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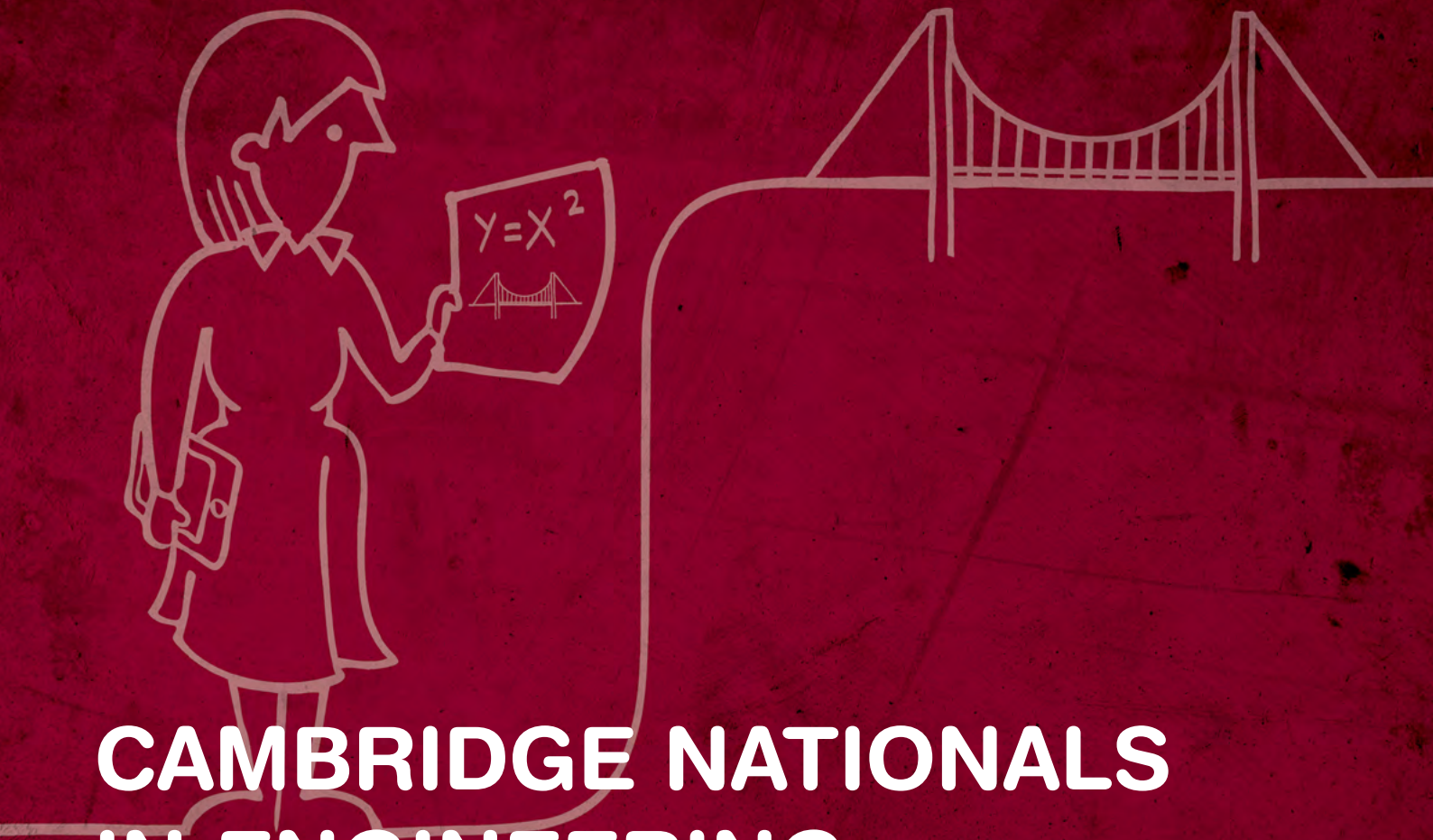


CAMBRIDGE NATIONALS IN ENGINEERING

PRINCIPLES IN ENGINEERING AND ENGINEERING BUSINESS

A PROJECT APPROACH TO DELIVERY – POWERING THE FUTURE

OCTOBER 2014

In partnership with

SIEMENS

OCR

Oxford Cambridge and RSA

INTRODUCTION

The purpose of this guide is to give you an overview of how you could holistically deliver a range of units from the Cambridge National in Engineering Level 1/2 in conjunction with Siemens. When delivering any qualification it is always useful to be able to look at the variety of units and consider how they are or could be linked together – a holistic approach.

An holistic approach will provide you with a structured plan to teach the learners how a range of topics work together across a number of units, providing them with some understanding of how skills and knowledge could link together in a working environment.

