiency)	**FIN3**	Multiply and divide numbers with no more than one decimal digit by an integer between 1 and 10, without the use of a calculator. Multiply and divide any number by 10, 100 and 1000 without the use of a calculator.
	FIN4	Multiply and divide a three-digit number by a two-digit number. Multiply numbers with up to two decimal places by an integer.
	FIN9	Solve problems using the four operations on integer and decimal numbers using a calculator.
	FIN11	Perform calculations involving the use of brackets and the order of operations.
	FIA2	Use formulae expressed in words or symbols, substituting positive numbers into the formula to find the value of the subject (usually in context).
	FIA3	Use simple function machines to deal with inputs and outputs, recognising basic inverse functions. Solve simple equations involving one operation.
Correct use of units	**FIG1**	Use: kilometres, metres, centimetres and millimetres; kilograms and grams;litres and millilitres. Convert measurements from one metric unit to another. Interpret scales on a range of measuring instruments.
Draw diagrams to represent forces and levers	**FIG3**	Measure and draw angles to the nearest degree. Identify acute, obtuse,reflex and right angles. Recall and use properties of angles at a point, angles at a point on a straight line (including right angles), perpendicular lines and opposite angles at a vertex.

Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO1: Understand physical properties and mechanical principles

Learners must be taught:

- **physical properties ie**
  - energy
    - forms (mechanical; electrical; chemical; light; sound; heat)
    - potential
    - kinetic
    - conversion
- **mechanical principles ie**
  - power, work and efficiency
    - mechanical advantage (levers; gears; pulleys)
  - forces and torque
  - mechanical efficiency
    - velocity and acceleration (m/s; m/s^2)
    - units and measurement
  - watt; joule; Nm; newton; gram; second; meter; pascal
- **mechanical principles using calculation of:**
  - levers (Class 1, 2 and 3)
    - pulleys and gears (simple and compound)
    - static and moving bodies

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Bronze – GCSE Mathematics B J567

Fundamental mechanical calculations eg force x distance

Round and estimate values in engineering calculations	**FBN2**	Round numbers to the nearest integer or to any given number of significant figures or decimal places. Estimate answers to one-stage calculations, particularly calculations involving measurement or money.
Use positive and negative numbers to represent forces and moments	**FBN8**	Use the four operations with positive and negative integers.
Manipulate and solve fundamental engineering formulae	**FBA2**	Substitute positive numbers into simple algebraic formulae. Derive a simple formula.
	FBA3	Manipulate algebraic expressions by collecting like terms.
	FBA4	Solve simple equations involving two steps.

Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO1: Understand physical properties and mechanical principles

Learners must be taught:

- **physical properties ie**
  - – energy
    - forms (mechanical; electrical; chemical; light; sound; heat)
    - potential
    - kinetic
    - conversion
- **mechanical principles ie**
  - – power, work and efficiency
    - mechanical advantage (levers; gears; pulleys)
  - – forces and torque
  - – mechanical efficiency
    - velocity and acceleration (m/s; m/s^2)
    - units and measurement
  - – watt; joule; Nm; newton; gram; second; meter; pascal
- **mechanical principles using calculation of:**
  - – levers (Class 1, 2 and 3)
    - pulleys and gears (simple and compound)
    - static and moving bodies

Foundation Initial | Foundation Bronze | **Foundation Silver** | Foundation Gold

Foundation Silver – GCSE Mathematics B J567

Fundamental mechanical calculations eg force x distance

Solve engineering calculations without a calculator	**FSN4**	Use the four operations on decimals without the use of a calculator.
Use ratios in relation to forces using levers, and speed reduction/torque amplification using pulleys and gears	**FSN5**	Use ratio notation including reduction to its simplest form. Understand and use ratio and proportion, including dividing a quantity in a given ratio.
Solve engineering calculations with the use of a calculator	**FSN6**	Use a calculator effectively and efficiently, entering a range of measures including 'time', interpreting the display and rounding off a final answer to a reasonable degree of accuracy. Perform calculations using the order of operations.

Extended opportunities

Indirect mapping

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO1: Understand physical properties and mechanical principles

Learners must be taught:

- **physical properties ie**
  - energy
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    - kinetic
    - conversion
- **mechanical principles ie**
  - power, work and efficiency
    - mechanical advantage (levers; gears; pulleys)
  - forces and torque
  - mechanical efficiency
    - velocity and acceleration (m/s; m/s^2)
    - units and measurement
  - watt; joule; Nm; newton; gram; second; meter; pascal
- **mechanical principles using calculation of:**
  - levers (Class 1, 2 and 3)
    - pulleys and gears (simple and compound)
    - static and moving bodies

Foundation Initial | Foundation Bronze | **Foundation Silver** | Foundation Gold

Foundation Silver – GCSE Mathematics B J567 – Indirect mapping

Manipulate engineering formula and plot data to determine other values

Use given engineering formulae to generate new formluae and solve numerically and using graphs eg velocity vs time or force vs displacement

FSA1 Use and generate formulae. Substitute positive and negative numbers into a formula or an expression.

FSA2 Set-up and solve linear equations with integer coefficients. This will include equations in which the unknown appears on both sides of the equation, or with brackets.

FSA3 Manipulate algebraic expressions by multiplying a single term over a bracket and by taking out common factors.

FSA4 Use tables to plot graphs of linear functions given explicitly.

Higher Silver – GCSE Mathematics B J567– Indirect mapping

Manipulate engineering formula and plot data to determine other values

Plot simple linear graphs and determine gradient and intercept using y=mx+c eg force vs displacement of a linear spring to calculate spring rate (gradient) and coil limit (intercept)

HSA7 Understand that the form y = mx + c represents a straight line and that m is the gradient of the line and c is the value of the y-intercept. Write the equation of a straight line in the form y = mx + c. Understand the gradients of parallel lines.

Direct mapping | Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO1: Understand physical properties and mechanical principles

Learners must be taught:

- **physical properties ie**
  - energy
    - forms (mechanical; electrical; chemical; light; sound; heat)
    - potential
    - kinetic
    - conversion
- **mechanical principles ie**
  - power, work and efficiency
    - mechanical advantage (levers; gears; pulleys)
  - forces and torque
  - mechanical efficiency
    - velocity and acceleration (m/s; m/s^2)
    - units and measurement
  - watt; joule; Nm; newton; gram; second; meter; pascal
- **mechanical principles using calculation of:**
  - levers (Class 1, 2 and 3)
    - pulleys and gears (simple and compound)
    - static and moving bodies

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Gold – GCSE Mathematics B J567

Fundamental mechanical calculations eg force x distance

Rearrange formula eg torque=force x distance	**FGA3** Change the subject of a formula in cases where the subject only appears once.

Foundation Gold – GCSE Mathematics B J567– Indirect mapping

Manipulate engineering formula and plot data to determine other values

Plot simple linear graphs and determine gradient eg force vs displacement of a spring to calculate spring rate (gradient)	**FGA4** Plot graphs of linear functions in which y is given explicitly or implicitly in terms of x. Find the gradient of linear graphs.

Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO2: Understand physical properties and electrical principles

Learners must be taught:

- **physical properties**
  - electrical power and energy
  - electrical values
    - potential difference (volt)
    - resistance (ohm)
    - current (amp)
  - Electro Motive Force (EMF)
- **electrical principles, ie**
  - Alternating and Direct current/voltage (AC and DC)
    - applications (power supplies)
    - reasons for choice
  - series and parallel circuits (lamps, bulbs and cells)
- **values for voltage, current, resistance and power using Ohm's law and power laws and measurement**
  - operation of simple DC electromechanical devices, ie
    - motor
    - generator
    - relay

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial – GCSE Mathematics B J567

Fundamental electrical calculations eg Using ohms law, power law

Fundamental electrical calculations eg Using ohms law	**FIN1**	Round numbers to a given power of 10.
	FIN2	Add and subtract three-digit numbers, without the use of a calculator. Add and subtract using numbers with up to two decimal places without the use of a calculator.
	FIN3	Multiply and divide numbers with no more than one decimal digit by an integer between 1 and 10, without the use of a calculator. Multiply and divide any number by 10, 100 and 1000 without the use of a calculator.
	FIN4	Multiply and divide a three-digit number by a two-digit number. Multiply numbers with up to two decimal places by an integer.
	FIN9	Solve problems using the four operations on integer and decimal numbers using a calculator
	FIN11	Perform calculations involving the use of brackets and the order of operations.
Measure and estimate values of voltage, current etc	**FIG2**	Make sensible estimates of a range of measures in everyday settings.

Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO2: Understand physical properties and electrical principles

Learners must be taught:

- **physical properties**
  - electrical power and energy
  - electrical values
    - potential difference (volt)
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    - current (amp)
  - Electro Motive Force (EMF)
- **electrical principles, ie**
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- **values for voltage, current, resistance and power using Ohm's law and power laws and measurement**
  - operation of simple DC electromechanical devices, ie
    - motor
    - generator
    - relay

Foundation Initial | **Foundation Bronze** | Foundation Silver | Foundation Gold

Foundation Bronze – GCSE Mathematics B J567

Fundamental electrical calculations eg Using ohms law, power law

Round and estimate values in engineering calculations	**FBN2**	Round numbers to the nearest integer or to any given number of significant figures or decimal places. Estimate answers to one-stage calculations, particularly calculations involving measurement or money.
Calculate power using the Power Law (square law)	**FBN3**	Use the terms square and square root (positive square roots only) and the correct notation. Find squares and square roots. Use the term cube and find cubes of numbers, appreciating the link to the volume of a cube. Use index notation for simple integer powers.
Use positive and negative numbers to represent direction of current flow	**FBN8**	Use the four operations with positive and negative integers.
Manipulate and solve fundamental engineering formulae	**FBA2**	Substitute positive numbers into simple algebraic formulae. Derive a simple formula.
	FBA3	Manipulate algebraic expressions by collecting like terms.
	FBA4	Solve simple equations involving two steps.

Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO2: Understand physical properties and electrical principles

Learners must be taught:

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  - electrical values
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    - resistance (ohm)
    - current (amp)
  - Electro Motive Force (EMF)
- **electrical principles, ie**
  - Alternating and Direct current/voltage (AC and DC)
    - applications (power supplies)
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  - series and parallel circuits (lamps, bulbs and cells)
- **values for voltage, current, resistance and power using Ohm's law and power laws and measurement**
  - operation of simple DC electromechanical devices, ie
    - motor
    - generator
    - relay

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Silver – GCSE Mathematics B J567

Fundamental electrical calculations eg Using ohms law, power law

Solve engineering calculations without a calculator	**FSN4**	Use the four operations on decimals without the use of a calculator.
Solve engineering calculations with the use of a calculator	**FSN6**	Use a calculator effectively and efficiently, entering a range of measures including 'time', interpreting the display and rounding off a final answer to a reasonable degree of accuracy. Perform calculations using the order of operations.

Foundation Silver – GCSE Mathematics B J567 – Indirect mapping

Manipulate engineering formula and plot data to determine other values

Use given engineering formulae to generate new formluae and solve numerically and using graphs eg voltage vs current, power vs resistance	**FSA1**	Use and generate formulae. Substitute positive and negative numbers into a formula or an expression.
	FSA2	Set-up and solve linear equations with integer coefficients. This will include equations in which the unknown appears on both sides of the equation, or with brackets.
	FSA3	Manipulate algebraic expressions by multiplying a single term over a bracket and by taking out common factors.
	FSA4	Use tables to plot graphs of linear functions given explicitly.

Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO2: Understand physical properties and electrical principles

Learners must be taught:

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    - current (amp)
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- **electrical principles, ie**
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    - reasons for choice
  - series and parallel circuits (lamps, bulbs and cells)
- **values for voltage, current, resistance and power using Ohm's law and power laws and measurement**
  - operation of simple DC electromechanical devices, ie
    - motor
    - generator
    - relay

Foundation Gold – GCSE Mathematics B J567

Fundamental electrical calculations eg Using ohms law, power law

Rearrange formula eg voltage=current x resistance	**FGA3**	Change the subject of a formula in cases where the subject only appears once.

Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO3: Understand physical properties and fluid power principles

Learners must be taught:

- **physical properties, ie**
  - pressure/vacuum
  - flow
  - forces
  - compressibility
- **fluid power principles, ie values for pressure, flow and force exerted, from calculation and measurement**
- **operation, applications and symbols of simple fluid power system components, ie**
  - supply and storage (compressor; receiver)
  - cylinders/actuators (linear single acting; double acting)
  - valves (directional; reducing; regulating; non-return; 3/2 - 5/2; shuttle)
  - control (push; lever; roller tip; solenoid)

Foundation **Initial** | Foundation **Bronze** | Foundation **Silver** | Foundation **Gold**

Foundation Initial – GCSE Mathematics B J567

Fundamental fluid calculations eg flow rate, pressure

Fundamental fluid calculations eg flow rate, pressure	**FIN3**	Multiply and divide numbers with no more than one decimal digit by an integer between 1 and 10, without the use of a calculator. Multiply and divide any number by 10, 100 and 1000 without the use of a calculator.
	FIN4	Multiply and divide a three-digit number by a two-digit number. Multiply numbers with up to two decimal places by an integer.
	FIN9	Solve problems using the four operations on integer and decimal numbers using a calculator
	FIN11	Perform calculations involving the use of brackets and the order of operations.
	FIA2	Use formulae expressed in words or symbols, substituting positive numbers into the formula to find the value of the subject (usually in context).
	FIA3	Use simple function machines to deal with inputs and outputs, recognising basic inverse functions. Solve simple equations involving one operation.
Correct use of units	**FIG1**	Use: kilometres, metres, centimetres and millimetres; kilograms and grams; litres and millilitres. Convert measurements from one metric unit to another. Interpret scales on a range of measuring instruments.
Measure and estimate values of pressure, flow rate etc	**FIG2**	Make sensible estimates of a range of measures in everyday settings.

Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

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  - supply and storage (compressor; receiver)
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  - valves (directional; reducing; regulating; non-return; 3/2 - 5/2; shuttle)
  - control (push; lever; roller tip; solenoid)

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Bronze – GCSE Mathematics B J567

Fundamental fluid calculations eg flow rate, pressure

Round and estimate values in engineering calculations	**FBN2**	Round numbers to the nearest integer or to any given number of significant figures or decimal places. Estimate answers to one-stage calculations, particularly calculations involving measurement or money.
Use positive and negative numbers to represent direction of fluid flow	**FBN8**	Use the four operations with positive and negative integers.
Manipulate and solve fundamental engineering formulae	**FBA2**	Substitute positive numbers into simple algebraic formulae. Derive a simple formula.
	FBA3	Manipulate algebraic expressions by collecting like terms.
	FBA4	Solve simple equations involving two steps.

Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

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Learners must be taught:

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  - pressure/vacuum
  - flow
  - forces
  - compressibility
- **fluid power principles, ie values for pressure, flow and force exerted, from calculation and measurement**
- **operation, applications and symbols of simple fluid power system components, ie**
  - supply and storage (compressor; receiver)
  - cylinders/actuators (linear single acting; double acting)
  - valves (directional; reducing; regulating; non-return; 3/2 - 5/2; shuttle)
  - control (push; lever; roller tip; solenoid)

Foundation Initial | Foundation Bronze | **Foundation Silver** | Foundation Gold

Foundation Silver – GCSE Mathematics B J567

Fundamental fluid calculations eg flow rate, pressure

Solve engineering calculations without a calculator	**FSN4** Use the four operations on decimals without the use of a calculator.
Solve engineering calculations with the use of a calculator	**FSN6** Use a calculator effectively and efficiently, entering a range of measures including 'time', interpreting the display and rounding off a final answer to a reasonable degree of accuracy. Perform calculations using the order of operations.

Foundation Silver – GCSE Mathematics B J567 – Indirect

Determine relationship between input and output of systems (transfer function)

Determine system efficiency from input to output

Use relationship between input and output of engineering systems to determine transfer function.

Use input and output to determine overall system efficiency. Solve numerically and using graphs linear systems represented by input to output relationship.

FSA1 Use and generate formulae. Substitute positive and negative numbers into a formula or an expression.

FSA2 Set-up and solve linear equations with integer coefficients. This will include equations in which the unknown appears on both sides of the equation, or with brackets.

FSA3 Manipulate algebraic expressions by multiplying a single term over a bracket and by taking out common factors.

FSA4 Use tables to plot graphs of linear functions given explicitly.

Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO3: Understand physical properties and fluid power principles

Learners must be taught:

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  - pressure/vacuum
  - flow
  - forces
  - compressibility
- **fluid power principles, ie values for pressure, flow and force exerted, from calculation and measurement**
- **operation, applications and symbols of simple fluid power system components, ie**
  - supply and storage (compressor; receiver)
  - cylinders/actuators (linear single acting; double acting)
  - valves (directional; reducing; regulating; non-return; 3/2 - 5/2; shuttle)
    control (push; lever; roller tip; solenoid)

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Gold – GCSE Mathematics B J567

Fundamental fluid calculations eg flow rate, pressure

Rearrange formula eg pressure=force/area	**FGA3**	Change the subject of a formula in cases where the subject only appears once.

Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO4: Know about the systems used to transmit power in engineering

Learners must be taught:

- **types of power sources used in engineering, ie**
  - mechanical
  - electrical
  - pneumatic
  - hydraulic
  - vacuum/atmospheric
- **applications and design of mechanical, electrical and fluid power, in engineering ie**
  - mechanical
  - electrical/pneumatic
  - hydraulic
  - vacuum/atmospheric
- **applications and design of integrated power systems used in engineering, ie**
  - electro mechanical
  - electro pneumatic
  - hydro mechanical vacuum mechanical

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial, Bronze, Silver, Gold – GCSE Mathematics B J567

None of the learning outcomes can be directly mapped for LO4.

Extended opportunities

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO1: Complex mechanical calculations

LO2: Complex electrical calculations

LO3: Complex fluid calculations

LO4: Complex systems calculations relevant to power transmission

Mathematics B J567 Higher Bronze | **Mathematics B J567 Higher Silver** | **Mathematics B J567 Higher Gold**

Extended opportunities – GCSE Mathematics B J567 Higher Bronze

Determine rate of change of an engineering function (e.g. acceleration: rate of change of velocity)	**HBA4** Plot graphs of linear functions in which y is given explicitly or implicitly in terms of *x*. Find the gradient of linear graphs.
	HBA5 Draw and interpret graphs modelling real situations, which may be nonlinear, including simple quadratic graphs.
Interpret non-linear and quadratic engineering functions (e.g. relating to non-linear springs, polymeric buffers)	**HBA6** Generate points and plot graphs of simple quadratic functions and use these to find approximate solutions of simple related equations.
	HBG4 Understand, recall and use Pythagoras' theorem in 2-D contexts.
Construct and interpret more complex engineering diagrams (e.g. representing forces, or linked mechanisms)	**HBG6** Construct loci to show paths and shapes. Use straight edge and a pair of compasses to produce standard constructions, including the midpoint and perpendicular bisector of a line segment and the bisector of an angle.

Unit R101
Engineering principles

LO1: Complex mechanical calculations

LO2: Complex electrical calculations

LO3: Complex fluid calculations

LO4: Complex systems calculations relevant to power transmission

Extended opportunities – GCSE Mathematics B J567 Higher Silver

Set up and solve simultaneous equations for engineering problems (e.g. circuits with multiple current loops)	**HSA4**	Set up two linear simultaneous equations. Find the exact solution of two linear simultaneous equations in two unknowns by eliminating a variable; interpret the equations as lines and their common solution as the point of intersection.
Determine lengths and co-ordinates on more complex engineering diagrams (e.g. diagrams representing linked mechanisms)	**HSG3**	Find the coordinates of the midpoint of a line segment *AB* given points *A* and *B* in 2-D. Use Pythagoras' theorem to find the length of a line segment *AB* given the points *A* and *B* in 2-D.

Unit R101
Engineering principles

LO1: Complex mechanical calculations

LO2: Complex electrical calculations

LO3: Complex fluid calculations

LO4: Complex systems calculations relevant to power transmission

Extended opportunities – GCSE Mathematics B J567 Higher Gold

Apply trigonometric functions to engineering problems (e.g. engineering problems with sinusoidal functions such as a.c. waveforms)	**HGA5**	Draw, sketch and recognise the function $y = kx$ for integer values of x and simple positive values of k, the trigonometric functions $y = \sin x$ and $y = \cos x$ for any angle.
Use vector notation to solve engineering problems (e.g. force vectors in beams and mechanisms, current and voltage vectors in a.c. circuits)	**HGG5**	Understand and use vector notation. Calculate, and represent graphically: the sum of two vectors, the difference of two vectors and a scalar multiple of a vector. Calculate the resultant of two vectors. Understand and use the commutative and associative properties of vector addition. Use vector methods in 2-D.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO1: Understand physical properties and mechanical principles

Learners must be taught:

- **physical properties**
  - energy
    - forms (mechanical; electrical; chemical; light; sound; heat)
    - potential
    - kinetic
    - conversion
- **mechanical principles, ie**
  - power, work and efficiency
    - mechanical advantage (levers; gears; pulleys)
    - forces and torque
    - mechanical efficiency
  - velocity and acceleration (m/s; m/s^2)
  - units and measurement
    - watt; joule; Nm; newton; gram; second; meter; pascal
- **mechanical principles using calculation of:**
  - levers (Class 1, 2 and 3)
  - pulleys and gears (simple and compound)
  - static and moving bodies

Gateway Additional Science B 2012 J262 | **21st Century Science A 2012 J242**

Calculation of speed, acceleration, force, work, weight, potential and kinetic energy

P3a Forces for transport (speed)	Calculation of average speed of a moving object
P3b Forces for transport (changing speed)	Calculation of acceleration of a moving object
P3c Forces for transport (forces and motion)	Calculation of force from force = mass x acceleration
P3d Forces for transport (work and power)	Calculation of work done and power
P3e Forces for transport (energy on the move)	Understand kinetic energy
P3f Forces for transport (crumple zones)	Calculate force using mass and acceleration
P3h Forces for transport (the energy of games and theme rides)	Understand potential energy

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO1: Understand physical properties and mechanical principles

Learners must be taught:

- **physical properties**
  - energy
    - forms (mechanical; electrical; chemical; light; sound; heat)
    - potential
    - kinetic
    - conversion
- **mechanical principles, ie**
  - power, work and efficiency
    - mechanical advantage (levers; gears; pulleys)
    - forces and torque
    - mechanical efficiency
  - velocity and acceleration (m/s; m/s^2)
  - units and measurement
    - watt; joule; Nm; newton; gram; second; meter; pascal
- **mechanical principles using calculation of:**
  - levers (Class 1, 2 and 3)
  - pulleys and gears (simple and compound)
  - static and moving bodies

