# CAMBRIDGE NATIONAL IN ENGINEERING

# Engineering Manufacture R109, R110, R111, R112

A comprehensive 113 page overview of how the following qualifications match to the Learning Outcomes for Cambridge National in Engineering, Principles in Engineering and Engineering Business showing opportunities for holistic teaching.

21st Century Physics A 2012 J245

**C**ambridge

NATIONALS

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 National in Engineering Design.

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.





# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture

- 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 R110 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.

- 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.
- FIG2 Make sensible estimates of a range of measures in everyday settings.

FBNB	Use the four operations with positive and negative integers.
FBN9	Use simple proportion, particularly in the context of recipes

Learners are required to interpret drawings that will include dimensions, tolerance and scale, (R110) which will require them to make comparisons of relevant data. In maths, (FIG1) learners are required to convert measurements from one metric unit to another and interpret scales on a range of measuring instruments. Learners could extract numeric values from any technical drawing to manipulate the dimensions and use simple proportion calculations (FBN9) to consider economies of scale or different production quantities of one off, batch and mass production. Joining these two requirements together makes the learning experience much more relevant to learners and should ultimately increase their interest.



# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

#### **Contents** Click on any of the Learning Outcomes to navigate to the page.

	R109	R110	R111	R112
Maths 👔	<u>LO1</u>	<u>LO1</u>	<u>LO1</u>	<u>LO1</u>
	<u>LO2</u>	<u>LO2</u>	<u>LO2</u>	LO2
	<u>LO3</u>	<u>LO3</u>	LO3	LO3
	<u>LO4</u>		<u>LO4</u>	<u>L04</u>
	R109	R110	R111	R112
Additional	<u>LO1</u>	<u>LO1</u>	<u>LO1</u>	<u>LO1</u>
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Science	<u>LO3</u>	<u>LO3</u>	LO3	LO3
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	R109	R110	R111	R112
	<u>LO1</u>	<u>LO1</u>	LO1	LO1
Physics	<u>LO2</u>	LO2	LO2	LO2
,	<u>LO3</u>	LO3	LO3	LO3
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	R109	R110	R111	R112
	<u>LO1</u>	<u>LO1</u>		LO1
Science	<u>LO2</u>	LO2	LO2	LO2
	<u>LO3</u>	LO3	LO3	LO3
	<u>LO4</u>		LO4	<u>L04</u>
	R109	R110	R111	R112
ICT				
ICI	1.00		<u>LO2</u>	
	<u>LO3</u>			<u>LO3</u>
	<u>LO4</u>		<u>LO4</u>	

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R109 Engineering materials, processes and production

Add Sci

# LO1: Know about properties and uses of engineering materials

Learners must be taught:

- types of engineering materials
- new and emerging materials (eg nanotechnology; advanced metal alloys)
- properties of engineering materials
- materials testing processes
- characteristics of engineering materials
- uses of specific materials



# Foundation Initial, Bronze, Silver and Gold and Higher Silver and Gold – GCSE Mathematics B J567

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

R110

R111

LO2

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

### Unit R109 Engineering materials, processes and production

Add Sci

# LO2: Understand engineering processes and their application

Learners must be taught:

#### • basic engineering processes, ie

- o material removal
- o hand forming
- o joining methods
- o heat treatment
- o surface finishing,

#### machine processes, ie

- o material removal
- o forming
- o moulding
- safe use of tools and equipment, ie
  - o features and controls of machines
  - o risk assessment
  - o appropriate use of Personal Protective Equipment (PPE)

R110

o safety precautions



### Foundation Initial, Bronze, Silver and Gold and Higher Silver and Gold – GCSE Mathematics B J567

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

R109

R111

R112

LO1

LO2

# CAMBRIDGE NATIONAL IN ENGINEERING

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# **Unit R109** Engineering materials, processes and production

Add Sci

#### LO3: Know about developments in engineering processes

Learners must be taught:

- applications of computer controlled production • processes, ie
  - o Computer Numerical Control (CNC) machining processes, ie
    - CNC lathes and milling/router machines
    - multi-axis machining centres
    - water jet cutting
    - punching machines
    - press brake machines
  - laser applications, ie 0
  - laser cutting/welding 0
- additive manufacturing and rapid prototyping • processes, (eg Selective Laser Sintering (SLS); Stereolithography (SLA); Direct Metal Laser Sintering (DMLS); Fused Deposition Modelling (FDM)/3D printing; electron beam melting)

R110



# Foundation Initial, Bronze, Silver and Gold and Higher Silver and Gold – GCSE Mathematics B J567

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

R112



Higher **Gold** 

Higher

Silver

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Foundation

**Science** 

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

## Unit R109 Engineering materials, processes and production

Add Sci

# LO4: Know about developments in engineering processes

Learners must be taught:

# • the impact of modern technologies in engineering production, ie

- o automation, processes
  - quality
  - workforce
  - costs
- o digital communications, ie
  - uses in research and development
  - material supply and control
  - global manufacturing

Initial Bronze Silver Gold

### Foundation Initial – GCSE Mathematics B J567

Keywords/Themes Quality, costs, materials stock control, research (internet), CAD

Theme		Incorporates		
Understands the impact of modern technology on manufacturing including analysing quality, costs and stock control. [Indirect]		Construct and interpret simple graphs, including conversion graphs.		
Jnderstands how digital communications, including nternet research of data and CAD have influenced	FIS4	Draw and interpret simple frequency tables, charts, pictograms and bar charts for discrete data.		
engineering production. [indifect]	FIS5	Extract and use information from common two-way tables including timetables.		

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

### Unit R109 Engineering materials, processes and production

Add Sci

# LO4: Know about developments in engineering processes

Learners must be taught:

#### the impact of modern technologies in engineering production, ie

- o automation, processes
  - quality
  - workforce
  - costs
- o digital communications, ie
  - uses in research and development
  - material supply and control
  - global manufacturing

Foundation Foundation Foundation Bronze Silver Gold Higher Gold

# Foundation Bronze – GCSE Mathematics B J567

Keywords/Themes Quality, costs, materials stock control, research (internet), CAD

Theme
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#### Incorporates

Understands the impact of modern technology on manufacturing including analysing quality, costs and stock control. [Indirect] -

Understands how digital communications, including internet research of data and CAD have influenced engineering production. [Indirect]

- **FBA5** Interpret information presented in a range of linear and nonlinear graphs, including travel (distance/time) graphs.
- **FBS3** Construct and interpret pie charts.
- **FBS4** Interpret graphs representing real data, including recognising misleading diagrams.

R111

R112

LO1

LO2

LO3

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Science

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

### Unit R109 Engineering materials, processes and production

Add Sci

# LO4: Know about developments in engineering processes

Learners must be taught:

#### the impact of modern technologies in engineering production, ie

- o automation, processes
  - quality
  - workforce
  - costs
- o digital communications, ie
  - uses in research and development
  - material supply and control
  - global manufacturing

Foundation<br/>InitialFoundation<br/>BronzeFoundation<br/>SilverFoundation<br/>GoldHigher<br/>SilverHigher<br/>Gold

# Foundation Silver – GCSE Mathematics B J567

Keywords/Themes Quality, costs, materials stock control, research (internet), CAD

#### Theme

#### Incorporates

FSS3

Understands the impact of modern technology on manufacturing including analysing quality, costs and stock control. [Indirect]

Understands how digital communications, including internet research of data and CAD have influenced engineering production. [Indirect]

Draw and interpret a wide range of graphs and diagrams for discrete and continuous data, including frequency polygons and stem and leaf diagrams. Compare distributions and make inferences, using the shapes of the distributions and measures of average and range.

R109

R111

R112

LO1

# **CAMBRIDGE NATIONAL IN ENGINEERING**

**Science** 

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

### Unit R109 Engineering materials, processes and production

Add Sci

# LO4: Know about developments in engineering processes

Learners must be taught:

# • the impact of modern technologies in engineering production, ie

- o automation, processes
  - quality
  - workforce
  - costs
- o digital communications, ie
  - uses in research and development
  - material supply and control
  - global manufacturing

Foundation<br/>InitialFoundation<br/>BronzeFoundation<br/>SilverFoundation<br/>GoldHigher<br/>SilverHigher<br/>Gold

# Foundation Gold – GCSE Mathematics B J567

Keywords/Themes Quality, costs, materials stock control, research (internet), CAD

Theme		Incorporates		
Understands the impact of modern technology on manufacturing including analysing quality, costs and stock control. [Indirect]	FGA5	Draw and interpret graphs modelling real situations, which may be nonlinear, including simple quadratic graphs.		
Understands how digital communications, including internet research of data and CAD have influenced engineering production. [Indirect]	FGS3	Draw and interpret scatter graphs for discrete and continuous variables, including using and understanding lines of best fit. Understand the vocabulary of correlation, including: positive, negative and zero correlation; weak, strong and moderate correlation. Look at data to find patterns and exceptions.		

R111

R112

LO1

Higher **Gold** 

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Foundation Initial

**Science** 

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

### Unit R109 Engineering materials, processes and production

Add Sci

# LO4: Know about developments in engineering processes

Learners must be taught:

# • the impact of modern technologies in engineering production, ie

- o automation, processes
  - quality
  - workforce
  - costs
- o digital communications, ie
  - uses in research and development
  - material supply and control
  - global manufacturing

Higher Silver – GCSE Mathematics B J567

**Bronze** 

Keywords/Themes Quality, costs, materials stock control, research (internet), CAD

Theme		Incorporates		
Understands the impact of modern technology on manufacturing including analysing quality, costs and stock control. [Indirect]	HSS1	Use tree diagrams to represent outcomes of combined events, recognising when events are independent. Find probabilities using tree diagrams.		
Understands how digital communications, including internet research of data and CAD have influenced engineering production. [Indirect]	HSS2	Draw and interpret cumulative frequency tables and diagrams and box plots for grouped data. Find the median, quartiles and interquartile range.		

Silver

Gold

Higher Silver

Higher **Gold** 

Higher

Silver

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Foundation

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

## Unit R109 Engineering materials, processes and production

Add Sci

# LO4: Know about developments in engineering processes

Learners must be taught:

#### the impact of modern technologies in engineering production, ie

- o automation, processes
  - quality
  - workforce
  - costs
- o digital communications, ie
  - uses in research and development
  - material supply and control
  - global manufacturing

Initial Bronze Silver Gold Higher Gold – GCSE Mathematics B J567

Keywords/Themes Quality, costs, materials stock control, research (internet), CAD

Theme
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#### Incorporates

Understands the impact of modern technology on manufacturing including analysing quality, costs and stock control. [Indirect]

Understands how digital communications, including internet research of data and CAD have influenced engineering production. [Indirect]

- **HGS2** Draw and interpret histograms for grouped data. Understand frequency density.
- **HGS3** Interpret and compare a wide range of data sets (including grouped discrete and continuous data) and draw conclusions.

R111

R112

LO1

LO<sub>2</sub>

Science

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

# LO1: Be able to plan for the making of a pre-production product

Learners must be taught:

- interpretation of 2D and 3D engineering drawings, ie
  - o third angle orthographic projection
  - o isometric/oblique
- standard drawing conventions on engineering drawings
  - o sectional views
  - o exploded drawings
  - o detail views
  - o materials and components
  - o dimensions
  - o tolerances
  - o scale
  - o annotations
  - o revisions
- production of plans for the making of a preproduction product, ie
  - o interpretation of the details and requirements of a pre-production product from engineering drawings

**R110** 

- o sequence of operations and time estimate
- o tools, equipment and processes
- o health and safety considerations
- o quality control checks



# Foundation Initial – GCSE Mathematics B J567

Keywords/Themes Drawings and views; dimensions, tolerance, scale; materials; Production plans: sequence, time, QC

Theme	Incorp	Incorporates				
Be able to interpret engineering drawings including dimensions, tolerances and scale. [Direct]		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.				
		Make sensible estimates of a range of measures in everyday settings.				
Be able to interpret engineering drawings including		Round numbers to a given power of 10.				
dimensions, tolerances and scale. [Indirect] Be able to produce production plans including sequences, time and quality control checks. [Indirect]		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.				
		Multiply and divide numbers with no more than one decimal digit by an intege 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. Multiply numbers with up to two decimal places by an integer.				
	FIN4	Multiply and divide a three-digit number by a two-digit number. Multiply numbers with up to two decimal places by an integer.				
	FIN5	Calculate a fraction of a given quantity. Identify fractions of a shape.				
		Solve problems using the four operations on integer and decimal numbers using a calculator				

R111

R112

LO1

LO<sub>2</sub>

**C**ambridge

NATIONALS

Gold

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Science

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

# LO1: Be able to plan for the making of a pre-production product

Learners must be taught:

- interpretation of 2D and 3D engineering drawings, ie
  - o third angle orthographic projection

o isometric/oblique

- standard drawing conventions on engineering drawings
  - o sectional views
  - o exploded drawings
  - o detail views
  - o materials and components
  - o dimensions
  - o tolerances
  - o scale
  - o annotations
  - o revisions
- production of plans for the making of a preproduction product, ie
  - o interpretation of the details and requirements of a pre-production product from engineering drawings

**R110** 

- o sequence of operations and time estimate
- o tools, equipment and processes
- o health and safety considerations
- o quality control checks

Foundation Initial Foundation Bronze CCSE Mathematics B 1567

### Foundation Bronze – GCSE Mathematics B J567

Keywords/Themes Drawings and views; dimensions, tolerance, scale; materials; Production plans: sequence, time, QC

#### Theme

Incorporates

Be able to interpret engineering drawings including dimensions, tolerances and scale. [Direct]

Be able to interpret engineering drawings including dimensions, tolerances and scale. [Indirect]

Be able to produce production plans including sequences, time and quality control checks. [Indirect] FBN8 Use the four operations with positive and negative integers.

FBN9 Use simple proportion, particularly in the context of recipes.

R109

R111

R112

LO1

LO2

# CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

# LO1: Be able to plan for the making of a pre-production product

Learners must be taught:

- interpretation of 2D and 3D engineering drawings, ie
  - o third angle orthographic projection

o isometric/oblique

- standard drawing conventions on engineering drawings
  - o sectional views
  - o exploded drawings
  - o detail views
  - o materials and components
  - o dimensions
  - o tolerances
  - o scale
  - o annotations
  - o revisions

#### production of plans for the making of a preproduction product, ie

o interpretation of the details and requirements of a pre-production product from engineering drawings

**R110** 

- o sequence of operations and time estimate
- o tools, equipment and processes
- o health and safety considerations
- o quality control checks



Keywords/Themes Drawings and views; dimensions, tolerance, scale; materials; Production plans: sequence, time, QC

Theme	Incorp	orates
Be able to interpret engineering drawings including dimensions, tolerances and scale. [Direct]		
Be able to interpret engineering drawings including dimensions, tolerances and scale. [Indirect]	FSN4	Use the four operations on decimals without the use of a calculator.
Be able to produce production plans including sequences, time and quality control checks.	FSN5	Use ratio notation including reduction to its simplest form. Understand and us ratio and proportion, including dividing a quantity in a given ratio.
[Indirect]	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.