This guide looks at the delivery and facilitation of learning of the following units:

Unit R101: Engineering principles

Unit R102: The engineered business world

Unit R103: Sustainable engineering

Unit R104: Optimising performance in engineering systems and products

In this example, the objective is for learners to develop their knowledge of engineering principles and engineering businesses through practical engagement with projects and activities designed and supported by Siemens.

The intention is that the learners will be taught a range of knowledge and skills within each of the units and then carry out relevant review activities at various stages. Each of the review activities (once successfully completed by the learner) will provide foundation knowledge for their final assessment. The practice review activities within the modules must not be used for Cambridge National final assessment purposes. Model assignment tasks for each of the Cambridge National qualifications can be found at www.ocr.org.uk.

It is assumed that the learners will be given the opportunity to carry out activities that will enable them to practice the skills they have learned within each module prior to being given final assessment activities.

When considering a holistic approach to delivery and learning it is important to consider the overall objectives. In this guide the objectives are to:

- Deliver all four units to achieve the Level 2 Cambridge National Certificate in Principles in Engineering and Engineering Business.
- Structure a programme of learning and reviews which are exciting and engaging for the learners.
- Provide the learners with an overview of how the knowledge and skills gained in one unit, support the knowledge and skills used within other units.
- Provides the learners with an opportunity to consider how they would use their engineering skills holistically within the working environment.

This guide is divided into four modules which may be sub-divided or combined according to the teaching time available.

The tables below show where each module provides delivery approaches and learning opportunities to ensure a thorough review of skills and understanding prior to final assessment and evidencing by the learner.

Please note that should final assessment be presented in a similar holistic way, learners must be able to present evidence for each of the controlled assessment units R102, R103 and R104 independently.

By Unit/Learning Outcome (LO)

	LO1	LO2	LO3	LO4
Unit R101	Module 1	Module 1		Module 1
Unit R102	Module 2 Module 4	Module 2	Module 2	Module 2
Unit R103	Module 3	Module 3	Module 2 Module 3	
Unit R104	Module 4	Module 4	Module 4	Module 4

By Module

	Unit	LO
Module 1	R101	LO1, LO2, LO4
Module 2	R102 R103	LO1, LO2, LO3, LO4 LO3
Module 3	R103	LO1, LO2, LO3
Module 4	R104 R102	LO1, LO2, LO3, LO4 LO1

Powering the Future Task

The Project Brief

(Learner version of the Project Brief is available from http://www.ocr.org.uk/qualifications/cambridge-nationals-principles-in-engineering-and-engineering-business-level-1-2-award-certificate-j830-j840/)

Standby power supplies are needed to ensure that critical systems receive continuous power in the event of power failure, for example in a hospital. Organisations can adopt different approaches to maintaining optimum performance of their standby power supply systems.

Learners have been asked to consider the methods used to maintain optimum system performance including:

- areas at risk from component failure
- types of failure
- design for maintenance and repair.

Learners will recommend the most appropriate methods for maintaining the standby power supply system.

You will perform simple maintenance procedures to ensure optimum system performance of the standby power supply systems, following recommended maintenance procedures.

This work can be undertaken as an individual or within a team. If working within a team learners are expected to contribute to each of the areas in order to gain the experience and knowledge required to successfully complete the Cambridge National in Engineering Principles in Engineering and Engineering Business.

The Powering the future project explores the engineering principles of supplying power to our essential services and looks at how the businesses involved in keeping hospitals operating.

The project inspires learners to use IT to learn about physics, electronics, mathematics, business structure, systems design, branding, media skills and financial strategy in the context of an essential resource.

Learners will use their understanding to recommend the most appropriate methods for maintaining a standby power supply system in a hospital and demonstrate maintenance procedures.

Module 1 – Engineering Principles

The delivery begins with unit R101 (LO1, LO2, LO3 and LO4) and R102 (LO2) and R104 (LO2)

Before learners can undertake the activities they will need to have a good understanding of:

- the main engineering principles
  - mechanical
  - electrical
  - fluid power
- different types of power source and form of energy
  - mechanical
  - electrical
  - power transmission.

In addition to the curriculum specification, learners will need an understanding of:

- power generation
  - different generation methods
  - reaction time of different generation methods
  - how power is stored and transmitted.

Contained within the following assessment criteria/LO(s)/ units:

Understand physical properties and mechanical principles	LO1	R101
Understand physical properties and electrical principles	LO2	R101
Know about the systems used to transmit power in engineering	LO3	R101

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

In order to explore the range of mechanical and fluid power engineering principles, learners could research, create and deliver a presentation explaining the different principles involved in producing power. Comparisons between wind, thermal generation and hydro power would demonstrate the shared and different principles at work.