Gateway Additional Science B 2012 J262 | 21st Century Science A 2012 J242

Calculation of speed, acceleration, force, work, weight, potential and kinetic energy

P4.1 Explaining motion (how can we describe motion)	Calculation of average speed of a moving object
P4.2 Explaining motion (what are forces)	Explain the interaction of forces between two objects
P4.3 Explaining motion (what is the connection between force and motion)	Calculation of momentum from mass and velocity
P4.4 Explaining motion (how can we describe motion in terms of energy change)	Calculation of work done, energy and kinetic energy

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO2: Understand physical properties and electrical principles

Learners must be taught:

- **physical properties**
  - electrical power and energy
  - electrical values
    - potential difference (volt)
    - resistance (ohm)
    - current (amp)
  - Electro Motive Force (EMF)

- **electrical principles, ie**
  - Alternating and Direct current/voltage (AC and DC)
    - applications (power supplies)
    - reasons for choice
  - series and parallel circuits (lamps, bulbs and cells)
    - values for voltage, current, resistance and power using Ohm's law and power laws and measurement
  - operation of simple DC electromechanical devices, ie
    - motor
    - generator
    - relay

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

Calculation of electrical resistance and power
Calculate resistance and voltage
Understand how a motor and generator work

P4c Radiation for life (safe electrical)

Calculating resistance from voltage and current, calculating power from voltage and current

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO2: Understand physical properties and electrical principles

Learners must be taught:

- **physical properties**
  - electrical power and energy
  - electrical values
    - potential difference (volt)
    - resistance (ohm)
    - current (amp)
  - Electro Motive Force (EMF)

- **electrical principles, ie**
  - Alternating and Direct current/voltage (AC and DC)
    - applications (power supplies)
    - reasons for choice
  - series and parallel circuits (lamps, bulbs and cells)
    - values for voltage, current, resistance and power using Ohm's law and power laws and measurement
  - operation of simple DC electromechanical devices, ie
    - motor
    - generator
    - relay

Gateway Additional Science B 2012 J262 | **21st Century Science A 2012 J242**

Calculation of electrical resistance and power
Calculate resistance and voltage
Understand how a motor and generator work

P5.1, P5.2 Electric circuits	Understanding current and calculating power and resistance
P5.3 Electric circuits	Calculate value of resistors in series and parallel, and voltages in a potential divider
P5.4/P5.5 Electric circuits	Understand how motors and generators work

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO3: Understand physical properties and fluid power principles

Learners must be taught:

- **physical properties**
  - pressure/vacuum
  - flow
  - forces
  - compressibility

    fluid power principles, ie values for pressure, flow and force exerted, from calculation and measurement

- **operation, applications and symbols of simple fluid power system components, ie**
  - supply and storage (compressor; receiver)
  - cylinders/actuators (linear single acting; double acting)
  - valves (directional; reducing; regulating; non-return; 3/2 - 5/2; shuttle)

    control (push; lever; roller tip; solenoid)

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

None of the learning outcomes can be directly mapped for LO3.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO4: Know about the systems used to transmit power in engineering

Learners must be taught:

- **types of power sources used in engineering, ie**
  - mechanical
  - electrical
  - pneumatic
  - hydraulic
  - vacuum/atmospheric
- **applications and design of mechanical, electrical and fluid power, in engineering ie**
  - mechanical
  - electrical pneumatic
  - hydraulic
  - vacuum/atmospheric
- **applications and design of integrated power systems used in engineering, ie**
  - electro mechanical
  - electro pneumatic
  - hydro mechanical vacuum mechanical

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

None of the learning outcomes can be directly mapped for LO4.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO1: Understand physical properties and mechanical principles

Learners must be taught:

- **physical properties ie**
  - energy
    - forms (mechanical; electrical; chemical; light; sound; heat)
    - potential
    - kinetic
    - conversion
- **mechanical principles ie**
  - power, work and efficiency
    - mechanical advantage (levers; gears; pulleys)
    - forces and torque
    - mechanical efficiency
  - velocity and acceleration (m/s; m/s^2)
  - units and measurement
    - watt; joule; Nm; newton; gram; second; meter; pascal
- **mechanical principles using calculation of:**
  - levers (Class 1, 2 and 3)
  - pulleys and gears (simple and compound)
  - static and moving bodies

Gateway Physics B 2012 J265 | **21st Century Physics A 2012 J245**

Calculation of speed, acceleration, force, work, weight, potential and kinetic energy	P3a Forces for transport (speed)	Calculation of average speed of a moving object
	P3b Forces for transport (acceleration)	Calculation of acceleration of a moving object
	P3c Forces for transport (forces and motion)	Calculation of force from force = mass x acceleration
	P3d Forces for transport (work and power)	Calculation of work done and power
	P3e Forces for transport (energy on the move)	Understand kinetic energy
	P3f Forces for transport (crumple zones)	Calculate force using mass and acceleration
	P3h Forces for transport (the energy of games and theme rides)	Understand potential energy

Indirect mapping

Understands energy and its practical applications	Understand the application of energy (relating to mechanical systems) including insulation and its transfer by conduction, convection and radiation	Understand the application of energy (relating to mechanical systems) including insulation and its transfer by conduction, convection and radiation
Understand the applications of vectors to analyse objects in motion	Use equation of motion to show path of moving mechanical objects (eg moving bodies)	~~Use equation of motion to show path~~ of moving mechanical objects (eg moving bodies)

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO1: Understand physical properties and mechanical principles

Learners must be taught:

- **physical properties ie**
  - energy
    - forms (mechanical; electrical; chemical; light; sound; heat)
    - potential
    - kinetic
    - conversion
- **mechanical principles ie**
  - power, work and efficiency
    - mechanical advantage (levers; gears; pulleys)
    - forces and torque
    - mechanical efficiency
  - velocity and acceleration (m/s; m/s^2)
  - units and measurement
    - watt; joule; Nm; newton; gram; second; meter; pascal
- **mechanical principles using calculation of:**
  - levers (Class 1, 2 and 3)
  - pulleys and gears (simple and compound)
  - static and moving bodies

Gateway Physics B 2012 J265		21st Century Physics A 2012 J245
Calculation of speed, acceleration, force, work, weight, potential and kinetic energy	P4.1 Explaining motion	Calculation of average speed and acceleration of a moving object
	P4.1 Explaining motion	Understand the interaction of forces between to objects (eg levers)
	P4.3, P4.4 Explaining motion	Understand momentum and kinetic energy in mechanical systems

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO2: Understand physical properties and electrical principles

Learners must be taught:

- **physical properties**
  - electrical power and energy
  - electrical values
    - potential difference (volt)
    - resistance (ohm)
    - current (amp)
  - Electro Motive Force (EMF)
- **electrical principles, ie**
  - Alternating and Direct current/voltage (AC and DC)
    - applications (power supplies)
    - reasons for choice
  - series and parallel circuits (lamps, bulbs and cells)
    - values for voltage, current, resistance and power using Ohm's law and power laws and by measurement
- **operation of simple DC electromechanical devices, ie**
  - motor
  - generator
  - relay

Gateway Physics B 2012 J265		21st Century Physics A 2012 J245
Understand how electricity is generated	P2b Living for the future (Generating electricity)	Understand how electricity is generated using a generator and an energy source
The use of fuels for power, power and energy	P2d Living for the future (Fuels for power)	Calculation of power from voltage and current, also energy in kWh
Calculation of electrical resistance and power	P4c Radiation for life (resisting) P6a Electricity for gadgets (resisting)	Calculating resistance from voltage and current, calculating power from voltage and current
Calculate resistance and voltage	P6b Electricity for gadgets (sharing) P6e Electricity for gadgets (motoring)	Calculate value of resistors in series and parallel, and voltages in a potential divider
Understand how a motor and generator work	P6f Electricity for gadgets (generating)	Understand how electric motors and generators convert electrical energy to and from mechanical energy
Understand a.c. Electricity		

Indirect mapping

Understands energy and its practical applications	P2a Collecting energy from the sun	Understand the conversion of energy from the sun into electrical energy
	P6g Electricity for gadgets (transforming)	Understand how electrical transformers increase or decrease a.c. voltage

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO2: Understand physical properties and electrical principles

Learners must be taught:

- **physical properties**
  - electrical power and energy
  - electrical values
    - potential difference (volt)
    - resistance (ohm)
    - current (amp)
  - Electro Motive Force (EMF)
- **electrical principles, ie**
  - Alternating and Direct current/voltage (AC and DC)
    - applications (power supplies)
    - reasons for choice
  - series and parallel circuits (lamps, bulbs and cells)
    - values for voltage, current, resistance and power using Ohm's law and power laws and by measurement
- **operation of simple DC electromechanical devices, ie**
  - motor
  - generator
  - relay

Gateway Physics B 2012 J265		21st Century Physics A 2012 J245
Understand how electricity is generated	P3.2 Sustainable energy	Understand how electric generators produce mains electricity from energy sources
The use of fuels for power, power and energy	P3.1 Sustainable energy	Calculation of power from voltage and current, also energy in kWh
Calculation of electrical resistance and power	P5.1, P5.2 Electric circuits	Understanding current and calculating power and resistance
Calculate resistance and voltage	P5.3 Electric circuits	Calculate value of resistors in series and parallel, and voltages in a potential divider
Understand how a motor and generator work	P5.4/P5.5 Electric circuits	Understand how motors and generators work
Understand a.c. Electricity		Understand the frequency of waves in hertz (Hz) in relation to a.c. electricity

Indirect mapping

Understands energy and its practical applications	P3.3 Sustainable energy	Understand how energy sources are chosen to create electricity

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO3: Understand physical properties and fluid power principles

Learners must be taught:

- **physical properties ie**
  - pressure/vacuum
  - flow
  - forces
  - compressibility
- **fluid power principles, ie values for pressure, flow and force exerted, from calculation and measurement**
- **operation, applications and symbols of simple fluid power system components, ie**
  - supply and storage (compressor; receiver)
  - cylinders/actuators (linear single acting; double acting)
  - valves (directional; reducing; regulating; non-return; 3/2 - 5/2; shuttle)

    control (push; lever; roller tip; solenoid)

Gateway Physics B 2012 J265

21st Century Physics A 2012 J245

None of the learning outcomes can be directly mapped for LO3.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO4: Know about the systems used to transmit power in engineering

Learners must be taught:

- **types of power sources used in engineering, ie**
  - mechanical
  - electrical
  - pneumatic
  - hydraulic
  - vacuum/atmospheric
- **applications and design of mechanical, electrical and fluid power, in engineering ie**
  - mechanical
  - electrical pneumatic
  - hydraulic
  - vacuum/atmospheric
- **applications and design of integrated power systems used in engineering, ie**
  - electro mechanical
  - electro pneumatic
  - hydro mechanical vacuum mechanical

Gateway Physics B 2012 J265

21st Century Physics A 2012 J245

None of the learning outcomes can be directly mapped for LO4.

21st Century Physics A 2012 J245 – Indirect mapping

Understands energy and its practical applications	P1a Heating houses P1b Keeping homes warm	Understand the application of energy (relating to engineering system design) including insulation and its transfer by conduction, convection and radiation

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO1: Understand physical properties and mechanical principles

Learners must be taught:

- **physical properties ie**
  - energy
    - forms (mechanical; electrical; chemical; light; sound; heat)
    - potential
    - kinetic
    - conversion
- **mechanical principles ie**
  - power, work and efficiency
    - mechanical advantage (levers; gears; pulleys)
    - forces and torque
    - mechanical efficiency
  - velocity and acceleration (m/s; m/s^2)
  - units and measurement
    - watt; joule; Nm; newton; gram; second; meter; pascal
- **mechanical principles using calculation of:**
  - levers (Class 1, 2 and 3)
  - pulleys and gears (simple and compound)
  - static and moving bodies

Gateway Science B 2012 J261 | **21st Century Science A 2012 J241**

None of the learning outcomes can be directly mapped for LO1.