LO1

R111

R112

Higher **Gold** 

Science

# CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

# LO1: Be able to plan for the making of a pre-production product

Learners must be taught:

- interpretation of 2D and 3D engineering drawings, ie
  - o third angle orthographic projection

o isometric/oblique

- standard drawing conventions on engineering drawings
  - o sectional views
  - o exploded drawings
  - o detail views
  - o materials and components
  - o dimensions
  - o tolerances
  - o scale
  - o annotations
  - o revisions
- production of plans for the making of a preproduction product, ie
  - o interpretation of the details and requirements of a pre-production product from engineering drawings

**R110** 

- o sequence of operations and time estimate
- o tools, equipment and processes
- o health and safety considerations
- o quality control checks



Keywords/Themes Drawings and views; dimensions, tolerance, scale; materials; Production plans: sequence, time, QC

Be able to interpret engineering drawings including	FGG1	Recognise that a measurement given to the nearest whole unit may be		
dimensions, tolerances and scale. [Indirect]		inaccurate by up to one half of a unit in either direction.		
Be able to produce production plans including sequences, time and quality control checks.		ratio and proportion, including dividing a quantity in a given ratio.		
[Indirect]	FGG7	Recognise, visualise and construct enlargements of objects using positive integer scale factors and a centre of enlargement. Identify the centre and the scale factor of an enlargement. Understand the implications of enlargement fo perimeter/length.		
		perimeter/iength.		
		perimeter/length.		

Foundation

R111

R112

LO1

LO3

LO<sub>2</sub>

Higher **Gold** 

# CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

# LO1: Be able to plan for the making of a pre-production product

Learners must be taught:

- interpretation of 2D and 3D engineering drawings, ie
  - o third angle orthographic projection
  - o isometric/oblique
- standard drawing conventions on engineering drawings
  - o sectional views
  - o exploded drawings
  - o detail views
  - o materials and components
  - o dimensions
  - o tolerances
  - o scale
  - o annotations
  - o revisions
- production of plans for the making of a preproduction product, ie
  - o interpretation of the details and requirements of a pre-production product from engineering drawings

**R110** 

- o sequence of operations and time estimate
- o tools, equipment and processes
- o health and safety considerations
- o quality control checks

Foundation	Foundation	Foundation	Foundation	Higher	Higher
Initial	Bronze	<b>Silver</b>	<b>Gold</b>	Silver	<b>Gold</b>

# Higher Silver and Gold – GCSE Mathematics B J567

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

R109

R111

R112

LO1

LO<sub>2</sub>

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Science

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

#### LO2: Be able to use processes, tools and equipment safely to make a preproduction product

Learners must be taught:

- appropriate processes for making preproduction products, ie
  - o bench work and hand-held tools
  - o manually controlled machining operations, eg
- how to use tools and equipment when making products, ie
  - o bench work
  - o setting of machines/equipment, eg
- how to follow safe working procedures when using tools and equipment
- how to use appropriate use Personal Protective Equipment (PPE) appropriately material removal

**R110** 

- use of appropriate quality control checks to review finished pre-production products, ie
  - o compare against engineering drawings
  - o important dimensions
  - o tolerances
  - o finish

Foundation	Foundation	Foundation	Foundation	Higher Silvor	Higher
Initial	Bronze	Silver	Gold	Silver	Gold

# Foundation Initial – GCSE Mathematics B J567

#### Keywords/Themes Measuring, marking out; QC: compare, tolerances

Theme	Incorporates				
Applies appropriate methods such as measuring and marking out when making a pre-production product. [Direct]	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.			
Be able to apply quality control checks including measurement and tolerance. [Direct]	FIG2	Make sensible estimates of a range of measures in everyday settings.			
Applies appropriate methods such as measuring	FIN1	Round numbers to a given power of 10.			
and marking out when making a pre-production product. [Indirect] Be able to apply quality control checks including measurement and tolerance. [Indirect]	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.			
	FIN5	Calculate a fraction of a given quantity. Identify fractions of a shape.			
	FIN6	Solve problems using the four operations on integer and decimal numbers using a calculator			

R109

R112

LO1

.

LO<sub>3</sub>

Foundation

# CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

LO2: Be able to use processes, tools and equipment safely to make a preproduction product

Learners must be taught:

- appropriate processes for making preproduction products, ie
  - o bench work and hand-held tools
  - o manually controlled machining operations, eg
- how to use tools and equipment when making products, ie
  - o bench work
  - o setting of machines/equipment, eg
- how to follow safe working procedures when using tools and equipment
- how to use appropriate use Personal Protective Equipment (PPE) appropriately material removal
- use of appropriate quality control checks to review finished pre-production products, ie
  - o compare against engineering drawings
  - o important dimensions
  - o tolerances
  - o finish

Coundation Bronze – GCS Keywords/Themes Measuring, marking out; QC: c	ompare, tolerances
Theme	Incorporates
Applies appropriate methods such as measuring and marking out when making a pre-production product. [Direct]	
Be able to apply quality control checks including measurement and tolerance. [Direct]	
Applies appropriate methods such as measuring	<b>FBN8</b> Use the four operations with positive and negative integers.
product. [Indirect]	<b>FBN9</b> Use simple proportion, particularly in the context of recipes.

Foundation

Higher

Higher

Foundation

R109

R111

**R110** 

R112

measurement and tolerance. [Indirect]

LO1

**Science** 

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

LO2: Be able to use processes, tools and equipment safely to make a preproduction product

Learners must be taught:

- appropriate processes for making preproduction products, ie
  - o bench work and hand-held tools
  - o manually controlled machining operations, eg
- how to use tools and equipment when making products, ie
  - o bench work
  - o setting of machines/equipment, eg
- how to follow safe working procedures when using tools and equipment
- how to use appropriate use Personal Protective Equipment (PPE) appropriately material removal
- use of appropriate quality control checks to review finished pre-production products, ie
  - o compare against engineering drawings
  - o important dimensions
  - o tolerances
  - o finish

Foundation Initial Foundation Bronze Foundation Silver – GCSI Keywords/Themes Measuring, marking out; QC: c	Foundat Silve Mat	ion Foundation Higher Higher Gold Bilver Gold Chematics B J567	
Theme	Incorp	orates	
Applies appropriate methods such as measuring and marking out when making a pre-production product. [Direct]			
Be able to apply quality control checks including measurement and tolerance. [Direct]			
Applies appropriate methods such as measuring and marking out when making a pre-production	FSN4	Use the four operations on decimals without the use of a calculator.	
product. [Indirect]	FSN5	Use ratio notation including reduction to its simplest form. Understand and use	
Be able to apply quality control checks including measurement and tolerance. [Indirect]		atio and proportion, including dividing a quantity in a given ratio.	
	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.	

R110

R111

R112

LO1

Science

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

LO2: Be able to use processes, tools and equipment safely to make a preproduction product

Learners must be taught:

- appropriate processes for making preproduction products, ie
  - o bench work and hand-held tools
  - o manually controlled machining operations, eg
- how to use tools and equipment when making products, ie
  - o bench work
  - o setting of machines/equipment, eg
- how to follow safe working procedures when using tools and equipment
- how to use appropriate use Personal Protective Equipment (PPE) appropriately material removal
- use of appropriate quality control checks to review finished pre-production products, ie
  - o compare against engineering drawings
  - o important dimensions
  - o tolerances
  - o finish

Foundation Initial Bronze	ilver Foundation Gold	ion Higher Higher Silver Gold
Foundation Gold – GCSE Keywords/Themes Measuring, marking out; QC: c	athematics B J are, tolerances	567
Theme	corporates	
Applies appropriate methods such as measuring and marking out when making a pre-production product. [Direct]		
Be able to apply quality control checks including measurement and tolerance. [Direct]		
Applies appropriate methods such as measuring and marking out when making a pre-production product. [Indirect]	GG1 Recognise that a measu inaccurate by up to one	rrement given to the nearest whole unit may be half of a unit in either direction.
Be able to apply quality control checks including measurement and tolerance. [Indirect]	GG7 Recognise, visualise and integer scale factors and scale factor of an enlarg	d construct enlargements of objects using positive d a centre of enlargement. Identify the centre and the gement. Understand the implications of enlargement for

perimeter/length.

R111

**R110** 

R112

LO1

# CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

LO2: Be able to use processes, tools and equipment safely to make a preproduction product

Learners must be taught:

- appropriate processes for making preproduction products, ie
  - o bench work and hand-held tools
  - o manually controlled machining operations, eg
- how to use tools and equipment when making products, ie
  - o bench work
  - o setting of machines/equipment, eg
- how to follow safe working procedures when using tools and equipment
- how to use appropriate use Personal Protective Equipment (PPE) appropriately material removal
- use of appropriate quality control checks to review finished pre-production products, ie
  - o compare against engineering drawings
  - o important dimensions
  - o tolerances
  - o finish



# Higher Silver and Gold – GCSE Mathematics B J567

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

R109

**R110** 

R112



# CAMBRIDGE NATIONAL IN ENGINEERING

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

#### LO3: Be able to modify a production plan for different scales of production

Learners must be taught:

- consideration of scales of manufacture, ie
  - one-off/job production 0
  - batch production 0
  - mass production 0
- impact of quantities of production on production plans, ie
  - processes 0
  - sequence of individual operations 0
  - timing of stages 0
  - health and safety considerations 0
  - quality control checks 0
  - suggested modifications 0



# Foundation Initial, Bronze, Silver and Gold and Higher Silver and Gold – GCSE Mathematics B J567

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

R109

R110



LO2

# CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R111 Computer aided manufacturing

LO1: Be able to plan the production of components on Computer Numerical Control (CNC) machines

Learners must be taught:

 factors to consider when producing plans for CNC machining operations in the production of components, ie

Add Sci

- o planning of operations, ie
  - sequence of operations
  - tool changes
- scale of manufacture waste minimisation
  - one-off
  - batch
  - mass production
- o type of machine ie
  - milling machines
  - turning centres
  - fabrication machines
- o tools required, ie
  - setting tools (eg spanners; Allen keys; clamps)
  - machining tools (eg drills; turning tools; end-mills)

R110

- cutting tools (eg cutting blades, CNC router)
- o materials, ie
- o speeds and feeds for the size and type of materials

Foundation Foundation Foundation Foundation Higher Higher Gold Silver Gold

### Foundation Initial, Bronze, Silver and Gold and Higher Silver and Gold – GCSE Mathematics B J567

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

R109

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LO2

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R111 Computer aided manufacturing

LO2: Be able to interpret information from CAD to manufacture components on CNC equipment

Add Sci

Learners must be taught:

- use of Computer Aided Design (CAD) packages, ie
  - export drawing information to CNC machineson-screen simulation

R110

- factors to consider when performing CNC machine programming operations, ie
  - o setting datum points
  - o co-ordinates (absolute and incremental)
  - o tool change-over
  - o tool offsets

R109

o language (eg G-codes)

Foundation<br/>InitialFoundation<br/>BronzeFoundation<br/>SilverFoundation<br/>GoldHigher<br/>SilverHigher<br/>Gold

# Foundation Initial – GCSE Mathematics B J567

#### Keywords/Themes CAD and drawings; CNC: datums, co-ordinates

Knows about the features of CAD drawings. [Direct]	FIG1	Use: kilometres, metres, centimetres and millimetres; kilograms and grams; and millilitres. Convert measurements from one metric unit to another Inter scales on a range of measuring instruments.
	FIG2	Make sensible estimates of a range of measures in everyday settings.
Understand factors to be considered in CNC	FIN1	Round numbers to a given power of 10.
Knows about the features of CAD drawings. [Indirect] Understand factors to be considered in CNC including datums and co-ordinates. [Indirect]	FIN2	Add and subtract three-digit numbers, without the use of a calculator Add subtract using numbers with up to two decimal places without the use of calculator.
	FIN3	Multiply and divide numbers with no more than one decimal digit by an in 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.
	FIN5	Calculate a fraction of a given quantity. Identify fractions of a shape.
	FIN9	Solve problems using the four operations on integer and decimal numbers using a calculator

Higher **Gold** 

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R111 Computer aided manufacturing

LO2: Be able to interpret information from CAD to manufacture components on CNC equipment

Add Sci

Learners must be taught:

- use of Computer Aided Design (CAD) packages, ie
  - o export drawing information to CNC machines o on-screen simulation
- factors to consider when performing CNC machine programming operations, ie
  - o setting datum points
  - o co-ordinates (absolute and incremental)
  - o tool change-over
  - o tool offsets
  - o language (eg G-codes)

#### Foundation Initial Foundation Bronze Silver Gold Silver

### Foundation Bronze – GCSE Mathematics B J567

#### Keywords/Themes CAD and drawings; CNC: datums, co-ordinates

Incorp	Incorporates			
FBN8	Use the four operations with positive and negative integers.			
FBN9	Use simple proportion, particularly in the context of recipes			
	FBN8 FBN9			



R110

R111

LO1

LO2

LO3

Higher **Gold** 

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Foundation

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R111 Computer aided manufacturing

LO2: Be able to interpret information from CAD to manufacture components on CNC equipment

Add Sci

Learners must be taught:

- use of Computer Aided Design (CAD) packages, ie
  - export drawing information to CNC machineson-screen simulation
- factors to consider when performing CNC machine programming operations, ie
  - o setting datum points
  - o co-ordinates (absolute and incremental)
  - o tool change-over
  - o tool offsets
  - o language (eg G-codes)

Initial Bronze Silver Gold Foundation Silver – GCSE Mathematics B J567

Foundation

#### Keywords/Themes CAD and drawings; CNC: datums, co-ordinates

ows about the features of CAD drawings. [Direct]		
derstand factors to be considered in CNC luding datums and co-ordinates. [Direct]	FSN4	Use the four operations on decimals without the use of a calculator.
ows about the features of CAD drawings. direct] Understand factors to be considered in	FSN5	Use ratio notation including reduction to its simplest form. Understand and us ratio and proportion, including dividing a quantity in a given ratio.
CNC including datums and co-ordinates. [Indirect]	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.