The Siemens' resources 'Blowing in the Wind' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks3.htm) and 'Underwater Energy' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) provide useful background information on the different forms of energy production.

Activity 2

Learners could produce a poster or a series of posters highlighting the different Mechanical and Electrical principles at work in a generator. Different groups of learners could look at different technologies, such as wind, marine or gas powered steam turbine. The Siemens' Living Energy e-magazine will support this (http://www.energy.siemens.com/br/en/energy-topics/publications/living-energy/)

The poster/s should include the key elements from the Learning Outcomes.

Activity 3

Learners could explore different power systems and apply mathematical calculations to the generation of power and create a series of trading cards as a group. Each card will represent a different technology and power type with points awarded for given criteria such as: cost per unit, reaction time, equipment cost, environmental impact, operational life and future impact.

Module 2 The Engineered Business World

The delivery then follows through units R102 (LO1, LO2, LO3 and LO4) and R103 (LO3).

Contained within the following assessment criteria/LO(s)/ units:

Know about engineering sectors, their products and services	LO1	R102
Understand how engineering companies operate	LO2	R102
Know about employment in engineering	LO3	R102
Understand innovation and technical advances in engineering	LO4	R102
Understand the impact of global manufacturing	LO3	R102

This will allow learners to develop their understanding of how engineering companies work, the employment opportunities and responsibilities and how the global market is impacting on engineering.

During the delivery of the units, learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

To learn about engineering sectors products and services and employment within the sector, learners could carry out research and create two flyers, aimed at recruiting young people into Siemens. One flyer should focus on the power side of Siemens and the other should focus on equipment manufacture.

Areas to be covered in the flyers include:

- company structure
- the products and services provided
- entry level job roles
- entry requirements
- training and development opportunities.

The Siemens' Careers website (http://www.siemens.co.uk/careers/en/) has the information learners require

Activity 2

To develop understanding of how engineering companies operate, learners could research one of the engineering sectors Siemens operates in (rail, power generation, white goods, wind turbines, industrial control systems) and then create a diagram of the organisation in that sector. Learners could use the 'About Siemens' web pages (http://www.siemens.co.uk/en/about_us/index.htm) and the Siemens' 'Product and technology videos' (http://www.energy.siemens.com/br/en/energy-topics/videos/)

The diagram should cover:

- global suppliers
- competitors
- partners
- cost
- quality control
- countries of operation and localised requirements
- organisational structure.

Activity 3

To support the development of learners understanding on innovation and technical advances, they could undertake a research exercise of an engineered product or service. Learners should identify new materials, processes or other technical advances that could be used in the manufacture of the product.

Learners could present their idea in a 'Dragon's Den' type scenario showing how the new materials or processes can be used to enhance the original product. The presentation could identify issues of cost, sustainability, availability and reliability.

The Siemens' Living Energy e-magazine will support this activity (http://www.energy.siemens.com/br/en/energy-topics/publications/living-energy/).

Powering the Future Task Link

Learners can develop an understanding of supply chains, organisational structures and how decisions are made when planning processes. This links to the task of identifying appropriate methods of maintaining the power system.

Module 3 Sustainable engineering

The delivery then follows through units R103 (LO1, LO2 and LO3).

Contained within the following assessment criteria/LO(s)/ units:

Know about the sustainability of engineering materials and products	LO1	R103
Know about sustainable design for engineered products	LO2	R103
Understand the impact of global manufacturing	LO3	R103

This will allow learners to develop an understanding of how engineering is contributing to a sustainable future. They will learn to compare different methods of power generation and to conduct simple cost-benefit analysis.

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

Teachers could introduce learners to the different classification of materials and specific material types, material characteristics and common uses. Metals might be usefully divided into two types; ferrous metals and non-ferrous metals. Learners could be presented with a range of images of Siemens' products from the 'Project Approach Resource Bank' (http://www.siemens.co.uk/education) and asked to create sticky labels to identify parts and materials on each image.

The labels should include details of:

- the material
- key properties
- main uses
- alternatives
- any issues with its use (cost, availability, environmental impacts).

Activity 2

To develop an understanding of materials used in engineering, learners could watch the video 'How it's Made – How Train Rails are made' by accessing the following web link: http://www.youtube.com/watch?v=TXRaXHEKW5E and work through the Siemens' resource 'Ringing True' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) which focuses on the use of materials in train wheels and the broader resources on the rail industry 'Rail Solutions' (http://w3.siemens.co.uk/MOBILITY/UK/EN/RAIL_SOLUTIONS/Pages/rail_solutions.aspx)

Activity 3

The Siemens' activities 'Here comes the sun' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) and 'Sustainability at Siemens' (http://www.siemens.co.uk/pool/about_us/sustainability/siemens_sustainability_uk_1_pager_2013.pdf) explore a range of environmental and sustainability areas and could be used to support the development of sustainable design ideas for learners.