Gateway Science B 2012 J261 – Indirect mapping

Understands energy and its practical applications	P1a Heating houses P1b Keeping homes warm	Understand the application of energy (relating to mechanical systems) including insulation and its transfer by conduction, convection and radiation

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO2: Understand physical properties and electrical principles

Learners must be taught:

- **physical properties**
  - electrical power and energy
  - electrical values
    - potential difference (volt)
    - resistance (ohm)
    - current (amp)
  - Electro Motive Force (EMF)
- **electrical principles, ie**
  - Alternating and Direct current/voltage (AC and DC)
    - applications (power supplies)
    - reasons for choice
  - series and parallel circuits (lamps, bulbs and cells)
    - values for voltage, current, resistance and power using Ohm's law and power laws and by measurement
- **operation of simple DC electromechanical devices, ie**
  - motor
  - generator
  - relay

Gateway Science B 2012 J261		21st Century Science A 2012 J241
Understand how electricity is generated	P2b Generating electricity	Understand how electricity is generated using a generator
The use of fuels for power	P2d Fuels for power	Calculation of power from voltage and current, also energy in kWh

Indirect mapping

Understands energy and its practical applications	P2a Collecting energy from the sun	Understand the conversion of energy from the sun into electrical energy. Also energy from other renewable sources eg wind turbines

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO2: Understand physical properties and electrical principles

Learners must be taught:

- **physical properties**
  - electrical power and energy
  - electrical values
    - potential difference (volt)
    - resistance (ohm)
    - current (amp)
  - Electro Motive Force (EMF)
- **electrical principles, ie**
  - Alternating and Direct current/voltage (AC and DC)
    - applications (power supplies)
    - reasons for choice
  - series and parallel circuits (lamps, bulbs and cells)
    - values for voltage, current, resistance and power using Ohm's law and power laws and by measurement
- **operation of simple DC electromechanical devices, ie**
  - motor
  - generator
  - relay

Gateway Science B 2012 J261		21st Century Science A 2012 J241
Understand how electricity is generated	P3.1, P3.2 Sustainable energy	Understand how electricity is generated using a generator
The use of fuels for power		Calculation of power from voltage and current

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO3: Understand physical properties and fluid power principles

Learners must be taught:

- **physical properties**
  - pressure/vacuum
  - flow
  - forces
  - compressibility
- **fluid power principles, ie values for pressure, flow and force exerted, from calculation and measurement**
- **operation, applications and symbols of simple fluid power system components, ie**
  - supply and storage (compressor; receiver)
  - cylinders/actuators (linear single acting; double acting)
  - valves (directional; reducing; regulating; non-return; 3/2 - 5/2; shuttle)

    control (push; lever; roller tip; solenoid)

Gateway Science B 2012 J261

21st Century Science A 2012 J241

None of the learning outcomes can be directly mapped for LO3.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R101 Engineering principles

LO4: Know about the systems used to transmit power in engineering

Learners must be taught:

- **types of power sources used in engineering, ie**
  - mechanical
  - electrical
  - pneumatic
  - hydraulic
  - vacuum/atmospheric
- **applications and design of mechanical, electrical and fluid power, in engineering ie**
  - mechanical
  - electrical pneumatic
  - hydraulic
  - vacuum/atmospheric
- **applications and design of integrated power systems used in engineering, ie**
  - electro mechanical
  - electro pneumatic
  - hydro mechanical vacuum mechanical

Gateway Science B 2012 J261 | **21st Century Science A 2012 J241**

None of the learning outcomes can be directly mapped for LO4.

Gateway Science B 2012 J261 – Indirect mapping

Understands energy and its practical applications	P2a Collecting energy from the sun	Understand the conversion of energy from the sun into electrical energy. Also energy from other renewable sources eg wind turbines

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO1: Knows about engineering sectors, their products and services

Learners must be taught:

- **services and products of different sectors within engineering eg**
  - aerospace (eg aircraft; satellites; military equipment)
  - automotive (eg cars; motor bikes; trucks; bus; agricultural; plant)
  - electronics (eg communication; systems control; information technology)
  - marine (eg commercial ships; military vessels; coastal services)
  - rail (eg passenger trains; freight transport; rail network)
  - metals (eg mining; processing; metals recovery)
  - chemical (eg industrial; domestic; medical; polymers; paints)
  - process (eg food; textiles; electrical goods)
  - civil (eg construction; roads/bridges; rail networks)
  - medical (eg pharmaceuticals; bio; orthopaedic; prosthetics)
  - utilities (eg electricity; gas, water, communication)

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial, Bronze, Silver and Gold

None of the learning outcomes can be directly mapped for LO1.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO2: Understand how engineering companies operate

Learners must be taught:

- **characteristics of engineering companies, ie**
  - size (eg micro; SME; large)
  - structure (eg flat; hierarchy; pyramid)
  - functions (eg HR; sales; marketing; production; finance)
  - scope of operation (eg local; national; global)
- **relationships within the engineering market place, ie**
  - competitors in the same engineering market
  - suppliers, and supply chain companies working together
  - partners working in the same engineering market

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial, Bronze, Silver and Gold

None of the learning outcomes can be directly mapped for LO2.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO3: Know about employment in engineering

Learners must be taught:

- **sources of engineering careers information available to young people (eg internet; careers fairs; information, advice and guidance services; apprenticeship services)**
- **career opportunities within engineering business functions, ie**
  - research and design (eg design engineer; material scientist)
  - manufacture (eg technician; production engineer; quality engineer)
  - maintenance (eg service engineer)
  - purchasing (eg procurement; quality engineer)
  - sales and marketing (eg technical representative)
- **entry routes for employment in engineering, ie**
  - trainee programmes
  - apprenticeships
  - graduate programmes
- **employee/employer rights and responsibilities, ie**
  - health and safety
  - equality
  - representative bodies (eg unions; trade bodies; Health & Safety Executive)
- **role of the Engineering Council and its member institutions (eg sector skills councils; professional body organisations; training councils)**

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial, Bronze, Silver and Gold

None of the learning outcomes can be directly mapped for LO3.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO4: Understand innovation and technical advances in engineering

Learners must be taught:

- **applications of recent engineering innovation and technical advances, eg**
  - satellites (eg GPS; telecommunications)
  - internet (eg fibre optics; global manufacturing)
  - fuel efficiency (eg aircraft; cars)
  - energy resources for the future (eg solar; wind; fusion/fission)
  - developments in materials technology (eg nanotechnology; composites; recycling)
  - microprocessor technology (eg smart phones; micros in everyday products)
  - medical engineering (eg artificial limbs; joints and organs)
- **impact of innovation and technical advances in respect of, ie**
  - materials/resources
  - design and production methods
  - sustainability of processes
  - product efficiency
  - costs to producers and users of products

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial, Bronze, Silver and Gold

None of the learning outcomes can be directly mapped for LO4.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO1: Knows about engineering sectors, their products and services

Learners must be taught:

- **services and products of different sectors within engineering eg**
  - aerospace (eg aircraft; satellites; military equipment)
  - automotive (eg cars; motor bikes; trucks; bus; agricultural; plant)
  - electronics (eg communication; systems control; information technology)
  - marine (eg commercial ships; military vessels; coastal services)
  - rail (eg passenger trains; freight transport; rail network)
  - metals (eg mining; processing; metals recovery)
  - chemical (eg industrial; domestic; medical; polymers; paints)
  - process (eg food; textiles; electrical goods)
  - civil (eg construction; roads/bridges; rail networks)
  - medical (eg pharmaceuticals; bio; orthopaedic; prosthetics)
  - utilities (eg electricity; gas, water, communication)

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

None of the learning outcomes can be directly mapped for LO1.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO2: Understand how engineering companies operate

Learners must be taught:

- **characteristics of engineering companies, ie**
  - size (eg micro; SME; large)
  - structure (eg flat; hierarchy; pyramid)
  - functions (eg HR; sales; marketing; production; finance)
  - scope of operation (eg local; national; global)
- **relationships within the engineering market place, ie**
  - competitors in the same engineering market
  - suppliers, and supply chain companies working together
  - partners working in the same engineering market

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

None of the learning outcomes can be directly mapped for LO2.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO3: Know about employment in engineering

Learners must be taught:

- **sources of engineering careers information available to young people (eg internet; careers fairs; information, advice and guidance services; apprenticeship services)**
- **career opportunities within engineering business functions, ie**
  - research and design (eg design engineer; material scientist)
  - manufacture (eg technician; production engineer; quality engineer)
  - maintenance (eg service engineer)
  - purchasing (eg procurement; quality engineer)
  - sales and marketing (eg technical representative)
- **entry routes for employment in engineering, ie**
  - trainee programmes
  - apprenticeships
  - graduate programmes
- **employee/employer rights and responsibilities, ie**
  - health and safety
  - equality
  - representative bodies (eg unions; trade bodies; Health and Safety Executive)
- **role of the Engineering Council and its member institutions (eg sector skills councils; professional body organisations; training councils)**

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

None of the learning outcomes can be directly mapped for LO3.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO4: Understand innovation and technical advances in engineering

Learners must be taught:

- **applications of recent engineering innovation and technical advances, eg**
  - satellites (eg GPS; telecommunications)
  - internet (eg fibre optics; global manufacturing)
  - fuel efficiency (eg aircraft; cars)
  - energy resources for the future (eg solar; wind; fusion/fission)
  - developments in materials technology (eg nanotechnology; composites; recycling)
  - microprocessor technology (eg smart phones; micros in everyday products)
  - medical engineering (eg artificial limbs; joints and organs)
- **impact of innovation and technical advances in respect of, ie**
  - materials/resources
  - design and production methods
  - sustainability of processes
  - product efficiency
  - costs to producers and users of products

Gateway Additional Science B 2012 J262		21st Century Science A 2012 J242
Nanotechnology	C4g The Periodic Table (metal structure and properties)	Understand why materials such as iron is used to make bridges, and copper is used to make electrical conductors
Superconductors	C4g The Periodic Table (metal structure and properties)	Understand what a superconductor is, and its engineering applications
Electrostatics	P4b Radiation for life (electrostatics)	Research how electrostatics are used in medical devices (eg defibrillators), in reducing pollution (eg precipitators) and in manufacture (eg paint spraying)
Understand how medical engineering innovations can be used for diagnosis and treatment	P4h Radiation for life (ultrasonic) P4g Radiation for life (treatment)	Understand how medical engineering innovations in the application of ultrasonic and x-rays can be used for medical diagnosis and treatment

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO4: Understand innovation and technical advances in engineering

Learners must be taught:

- **applications of recent engineering innovation and technical advances, eg**
  - satellites (eg GPS; telecommunications)
  - internet (eg fibre optics; global manufacturing)
  - fuel efficiency (eg aircraft; cars)
  - energy resources for the future (eg solar; wind; fusion/fission)
  - developments in materials technology (eg nanotechnology; composites; recycling)
  - microprocessor technology (eg smart phones; micros in everyday products)
  - medical engineering (eg artificial limbs; joints and organs)
- **impact of innovation and technical advances in respect of, ie**
  - materials/resources
  - design and production methods
  - sustainability of processes
  - product efficiency
  - costs to producers and users of products