R109

R110

R111

R112

LO1

LO2

Foundation

Higher Silver

LO3

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R111 Computer aided manufacturing

LO2: Be able to interpret information from CAD to manufacture components on CNC equipment

Add Sci

Learners must be taught:

- use of Computer Aided Design (CAD) packages, ie
  - export drawing information to CNC machineson-screen simulation
- factors to consider when performing CNC machine programming operations, ie
  - o setting datum points
  - o co-ordinates (absolute and incremental)
  - o tool change-over
  - o tool offsets
  - o language (eg G-codes)

Foundation<br/>InitialFoundation<br/>BronzeFoundation<br/>SilverFoundation<br/>GoldHigher<br/>SilverHigher<br/>Gold

# Foundation Gold – GCSE Mathematics B J567

#### Keywords/Themes CAD and drawings; CNC: datums, co-ordinates

heme	Incorporates		
(nows about the features of CAD drawings. [Direct]			
Inderstand factors to be considered in CNC ncluding datums and co-ordinates. [Direct]	FGG1	Recognise that a measurement given to the nearest whole unit may be inaccurate by up to one half of a unit in either direction.	
(nows about the features of CAD drawings. Indirect] Understand factors to be considered in INC including datums and co-ordinates. [Indirect]	FGG7	Recognise, visualise and construct enlargements of objects using positive integer scale factors and a centre of enlargement. Identify the centre and the scale factor of an enlargement. Understand the implications of enlargement for perimeter/length.	

R110

R111

R112

LO1

LO2

LO3

Higher **Gold** 

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R111 Computer aided manufacturing

LO2: Be able to interpret information from CAD to manufacture components on CNC equipment

Add Sci

Learners must be taught:

- use of Computer Aided Design (CAD) packages,
  ie
  - o export drawing information to CNC machines o on-screen simulation
- factors to consider when performing CNC machine programming operations, ie
  - o setting datum points
  - o co-ordinates (absolute and incremental)
  - o tool change-over
  - o tool offsets
  - o language (eg G-codes)

#### Foundation Initial Foundation Bronze Silver Gold Silver

# Higher Silver and Gold – GCSE Mathematics B J567

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

R109

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R111

R110

R112

LO1

LO2

LO4

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R111 Computer aided manufacturing

LO3: Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components

Add Sci

Learners must be taught:

- procedures for setting up CNC equipment, ie
  - o tooling
  - o work holding
  - o computer interface
  - o safety procedures
- procedures to produce products to required specification, ie
  - o initial setting
  - o safe use, ie
    - potential hazards
    - appropriate Personal Protective Equipment

R110

- methods used to compare items manufactured by manually controlled and CNC production, ie
  - o visual (eg standard of finish)
  - o dimensional (eg accuracy component tolerance)
  - o cycle time (eg assembly)
  - o consistency (eg batch tolerance)

Foundation	Foundation	Foundation	Foundation	Higher	Higher
Initial	<b>Bronze</b>	<b>Silver</b>	Gold	Silver	<b>Gold</b>

# Foundation Initial – GCSE Mathematics B J567

#### Keywords/Themes Dimensions and tolerance

**Science** 

Understand methods used to compare items manufactured by CNC including dimensions and tolerance. [Direct]		Use: kilometres, metres, centimetres and millimetres; kilograms and grams; litr and millilitres. Convert measurements from one metric unit to another Interpr scales on a range of measuring instruments.		
	FIG2	Make sensible estimates of a range of measures in everyday settings.		
Understand methods used to compare items	FIN1	Round numbers to a given power of 10.		
manufactured by CNC including dimensions and tolerance. [Indirect]		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 integ 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.		
	FIN5	Calculate a fraction of a given quantity. Identify fractions of a shape.		
		Solve problems using the four operations on integer and decimal numbers using a calculator		

R109

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R111 Computer aided manufacturing

LO3: Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components

Add Sci

Learners must be taught:

- procedures for setting up CNC equipment, ie
  - o tooling
  - o work holding
  - o computer interface
  - o safety procedures
- procedures to produce products to required specification, ie
  - o initial setting
  - o safe use, ie
    - potential hazards
    - appropriate Personal Protective Equipment

R110

- methods used to compare items manufactured by manually controlled and CNC production, ie
  - o visual (eg standard of finish)
  - o dimensional (eg accuracy component tolerance)
  - o cycle time (eg assembly)
  - o consistency (eg batch tolerance)



# Foundation Bronze – GCSE Mathematics B J567

#### Keywords/Themes Dimensions and tolerance

Science

Theme	Incorp	orates
Understand methods used to compare items manufactured by CNC including dimensions and tolerance. [Direct]		
Understand methods used to compare items	FBN8	Use the four operations with positive and negative integers.
tolerance. [Indirect]	FBN9	Use simple proportion, particularly in the context of recipes.

R111

R112

LO1

Higher **Gold** 

# CAMBRIDGE NATIONAL IN ENGINEERING

Foundation

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# **Unit R111 Computer aided** manufacturing

LO3: Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components

Add Sci

Learners must be taught:

- procedures for setting up CNC equipment, ie •
  - 0 tooling
  - work holding 0
  - computer interface 0
  - safety procedures 0
- procedures to produce products to required specification, ie
  - initial setting 0
  - safe use, ie 0
    - potential hazards
    - appropriate Personal Protective Equipment
- methods used to compare items manufactured • by manually controlled and CNC production, ie
  - visual (eg standard of finish) 0
  - dimensional (eg accuracy component 0 tolerance)
  - cycle time (eg assembly) 0
  - consistency (eg batch tolerance) 0

Initial	Bronze	Silver	Gold	Silver
Foundation	Silver – GC	SF Mathem	atics B 1567	

Foundation

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Foundation

#### Keywords/Themes Dimensions and tolerance

	Incorp	Incorporates	
Understand methods used to compare items manufactured by CNC including dimensions and tolerance. [Direct]			
Understand methods used to compare items manufactured by CNC including dimensions and tolerance. [Indirect]	FSN4	Use the four operations on decimals without the use of a calculator.	
	FSN5	Use ratio notation including reduction to its simplest form. Understand and use ratio and proportion, including dividing a quantity in a given ratio.	
	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

Higher

R109

R110

R112

LO1

LO2

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R111 Computer aided manufacturing

LO3: Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components

Add Sci

Learners must be taught:

- procedures for setting up CNC equipment, ie
  - o tooling
  - o work holding
  - o computer interface
  - o safety procedures
- procedures to produce products to required specification, ie
  - o initial setting
  - o safe use, ie
    - potential hazards
    - appropriate Personal Protective Equipment

R110

- methods used to compare items manufactured by manually controlled and CNC production, ie
  - o visual (eg standard of finish)
  - o dimensional (eg accuracy component tolerance)
  - o cycle time (eg assembly)
  - o consistency (eg batch tolerance)



# Foundation Gold – GCSE Mathematics B J567

#### Keywords/Themes Dimensions and tolerance

Theme	Incorporates	
Understand methods used to compare items manufactured by CNC including dimensions and tolerance. [Direct]		
Understand methods used to compare items manufactured by CNC including dimensions and tolerance. [Indirect]	FGG1	Recognise that a measurement given to the nearest whole unit may be inaccurate by up to one half of a unit in either direction.
	FGG7	Recognise, visualise and construct enlargements of objects using positive integer scale factors and a centre of enlargement. Identify the centre and the scale factor of an enlargement. Understand the implications of enlargement for perimeter/length.

R111

R112

LO1

LO2

LO3

# **CAMBRIDGE NATIONAL IN ENGINEERING**

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R111 Computer aided manufacturing

LO3: Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components

Add Sci

Learners must be taught:

- procedures for setting up CNC equipment, ie
  - o tooling
  - o work holding
  - o computer interface
  - o safety procedures
- procedures to produce products to required specification, ie
  - o initial setting
  - o safe use, ie
    - potential hazards
    - appropriate Personal Protective Equipment
- methods used to compare items manufactured by manually controlled and CNC production, ie
  - o visual (eg standard of finish)
  - o dimensional (eg accuracy component tolerance)
  - o cycle time (eg assembly)
  - o consistency (eg batch tolerance)

# FoundationFoundationFoundationHigherInitialBronzeSilverGoldSilver

# Higher Silver and Gold – GCSE Mathematics B J567

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

R109

R110

R111

# CAMBRIDGE NATIONAL IN ENGINEERING

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R111 Computer aided manufacturing

LO4: Know about applications of computer control processes used to manufacture products

Add Sci

Learners must be taught:

- applications of computer control, ie
  - o rapid prototyping, ie
    - laminating
    - 3D printing
    - stereo lithography
    - laser sintering
  - o o manufacturing processes, ie
    - CNC machining
    - additive manufacturing
  - o o robotics, ie
    - · welding
    - riveting
    - pick-and-place assembly
- computer controlled processes used for different scales of manufacture, ie
  - o one-off/prototype manufacture
  - o batch production
  - o high-volume manufacturing



## Foundation Initial, Bronze, Silver and Gold, and Higher Silver and Gold – GCSE Mathematics B J567

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

R111

# CAMBRIDGE NATIONAL IN ENGINEERING

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

# LO1: Understand the importance of quality control

Add Sci

Learners must be taught:

- reasons for implementing quality control in production, ie
  - o early intercept (eg problems in production)
  - o waste management (eg reduce production waste)
  - o consistency (eg finished products)
  - o reduce costs (eg materials time)
  - o conformity (eg industry standards regulations)
  - o reduce returns (eg reputation customer perception)

#### • quality procedures, ie

- o quality control
- o quality standards
- o quality assurance
- o total quality management



# Foundation Initial – GCSE Mathematics B J567

Keywords/Themes Wastes management, reduce costs

Theme	Incorporates	
Understand how quality control techniques and data are used to reduce waste including time and cost. [Indirect]	FIA5	Construct and interpret simple graphs, including conversion graphs.
	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.

R110

R112

LO1

-

LO2
# CAMBRIDGE NATIONAL IN ENGINEERING

Science

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# **Unit R112 Quality control of** engineered products

#### LO1: Understand the importance of quality control

Add Sci

Learners must be taught:

#### reasons for implementing quality control in • production, ie

- early intercept (eg problems in production) 0
- waste management (eg reduce production 0 waste)
- consistency (eg finished products) 0
- reduce costs (eg materials time) 0
- conformity (eq industry standards regulations) 0
- reduce returns (eq reputation customer 0 perception)

#### • quality procedures, ie •

- guality control 0
- quality standards 0
- 0 quality assurance
- total quality management 0



# Foundation Bronze – GCSE Mathematics B J567

Keywords/Themes Wastes management, reduce costs

Theme	Incorporates	
Understand how quality control techniques and data are used to reduce waste including time and cost [Indirect]	FBA5	Interpret information presented in a range of linear and non-linear graphs, including travel (distance/time) graphs.
	FBS3	Recognise, visualise and construct enlargements of objects using positive integer scale factors and a centre of enlargement. Identify the centre and the scale factor of an enlargement. Understand the implications of enlargement for perimeter/length.
	FBS4	Interpret graphs representing real data, including recognising misleading diagrams.

R109

R110

R111

R112

L01

LO2

LO3

# CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

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# **Unit R112 Quality control of** engineered products

#### LO1: Understand the importance of quality control

Add Sci

Learners must be taught:

- reasons for implementing quality control in • production, ie
  - early intercept (eg problems in production) 0
  - waste management (eg reduce production 0 waste)
  - consistency (eg finished products) 0
  - reduce costs (eg materials time) 0
  - conformity (eq industry standards regulations) 0
  - reduce returns (eq reputation customer 0 perception)

#### • quality procedures, ie •

- guality control 0
- quality standards 0
- 0 quality assurance
- total quality management 0



# Foundation Silver – GCSE Mathematics B J567

Keywords/Themes Wastes management, reduce costs

Theme	Incorporates	
Understand how quality control techniques and data are used to reduce waste including time and cost. [Indirect]	FSS3	Draw and interpret a wide range of graphs and diagrams for discrete and continuous data, including frequency polygons and stem and leaf diagrams. Compare distributions and make inferences, using the shapes of the distributions and measures of average and range.

R110

R111

R112

L01

LO2

# CAMBRIDGE NATIONAL IN ENGINEERING

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# **Unit R112 Quality control of** engineered products

#### LO1: Understand the importance of quality control

Add Sci

Learners must be taught:

- reasons for implementing quality control in • production, ie
  - early intercept (eg problems in production) 0
  - waste management (eg reduce production 0 waste)
  - consistency (eg finished products) 0
  - reduce costs (eg materials time) 0
  - conformity (eq industry standards regulations) 0
  - reduce returns (eq reputation customer 0 perception)

#### • quality procedures, ie •

- guality control 0
- quality standards 0
- 0 quality assurance
- total quality management 0



# Foundation Gold – GCSE Mathematics B J567

Keywords/Themes Wastes management, reduce costs

Theme	Incorporates	
Understand how quality control techniques and data are used to reduce waste including time and	FGA5	Draw and interpret graphs modelling real situations, which may be nonlinear, including simple quadratic graphs.
	FGS3	Draw and interpret scatter graphs for discrete and continuous variables, including using and understanding lines of best fit. Understand the vocabulary of correlation, including: positive, negative and zero correlation; weak, strong and moderate correlation. Look at data to find patterns and exceptions.

R109

R110

R112

L01

LO2

LO3

# CAMBRIDGE NATIONAL IN ENGINEERING

**Science** 

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

# LO1: Understand the importance of quality control

Add Sci

Learners must be taught:

- reasons for implementing quality control in production, ie
  - o early intercept (eg problems in production)
  - o waste management (eg reduce production waste)
  - o consistency (eg finished products)
  - o reduce costs (eg materials time)
  - o conformity (eg industry standards regulations)

R110

o reduce returns (eg reputation – customer perception)

#### • quality procedures, ie

- o quality control
- o quality standards
- o quality assurance
- o total quality management

# Foundation<br/>InitialFoundation<br/>BronzeFoundation<br/>SilverFoundation<br/>GoldHigher<br/>SilverHigher Silver – GCSE Mathematics B J567

Keywords/Themes Wastes management , reduce costs

Theme	Incorporates	
Understand how quality control techniques and data are used to reduce waste including time and	ality control techniques and uce waste including time andHSS1Use tree diagrams to represent outcomes of combined events, recogniz when events are independent. Find probabilities using tree diagrams.	Use tree diagrams to represent outcomes of combined events, recognising when events are independent. Find probabilities using tree diagrams.
	HSS2	Draw and interpret cumulative frequency tables and diagrams and box plots for grouped data. Find the median, quartiles and interquartile range.

R109

R111

R112

LO1

LO2

LO3

LO4

Higher **Gold** 

# CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

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# **Unit R112 Quality control of** engineered products

#### LO1: Understand the importance of quality control

Add Sci

Learners must be taught:

- reasons for implementing quality control in • production, ie
  - early intercept (eg problems in production) 0
  - waste management (eg reduce production 0 waste)
  - consistency (eg finished products) 0
  - reduce costs (eg materials time) 0
  - conformity (eq industry standards regulations) 0
  - reduce returns (eq reputation customer 0 perception)

#### • quality procedures, ie •

- guality control 0
- quality standards 0
- 0 quality assurance
- total quality management 0

#### Foundation Higher Initial Silver Gold Silver Bronze Higher Gold– GCSE Mathematics B J567

Keywords/Themes Wastes management, reduce costs

Theme	Incorpo	prates
Understand how quality control techniques and data are used to reduce waste including time and	HGS2	Draw and interpret histograms for grouped data. Understand frequency density.
	HGS3	Interpret and compare a wide range of data sets (including grouped discrete and continuous data) and draw conclusions.