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

For 21st Century Science A J242 none of the learning outcomes can be directly mapped for LO4.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO1: Knows about engineering sectors, their products and services

Learners must be taught:

- **services and products of different sectors within engineering eg**
  - aerospace (eg aircraft; satellites; military equipment)
  - automotive (eg cars; motor bikes; trucks; bus; agricultural; plant)
  - electronics (eg communication; systems control; information technology)
  - marine (eg commercial ships; military vessels; coastal services)
  - rail (eg passenger trains; freight transport; rail network)
  - metals (eg mining; processing; metals recovery)
  - chemical (eg industrial; domestic; medical; polymers; paints)
  - process (eg food; textiles; electrical goods)
  - civil (eg construction; roads/bridges; rail networks)
  - medical (eg pharmaceuticals; bio; orthopaedic; prosthetics)
  - utilities (eg electricity; gas, water, communication)

Gateway Physics B 2012 J265

21st Century Physics A 2012 J245

None of the learning outcomes can be directly mapped for LO1.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO2: Understand how engineering companies operate

Learners must be taught:

- **characteristics of engineering companies, ie**
  - size (eg micro; SME; large)
  - structure (eg flat; hierarchy; pyramid)
  - functions (eg HR; sales; marketing; production; finance)
  - scope of operation (eg local; national; global)
- **relationships within the engineering market place, ie**
  - competitors in the same engineering market
  - suppliers, and supply chain companies working together
  - partners working in the same engineering market

Gateway Physics B 2012 J265

21st Century Physics A 2012 J245

None of the learning outcomes can be directly mapped for LO2.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO3: Know about employment in engineering

Learners must be taught:

- **sources of engineering careers information available to young people (eg internet; careers fairs; information, advice and guidance services; apprenticeship services)**
- **career opportunities within engineering business functions, ie**
  - research and design (eg design engineer; material scientist)
  - manufacture (eg technician; production engineer; quality engineer)
  - maintenance (eg service engineer)
  - purchasing (eg procurement; quality engineer)
  - sales and marketing (eg technical representative)
- **entry routes for employment in engineering, ie**
  - trainee programmes
  - apprenticeships
  - graduate programmes
- **employee/employer rights and responsibilities, ie**
  - health and safety
  - equality
  - representative bodies (eg unions; trade bodies; Health and Safety Executive)
- **role of the Engineering Council and its member institutions (eg sector skills councils; professional body organisations; training councils)**

Gateway Physics B 2012 J265

21st Century Physics A 2012 J245

None of the learning outcomes can be directly mapped for LO3.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO4: Understand innovation and technical advances in engineering

Learners must be taught:

- **applications of recent engineering innovation and technical advances, eg**
  - satellites (eg GPS; telecommunications)
  - internet (eg fibre optics; global manufacturing)
  - fuel efficiency (eg aircraft; cars)
  - energy resources for the future (eg solar; wind; fusion/fission)
  - developments in materials technology (eg nanotechnology; composites; recycling)
  - microprocessor technology (eg smart phones; micros in everyday products)
  - medical engineering (eg artificial limbs; joints and organs)
- **impact of innovation and technical advances in respect of, ie**
  - materials/resources
  - design and production methods
  - sustainability of processes
  - product efficiency
  - costs to producers and users of products

Gateway Physics B 2012 J265		21st Century Physics A 2012 J245
Understand how optics, light, lasers and radiation can be used in engineering innovations	P1c, P1d , P1e Energy for the home	Understand optics (eg telescopes) Understand how light and lasers are used in communication (eg fibre optics, DVD player)
Understand how radiation can be used to transmit data including wireless signals	P1f, P1g Energy in the home	Understand applications of electromagnetic waves (eg toaster, microwave oven, mobile phone)
Understand how medical engineering innovations can be used for treatment	P4g Radiation for life (treatment)	Understand innovative applications of data transmission (eg remote control, television, radio, mobile phone, wireless internet)
Understand how nuclear energy can be used to generate electricity	P4h Radiation for life (fission and fusion)	Understand how medical engineering innovations in the application of x-rays can be used for medical diagnosis and treatment
Understand applications of man-made satellites	P5a Space for reflection (satellites, gravity and circular motion) P5e Space for reflection (satellite communication)	Understand the applications of man-made satellites (eg communication, GPS, International Space Station)
Understand how waves are used in engineering	P5g Space for refraction (reflection of waves)	Understand how optical waves are used in engineering innovations (eg optical fibres, cat's eye reflectors)

Gateway Physics B 2012 J265 – Indirect mapping

Understand the perceived dangers associated with engineered technological advances	P1e Energy in the home	Understand the conflicting evidence of the risks associated with mobile phones and phone masts

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO4: Understand innovation and technical advances in engineering

Learners must be taught:

- **applications of recent engineering innovation and technical advances, eg**
  - satellites (eg GPS; telecommunications)
  - internet (eg fibre optics; global manufacturing)
  - fuel efficiency (eg aircraft; cars)
  - energy resources for the future (eg solar; wind; fusion/fission)
  - developments in materials technology (eg nanotechnology; composites; recycling)
  - microprocessor technology (eg smart phones; micros in everyday products)
  - medical engineering (eg artificial limbs; joints and organs)
- **impact of innovation and technical advances in respect of, ie**
  - materials/resources
  - design and production methods
  - sustainability of processes
  - product efficiency
  - costs to producers and users of products

Gateway Physics B 2012 J265		21st Century Physics A 2012 J245
Understand how optics, light, lasers and radiation can be used in engineering innovations	P2.2 Radiation and life	Understand how innovations in the application of x-rays can be used for medical diagnosis and treatment and for detecting objects
Understand how radiation can be used to transmit data including wireless signals	P2.4 Radiation and life	Understand how electromagnetic waves are used in communication (eg television, radio)
Understand how medical engineering innovations can be used for treatment	P6.2 Radioactive materials	Understand how radiation can be used in engineering innovations (eg medical treatment, electrical energy generation)
Understand how nuclear energy can be used to generate electricity		
Understand applications of man-made satellites		
Understand how waves are used in engineering		

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO1: Knows about engineering sectors, their products and services

Learners must be taught:

- **services and products of different sectors within engineering eg**
  - aerospace (e.g. aircraft; satellites; military equipment)
  - automotive (e.g. cars; motor bikes; trucks; bus; agricultural; plant)
  - electronics (e.g. communication; systems control; information technology)
  - marine (e.g. commercial ships; military vessels; coastal services)
  - rail (e.g. passenger trains; freight transport; rail network)
  - metals (e.g. mining; processing; metals recovery)
  - chemical (e.g. industrial; domestic; medical; polymers; paints)
  - process (e.g. food; textiles; electrical goods)
  - civil (e.g. construction; roads/bridges; rail networks)
  - medical (e.g. pharmaceuticals; bio; orthopaedic; prosthetics)
  - utilities (e.g. electricity; gas, water, communication)

Gateway Science B 2012 J261 | **21st Century Science A 2012 J241**

None of the learning outcomes can be directly mapped for LO1.

21st Century Science A 2012 J241 – Indirect mapping

Examples of industrial sectors used to support engineering	C1a Making crude oil useful C1b Using carbon fuels C1d Making polymers C1e Designer polymers	Examples of industrial processes relating to the application of natural and man-made materials e.g. chemical industry and poltmers
	C2b Construction materials C2c Metals and alloys C2d Making cars	Examples of processes relating to the extraction and creation of materials e.g. mining and metal recovery
	P2a Collecting energy from the sun P2b Generating electricity P2c Global warming P2d Fuels for power P2e Nuclear radiations	Examples of generation of electricity e.g. utilities

21st Century Science A 2012 J241 – Indirect mapping

Examples of industrial sectors used to support engineering	C3.1 Chemicals in our lives - risks and benefits	Examples of how chemical industries have developed including their geographical location near natural resources

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO2: Understand how engineering companies operate

Learners must be taught:

- **characteristics of engineering companies, ie**
  - size (e.g. micro; SME; large)
  - structure (e.g. flat; hierarchy; pyramid)
  - functions (e.g. HR; sales; marketing; production; finance)
  - scope of operation (e.g. local; national; global)
- **relationships within the engineering market place, ie**
  - competitors in the same engineering market
  - suppliers, and supply chain companies working together
  - partners working in the same engineering market

Gateway Science B 2012 J261

21st Century Science A 2012 J241

None of the learning outcomes can be directly mapped for LO2.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO3: Know about employment in engineering

Learners must be taught:

- **sources of engineering careers information available to young people (e.g. internet; careers fairs; information, advice and guidance services; apprenticeship services)**
- **career opportunities within engineering business functions, ie**
  - research and design (e.g. design engineer; material scientist)
  - manufacture (e.g. technician; production engineer; quality engineer)
  - maintenance (e.g. service engineer)
  - purchasing (e.g. procurement; quality engineer)
  - sales and marketing (e.g. technical representative)
- **entry routes for employment in engineering, ie**
  - trainee programmes
  - apprenticeships
  - graduate programmes
- **employee/employer rights and responsibilities, ie**
  - health and safety
  - equality
  - representative bodies (e.g. unions; trade bodies; Health and Safety Executive)
- **role of the Engineering Council and its member institutions (e.g. sector skills councils; professional body organisations; training councils)**

Gateway Science B 2012 J261

21st Century Science A 2012 J241

None of the learning outcomes can be directly mapped for LO3.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO4: Understand innovation and technical advances in engineering

Learners must be taught:

- **applications of recent engineering innovation and technical advances, eg**
  - satellites (e.g. GPS; telecommunications)
  - internet (e.g. fibre optics; global manufacturing)
  - fuel efficiency (e.g. aircraft; cars)
  - energy resources for the future (e.g. solar; wind; fusion/fission)
  - developments in materials technology (e.g. nanotechnology; composites; recycling)
  - microprocessor technology (e.g. smart phones; micros in everyday products)
  - medical engineering (e.g. artificial limbs; joints and organs)
- **impact of innovation and technical advances in respect of, ie**
  - materials/resources
  - design and production methods
  - sustainability of processes
  - product efficiency
  - costs to producers and users of products

Gateway Science B 2012 J261		21st Century Science A 2012 J241
Understand the application of data transmission (including wireless signals) in modern technological engineering innovations	P1f Data transmission P1g Wireless signals	Understand the application of data and wireless transmission e.g. Mobile phones, sat nav, internet
Understand energy resources	P2a Collecting energy from the sun P2b Generating electricity P2c Global warming P2d Fuels for power P2e Nuclear radiations	Understand the use of natural resources for the generation of energy e.g. solar, wind, fossil fuels, nuclear and their implications

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO4: Understand innovation and technical advances in engineering

Learners must be taught:

- **applications of recent engineering innovation and technical advances, eg**
  - satellites (e.g. GPS; telecommunications)
  - internet (e.g. fibre optics; global manufacturing)
  - fuel efficiency (e.g. aircraft; cars)
  - energy resources for the future (e.g. solar; wind; fusion/fission)
  - developments in materials technology (e.g. nanotechnology; composites; recycling)
  - microprocessor technology (e.g. smart phones; micros in everyday products)
  - medical engineering (e.g. artificial limbs; joints and organs)
- **impact of innovation and technical advances in respect of, ie**
  - materials/resources
  - design and production methods
  - sustainability of processes
  - product efficiency
  - costs to producers and users of products