R110

R112

L01

LO2

LO3

Higher **Gold** 

**Science** 

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

# LO2: Be able to assess product quality from inspection and quality control techniques

Add Sci

Learners must be taught:

- quality control techniques used in stages of production
- application of basic inspection checks in stages of production
- use of inspection equipment in stages of production
- techniques for evaluating product from quality control checks

R110

Foundation<br/>InitialFoundation<br/>BronzeFoundation<br/>SilverFoundation<br/>GoldHigher<br/>SilverHigher<br/>Gold

# Foundation Initial – GCSE Mathematics B J567

Keywords/Themes Tolerance, sampling, comparison, measuring – dimensions, xrays and ultrasonics

Theme		orates
Understand quality and inspection techniques including tolerance, sampling, measurements and dimensions. [Direct]	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.
	FIG2	Make sensible estimates of a range of measures in everyday settings.
Understand quality and inspection techniques including tolerance, sampling, measurements and dimensions. [Indirect]	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.
	FIN5	Calculate a fraction of a given quantity. Identify fractions of a shape.
	FIN9	Solve problems using the four operations on integer and decimal numbers

R109

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

# LO2: Be able to assess product quality from inspection and quality control techniques

Add Sci

Learners must be taught:

- quality control techniques used in stages of production
- application of basic inspection checks in stages of production
- use of inspection equipment in stages of production
- techniques for evaluating product from quality control checks

R110

Foundation<br/>InitialFoundation<br/>BronzeFoundation<br/>SilverFoundation<br/>GoldHigher<br/>SilverHigher<br/>Gold

# Foundation Bronze – GCSE Mathematics B J567

Keywords/Themes Tolerance, sampling, comparison, measuring – dimensions, xrays and ultrasonics

Theme	Incorporates	
Understand quality and inspection techniques including tolerance, sampling, measurements and dimensions. [Direct]		
Understand quality and inspection techniques	FBN8	Use the four operations with positive and negative integers.
dimensions. [Indirect]	FBN9	Use simple proportion, particularly in the context of recipes.

R109

)

R111

R112

LO2

**Science** 

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

# LO2: Be able to assess product quality from inspection and quality control techniques

Add Sci

Learners must be taught:

- quality control techniques used in stages of production
- application of basic inspection checks in stages of production
- use of inspection equipment in stages of production
- techniques for evaluating product from quality control checks

R110

Foundation<br/>InitialFoundation<br/>BronzeFoundation<br/>SilverFoundation<br/>GoldHigher<br/>SilverHigher<br/>Gold

# Foundation Silver – GCSE Mathematics B J567

Keywords/Themes Tolerance, sampling, comparison, measuring – dimensions, xrays and ultrasonics

Understa including dimensio	and quality and inspection techniques g tolerance, sampling, measurements and ons. [Direct]		
Understand quality and inspection techniques including tolerance, sampling, measurements and dimensions. [Indirect]	FSN4	FSN4 Use the four operations on decimals without the use of a calculator.	
	FSN5	FSN5 Use ratio notation including reduction to its simplest form. Understa and use ratio and proportion, including dividing a quantity in a given ratio.	
	FSN6	FSN6 Use a calculator effectively and efficiently, entering a range of measu including 'time', interpreting the display and rounding off a final answer to a reasonable degree of accuracy. Perform calculations using the order of operations.	

R109

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

# LO2: Be able to assess product quality from inspection and quality control techniques

Add Sci

Learners must be taught:

- quality control techniques used in stages of production
- application of basic inspection checks in stages of production
- use of inspection equipment in stages of production
- techniques for evaluating product from quality control checks

Foundation<br/>InitialFoundation<br/>BronzeFoundation<br/>SilverFoundation<br/>GoldHigher<br/>SilverHigher<br/>Gold

# Foundation Gold – GCSE Mathematics B J567

Keywords/Themes Tolerance, sampling, comparison, measuring – dimensions, xrays and ultrasonics

Гһете	Incorp	orates
Understand quality and inspection techniques ncluding tolerance, sampling, measurements and dimensions. [Direct]		
Understand quality and inspection techniques ncluding tolerance, sampling, measurements and	FGG1	Recognise that a measurement given to the nearest whole unit may be inaccurate by up to one half of a unit in either direction.
	FGG7	Recognise, visualise and construct enlargements of objects using positive integer scale factors and a centre of enlargement. Identify the centre and the scale factor of an enlargement. Understand the implications of enlargement for perimeter/length.

R109

R110

R111

R112

LO2

LO3

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

LO2: Be able to assess product quality from inspection and quality control techniques

Add Sci

Learners must be taught:

- quality control techniques used in stages of production
- application of basic inspection checks in stages of production
- use of inspection equipment in stages of production
- techniques for evaluating product from quality control checks



# Higher Silver and Gold – GCSE Mathematics B J567

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

R110

R111

R112

LO1

LO2

# CAMBRIDGE NATIONAL IN ENGINEERING

**Science** 

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# **Unit R112 Quality control of** engineered products

#### LO3: Know how modern technologies can be used in quality control

Add Sci

Learners must be taught:

#### applications of modern technologies, ie •

- non-destructive testing (eg visual inspection; 0 ultrasonic testing; dye
- penetrant; X-ray crack testing) 0
- 3D scanning 0
- CNC measurement checks 0
- use of robotics 0
- application within Computer Integrated 0 Engineering (CIE)/Computer Integrated Manufacture (CIM)
- automatic inspection/rejection 0

Higher **Gold** Foundation Foundation Higher Initial Silver Gold Silver **Bronze** 

# Foundation Initial – GCSE Mathematics B J567

#### Keywords/Themes NDT: xray, ultrasonics, CNC measurements

Theme	Incorpo	prates
Understand how CNC measurement checks are used in quality control. [Direct]	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.
	FIG2	Make sensible estimates of a range of measures in everyday settings.
Understand how CNC measurement checks are used in quality control. [Indirect]	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.
	FIN5	Calculate a fraction of a given quantity. Identify fractions of a shape.
	FIN9	Solve problems using the four operations on integer and decimal numbers using a calculator

R112

LO1

# **CAMBRIDGE NATIONAL IN ENGINEERING**

**Science** 

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

# LO3: Know how modern technologies can be used in quality control

Add Sci

Learners must be taught:

#### • applications of modern technologies, ie

- o non-destructive testing (eg visual inspection; ultrasonic testing; dye
- o penetrant; X-ray crack testing)
- o 3D scanning
- o CNC measurement checks
- o use of robotics
- o application within Computer Integrated Engineering (CIE)/Computer Integrated Manufacture (CIM)
- o automatic inspection/rejection

Foundation<br/>InitialFoundation<br/>BronzeFoundation<br/>SilverFoundation<br/>GoldHigher<br/>SilverHigher<br/>Gold

# Foundation Bronze – GCSE Mathematics B J567

#### Keywords/Themes NDT: xray, ultrasonics, CNC measurements

Theme	Incorporates	
Understand how CNC measurement checks are used in quality control. [Direct]		
Understand how CNC measurement checks are used		Use the four operations with positive and negative integers.
	FBN9	Use simple proportion, particularly in the context of recipes.

R112

**Science** 

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

# LO3: Know how modern technologies can be used in quality control

Add Sci

Learners must be taught:

#### • applications of modern technologies, ie

- o non-destructive testing (eg visual inspection; ultrasonic testing; dye
- o penetrant; X-ray crack testing)
- o 3D scanning
- o CNC measurement checks
- o use of robotics
- o application within Computer Integrated Engineering (CIE)/Computer Integrated Manufacture (CIM)
- o automatic inspection/rejection

Foundation Foundation Foundation Foundation Bronze Foundation Gold Higher Gold

# Foundation Silver – GCSE Mathematics B J567

#### Keywords/Themes NDT: xray, ultrasonics, CNC measurements

Theme	Incorporates	
Understand how CNC measurement checks are used in quality control. [Direct]		
Understand how CNC measurement checks are used in quality control. [Indirect]	FSN4	Use the four operations on decimals without the use of a calculator.
	FSN5	Use ratio notation including reduction to its simplest form. Understand and use ratio and proportion, including dividing a quantity in a given ratio.
	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.

R110

R111

R112

LO1

**Science** 

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

# LO3: Know how modern technologies can be used in quality control

Add Sci

Learners must be taught:

#### • applications of modern technologies, ie

- o non-destructive testing (eg visual inspection; ultrasonic testing; dye
- o penetrant; X-ray crack testing)
- o 3D scanning
- o CNC measurement checks
- o use of robotics
- o application within Computer Integrated Engineering (CIE)/Computer Integrated Manufacture (CIM)
- o automatic inspection/rejection

FoundationFoundationFoundationHigherHigherInitialBronzeSilverGoldSilverGold

# Foundation Gold – GCSE Mathematics B J567

#### Keywords/Themes NDT: xray, ultrasonics, CNC measurements

Theme	Incorporates	
Understand how CNC measurement checks are used in quality control. [Direct]		
Understand how CNC measurement checks are used in quality control. [Indirect]	FGG1	Recognise that a measurement given to the nearest whole unit may be inaccurate by up to one half of a unit in either direction.
	FGG7	Recognise, visualise and construct enlargements of objects using positive integer scale factors and a centre of enlargement. Identify the centre and the scale factor of an enlargement. Understand the implications of enlargement for perimeter/length.

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R110

R112

LO1

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

# LO3: Know how modern technologies can be used in quality control

Add Sci

Learners must be taught:

- applications of modern technologies, ie
  - o non-destructive testing (eg visual inspection; ultrasonic testing; dye
  - o penetrant; X-ray crack testing)
  - o 3D scanning
  - o CNC measurement checks
  - o use of robotics
  - o application within Computer Integrated Engineering (CIE)/Computer Integrated Manufacture (CIM)
  - o automatic inspection/rejection

Foundation<br/>InitialFoundation<br/>BronzeFoundation<br/>SilverHigher<br/>GoldHigher<br/>SilverHigher<br/>Gold

# Higher Silver and Gold – GCSE Mathematics B J567

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

# CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

R111

# Unit R112 Quality control of engineered products

Add Sci

# LO4: Know the principles of lean manufacturing

Learners must be taught:

#### • causes of waste in manufacturing, ie

- o time
- o materials
- o resources
- o processes
- o supply
- o space

#### categories of waste (7 lean wastes -TIMWOOD),ie

- o Transportation
- o Inventory
- o Movement
- o Waiting
- o Over-processing
- o Overproduction
- o Defects

#### • methods of reducing waste, ie

- o Design for Manufacturing Assembly (DFMA)
- o sustainable design (eg material reduction, life cycle analysis, end-of-life disposal, recycled materials)

Foundation	Foundation	Foundation	Foundation	Higher	Higher
Initial	Bronze	Silver	Gold	Silver	Gold

# Foundation Initial – GCSE Mathematics B J567

Keywords/Themes Time, materials, resources, Life Cycle Analysis, Sustainable design, LEAN

Theme	Incorporates	
Understand how data analysed using lean manufacturing techniques reduces waste in manufacture including time and resources. [Indirect]	FSS3	Construct and interpret simple graphs, including conversion graphs.
	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.

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

Add Sci

# LO4: Know the principles of lean manufacturing

Learners must be taught:

#### causes of waste in manufacturing, ie

- o time
- o materials
- o resources
- o processes
- o supply
- o space

#### categories of waste (7 lean wastes -TIMWOOD),ie

- o Transportation
- o Inventory
- o Movement
- o Waiting
- o Over-processing
- o Overproduction
- o Defects

#### • methods of reducing waste, ie

- o Design for Manufacturing Assembly (DFMA)
- o sustainable design (eg material reduction, life cycle analysis, end-of-life disposal, recycled materials)

Foundation<br/>InitialFoundation<br/>BronzeFoundation<br/>SilverFoundation<br/>GoldHigher<br/>SilverHigher<br/>Gold

# Foundation Bronze – GCSE Mathematics B J567

Keywords/Themes Time, materials, resources, Life Cycle Analysis, Sustainable design, LEAN

Theme	Incorp	Incorporates	
Understand how data analysed using lean manufacturing techniques reduces waste in manufacture including time and resources. [Indirect]	FBA5	Interpret information presented in a range of linear and non-linear graphs, including travel (distance/time) graphs.	
	FBS3	Construct and interpret pie charts.	
	FBS4	Interpret graphs representing real data, including recognising misleading diagrams.	

R111

# CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

Add Sci

# LO4: Know the principles of lean manufacturing

Learners must be taught:

#### • causes of waste in manufacturing, ie

- o time
- o materials
- o resources
- o processes
- o supply
- o space

#### categories of waste (7 lean wastes -TIMWOOD),ie

- o Transportation
- o Inventory
- o Movement
- o Waiting
- o Over-processing
- o Overproduction
- o Defects

#### • methods of reducing waste, ie

- o Design for Manufacturing Assembly (DFMA)
- o sustainable design (eg material reduction, life cycle analysis, end-of-life disposal, recycled materials)

Foundation Foundation Foundation Foundation Higher Higher Gold Gold Gold

# Foundation Silver– GCSE Mathematics B J567

Keywords/Themes Time, materials, resources, Life Cycle Analysis, Sustainable design, LEAN

Theme	Incorporates	
Understand how data analysed using lean manufacturing techniques reduces waste in manufacture including time and resources. [Indirect]	FSS3	Draw and interpret a wide range of graphs and diagrams for discrete and continuous data, including frequency polygons and stem and leaf diagrams. Compare distributions and make inferences, using the shapes of the distributions and make and range.