Gateway Science B 2012 J261		21st Century Science A 2012 J241
Understand the application of data transmission (including wireless signals) in modern technological engineering innovations	C2.3, C2.4 Materials choices	Understand the applications of plastics and nanotechnology in engineered products
Understand energy resources	P2.4 Radiation and life	Understand the application of electromagnetic waves used in communication e.g. mobile phone, radio, television

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO1: Researching sectors, products, services

Searching for and presenting information [Direct]

ICT: J800/J810/J820

R001 (M) LO1: Understand how ICT can be used to meet business needs	Use ICT to search for and present information about engineering sectors, products and services
R002 (M) LO1: Be able to use techniques to search for, store and share information	

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO2: Researching companies

Searching for and presenting information [Direct]

ICT: J800/J810/J820

R001 (M) LO1: Understand how ICT can be used to meet business needs	Use ICT to search for and present information on engineering companies, their structure, size and how they operate
R002 (M) LO1: Be able to use techniques to search for, store and share information	

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO3: Sources of careers: internet Researching info: health and safety, engineering council

Searching for and presenting information [Direct]

ICT: J800/J810/J820

R001 (M) LO1: Understand how ICT can be used to meet business needs	Use ICT to search for and present information relating to careers in engineering, including employer/employee responsibilities and the Engineering Council
R002 (M) LO1: Be able to use techniques to search for, store and share information	

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R102 The engineered business world

LO4: Researching innovations/technical advances

Searching for and presenting information [Direct]

ICT: J800/J810/J820

R001 (M) LO1: Understand how ICT can be used to meet business needs	Use ICT to search for and present information relating to technical advances and innovations in engineering
R002 (M) LO1: Be able to use techniques to search for, store and share information	

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO1: Know about the sustainability of engineering materials and products

Learners must be taught:

- **the types of materials used in engineered products ie**
  - metals (eg ferrous metals and alloys, non-ferrous metals and alloys)
  - polymeric (eg thermoplastic plastics; thermoset plastics; elastomers)
  - ceramics (eg glasses; glass ceramics; graphite; diamond)
  - composites (eg reinforced plastics; metal-matrix composites; ceramicmatrix composites; sandwich structures; concrete)
- **sustainability of the types of materials used in engineered products ie**
  - reusable/recyclable (eg aluminium; thermoplastic plastics)
  - finite resource (eg Helium; rare metals/fossil fuel)
- **environmental considerations affecting the sustainability of engineered products ie**
  - repairable (eg fix items torn or broken)
  - reusable (eg resold – redesigned)
  - recyclable (eg re-making a product into something else)
  - reduce (eg number of bought items)
  - rethink (eg using fair trade practices - energy used)
  - renewable (eg cotton, wood, oil seed rape)

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial, Bronze, Silver, Gold

None of the learning outcomes can be directly mapped for LO1.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO2: Know about sustainable design for engineering products

Learners must be taught:

- **considerations for the sustainable design of engineered products ie**
  - material selection (eg finite resources)
  - energy used to manufacture (eg lean manufacturing processes)
  - product life cycle (eg introduce; growth; maturity; decline).
  - design for obsolescence (eg mobile phone)
  - design for maintenance (eg motor vehicle)
  - environmental (eg energy the product consumes; carbon footprint of product; end of life disposal).

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial, Bronze, Silver, Gold

None of the learning outcomes can be directly mapped for LO2.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO3: Understand the impact of global manufacturing

Learners must be taught:

- **impact of global manufacturing on sustainability of engineered products ie**
  - production (eg labour markets; fair trade; materials supply)
  - transportation and distribution (eg cost; time; carbon footprint)
  - materials (eg sustainable; finite resources)
  - finance (eg local labour cost, access to materials)
  - ethical procurement (eg fair trade; labour exploitation)
  - environmental (eg location; materials; transport; pollution).

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial, Bronze, Silver, Gold

None of the learning outcomes can be directly mapped for LO3.

Foundation Initial, Bronze, Silver – Indirect mapping

Construct and use graphs to interpret data eg Labour, transport and material costs

Foundation Initial – Indirect mapping

FIA5 Construct and interpret simple graphs, including conversion graphs.

Plot and interpret cost or material usage chart, plot graph of transport time and cost etc.

Foundation Bronze – Indirect mapping

FBS3 Construct and interpret pie charts.

FBS4 Interpret graphs representing real data, including recognising misleading diagrams.

Plot and interpret cost or material usage chart, plot graph of transport time and cost etc. Plot and interpret pie charts

Foundation Gold – Indirect mapping

FGN4 Use percentages to compare proportion. Use and find percentage change.

FGN5 Check solutions to calculations using various methods including approximating, using inverse operations and recognising the effect of multiplying and dividing by numbers less than one and greater than one.

Estimate answers using appropriate techniques.

Use percentages to compare change eg distribution time vs transport cost, labour costs vs. production rates
Estimate answers using approximation eg labour and transportation costs for engineered products

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO1: Know about the sustainability of engineering materials and products

Learners must be taught:

- **the types of materials used in engineered products ie**
  - metals (eg ferrous metals and alloys, non-ferrous metals and alloys)
  - polymeric (eg thermoplastic plastics; thermoset plastics; elastomers)
  - ceramics (eg glasses; glass ceramics; graphite; diamond)
  - composites (eg reinforced plastics; metal-matrix composites; ceramicmatrix composites; sandwich structures; concrete)
- **sustainability of the types of materials used in engineered products ie**
  - reusable/recyclable (eg aluminium; thermoplastic plastics)
  - finite resource (eg Helium; rare metals/fossil fuel)
- **environmental considerations affecting the sustainability of engineered products ie**
  - repairable (eg fix items torn or broken)
  - reusable (eg resold – redesigned)
  - recyclable (eg re-making a product into something else)
  - reduce (eg number of bought items)
  - rethink (eg using fair trade practices - energy used)
  - renewable (eg cotton, wood, oil seed rape).

Gateway Additional Science B 2012 J262 | **21st Century Science A 2012 J242**

Carbon and nanochemistry	C3h Chemical economics (allotropes of carbon and nanochemistry)	Appreciate how carbon and nanotubes are used in engineering applications (eg tennis rackets, semiconductors, lubricants)
Metal structures	C4g The Periodic Table (metal structure and properties)	Understand why materials such as iron is used to make bridges, and copper is used to make electrical conductors
Superconductors	C4g The Periodic Table (metal structure and properties)	Understand what a superconductor is, and its engineering applications

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO1: Know about the sustainability of engineering materials and products

Learners must be taught:

- **the types of materials used in engineered products ie**
  - metals (eg ferrous metals and alloys, non-ferrous metals and alloys)
  - polymeric (eg thermoplastic plastics; thermoset plastics; elastomers)
  - ceramics (eg glasses; glass ceramics; graphite; diamond)
  - composites (eg reinforced plastics; metal-matrix composites; ceramicmatrix composites; sandwich structures; concrete)
- **sustainability of the types of materials used in engineered products ie**
  - reusable/recyclable (eg aluminium; thermoplastic plastics)
  - finite resource (eg Helium; rare metals/fossil fuel)
- **environmental considerations affecting the sustainability of engineered products ie**
  - repairable (eg fix items torn or broken)
  - reusable (eg resold – redesigned)
  - recyclable (eg re-making a product into something else)
  - reduce (eg number of bought items)
  - rethink (eg using fair trade practices - energy used)
  - renewable (eg cotton, wood, oil seed rape).

Gateway Additional Science B 2012 J262		21st Century Science A 2012 J242
Carbon and nanochemistry		
Metal structures	C5.4 Chemicals of the natural environment (how we can extract useful metals from minerals)	Understand how metals can be extracted from rocks and minerals (eg copper, iron, aluminium) and the properties of these metals
Superconductors		

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO2: Know about sustainable design for engineering products

Learners must be taught:

- **considerations for the sustainable design of engineered products ie**
  - material selection (eg finite resources)
  - energy used to manufacture (eg lean manufacturing processes)
  - product life cycle (eg introduce; growth; maturity; decline).
  - design for obsolescence (eg mobile phone)
  - design for maintenance (eg motor vehicle)
  - environmental (eg energy the product consumes; carbon footprint of product; end of life disposal).

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

None of the learning outcomes can be directly mapped for LO2.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO3: Understand the impact of global manufacturing

Learners must be taught:

- **impact of global manufacturing on sustainability of engineered products ie**
  - production (eg labour markets; fair trade; materials supply)
  - transportation and distribution (eg cost; time; carbon footprint)
  - materials (eg sustainable; finite resources)
  - finance (eg local labour cost, access to materials)
  - ethical procurement (eg fair trade; labour exploitation)
  - environmental (eg location; materials; transport; pollution).

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

None of the learning outcomes can be directly mapped for LO3.

Gateway Additional Science B 2012 J262 – Indirect mapping

The use of radiation to provide clean manufacturing	P4b Radiation for life (electrostatics)	Understand the use of electrostatics to reduce pollution (eg in dust or smoke precipitators (chimneys)

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO1: Know about the sustainability of engineering materials and products

Learners must be taught:

- **the types of materials used in engineered products ie**
  - metals (eg ferrous metals and alloys, non-ferrous metals and alloys)
  - polymeric (eg thermoplastic plastics; thermoset plastics; elastomers)
  - ceramics (eg glasses; glass ceramics; graphite; diamond)
  - composites (eg reinforced plastics; metal-matrix composites; ceramicmatrix composites; sandwich structures; concrete)
- **sustainability of the types of materials used in engineered products ie**
  - reusable/recyclable (eg aluminium; thermoplastic plastics)
  - finite resource (eg Helium; rare metals/fossil fuel)
- **environmental considerations affecting the sustainability of engineered products ie**
  - repairable (eg fix items torn or broken)
  - reusable (eg resold – redesigned)
  - recyclable (eg re-making a product into something else)
  - reduce (eg number of bought items)
  - rethink (eg using fair trade practices - energy used)
  - renewable (eg cotton, wood, oil seed rape).

Gateway Physics B 2012 J265

21st Century Physics A 2012 J245

None of the learning outcomes can be directly mapped for LO1.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO2: Know about sustainable design for engineering products

Learners must be taught:

- **considerations for the sustainable design of engineered products ie**
  - material selection (eg finite resources)
  - energy used to manufacture (eg lean manufacturing processes)
  - product life cycle (eg introduce; growth; maturity; decline).
  - design for obsolescence (eg mobile phone)
  - design for maintenance (eg motor vehicle)
  - environmental (eg energy the product consumes; carbon footprint of product; end of life disposal).

Gateway Physics B 2012 J265

21st Century Physics A 2012 J245

None of the learning outcomes can be directly mapped for LO2.

Gateway Physics B 2012 J265 – Indirect mapping

The creation of pollutants in the disposal of engineered products	P1h Stable earth	Understand how CFCs created through disposal have affected the environment

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO3: Understand the impact of global manufacturing

Learners must be taught:

- **impact of global manufacturing on sustainability of engineered products ie**
  - production (eg labour markets; fair trade; materials supply)
  - transportation and distribution (eg cost; time; carbon footprint)
  - materials (eg sustainable; finite resources)
  - finance (eg local labour cost, access to materials)
  - ethical procurement (eg fair trade; labour exploitation)
  - environmental (eg location; materials; transport; pollution).

Gateway Physics B 2012 J265 | **21st Century Physics A 2012 J245**

None of the learning outcomes can be directly mapped for LO3.

Gateway Physics B 2012 J265 – Indirect mapping

The creation of pollutants in the manufacture and transportation of engineered products	P1h Stable earth	Understand how CFCs generated through manufacture have affected the environment.
The creation and use of energy in the manufacture and transportation of engineered products	P2a, P2b, P2c, P2d, P2e Living for the future (energy resources)	Understand the use of natural resources for the generation of energy used in the manufacture and transportation of engineered products eg solar, wind, fossil fuels, nuclear and their implications
The use of radiation to provide clean manufacturing	P44b Radiation for life (electrostatics)	Understand the use of electrostatics to reduce pollution (eg in dust or smoke precipitators (chimneys)

21st Century Physics A 2012 J245 – Indirect mapping

The creation of pollutants in the manufacture and transportation of engineered products	P2.3 Radiation and life	Understand how manufacture and transportation of engineered products might contribute to global warming
The creation and use of energy in the manufacture and transportation of engineered products		Understand the use of natural resources for the generation of energy used in the manufacture and transportation of engineered products eg solar, wind, fossil fuels, nuclear and their implications

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO1: Know about the sustainability of engineering materials and products

Learners must be taught:

- **the types of materials used in engineered products ie**
  - metals (eg ferrous metals and alloys, non-ferrous metals and alloys)
  - polymeric (eg thermoplastic plastics; thermoset plastics; elastomers)
  - ceramics (eg glasses; glass ceramics; graphite; diamond)
  - composites (eg reinforced plastics; metal-matrix composites; ceramicmatrix composites; sandwich structures; concrete)
- **sustainability of the types of materials used in engineered products ie**
  - reusable/recyclable (eg aluminium; thermoplastic plastics)
  - finite resource (eg Helium; rare metals/fossil fuel)
- **environmental considerations affecting the sustainability of engineered products ie**
  - repairable (eg fix items torn or broken)
  - reusable (eg resold – redesigned)
  - recyclable (eg re-making a product into something else)
  - reduce (eg number of bought items)
  - rethink (eg using fair trade practices - energy used)
  - renewable (eg cotton, wood, oil seed rape).

Gateway Science B 2012 J261		21st Century Science A 2012 J241
Understand the molecular composition , properties and application of designer polymers in engineering products	C1e Designer polymers	Understand designer polymeers and their applications in engineering products
Relationship between Earth's crust and natural materials used in engineering eg aluminium, iron ore, brick, clay, glass and sand	C2b Construction materials	Understand the application of natural materials in the design and construction of engineered products
Understand the application of metals in engineering product construction and manufacture eg copper, steel, alloys	C2c Metals and alloys	Understand the application of metals and alloys eg copper for electrical wires, solder for electrical joints

Gateway Science B 2012 J261 – Indirect mapping

Making polymers and understanding their molecular composition , properties and application in engineering products	C1d Making polymers	Understand the molecular construction of polymers

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO1: Know about the sustainability of engineering materials and products

Learners must be taught:

- **the types of materials used in engineered products ie**
  - metals (eg ferrous metals and alloys, non-ferrous metals and alloys)
  - polymeric (eg thermoplastic plastics; thermoset plastics; elastomers)
  - ceramics (eg glasses; glass ceramics; graphite; diamond)
  - composites (eg reinforced plastics; metal-matrix composites; ceramicmatrix composites; sandwich structures; concrete)
- **sustainability of the types of materials used in engineered products ie**
  - reusable/recyclable (eg aluminium; thermoplastic plastics)
  - finite resource (eg Helium; rare metals/fossil fuel)
- **environmental considerations affecting the sustainability of engineered products ie**
  - repairable (eg fix items torn or broken)
  - reusable (eg resold – redesigned)
  - recyclable (eg re-making a product into something else)
  - reduce (eg number of bought items)
  - rethink (eg using fair trade practices - energy used)
  - renewable (eg cotton, wood, oil seed rape).

Gateway Science B 2012 J261		21st Century Science A 2012 J241
Understand the molecular composition , properties and application of designer polymers in engineering products	C2.1 , C2.2, C2.3, C2.4 Material choices	Understand the properties of materials eg plastics, rubber, fibres Understand the derivation of materials used in engineering from natural sources, including raw materials Understand the manufacture and application of plastics and nanotechnology

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO2: Know about sustainable design for engineering products

Learners must be taught:

- **considerations for the sustainable design of engineered products ie**
  - material selection (eg finite resources)
  - energy used to manufacture (eg lean manufacturing processes)
  - product life cycle (eg introduce; growth; maturity; decline).
  - design for obsolescence (eg mobile phone)
  - design for maintenance (eg motor vehicle)
  - environmental (eg energy the product consumes; carbon footprint of product; end of life disposal).

Gateway Science B 2012 J261

21st Century Science A 2012 J241

Correct selection and application of materials to give extended product life. Design for disposal.	C2d Making cars	Design of engineered products (eg the car) for extended life and disposal through correct selection and application of materials

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO2: Know about sustainable design for engineering products

Learners must be taught:

- **considerations for the sustainable design of engineered products ie**
  - material selection (eg finite resources)
  - energy used to manufacture (eg lean manufacturing processes)
  - product life cycle (eg introduce; growth; maturity; decline).
  - design for obsolescence (eg mobile phone)
  - design for maintenance (eg motor vehicle)
  - environmental (eg energy the product consumes; carbon footprint of product; end of life disposal).

Gateway Science B 2012 J261		21st Century Science A 2012 J241
Correct selection and application of materials to give extended product life. Design for disposal.	C3.1 Chemicals in our lives - risks and benefits	Appreciate the reason for materials selection in engineered products and its relationship to lfe cycle assessment (LCA)

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO3: Understand the impact of global manufacturing

Learners must be taught:

- **impact of global manufacturing on sustainability of engineered products ie**
  - production (eg labour markets; fair trade; materials supply)

Gateway Science B 2012 J261		21st Century Science A 2012 J241
Use of natural fuels and their derivatives in manufacturing and transporting engineered products, including their global impact	C1a Making crude oil useful C1b Using carbon fuels	Use of crude oil and its derivatives in the manufacture and transportation of engineering products
	C1c Clean air	Understand pollutants created by manufacturing processes and transportation and their global impact
Understand the implications of using polymers for engineering products in terms of their disposal	C1e Designer polymers	Understand the implications for the disposal of products made from polymers
Understand the implication for using natural resources	C2b Construction materials C2c Metals and Alloys	Understand the implications for the use and disposal of natural resources in the manufacture of engineering products

Gateway Science B 2012 J261 – Indirect mapping

The creation and use of energy in the manufacture and transportation of engineered products	P2a Collecting energy from the sun P2b Generating electricity P2c Global warming P2d Fuels for power P2e Nuclear radiations	Understand the use of natural resources for the generation of energy used in the manufacture and transportation of engineered products eg solar, wind, fossil fuels, nuclear and their implications

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO3: Understand the impact of global manufacturing

Learners must be taught:

- **impact of global manufacturing on sustainability of engineered products ie**
  - production (eg labour markets; fair trade; materials supply)

Gateway Science B 2012 J261		21st Century Science A 2012 J241
Use of natural fuels and their derivatives in manufacturing and transporting engineered products, including their global impact	P2.3 Radiation and life	Understand the impact on global warming of burning fossil fuels in the production and transportation of engineered products
	C1.2 Air quality C1.3 Air quality	Understand pollutants created by manufacturing processes and transportation and their global impact eg coal, petrol, fuels
Understand the implications of using polymers for engineering products in terms of their disposal		
Understand the implication for using natural resources		

21st Century Science A 2012 J241 – Indirect mapping

The creation and use of energy in the manufacture and transportation of engineered products	P3.1, P3.2, P3.3 Sustainable energy	Understand the use of natural resources for the generation of energy used in the manufacture and transportation of engineered products eg solar, wind, fossil fuels, nuclear and their implications

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO1: Researching sustainability

Searching for and presenting information [Direct]

ICT: J800/J810/J820

R001 (M) LO1: Understand how ICT can be used to meet business needs	Use ICT to research and present information on sustainability of engineering materials and products
R002 (M) LO1: Be able to use techniques to search for, store and share information	

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO2: Researching sustainability

Searching for and presenting information [Direct]

ICT: J800/J810/J820

R001 (M) LO1: Understand how ICT can be used to meet business needs	Use ICT to research and present information on sustainable design of engineering products
R002 (M) LO1: Be able to use techniques to search for, store and share information	

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R103 Sustainable engineering

LO3: Researching impacts of global manufacturing

Searching for and presenting information [Direct]

ICT: J800/J810/J820

R001 (M) LO1: Understand how ICT can be used to meet business needs	Use ICT to research and present information on the global impact of manufacturing
R002 (M) LO1: Be able to use techniques to search for, store and share information	

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO1: Understand why engineering systems and products are designed and maintained for optimum performance

Learners must be taught:

- **why systems and products are designed for maintenance, ie**
  - ease of component repair/replacement
  - environmental/sustainability considerations
  - maintain product quality/performance
- **reasons for maintenance and repair of systems and products, ie**
  - maintaining safety
  - improving functionality and reliability
  - reducing running costs and downtime
- **implications of not maintaining systems and products, ie**
  - becoming unsafe (to use)
  - financial impacts
  - legal issues
  - loss of reliability
  - premature product or system replacement
  - reduced efficiency.

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial, Bronze, Silver, Gold

None of the learning outcomes can be directly mapped for LO1.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO2: Know methods used in engineering sectors to maintain optimum performance

Learners must be taught:

- **methods used to maintain optimum system and product performance, ie**
  - predictive, ie condition-based monitoring (eg thermography; vibration; oil sample)
  - preventive (eg planned; scheduled; periodic; safety, statistical, critical; regulatory)
  - corrective (eg unscheduled; reactive; remedial; deferred)
  - improvement (eg upgrading; design outs)
  - run to failure (eg end of life repair; emergency; unscheduled).

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial, Bronze, Silver, Gold

None of the learning outcomes can be directly mapped for LO2.

Foundation Initial, Bronze, Silver – Indirect mapping

Undertake statistical analysis relating to reliability and maintenance interval.

Foundation Initial – Indirect mapping

FIS1 Understand and use the vocabulary of probability, including terms such as 'fair', 'evens', 'certain', 'likely', 'unlikely' and 'impossible'. Understand and use the probability scale.

FIS3 Calculate the mean, median, mode and range of discrete data.

FIS4 Draw and interpret simple frequency tables, charts, pictograms and bar charts for discrete data.

FIS5 Extract and use information from common two-way tables including timetables.

Calculate mean time to failure (MTTF), mean time between failure (MTBF). Construct and interpret graphs showing failure rates.

Foundation Bronze – Indirect mapping

FBS1 Understand and use measures of probability from equally likely outcomes.
List all outcomes for two successive events in a systematic way and derive related probabilities.
FBS2 Use and interpret the statistical measures: mode, median, mean and range for discrete and continuous data, including comparing distributions.
FBS3 Construct and interpret pie charts.
FBS4 Interpret graphs representing real data, including recognising misleading diagrams.