R112

LO1

# CAMBRIDGE NATIONAL IN ENGINEERING

Science

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# **Unit R112 Quality control of** engineered products

Add Sci

#### LO4: Know the principles of lean manufacturing

Learners must be taught:

#### causes of waste in manufacturing, ie ٠

- time 0
- materials 0
- resources 0
- processes 0
- supply 0
- 0 space

#### • categories of waste (7 lean wastes -TIMWOOD),ie

- Transportation 0
- Inventory 0
- Movement 0
- Waiting 0
- 0 Over-processing
- Overproduction 0
- Defects 0

#### • methods of reducing waste, ie

- Design for Manufacturing Assembly (DFMA) 0
- sustainable design (eg material reduction, life 0 cycle analysis, end-of-life disposal, recycled materials)

Higher **Gold** Foundation Foundation Higher Silver Initial Silver Gold Bronze

# Foundation Gold–GCSE Mathematics B J567

Keywords/Themes Time, materials, resources, Life Cycle Analysis, Sustainable design, LEAN

Theme	Incorporates	
Understand how data analysed using lean manufacturing techniques reduces waste in manufacture including time and resources	FGA5	Draw and interpret graphs modelling real situations, which may be nonlinear, including simple quadratic graphs.
[Indirect]	FGS3	Draw and interpret scatter graphs for discrete and continuous variables, including using and understanding lines of best fit. Understand the vocabulary of correlation, including: positive, negative and zero correlation; weak, strong and moderate correlation. Look at data to find patterns and exceptions.

R111

LO<sub>2</sub>

LO1

Science

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

Add Sci

# LO4: Know the principles of lean manufacturing

Learners must be taught:

#### • causes of waste in manufacturing, ie

- o time
- o materials
- o resources
- o processes
- o supply
- o space

#### categories of waste (7 lean wastes -TIMWOOD),ie

- o Transportation
- o Inventory
- o Movement
- o Waiting
- o Over-processing
- o Overproduction
- o Defects

#### • methods of reducing waste, ie

- o Design for Manufacturing Assembly (DFMA)
- o sustainable design (eg material reduction, life cycle analysis, end-of-life disposal, recycled materials)

Foundation Foundation Foundation Bronze Foundation Gold Higher Gold

# Higher Silver– GCSE Mathematics B J567

Keywords/Themes Time, materials, resources, Life Cycle Analysis, Sustainable design, LEAN

Theme	Incorporates	
Understand how data analysed using lean manufacturing techniques reduces waste in manufacture including time and resources. [Indirect]	HSS1	Use tree diagrams to represent outcomes of combined events, recognising when events are independent. Find probabilities using tree diagrams.
	HSS2	Draw and interpret cumulative frequency tables and diagrams and box plots for grouped data. Find the median, quartiles and interquartile range.

R112

Science

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

Add Sci

# LO4: Know the principles of lean manufacturing

Learners must be taught:

#### • causes of waste in manufacturing, ie

- o time
- o materials
- o resources
- o processes
- o supply
- o space

#### categories of waste (7 lean wastes -TIMWOOD),ie

- o Transportation
- o Inventory
- o Movement
- o Waiting
- o Over-processing
- o Overproduction
- o Defects

#### • methods of reducing waste, ie

- o Design for Manufacturing Assembly (DFMA)
- o sustainable design (eg material reduction, life cycle analysis, end-of-life disposal, recycled materials)

Foundation Initial Foundation Foundation Bronze Silver Gold Higher Gold

### Higher Gold– GCSE Mathematics B J567

Keywords/Themes Time, materials, resources, Life Cycle Analysis, Sustainable design, LEAN

Theme	Incorp	Incorporates	
Understand how data analysed using lean manufacturing techniques reduces waste in manufacture including time and resources. [Indirect]	HGS2	Draw and interpret histograms for grouped data. Understand frequency density.	
	HGS3	Interpret and compare a wide range of data sets (including grouped discrete and continuous data) and draw conclusions.	

R112

R111

LO<sub>3</sub>

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842 - Maths, Science and ICT in Engineering

### **Unit R109 Engineering materials**, processes and production

Add Sci

#### LO1: Know about properties and uses of engineering materials

Learners must be taught:

- types of engineering materials
- new and emerging materials (eg nanotechnology; advanced metal alloys)
- properties of engineering materials
- materials testing processes
- characteristics of engineering materials
- uses of specific materials

Keywords/Themes Materials, metals, plastics, polymers, destructive and non-destructive testing

#### Additional Science B 2012 J262

#### Theme

Knows about the properties and uses of engineering materials, including metals, plastics polymers, ceramics, composites and smart materials. [Direct]

Science

Understands materials testing processes - including destructive and non-destructive testing. [Direct]

#### Incorporates

- C4g The Periodic Table (metals)
- C3h Chemical Economics (nanotubes and innovations)
- Radiation for Life (Ultrasound innovations and testing) P4d
- P4h Radiation for Life (Radioisotopes - use for testing)
- Radiation for Life (use of radiation for treatment innovations and testing) P4a

#### 21st Century Additional Science A 2012 J242

#### Theme

#### Incorporates

Knows about the properties and uses of engineering materials, including metals, plastics polymers, ceramics, composites and smart materials. [Direct]

Understands materials testing processes - including destructive and non-destructive testing. [Direct]

- Chemicals of the natural environment (metals) C5.3/
- C5.4

P6.2 Radioactive materials (innovation and testing)

**R109** 

R111

R110

R112

L01

LO2

LO<sub>3</sub>

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

### Unit R109 Engineering materials, processes and production

Add Sci

# LO2: Understand engineering processes and their application

Learners must be taught:

- basic engineering processes, ie
  - o material removal
  - o hand forming
  - o joining methods
  - o heat treatment
  - o surface finishing,

#### • machine processes, ie

- o material removal
- o forming
- o moulding
- safe use of tools and equipment, ie
  - o features and controls of machines
  - o risk assessment
  - o appropriate use of Personal Protective Equipment (PPE)
  - o safety precautions

Keywords/Themes Materials (processing), painting

Science

#### Additional Science B 2012 J262

#### Theme

#### Incorporates

Knows about the processing of materials, including surface finishing. [Direct]

- C4g The Periodic Table (metals)
- C3h Chemical Economics (nanotubes and innovations)
- C4g Radiation for Life (electrostatics painting)

#### 21st Century Additional Science A 2012 J242

#### Theme

#### Incorporates

- Knows about the processing of materials, including surface finishing. [Direct]
- **C5.3**/ Chemicals of the natural environment (metals) **C5.4**

R110

R111

R112

LO1

LO2

LO<sub>3</sub>

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

# Unit R109 Engineering materials, processes and production

Add Sci

# LO3: Know about developments in engineering processes

Learners must be taught:

- applications of computer controlled production processes, ie
  - o Computer Numerical Control (CNC) machining processes, ie
    - CNC lathes and milling/router machines
    - multi-axis machining centres
    - water jet cutting
    - punching machines
    - press brake machines
  - o laser applications, ie
  - o laser cutting/welding
- additive manufacturing and rapid prototyping processes, (eg Selective Laser Sintering (SLS); Stereolithography (SLA); Direct Metal Laser Sintering (DMLS); Fused Deposition Modelling (FDM)/3D printing; electron beam melting)

Keywords/Themes CNC machining, laser cutting, lasers

#### Additional Science B 2012 J262

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

#### 21st Century Additional Science A 2012 J242

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

R110

R112

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Science

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

### Unit R109 Engineering materials, processes and production

Add Sci

# LO4: Know about developments in engineering processes

Learners must be taught:

- the impact of modern technologies in engineering production, ie
  - o automation,processes
    - quality
    - workforce
    - costs
  - o digital communications, ie
    - uses in research and development
    - material supply and control
    - global manufacturing

Keywords/Themes Quality, costs, materials stock control, research (internet), CAD

#### Additional Science B 2012 J262

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

#### 21st Century Additional Science A 2012 J242

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



R112

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Science

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

# LO1: Be able to plan for the making of a pre-production product

Learners must be taught:

- interpretation of 2D and 3D engineering drawings, ie
  - o third angle orthographic projection

o isometric/oblique

- • standard drawing conventions on engineering drawings, ie
  - o sectional views
  - o exploded drawings
  - o detail views
  - o materials and components
  - o dimensions
  - o tolerances
  - o scale
  - o annotations
  - o revisions

#### production of plans for the making of a preproduction product, ie

o interpretation of the details and requirements of a pre-production product from engineering drawings

**R110** 

- o sequence of operations and time estimate
- o tools, equipment and processes
- o health and safety considerations
- o quality control checks

Keywords/Themes Drawings and views, dimensions, tolerance, scale. Materials, production plans: sequence, time, QC

#### GCSE Science B 2012 J261

#### Theme

#### Incorporates

Understand pre-production planning including the application of materials. [Direct]

- C4g The Periodic Table (metals)
- C3h Chemical Economics (nanotubes and innovations)

#### 21st Century Science A 2012 J241

#### Theme

#### Incorporates

Understand pre-production planning including the application of materials. [Direct]

**C5.3**/ Chemicals of the natural environment (metals) **C5.4** 

R111

R112

LO1

# CAMBRIDGE NATIONAL IN ENGINEERING

**Science** 

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

#### LO2: Be able to use processes, tools and equipment safely to make a preproduction product

Learners must be taught:

- appropriate processes for making preproduction products, ie
  - o bench work and hand-held tools
  - o manually controlled machining operations, eg
- how to use tools and equipment when making products, ie
  - o bench work
  - o setting of machines/equipment, eg
- how to follow safe working procedures when using tools and equipment
- how to use appropriate use Personal Protective Equipment (PPE) appropriately material removal

**R110** 

- use of appropriate quality control checks to review finished pre-production products, ie
  - o compare against engineering drawings
  - o important dimensions
  - o tolerances
  - o finish

Keywords/Themes Quality, costs, materials stock control, research (internet), CAD

#### GCSE Science B 2012 J261

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

#### 21st Century Science A 2012 J241

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



9

R111

LO<sub>2</sub>

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# Unit R110 Preparing and planning for manufacture

Add Sci

# LO3: Be able to modify a production plan for different scales of production

Learners must be taught:

- consideration of scales of manufacture, ie
  - o one-off/job production

o batch production

- o mass production
- impact of quantities of production on production plans, ie
  - o processes
  - o sequence of individual operations

o timing of stages

- o health and safety considerations
- o quality control checks
- o suggested modifications

Keywords/Themes Scale of manufacture (batch etc.)

Science

#### GCSE Science B 2012 J261

#### Theme

Incorporates

Understand commercial production methods (scale of production). [Indirect] C3g Chemical Economics (batch and continuous manufacture)

#### 21st Century Science A 2012 J241

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

R110

R111

LO3

**C**ambridge

NATIONALS

Science

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

### Unit R111 Computer aided manufacturing

#### LO1: Be able to plan the production of components on Computer Numerical Control (CNC) machines

Learners must be taught:

 factors to consider when producing plans for CNC machining operations in the production of components, ie

Add Sci

- o planning of operations, ie
  - sequence of operations
  - tool changes
- o scale of manufacture waste minimisation
  - one-off
  - batch
  - mass production
- o type of machine ie
  - milling machines
  - turning centres
  - fabrication machines
- o tools required, ie
  - setting tools (eg spanners; Allen keys; clamps)
  - machining tools (eg drills; turning tools; end-mills)

R110

R111

- cutting tools (eg cutting blades, CNC router)
- o materials, ie
- o speeds and feeds for the size and type of materials

Keywords/Themes Scale of manufacture (batch etc), waste minimisation, materials

#### GCSE Science B 2012 J261

#### Theme

Incorporates

Knows materials planning for CNC production.

Understand commercial production methods (scale of production) relevant to CNC machining and waste minimisation. [Indirect] C3g Chemical Economics (batch and continuous manufacture)

#### 21st Century Science A 2012 J241

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

R112

LO2

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

### Unit R111 Computer aided manufacturing

#### LO2: Be able to interpret information from CAD to manufacture components on CNC equipment

Add Sci

Learners must be taught:

- use of Computer Aided Design (CAD) packages, ie
  - export drawing information to CNC machineson-screen simulation
- factors to consider when performing CNC machine programming operations, ie
  - o setting datum points
  - o co-ordinates (absolute and incremental)
  - o tool change-over
  - o tool offsets
  - o language (eg G-codes)

Keywords/Themes CAD and drawings, CNC: datums, co-ordinates

#### GCSE Science B 2012 J261

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

#### 21st Century Science A 2012 J241

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



R110

R111

LO1

LO2

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LO3

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

### Unit R111 Computer aided manufacturing

#### LO3: Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components

Add Sci

Learners must be taught:

- procedures for setting up CNC equipment, ie
  - o tooling
  - o work holding
  - o computer interface
  - o safety procedures
- procedures to produce products to required specification, ie
  - o initial setting
  - o safe use, ie
    - potential hazards
    - appropriate Personal Protective Equipment
- methods used to compare items manufactured by manually controlled and CNC production, ie
  - o visual (eg standard of finish)
  - o dimensional (eg accuracy component tolerance)
  - o cycle time (eg assembly)
  - o consistency (eg batch tolerance)

Keywords/Themes Dimensions and tolerance

#### GCSE Science B 2012 J261

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

#### 21st Century Science A 2012 J241

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

R110

R112

LO3

LO<sub>2</sub>

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

### Unit R111 Computer aided manufacturing

# LO4: Know about applications of computer control processes used to manufacture products

Add Sci

Learners must be taught:

#### • applications of computer control, ie

- o rapid prototyping, ie
  - laminating
  - 3D printing
  - stereo lithography
  - laser sintering
- o o manufacturing processes, ie
  - CNC machining
  - additive manufacturing
- o o robotics, ie
  - welding
  - riveting
  - pick-and-place assembly
- computer controlled processes used for different scales of manufacture, ie
  - o one-off/prototype manufacture
  - o batch production
  - o high-volume manufacturing

Keywords/Themes Lasers (in manufacture), additives, scale of manufacture (batch etc)

#### GCSE Science B 2012 J261

#### Theme

Incorporates

Understands how technologies, such as lasers, are used in computer-controlled engineering processes.