Calculate mean time to failure (MTTF), mean time between failure (MTBF). Construct and interpret graphs showing failure rates as pie charts. Interpret graphs showing real data (eg MTTF, MTBF)

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO3: Understand factors that contribute tot system/product failure

Learners must be taught:

- **types of system/component failure, ie**
  - stress fractures
  - fatigue
  - wear
  - seizure
  - vibration
  - corrosion
- **reasons for system/component failure, ie**
  - maladjustment
  - overloading
  - operational abuse
  - poor lubrication
  - malfunction
  - fouling

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial, Bronze, Silver, Gold

None of the learning outcomes can be directly mapped for LO3.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO4: Be able to perform simple procedures to optimise product/system performance

Learners must be taught:

- **how to use manufacturers'/system information, ie**
  - assembly/disassembly
  - system checks
  - specialist equipment instructions
  - diagnostics
- **how to use tools and equipment safely when performing maintenance tasks**
- **methods to perform simple replacement tasks, eg**
  - oil/lubricant
  - belt/chain
  - worn/damaged/faulty component(s)
  - filtration system components
  - engineering machines/equipment components
- **methods to perform simple performance checks and adjustment tasks, eg**
  - cable/plug security and condition
  - emergency switches, guards and interlocks function
  - belt/chain tensions
  - post-component replacement
  - levels and condition of fluid
  - engineering production machines/equipment

Foundation Initial | Foundation Bronze | Foundation Silver | Foundation Gold

Foundation Initial, Bronze, Silver, Gold

None of the learning outcomes can be directly mapped for LO4.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO1: Understand why engineering systems and products are designed and maintained for optimum performance

Learners must be taught:

- **why systems and products are designed for maintenance, ie**
  - ease of component repair/replacement
  - environmental/sustainability considerations
  - maintain product quality/performance
- **reasons for maintenance and repair of systems and products, ie**
  - maintaining safety
  - improving functionality and reliability
  - reducing running costs and downtime
- **implications of not maintaining systems and products, ie**
  - becoming unsafe (to use)
  - financial impacts
  - legal issues
  - loss of reliability
  - premature product or system replacement
  - reduced efficiency

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

None of the learning outcomes can be directly mapped for LO1.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO2: Know methods used in engineering sectors to maintain optimum performance

Learners must be taught:

- **methods used to maintain optimum system and product performance, ie**
  - predictive, ie
    - condition-based monitoring (eg thermography; vibration; oil sample)
  - preventive (eg planned; scheduled; periodic; safety, statistical, critical; regulatory)
  - corrective (eg unscheduled; reactive; remedial; deferred)
  - improvement (eg upgrading; design outs)
  - run to failure (eg end of life repair; emergency; unscheduled)

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

Use of ultrasound and radiation for condition-based monitoring	P4d Radiation for life (ultrasound) P4f Radiation for life (uses of radioisotopes) P4g Radiation for life (treatment)	Uses of ultrasound and radioactive isotopes (including x-rays) for condition monitoring (eg in materials and pipes)

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO2: Know methods used in engineering sectors to maintain optimum performance

Learners must be taught:

- **methods used to maintain optimum system and product performance, ie**
  - predictive, ie
    - condition-based monitoring (eg thermography; vibration; oil sample)
  - preventive (eg planned; scheduled; periodic; safety, statistical, critical; regulatory)
  - corrective (eg unscheduled; reactive; remedial; deferred)
  - improvement (eg upgrading; design outs)
  - run to failure (eg end of life repair; emergency; unscheduled)

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

None of the learning outcomes for 21st Century Physics A J242 can be directly mapped for LO2.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO3: Understand factors that contribute tot system/product failure

Learners must be taught:

- **types of system/component failure, ie**
  - stress fractures
  - fatigue
  - wear
  - seizure
  - vibration
  - corrosion
- **reasons for system/component failure, ie**
  - maladjustment
  - overloading
  - operational abuse
  - poor lubrication
  - malfunction
  - fouling

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

None of the learning outcomes can be directly mapped for LO3.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO4: Be able to perform simple procedures to optimise product/system performance

Learners must be taught:

- **how to use manufacturers'/system information, ie**
  - assembly/disassembly
  - system checks
  - specialist equipment instructions
  - diagnostics
- **how to use tools and equipment safely when performing maintenance tasks**
- **methods to perform simple replacement tasks, eg**
  - oil/lubricant
  - belt/chain
  - worn/damaged/faulty component(s)
  - filtration system components
  - engineering machines/equipment components
- **methods to perform simple performance checks and adjustment tasks, eg**
  - cable/plug security and condition
  - emergency switches, guards and interlocks function
  - belt/chain tensions
  - post-component replacement
  - levels and condition of fluid
  - engineering production machines/equipment

Gateway Additional Science B 2012 J262

21st Century Science A 2012 J242

None of the learning outcomes can be directly mapped for LO4.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO1: Understand why engineering systems and products are designed and maintained for optimum performance

Learners must be taught:

- **why systems and products are designed for maintenance, ie**
  - ease of component repair/replacement
  - environmental/sustainability considerations
  - maintain product quality/performance
- **reasons for maintenance and repair of systems and products, ie**
  - maintaining safety
  - improving functionality and reliability
  - reducing running costs and downtime
- **implications of not maintaining systems and products, ie**
  - becoming unsafe (to use)
  - financial impacts
  - legal issues
  - loss of reliability
  - premature product or system replacement
  - reduced efficiency

Gateway Physics B 2012 J265

21st Century Physics A 2012 J245

None of the learning outcomes can be directly mapped for LO1.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO2: Know methods used in engineering sectors to maintain optimum performance

Learners must be taught:

- **methods used to maintain optimum system and product performance, ie**
  - predictive, ie
    - condition-based monitoring (eg thermography; vibration; oil sample)
  - preventive (eg planned; scheduled; periodic; safety, statistical, critical; regulatory)
  - corrective (eg unscheduled; reactive; remedial; deferred)
  - improvement (eg upgrading; design outs)
  - run to failure (eg end of life repair; emergency; unscheduled)

Gateway Physics B 2012 J265 | **21st Century Physics A 2012 J245**

None of the learning outcomes can be directly mapped for LO2.

Gateway Physics B 2012 J265 – Indirect mapping

Use of ultrasound and radiation for condition-based monitoring	P4d Radiation for life (ultrasound) P4f Radiation for life (use of radioisotopes) P4g Radiation for life (treatment)	Uses of ultrasound and radioactive isotopes (including x-rays) for condition monitoring (eg in materials and pipes)

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO3: Understand factors that contribute tot system/product failure

Learners must be taught:

- **types of system/component failure, ie**
  - stress fractures
  - fatigue
  - wear
  - seizure
  - vibration
  - corrosion
- **reasons for system/component failure, ie**
  - maladjustment
  - overloading
  - operational abuse
  - poor lubrication
  - malfunction
  - fouling

Gateway Physics B 2012 J265

21st Century Physics A 2012 J245

None of the learning outcomes can be directly mapped for LO3.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO4: Be able to perform simple procedures to optimise product/system performance

Learners must be taught:

- **how to use manufacturers'/system information, ie**
  - assembly/disassembly
  - system checks
  - specialist equipment instructions
  - diagnostics
- **how to use tools and equipment safely when performing maintenance tasks**
- **methods to perform simple replacement tasks, eg**
  - oil/lubricant
  - belt/chain
  - worn/damaged/faulty component(s)
  - filtration system components
  - engineering machines/equipment components
- **methods to perform simple performance checks and adjustment tasks, eg**
  - cable/plug security and condition
  - emergency switches, guards and interlocks function
  - belt/chain tensions
  - post-component replacement
  - levels and condition of fluid
  - engineering production machines/equipment

Gateway Physics B 2012 J265

21st Century Physics A 2012 J245

None of the learning outcomes can be directly mapped for LO4.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO1: Understand why engineering systems and products are designed and maintained for optimum performance

Learners must be taught:

- **why systems and products are designed for maintenance, ie**
  - ease of component repair/replacement
  - environmental/sustainability considerations
  - maintain product quality/performance
- **reasons for maintenance and repair of systems and products, ie**
  - maintaining safety
  - improving functionality and reliability
  - reducing running costs and downtime
- **implications of not maintaining systems and products, ie**
  - becoming unsafe (to use)
  - financial impacts
  - legal issues
  - loss of reliability
  - premature product or system replacement
  - reduced efficiency

Gateway Science B 2012 J261

21st Century Science A 2012 J241

None of the learning outcomes can be directly mapped for LO1.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO2: Know methods used in engineering sectors to maintain optimum performance

Learners must be taught:

- **why systems and products are designed for maintenance, ie**
  - ease of component repair/replacement
  - environmental/sustainability considerations
  - maintain product quality/performance
- **reasons for maintenance and repair of systems and products, ie**
  - maintaining safety
  - improving functionality and reliability
  - reducing running costs and downtime
- **implications of not maintaining systems and products, ie**
  - becoming unsafe (to use)
  - financial impacts
  - legal issues
  - loss of reliability
  - premature product or system replacement
  - reduced efficiency

Gateway Science B 2012 J261

21st Century Science A 2012 J241

None of the learning outcomes can be directly mapped for LO2.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO3: Understand factors that contribute tot system/product failure

Learners must be taught:

- **types of system/component failure, ie**
  - stress fractures
  - fatigue
  - wear
  - seizure
  - vibration
  - corrosion
- **reasons for system/component failure, ie**
  - maladjustment
  - overloading
  - operational abuse
  - poor lubrication
  - malfunction
  - fouling

Gateway Science B 2012 J261

21st Century Science A 2012 J241

Understand the selection and protection of materials to reduce effects of corrosion	C2d Making cars	Understand the effects of corrosion, its cause and how materials selection and protection can mitigate this.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO3: Understand factors that contribute tot system/product failure

Learners must be taught:

- **types of system/component failure, ie**
  - stress fractures
  - fatigue
  - wear
  - seizure
  - vibration
  - corrosion
- **reasons for system/component failure, ie**
  - maladjustment
  - overloading
  - operational abuse
  - poor lubrication
  - malfunction
  - fouling

Gateway Science B 2012 J261 | 21st Century Science A 2012 J241

None of the learning outcomes for 21st Century Science A J241 can be directly mapped for LO3.

CAMBRIDGE NATIONAL IN ENGINEERING

Principles in Engineering and Engineering Business J830/J840 – Maths, Science and ICT in Engineering

Unit R104 Optimising performance in engineering systems and products

LO4: Be able to perform simple procedures to optimise product/system performance

Learners must be taught:

- **how to use manufacturers'/system information, ie**
  - assembly/disassembly
  - system checks
  - specialist equipment instructions
  - diagnostics
- **how to use tools and equipment safely when performing maintenance tasks**
- **methods to perform simple replacement tasks, eg**
  - oil/lubricant
  - belt/chain
  - worn/damaged/faulty component(s)
  - filtration system components
  - engineering machines/equipment components
- **methods to perform simple performance checks and adjustment tasks, eg**
  - cable/plug security and condition
  - emergency switches, guards and interlocks function
  - belt/chain tensions
  - post-component replacement
  - levels and condition of fluid
  - engineering production machines/equipment

Gateway Science B 2012 J261

21st Century Science A 2012 J241

None of the learning outcomes can be directly mapped for LO4.

Maths GCSE

GCSE Mathematics is a tiered qualification comprising **Foundation**, **Initial**, **Bronze**, **Silver** and **Gold** and **Higher Initial**, **Higher Bronze**, **Higher Silver** and **Higher Gold**. A number of key mathematical themes directly and indirectly relevant to solving engineering problems are covered across tiers with increasing breadth and depth. Key themes include application of number, algebra, trigonometry and statistical analysis. Relevance to engineering problem solving includes producing and re-arranging equations and formulae, producing and interpreting graphs, understanding proportion, percentages, volumes and masses, and performing statistical operations.

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Telephone 02476 851509

Email cambridgenationals@ocr.org.uk

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