Science

Understand commercial production methods (scale of production) relevant to CNC machining processes. [Indirect] C3g Chemical Economics (batch and continuous manufacture)

#### 21st Century Science A 2012 J241

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



R111

R112

LO<sub>3</sub>

# CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** - Maths, Science and ICT in Engineering

### **Unit R112 Quality control of** engineered products

#### LO1: Understand the importance of quality control

Add Sci

Learners must be taught:

- reasons for implementing quality control in • production, ie
  - early intercept (eg problems in production) 0
  - waste management (eg reduce production 0 waste)
  - consistency (eg finished products) 0
  - reduce costs (eg materials time) 0
  - conformity (eq industry standards regulations) 0
  - reduce returns (eq reputation customer 0 perception)

#### • quality procedures, ie ٠

- guality control 0
- quality standards 0
- 0 quality assurance
- total quality management 0

Keywords/Themes Wastes management, reduce costs

Science

#### GCSE Science B 2012 J261

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

#### 21st Century Science A 2012 J241

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



R111

R110

LO<sub>2</sub>

LO4

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

# LO2: Be able to assess product quality from inspection and quality control techniques

Add Sci

Learners must be taught:

- quality control techniques used in stages of production
- application of basic inspection checks in stages of production
- use of inspection equipment in stages of production
- techniques for evaluating product from quality control checks

R110

Keywords/Themes Tolerance, sampling, comparison, measuring – dimensions, Xrays and ultrasonics

#### GCSE Science B 2012 J261

#### Theme

#### Incorporates

Understand quality control techniques, such as the use of x-rays and ultrasonic testing. [Direct]

Science

- **P4d** Radiation for Life (Ultrasound innovations and testing)
- **P4h** Radiation for Life (Radioisotopes use for testing)
- P4g Radiation for Life (use of radiation for treatment innovations and testing)

#### 21st Century Science A 2012 J241

#### Theme

#### Incorporates

- Understand quality control techniques, such as the use of x-rays and ultrasonic testing. [Direct]
- **P6.2** Radioactive materials (innovation and testing)



)9

R111

R112

LO1

LO2

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LO3

L04

ICT

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

# **Unit R112 Quality control of** engineered products

#### LO3: Know how modern technologies can be used in quality control

Add Sci

Learners must be taught:

- applications of modern technologies, ie •
  - non-destructive testing (eg visual inspection; 0 ultrasonic testing; dye
  - penetrant; X-ray crack testing) 0
  - 3D scanning 0
  - CNC measurement checks 0
  - use of robotics 0
  - 0 application within Computer Integrated Engineering (CIE)/Computer Integrated Manufacture (CIM)
  - automatic inspection/rejection 0

#### Keywords/Themes NDT: xray, ultrasonics, CNC measurements

#### GCSE Science B 2012 J261

#### Theme

#### Incorporates

Understand modern inspection techniques, including the use of x-rays and ultrasonic testing. [Direct]

Science

- P4d Radiation for Life (Ultrasound – innovations and testing)
- Radiation for Life (Radioisotopes use for testing) P4h
- P4q Radiation for Life (use of radiation for treatment - innovations and testing)

#### 21st Century Science A 2012 J241

#### Theme

#### Incorporates

- Understand modern inspection techniques, including the use of x-rays and ultrasonic testing. [Direct]
- Radioactive materials (innovation and testing) P6.2

R110

R111

R112

LO1

LO2

LO<sub>3</sub>

# CAMBRIDGE NATIONAL IN ENGINEERING

Science

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

### Unit R112 Quality control of engineered products

Add Sci

# LO4: Know the principles of lean manufacturing

Learners must be taught:

#### • causes of waste in manufacturing, ie

- o time
- o materials
- o resources
- o processes
- o supply
- o space

#### categories of waste (7 lean wastes -TIMWOOD),ie

- o Transportation
- o Inventory
- o Movement
- o Waiting
- o Over-processing
- o Overproduction
- o Defects

#### • methods of reducing waste, ie

- o Design for Manufacturing Assembly (DFMA)
- o sustainable design (eg material reduction, life cycle analysis, end-of-life disposal, recycled materials)

Keywords/Themes Time, materials, resources, Life Cycle Analysis, Sustainable design, LEAN

#### GCSE Science B 2012 J261

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

#### 21st Century Science A 2012 J241

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



LO4

LO<sub>3</sub>
## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

Unit R109 Engineering materials, processes and production

# LO1: Know about properties and uses of engineering materials

Learners must be taught:

- types of engineering materials
- new and emerging materials (eg nanotechnology; advanced metal alloys)
- properties of engineering materials
- materials testing processes
- characteristics of engineering materials
- uses of specific materials

Keywords/Themes Materials; metals, plastics, polymers, destructive and non-destructive testing

#### GCSE Physics B 2012 J265

Theme	Incor	porates
Knows about the properties and uses of engineering materials, including metals, plastics polymers, ceramics, composites and smart materials.		
Understands materials testing processes – including destructive and non-destructive testing. [Direct]	P4f	Uses of radioisotopes (used for testing)

#### 21st Century Physics A 2012 J245

Theme	Incorporates
Knows about the properties and uses of engineering materials, including metals, plastics polymers, ceramics, composites and smart materials.	
Understands materials testing processes – including destructive and non-destructive testing. [Direct]	<ul><li>P2.2, Radiation for life (used for testing)</li><li>P2.4</li></ul>

**R109** 

R111

R110

R112

LO1

LO2

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R109 Engineering materials, processes and production

# LO2: Understand engineering processes and their application

Learners must be taught:

- basic engineering processes, ie
  - o material removal
  - o hand forming
  - o joining methods
  - o heat treatment
  - o surface finishing,

#### • machine processes, ie

- o material removal
- o forming
- o moulding
- safe use of tools and equipment, ie
  - o features and controls of machines
  - o risk assessment
  - o appropriate use of Personal Protective Equipment (PPE)

R110

o safety precautions

Keywords/Themes Materials (processing), painting

## GCSE Physics B 2012 J265

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

#### 21st Century Physics A 2012 J245

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

R112

**LO2** 

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

## Unit R109 Engineering materials, processes and production

# LO3: Know about developments in engineering processes

Learners must be taught:

- applications of computer controlled production processes, ie
  - o Computer Numerical Control (CNC) machining processes, ie
    - CNC lathes and milling/router machines
    - multi-axis machining centres
    - water jet cutting
    - punching machines
    - press brake machines
  - o laser applications, ie
  - o laser cutting/welding
- additive manufacturing and rapid prototyping processes, (eg Selective Laser Sintering (SLS); Stereolithography (SLA); Direct Metal Laser Sintering (DMLS); Fused Deposition Modelling (FDM)/3D printing; electron beam melting)

Keywords/Themes CNC machining, laser cutting, lasers

## GCSE Physics B 2012 J265

Theme	Incorp	porates
Understands how technologies, such as lasers, have contributed to developments in engineering processes. [Direct]	P1d	Light and Lasers

#### 21st Century Physics A 2012 J245

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

R110

R111

R112

LO1

LO2

LO3

L04

## CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R109 Engineering materials, processes and production

# LO4: Know about developments in engineering processes

Learners must be taught:

- the impact of modern technologies in engineering production, ie
  - o automation, processes
    - quality
    - workforce
    - costs
  - o digital communications, ie
    - uses in research and development
    - material supply and control
    - global manufacturing

Keywords/Themes Materials (processing), painting

### GCSE Physics B 2012 J265

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

#### 21st Century Physics A 2012 J245

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



R112

## CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R110 Preparing and planning for manufacture

# LO1: Be able to plan for the making of a pre-production product

Learners must be taught:

- interpretation of 2D and 3D engineering drawings, ie
  - o third angle orthographic projection
  - o isometric/oblique
- standard drawing conventions on engineering drawings, ie
  - o sectional views
  - o exploded drawings
  - o detail views
  - o materials and components
  - o dimensions
  - o tolerances
  - o scale
  - o annotations
  - o revisions

#### production of plans for the making of a preproduction product, ie

- o interpretation of the details and requirements of a pre-production product from engineering drawings
- o sequence of operations and time estimate
- o tools, equipment and processes
- o health and safety considerations
- o quality control checks

Keywords/Themes Drawings and views; dimensions, tolerance, scale; Materials

## GCSE Physics B 2012 J265

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

#### 21st Century Physics A 2012 J245

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



R111

R112

LO1

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R110 Preparing and planning for manufacture

#### LO2: Be able to use processes, tools and equipment safely to make a preproduction product

Learners must be taught:

- appropriate processes for making preproduction products, ie
  - o bench work and hand-held tools
  - o manually controlled machining operations, eg
- how to use tools and equipment when making products, ie
  - o bench work
  - o setting of machines/equipment, eg
- how to follow safe working procedures when using tools and equipment
- how to use appropriate use Personal Protective Equipment (PPE) appropriately material removal
- use of appropriate quality control checks to review finished pre-production products, ie
  - o compare against engineering drawings
  - o important dimensions
  - o tolerances
  - o finish

Keywords/Themes Measuring, marking out; QC: compare, tolerances

## GCSE Physics B 2012 J265

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

#### 21st Century Physics A 2012 J245

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

R110

R111

R112

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R110 Preparing and planning for manufacture

LO3: Be able to modify a production plan for different scales of production

Learners must be taught:

- consideration of scales of manufacture, ie
  - o one-off/job production
  - o batch production
  - o mass production
- impact of quantities of production on production plans, ie
  - o processes
  - o sequence of individual operations

o timing of stages

- o health and safety considerations
- o quality control checks
- o suggested modifications

Keywords/Themes Measuring, marking out; QC: compare, tolerances

## GCSE Physics B 2012 J265

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

#### 21st Century Physics A 2012 J245

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

R109

R110

R111

LO3

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

Unit R111 Computer aided manufacturing

#### LO1: Be able to plan the production of components on Computer Numerical Control (CNC) machines

Learners must be taught:

- factors to consider when producing plans for CNC machining operations in the production of components, ie
  - o planning of operations, ie
    - sequence of operations
    - tool changes
  - o scale of manufacture waste minimisation
    - one-off
    - batch
    - mass production
  - o type of machine ie
    - milling machines
    - turning centres
    - fabrication machines
  - o tools required, ie
    - setting tools (eg spanners; Allen keys; clamps)
    - machining tools (eg drills; turning tools; end-mills)

R110

- cutting tools (eg cutting blades, CNC router)
- o materials, ie
- o speeds and feeds for the size and type of materials

Keywords/Themes Scale of manufacture (batch etc), waste minimisation, materials

P1h

## GCSE Physics B 2012 J265

Theme

Incorporates

# Knows materials planning for CNC production.

Understand commercial production methods (scale of production) relevant to CNC machining and waste minimisation. [Indirect]

- P2aP1h: Stable Earth (ozone)P2bGenerating electricityP2cGlobal warmingP2dFuels for powerP2eNuclear radiations
- P4h Fission and fusion (energy generation)

Uses of radioisotopes (used for testing)

#### 21st Century Physics A 2012 J245

# Theme Incorporates Knows materials planning for CNC production. P2.3 Radiation for life (used for testing) Understand commercial production methods (scale of production) relevant to CNC machining and waste minimisation. [Indirect] P2.4 Sustainable energy

R109

R111

R112

LO1

LO2

LO<sub>3</sub>

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R111 Computer aided manufacturing

LO2: Be able to interpret information from CAD to manufacture components on CNC equipment

Learners must be taught:

- use of Computer Aided Design (CAD) packages, ie
  - export drawing information to CNC machineson-screen simulation
- factors to consider when performing CNC machine programming operations, ie
  - o setting datum points
  - o co-ordinates (absolute and incremental)
  - o tool change-over
  - o tool offsets
  - o language (eg G-codes)

Keywords/Themes CAD and drawings, CNC: datums, co-ordinates

### GCSE Physics B 2012 J265

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

#### 21st Century Physics A 2012 J245

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

R110

R111

R112

LO1

LO<sub>2</sub>

# ICT

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R111 Computer aided manufacturing

#### LO3: Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components

Learners must be taught:

- procedures for setting up CNC equipment, ie
  - o tooling
  - o work holding
  - o computer interface
  - o safety procedures
- procedures to produce products to required specification, ie
  - o initial setting
  - o safe use, ie
    - potential hazards
    - appropriate Personal Protective Equipment

R110

- methods used to compare items manufactured by manually controlled and CNC production, ie
  - o visual (eg standard of finish)
  - o dimensional (eg accuracy component tolerance)
  - o cycle time (eg assembly)
  - o consistency (eg batch tolerance)

Keywords/Themes CAD and drawings, CNC: datums, co-ordinates

### GCSE Physics B 2012 J265

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

#### 21st Century Physics A 2012 J245

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



R111

LO4

## CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

## Unit R111 **Computer aided** manufacturing

LO4: Know about applications of computer control processes used to manufacture products

Learners must be taught:

- applications of computer control, ie
  - 0 rapid prototyping, ie
    - laminating -
    - 3D printing
    - stereo lithography
    - laser sintering
  - o manufacturing processes, ie 0
    - **CNC** machining
    - additive manufacturing
  - o robotics, ie 0
    - welding
    - riveting
    - pick-and-place assembly
- computer controlled processes used for different scales of manufacture, ie
  - one-off/prototype manufacture 0
  - batch production 0
  - high-volume manufacturing 0

Keywords/Themes Lasers (in manufacture), additives; Scale of manufacture (batch etc)

## GCSE Physics B 2012 J265

Theme	Incorp	porates
Understands how technologies, such as lasers, are used in computer-controlled engineering processes. [Direct]	P1d	Light and Lasers
Understand commercial production methods (scale of production) relevant to CNC machining processes.		

#### 21st Century Physics A 2012 J245

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



R112

R111

LO1

## CAMBRIDGE NATIONAL IN ENGINEERING

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

## **Unit R112 Quality control of** engineered products

#### LO1: Understand the importance of quality control

Learners must be taught:

- reasons for implementing quality control in • production, ie
  - early intercept (eg problems in production) 0
  - waste management (eg reduce production 0 waste)
  - consistency (eg finished products) 0
  - reduce costs (eq materials time) 0
  - conformity (eq industry standards regulations) 0
  - reduce returns (eq reputation customer 0 perception)

#### • quality procedures, ie •

- guality control 0
- quality standards 0
- 0 quality assurance
- total quality management 0

Keywords/Themes Wastes management; Reduce costs

## GCSE Physics B 2012 J265

Theme	Incorpo	prates
Understand the significance of quality	P1h	Stable Earth (ozone)
and cost. [indirect]	P2a	Collecting energy from the Sun
	P2b	Generating electricity
	P2c	Global warming
	P2d	Fuels for power
	P2e	Nuclear radiations
	P4h	Fission and fusion (energy generation)

## 21st Century Physics A 2012 J245

Theme	Incorpo	orates
Understand the significance of quality	P2.3	Radiation and life (global warming)
and cost. [indirect]	P3.3	Sustainable energy

R109

R111

R112

L01

LO2

LO3

## CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842 - Maths, Science and ICT in Engineering

## **Unit R112 Quality control of** engineered products

#### LO2: Be able to assess product quality from inspection and quality control techniques

Learners must be taught:

- quality control techniques used in stages of • production
- application of basic inspection checks in stages • of production
- use of inspection equipment in stages of • production
- techniques for evaluating product from quality • control checks

R110

Keywords/Themes Tolerance, sampling, comparison; Measuring – dimensions; Xrays and ultrasonics

### GCSE Physics B 2012 J265

Theme	Incorp	porates	
Understand quality control techniques, such as the use of x-rays and ultrasonic testing. [Direct]	P4f	Uses of radioisotopes (used for testing)	

#### 21st Century Physics A 2012 J245

Theme	Incorp	porates
Understand quality control techniques, such as the use of x-rays and ultrasonic testing. [Direct]	P2.2, P2.4	Radiation for life (used for testing)

R109

R111

R112

LO1

LO<sub>2</sub>

LO3

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

## Unit R112 Quality control of engineered products

# LO3: Know how modern technologies can be used in quality control

Learners must be taught:

- applications of modern technologies, ie
  - o non-destructive testing (eg visual inspection; ultrasonic testing; dye
  - o penetrant; X-ray crack testing)
  - o 3D scanning
  - o CNC measurement checks
  - o use of robotics
  - o application within Computer Integrated Engineering (CIE)/Computer Integrated Manufacture (CIM)
  - o automatic inspection/rejection

Keywords/Themes NDT: xray, ultrasonics, CNC measurements

## GCSE Physics B 2012 J265

Theme	Incorp	porates
Understand modern inspection techniques, including the use of x-rays and ultrasonic testing. [Direct]	P4f	Uses of radioisotopes (used for testing)

## 21st Century Physics A 2012 J245

Theme	Incorp	porates
Understand modern inspection techniques, including the use of x-rays and ultrasonic testing. [Direct]	P2.2, P2.4	Radiation for life (used for testing)

R111

R112

## CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842 - Maths, Science and ICT in Engineering

R111

## **Unit R112 Quality control of** engineered products

#### LO4: Know the principles of lean manufacturing

Learners must be taught:

- causes of waste in manufacturing, ie
  - time 0
  - materials 0
  - resources 0
  - processes 0
  - supply 0
  - space 0
- categories of waste (7 lean wastes -TIMWOOD),ie
  - Transportation 0
  - Inventory 0
  - Movement 0
  - Waiting 0
  - 0 Over-processing
  - Overproduction 0
  - Defects 0

#### methods of reducing waste, ie

- Design for Manufacturing Assembly (DFMA) 0
- sustainable design (eg material reduction, life 0 cycle analysis, end-of-life disposal, recycled materials)

Keywords/Themes Time, materials, resources; Life Cycle Analysis; Sustainable design, LEAN

## GCSE Physics B 2012 J265

#### Theme

Incorporates

#### Understand life cycle analysis.

Understand how sustainable (LEAN) design and manufacturing contributes to reducing waste (eg production and material waste, end of life disposal, recyclability). [Direct]

P1h	Stable Earth (ozone)
P2a	Collecting energy from the Sun
P2b	Generating electricity
P2c	Global warming
P2d	Fuels for power
<b>D</b> 2	

#### P2e Nuclear radiations

P4h Fission and fusion (energy generation)

LO1

## 21st Century Physics A 2012 J245

R112

#### Theme Incorporates Understand how sustainable (LEAN) P2.3 Radiation and life (global warming) design and manufacturing contributes P3.3 Sustainable energy to reducing waste (eg production and material waste, end of life disposal, recyclability). [Direct]

R109

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

## Unit R109 Engineering materials, processes and production

# LO1: Know about properties and uses of engineering materials

Learners must be taught:

- types of engineering materials
- new and emerging materials (eg nanotechnology; advanced metal alloys)
- properties of engineering materials
- materials testing processes
- characteristics of engineering materials
- uses of specific materials

Keywords/Themes Materials; metals, plastics, polymers; destructive and non-destructive testing

### GCSE Science B 2012 J261

#### Theme Incorporates Knows about the properties and uses C1d Making polymers of engineering materials, including C1e Designer polymers metals, plastics polymers, ceramics, composites and smart materials. C1h Paints and pigments [Direct] C2b Construction materials C2c Metals and alloys C2d Making cars Understands materials testing

processes – including destructive and non-destructive testing.

## 21st Century Science A 2012 J241

Theme	Incorporates
Knows about the properties and uses of engineering materials, including metals, plastics polymers, ceramics, composites and smart materials. [Direct]	roperties and uses of C2.1, Material Choices als, including metals, C2.2, eramics, composites C2.3, s. [Direct] C2.4
Inderstands materials testing processes – including destructive and non-destructive testing.	ials testing ng destructive and sting.

**R109** 

R110

LO1

LO2

# CAMBRIDGE NATIONAL IN ENGINEERING

Theme

[Direct]

**Engineering Manufacture J832/J842** 

- Maths, Science and ICT in Engineering

## **Unit R109 Engineering materials**, processes and production

#### LO2: Understand engineering processes and their application

Learners must be taught:

- basic engineering processes, ie
  - material removal 0
  - hand forming 0
  - joining methods 0
  - heat treatment 0
  - surface finishing, 0
- machine processes, ie
- material removal 0
- forming 0
- moulding 0

#### safe use of tools and equipment, ie ٠

- features and controls of machines 0
- risk assessment 0
- appropriate use of Personal Protective 0 Equipment (PPE)
- safety precautions 0

Keywords/Themes Materials (processing), painting

## GCSE Science B 2012 J261

#### Incorporates Knows about the processing of C1d Making polymers materials, including surface finishing. C1e Designer polymers C1h Paints and pigments C2b Construction materials C2c Metals and alloys C2d Making cars

#### 21st Century Science A 2012 J241

Theme	Incorporates	
Knows about the processing of materials, including surface finishing. [Direct]	C2.1, Material Choices C2.2, C2.3, C2.4	

**R109** 

R110

R111

R112

LO1

LO<sub>2</sub>

LO3

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R109 Engineering materials, processes and production

Add Sci

# LO3: Know about developments in engineering processes

Learners must be taught:

- applications of computer controlled production processes, ie
  - o Computer Numerical Control (CNC) machining processes, ie
    - CNC lathes and milling/router machines
    - multi-axis machining centres
    - water jet cutting
    - punching machines
    - press brake machines
  - o laser applications, ie
  - o laser cutting/welding

#### additive manufacturing and rapid prototyping processes, (eg Selective Laser Sintering (SLS); Stereolithography (SLA); Direct Metal Laser Sintering (DMLS); Fused Deposition Modelling (FDM)/3D printing; electron beam melting)

R110

Keywords/Themes CNC machining, laser cutting, lasers

**Science** 

## GCSE Science B 2012 J261

#### Theme

Incorporates

Understands how technologies, such as lasers, have contributed to developments in engineering processes.

#### 21st Century Science A 2012 J241

Incorporates

Understands how technologies, such as lasers, have contributed to developments in engineering processes.

Theme

#### R109

R111

R112

LO1

LO2

LO3

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R109 Engineering materials, processes and production

Add Sci

# LO4: Know about developments in engineering processes

Learners must be taught:

- the impact of modern technologies in engineering production, ie
  - o automation, processes
    - quality
    - workforce
    - costs
  - o digital communications, ie
    - uses in research and development
    - material supply and control
    - global manufacturing

Keywords/Themes Quality, costs, materials stock control. Research (internet), CAD

#### GCSE Science B 2012 J261

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

#### 21st Century Science A 2012 J241

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

R111

R112

# CAMBRIDGE NATIONAL IN ENGINEERING

Theme

[Direct]

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

## Unit R110 **Preparing and planning** for manufacture

#### LO1: Be able to plan for the making of a pre-production product

Learners must be taught:

- interpretation of 2D and 3D engineering • drawings, ie
  - third angle orthographic projection 0
  - isometric/oblique 0
- standard drawing conventions on engineering drawings, ie
  - sectional views 0
  - exploded drawings 0
  - detail views 0
  - materials and components 0
  - dimensions 0
  - tolerances 0
  - scale 0
  - 0 annotations
  - revisions 0

#### production of plans for the making of a pre-٠ production product, ie

interpretation of the details and requirements 0 of a pre-production product from engineering drawings

**R110** 

- sequence of operations and time estimate 0
- tools, equipment and processes 0
- health and safety considerations 0
- quality control checks 0

Keywords/Themes Drawings and views. Dimensions, tolerance, scale, materials, production plans: sequence, time, QC

## GCSE Science B 2012 J261

#### Incorporates Understand pre-production planning C1d Making polymers including the application of materials. C1e Designer polymers C1h Paints and pigments C2b Construction materials C2c Metals and alloys C2d Making cars

## 21st Century Science A 2012 J241

Theme	Incorporates	
Understand pre-production planning including the application of materials. [Direct]	C2.1, C2.2, C2.3, C2.4	Material Choices

R111

R112

LO1

## CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R110 Preparing and planning for manufacture

#### LO2: Be able to use processes, tools and equipment safely to make a preproduction product

Learners must be taught:

- appropriate processes for making preproduction products, ie
  - o bench work and hand-held tools
  - o manually controlled machining operations, eg
- how to use tools and equipment when making products, ie
  - o bench work
  - o setting of machines/equipment, eg
- how to follow safe working procedures when using tools and equipment
- how to use appropriate use Personal Protective Equipment (PPE) appropriately material removal

**R110** 

- use of appropriate quality control checks to review finished pre-production products, ie
  - o compare against engineering drawings
  - o important dimensions
  - o tolerances
  - o finish

Keywords/Themes Measuring, marking out. QC: compare, tolerances

### GCSE Science B 2012 J261

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

#### 21st Century Science A 2012 J241

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

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

## Unit R110 Preparing and planning for manufacture

#### LO3: Be able to modify a production plan for different scales of production

Learners must be taught:

- consideration of scales of manufacture, ie
  - o one-off/job production

o batch production

- o mass production
- impact of quantities of production on production plans, ie
  - o processes
  - o sequence of individual operations
  - o timing of stages
  - o health and safety considerations
  - o quality control checks
  - o suggested modifications

Keywords/Themes Drawings and views. Dimensions, tolerance, scale, materials, production plans: sequence, time, QC

## GCSE Science B 2012 J261

Theme

Incorporates

Understand commercial production methods (scale of production).

## 21st Century Science A 2012 J241

Incorporates

Understand commercial production methods (scale of production).

R109

R110

R111

Theme

LO<sub>3</sub>

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

## Unit R111 Computer aided manufacturing

#### LO1: Be able to plan the production of components on Computer Numerical Control (CNC) machines

Learners must be taught:

- factors to consider when producing plans for CNC machining operations in the production of components, ie
  - o planning of operations, ie
    - sequence of operations
    - tool changes
  - o scale of manufacture waste minimisation
    - one-off
    - batch
    - mass production
  - o type of machine ie
    - milling machines
    - turning centres
    - fabrication machines
  - o tools required, ie
    - setting tools (eg spanners; Allen keys; clamps)
    - machining tools (eg drills; turning tools; end-mills)

R110

- cutting tools (eg cutting blades, CNC router)
- o materials, ie
- o speeds and feeds for the size and type of materials

Keywords/Themes Scale of manufacture (batch etc), Waste minimisation, Materials

heme	Incorp	Incorporates		
Knows materials planning for CNC	C1d	Making polymers		
production. [Direct]	C1e	Designer polymers		
	C1h	Paints and pigments		
	C2b	Construction materials		
	C2c	Metals and alloys		
	C2d	Making cars		
Understand commercial production methods (scale of production) relevant to CNC machining and waste minimisation. [Indirect]	C1a	Making crude oil useful		
	C1b	Using carbon fuels		
	C1c	Clean air		
	P2a	Collecting energy from the Sun		
	P2b	Generating electricity		
	P2c	Global warming		
	P2d	Fuels for power		
	P2e	Nuclear radiations		
	P1h	Stable Earth		
	B2g	Population and pollution		
	B2h	Sustainability		

R109

R111

R112

LO1

LO3

LO<sub>2</sub>

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

## Unit R111 Computer aided manufacturing

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    - tool changes
  - o scale of manufacture waste minimisation
    - one-off
    - batch
    - mass production
  - o type of machine ie
    - milling machines
    - turning centres
    - fabrication machines
  - o tools required, ie
    - setting tools (eg spanners; Allen keys; clamps)
    - machining tools (eg drills; turning tools; end-mills)

R110

- cutting tools (eg cutting blades, CNC router)
- o materials, ie
- o speeds and feeds for the size and type of materials

Keywords/Themes Scale of manufacture (batch etc), Waste minimisation, Materials

#### GCSE Science B 2012 J261 21st Century Science A 2012 J241 Theme Incorporates Knows materials planning for CNC C2.1, C2.2, production. [Direct] Material Choices C2.3, C2.4 Understand commercial production C1.2, Air Quality methods (scale of production) C1.2 relevant to CNC machining and waste P2.2, Radiation and life (Global Warming, Ozone layer) minimisation. [Indirect] P2.3 P3.1, Sustainable energy P3.2, P3.3

R109

R111

R112

LO1

LO2

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R111 Computer aided manufacturing

LO2: Be able to interpret information from CAD to manufacture components on CNC equipment

Add Sci

Learners must be taught:

- use of Computer Aided Design (CAD) packages, ie
  - o export drawing information to CNC machines o on-screen simulation
- factors to consider when performing CNC machine programming operations, ie
  - o setting datum points
  - o co-ordinates (absolute and incremental)
  - o tool change-over
  - o tool offsets
  - o language (eg G-codes)

Keywords/Themes CAD and drawings, CNC: datums, co-ordinates

### GCSE Science B 2012 J261

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

#### 21st Century Science A 2012 J241

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

R109

R110

R111

R112

LO1

LO<sub>2</sub>

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LO3

## CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R111 Computer aided manufacturing

LO3: Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components

Add Sci

Learners must be taught:

- procedures for setting up CNC equipment, ie
  - o tooling
  - o work holding
  - o computer interface
  - o safety procedures
- procedures to produce products to required specification, ie
  - o initial setting
  - o safe use, ie
    - potential hazards
    - appropriate Personal Protective Equipment
- methods used to compare items manufactured by manually controlled and CNC production, ie
  - o visual (eg standard of finish)
  - o dimensional (eg accuracy component tolerance)
  - o cycle time (eg assembly)
  - o consistency (eg batch tolerance)

Keywords/Themes Dimensions and tolerance

## GCSE Science B 2012 J261

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

#### 21st Century Science A 2012 J241

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

R110

R111

R112

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

– Maths, Science and ICT in Engineering

## Unit R111 Computer aided manufacturing

# LO4: Know about applications of computer control processes used to manufacture products

Learners must be taught:

- applications of computer control, ie
  - o rapid prototyping, ie
    - laminating
    - 3D printing
    - stereo lithography
    - laser sintering
  - o o manufacturing processes, ie
    - CNC machining
    - additive manufacturing
  - o o robotics, ie
    - welding
    - riveting
    - pick-and-place assembly

#### computer controlled processes used for different scales of manufacture, ie

- o one-off/prototype manufacture
- o batch production
- o high-volume manufacturing

Keywords/Themes Lasers (in manufacture), additives, scale of manufacture (batch etc)

## GCSE Science B 2012 J261

 Theme
 Incorporates

 Understands how technologies, such as lasers, are used in computer-controlled engineering processes.
 Image: Computer - Controlled engineering processes.

 Understand commercial production methods (scale of production) relevant to CNC machining processes.
 Image: Computer - Controlled engineering processes.

## 21st Century Science A 2012 J241

Theme	Incorporates
Understands how technologies, such as lasers, are used in computer-controlled engineering processes.	
Understand commercial production methods (scale of production) relevant to CNC machining processes.	

LO1

R111

R112

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Theme

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

## Unit R112 Quality control of engineered products

# LO1: Understand the importance of quality control

Learners must be taught:

- reasons for implementing quality control in production, ie
  - o early intercept (eg problems in production)
  - o waste management (eg reduce production waste)
  - o consistency (eg finished products)
  - o reduce costs (eg materials time)
  - o conformity (eg industry standards regulations)
  - o reduce returns (eg reputation customer perception)
- quality procedures, ie
  - o quality control
  - o quality standards
  - o quality assurance
  - o total quality management

Keywords/Themes Wastes management, reduce costs

#### GCSE Science B 2012 J261

#### 21st Century Science A 2012 J241

# Understand the significance of quality control in the minimisation of waste and cost. [Indirect]

C1a	Making crude oil useful
C1b	Using carbon fuels
C1c	Clean air
P2a	Collecting energy from the Sun
P2b	Generating electricity
P2c	Global warming
P2d	Fuels for power
P2e	Nuclear radiations
P1h	Stable Earth
B2g	Population and pollution
B2h	Sustainability

R110

LO1

Incorporates

LO2

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

## Unit R112 Quality control of engineered products

# LO1: Understand the importance of quality control

Learners must be taught:

#### reasons for implementing quality control in production, ie

- o early intercept (eg problems in production)
- o waste management (eg reduce production waste)
- o consistency (eg finished products)
- o reduce costs (eg materials time)
- o conformity (eg industry standards regulations)
- o reduce returns (eg reputation customer perception)

#### • quality procedures, ie

- o quality control
- o quality standards
- o quality assurance
- o total quality management

Keywords/Themes Wastes management, reduce costs

## GCSE Science B 2012 J261

### 21st Century Science A 2012 J241

Theme	Incorporates	
Understand the significance of quality control in the minimisation of waste and cost. [Indirect]	C1.2, C1.2	Air Quality
	P2.2, P2.3	Radiation and life (Global Warming, Ozone layer)
	P3.1, P3.2, P3.3	Sustainable energy

R110

R111

R112

LO1

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LO2

# CAMBRIDGE NATIONAL IN ENGINEERING

Engineering Manufacture J832/J842 – Maths, Science and ICT in Engineering

## Unit R112 Quality control of engineered products

# LO2: Be able to assess product quality from inspection and quality control techniques

Learners must be taught:

- quality control techniques used in stages of production
- application of basic inspection checks in stages of production
- use of inspection equipment in stages of production
- techniques for evaluating product from quality control checks

Keywords/Themes Tolerance, sampling, comparison, measuring – dimensions, x-rays and ultrasonics

## GCSE Science B 2012 J261

Theme

Incorporates

Incorporates

Understand quality control techniques, such as the use of x-rays and ultrasonic testing.

#### 21st Century Science A 2012 J241

Understand quality control techniques, such as the use of x-rays and ultrasonic testing.

Theme

R109

R110

R111

R112

LO2

LO3

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## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

**NATIONALS** – Maths, Science and ICT in Engineering

## Unit R112 Quality control of engineered products

#### LO3: Know how modern technologies can be used in quality control

Learners must be taught:

- applications of modern technologies, ie
  - o non-destructive testing (eg visual inspection; ultrasonic testing; dye
  - o penetrant; X-ray crack testing)
  - o 3D scanning
  - o CNC measurement checks
  - o use of robotics
  - o application within Computer Integrated Engineering (CIE)/Computer Integrated Manufacture (CIM)

R110

o automatic inspection/rejection

Keywords/Themes NDT: xray, ultrasonics, CNC measurements

## GCSE Science B 2012 J261

Theme

Incorporates

Understand modern inspection techniques, including the use of x-rays and ultrasonic testing.

#### 21st Century Science A 2012 J241

Incorporates

Understand modern inspection techniques, including the use of x-rays and ultrasonic testing.

Theme

R109

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R111

R112

LO1

LO2

LO3

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

## Unit R112 Quality control of engineered products

# LO4: Know the principles of lean manufacturing

Learners must be taught:

#### • causes of waste in manufacturing, ie

- o time
- o materials
- o resources
- o processes
- o supply
- o space

#### categories of waste (7 lean wastes -TIMWOOD),ie

- o Transportation
- o Inventory
- o Movement
- o Waiting
- o Over-processing
- o Overproduction
- o Defects

#### • methods of reducing waste, ie

- o Design for Manufacturing Assembly (DFMA)
- o sustainable design (eg material reduction, life cycle analysis, end-of-life disposal, recycled materials)

Keywords/Themes Wastes management, reduce costs

## GCSE Science B 2012 J261

#### 21st Century Science A 2012 J241

Theme		Incorporates	
Understand life cycle analysis. [Direct]	C1.2, C1.2	Air Quality	
Understand the significance of quality control in the minimisation of waste and cost. [Indirect]	P2.2, P2.3	Radiation and life (Global Warming, Ozone layer)	
	P3.1, P3.2, P3.3	Sustainable energy	

R111

## **CAMBRIDGE NATIONAL IN ENGINEERING**

Engineering Manufacture J832/J842

- Maths, Science and ICT in Engineering

## Unit R112 Quality control of engineered products

# LO4: Know the principles of lean manufacturing

Learners must be taught:

#### • causes of waste in manufacturing, ie

- o time
- o materials
- o resources
- o processes
- o supply
- o space

#### categories of waste (7 lean wastes -TIMWOOD),ie

- o Transportation
- o Inventory
- o Movement
- o Waiting
- o Over-processing
- o Overproduction
- o Defects

•

#### • methods of reducing waste, ie

- o Design for Manufacturing Assembly (DFMA)
- o sustainable design (eg material reduction, life cycle analysis, end-of-life disposal, recycled materials)

Keywords/Themes Wastes management, reduce costs

GCSE Science B 2012 J261		21st Century Science A 2012 J241
Theme	Incorporates	
Understand the significance of quality control in the minimisation of waste and cost. [Indirect]	C1.2, C1.2	Air Quality
	P2.2, P2.3	Radiation and life (Global Warming, Ozone layer)
	P3.1, P3.2, P3.3	Sustainable energy

R111

R112

LO1

## CAMBRIDGE NATIONAL IN ENGINEERING

Systems Control in Engineering J833/J843 - Maths, Science and ICT in Engineering

## **Unit R109 Engineering materials**, processes and production

Add Sci

#### LO3: Know about developments in engineering processes

Learners must be taught:

- applications of computer controlled production processes, ie
  - o Computer Numerical Control (CNC) machining processes, ie
    - CNC lathes and milling/router machines
    - multi-axis machining centres
    - water jet cutting
    - punching machines
    - press brake machines
  - laser applications, ie 0
  - laser cutting/welding 0
- additive manufacturing and rapid prototyping • processes, (eg Selective Laser Sintering (SLS); Stereolithography (SLA); Direct Metal Laser Sintering (DMLS); Fused Deposition Modelling (FDM)/3D printing; electron beam melting)

## Cambridge National in ICT: J800/J810/J820

Keywords/Themes CNC machining, laser cutting, lasers, rapid prototyping

Theme	Incorporates
CNC production processes [Indirect]	R008 (T)
	<b>LO 1:</b> Be able to devise algorithms to solve problems
	LO 2: Be able to develop computer programs
	LO 3: Be able to test and evaluate computer
	programs

#### Theme comments

Knows about the application of ICT and programming in Computer Numeric Control (CNC) production processes

**R109** 

R111

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NATIONALS

## **CAMBRIDGE NATIONAL IN ENGINEERING**

**Science** 

Systems Control in Engineering J833/J843 – Maths, Science and ICT in Engineering

## Unit R109 Engineering materials, processes and production

Add Sci

# LO4: Know about developments in engineering processes

Learners must be taught:

- the impact of modern technologies in engineering production, ie
  - o automation, processes
    - quality
    - workforce
    - costs
  - o digital communications, ie
    - uses in research and development
    - material supply and control
    - global manufacturing

## Cambridge National in ICT: J800/J810/J820

Keywords/Themes Quality, costs, materials stock control, research (internet), Digital Comms: Internet research, CAD, stock control, automatic ordering, electronic transfer

Theme	Incorporates	Theme comments	
Digital communications and ICT in engineering production – research and development [Direct]	<ul> <li>R001 (M)</li> <li>LO 1: Understand how ICT can be used to meet business needs</li> <li>R002 (M)</li> <li>LO 1: Be able to use techniques to search for, store and share information</li> </ul>	Understand the use of ICT for research and development (eg internet searching)	
	<ul> <li>R001 (M)</li> <li>LO 2: Know how to work with information and data to meet specified business needs</li> </ul>	Understand the use of ICT for research and development (eg file and drawing sharing)	
	R001 (M) LO 3: Know how ICT can be used to support business working practices	Understand the use of ICT for research and development (eg video- conferencing)	
Digital communications and ICT in engineering production – material supply and control [Indirect]	<ul> <li>R004 (B)</li> <li>LO 1: Be able to modify databases to meet user requirements</li> <li>LO 2: Be able to produce outputs from databases to meet user requirements</li> <li>LO 3: Be able to create user interfaces for databases to meet user requirements</li> <li>LO 4: Be able to analyse a databases suitability for a business purpose</li> </ul>	Understand the use of ICT in materials supply and control (eg databases)	
	<ul><li>R001 (M)</li><li>LO 2: Know how to work with information and data to meet specified business needs</li></ul>	Understand the use of ICT in materials supply and control (e.g. sharing of data)	

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NATIONALS

## **CAMBRIDGE NATIONAL IN ENGINEERING**

**Science** 

Systems Control in Engineering J833/J843 – Maths, Science and ICT in Engineering

## Unit R111 Computer aided manufacturing

LO2: Be able to interpret information from CAD to manufacture components on CNC equipment

Add Sci

Learners must be taught:

- use of Computer Aided Design (CAD) packages, ie
  - export drawing information to CNC machineson-screen simulation
- factors to consider when performing CNC machine programming operations, ie
  - o setting datum points
  - o co-ordinates (absolute and incremental)
  - o tool change-over
  - o tool offsets
  - o language (eg G-codes)

## Cambridge National in ICT: J800/J810/J820

Keywords/Themes CAD and drawings, CNC: datums, co-ordinates, CAD and CNC: interpret information

Theme	Incorporates	Theme comments	
Computer aided drawing (CAD) [Direct]	R006 (C)	Be able to use ICT (CAD and CNC	
	<ul> <li>LO 1: Be able to specify a digital image solution for a client's needs</li> <li>LO 2: Be able to create digital images</li> <li>LO 3: Be able to store, retrieve and present digital images</li> </ul>	applications) to interpret information in preparation to manufacture components	
Computer numeric control [Direct]	R008 (T)		
	LO 1: Be able to devise algorithms to solve problems		
	LO 2: Be able to develop computer programs		
	LO 3: Be able to test and evaluate computer		
	programs		

LO2

LO3
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NATIONALS

# CAMBRIDGE NATIONAL IN ENGINEERING

**Science** 

Systems Control in Engineering J833/J843

- Maths, Science and ICT in Engineering

# Unit R111 **Computer aided** manufacturing

#### LO3: Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components

Add Sci

Learners must be taught:

- procedures for setting up CNC equipment, ie
  - tooling 0
  - work holding 0
  - computer interface 0
  - safety procedures 0
- procedures to produce products to required specification, ie
  - 0 initial setting
  - safe use, ie 0
    - potential hazards
    - appropriate Personal Protective Equipment
- methods used to compare items manufactured • by manually controlled and CNC production, ie
  - visual (eg standard of finish) 0
  - dimensional (eg accuracy component 0 tolerance)
  - cycle time (eg assembly) 0
  - consistency (eg batch tolerance) 0

## Cambridge National in ICT: J800/J810/J820

Keywords/Themes Dimensions and tolerance, Set up CNC

Theme	Incorporates
Computer numeric control [Direct]	R008 (T)
	LO 1: Be able to devise algorithms to solve problems
	LO 2: Be able to develop computer programs
	LO 3: Be able to test and evaluate computer
	programs

#### Theme comments

Be able to use ICT as part of setting-up and using computer numeric control (CNC) to manufacture components

R111

LO<sub>2</sub>

LO3

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NATIONALS

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Systems Control in Engineering J833/J843 – Maths, Science and ICT in Engineering

## Unit R111 Computer aided manufacturing

LO4: Know about applications of computer control processes used to manufacture products

Add Sci

Learners must be taught:

- applications of computer control, ie
  - o rapid prototyping, ie
    - laminating
    - 3D printing
    - stereo lithography
    - laser sintering
  - o o manufacturing processes, ie
    - CNC machining
    - additive manufacturing
  - o o robotics, ie
    - welding
    - riveting
    - pick-and-place assembly
- computer controlled processes used for different scales of manufacture, ie
  - o one-off/prototype manufacture
  - o batch production
  - o high-volume manufacturing

Cambridge National in ICT: J800/J810/J820

programs

Keywords/Themes Lasers (in manufacture), additives, scale of manufacture (batch etc), CNC in manufacture: rapid prototyping, CNC machining, robotics

LO 3: Be able to test and evaluate computer

Theme	Incorporates
Computer control	R008 (T)
processes used in manufacture[Indirect]	<b>LO 1:</b> Be able to devise algorithms to solve problems LO 2: Be able to develop computer programs

Science

Understand applications of computers and ICT in computer control when manufacturing products

Theme comments

R111

LO2

LO3

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NATIONALS

# **CAMBRIDGE NATIONAL IN ENGINEERING**

Therese

Systems Control in Engineering J833/J843 – Maths, Science and ICT in Engineering

# Unit R112 Quality control of engineered products

# LO3: Know how modern technologies can be used in quality control

Add Sci

Learners must be taught:

- applications of modern technologies, ie
  - o non-destructive testing (eg visual inspection; ultrasonic testing; dye
  - o penetrant; X-ray crack testing)
  - o 3D scanning
  - o CNC measurement checks
  - o use of robotics
  - o application within Computer Integrated Engineering (CIE)/Computer Integrated Manufacture (CIM)
  - o automatic inspection/rejection

#### Cambridge National in ICT: J800/J810/J820

**Keywords/Themes** NDT: xray, ultrasonics, CNC measurements, modern techniques: 3D scanning, CNC, CIM, CIE, automatic inspection

Computerised quality control [Indirect]	

#### Incorporates

R008 (T)
LO 1: Be able to devise algorithms to solve problems
LO 2: Be able to develop computer programs
LO 3: Be able to test and evaluate computer programs

#### **Theme comments**

Understand modern (computerised) techniques used in quality control (e.g. CNC measurement checking, Computer Integrated Engineering (CIE), Computer Integrated Manufacture (CIM))

R112

## 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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