Activity 4

Learners could develop a sustainability rating system for use on engineered products and services. The objective is to compare a range of products using a rating system created by the learners, which cover a range of sustainability and environmental impact issues. Learners could then present the top three rated products based on their own research.

Siemens''Sustainability reports and documents' (http://www.siemens.com/sustainability/en/sustainability/reporting/current-report.htm) will give valuable information for the research.

Module 4 Optimising performance in engineering systems and products

The delivery then follows through units R104 (LO1, LO2, LO3 and LO4).

Contained within the following assessment criteria/LO(s)/ units:

Understand why engineering systems and products are designed and maintained for optimum performance	LO1	R104
Know methods used in engineering sectors to maintain optimum performance	LO2	R104
Understand factors that contribute to system/ product failure	LO3	R104
Be able to perform simple procedures to optimise product/system performance	LO4	R104
Know about engineering sectors, their products and services	LO1	R102

This will allow learners to develop problem solving techniques and understanding of how established systems are modified and optimised.

They will also develop the skills associated with risk assessment and contingency planning.

During the delivery of the units, learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

To develop their understanding of optimisation, learners could watch the 'Bang Goes the Theory' episode on the National Grid, accessible from: http://www.bbc.co.uk/programmes/p01tbh0j and undertake a review of how National Grid optimises the power delivery to the electricity grid.

To support the concept of system operation, learners could take part in the Siemens''E-Zero Island' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) activity. This models a multi-faceted system using data and logic, applying ideas about energy transfer and sustainability to a novel context to produce a practical overall system.

Alternatively, learners could use the Siemens''London Underground' (http://w3.siemens.co.uk/smartgrid/uk/en/Services/mcs/smb/Pages/Case-Studies.aspx) case study to explore how a large system is optimised. The teacher might begin with a class discussion of factors that contribute to failure of engineered products and systems.

Whichever option is taken, learners could create a worst case scenario of what would happen if all maintenance on the grid or underground ceased. This could be done in the form of a news article from the point of view of the scenario having happened.

Activity 2

Learners could use the Siemens''Power Engineering Guide' (http://www.energy.siemens.com/br/en/energy-topics/publications/power-engineering-guide/) and the 'Living Energy e-magazine' (http://www.energy.siemens.com/br/en/energy-topics/publications/living-energy/) to identify the components and processes that are maintained in a power generation system. An example of this would be a gearbox in a wind turbine generator. Learners should highlight how the system was designed to make sure maintenance can be carried out easily.

Activity 3

When exploring product lifecycle, learners could be asked to identify engineered products that are designed not to be repaired or maintained. They should consider the features or technology that prevent maintenance or repair. Suitable products include a calculator or low cost radio.

Activity 4

Learners could explore the different methods used to maintain optimum performance by considering the different approaches businesses take to maintain equipment in service, whilst minimising disruption.

Learners could research condition based monitoring to inform operation, servicing and repairs. Learners could access a video to demonstrate this at the following web links;

http://youtu.be/GV6JasEuGn4 and http://youtu.be/lq401qW-BRE

Activity 5

To support learners in understanding maintenance procedures they could be asked to disassemble an accessible engineered product that would lend itself to show types and signs of component failure, such as a hairdryer, engine block, cylinder head, electric motor, drill or other power tool. Learners could be asked to identify signs of fatigue, seizure, vibration, corrosion on moving parts and static parts. Learners could apply their knowledge of inspecting engineered products for wear and signs of failure by completing a product evaluation form.

Siemens''Customer Service Videos' (http://www.siemens-home.co.uk/features-and-benefits/customer-service-video-gallery.html) can add product information.

Learners could develop their understanding of different types of bearings and bearing surfaces by watching a video accessed at the web link; http://youtu.be/KGglvDNDuYc

Learners could research different modes of failure eg fatigue, signs of wear, seizure and corrosion in engineered applications such as in engines and compressors. One example can be accessed by following the web link;

http://www.gregsengine.com/engine-bearing-failure-chart.html

Glossary

Trading cards – a card game where cards are created for items with a range of common attributes given individual figures or scores.

Dragon's Den – individuals or teams present an idea to a panel of up to four judges who challenge the ideas and make a decision of whether or not the idea is worth investing in.

Cost-benefit analysis – a business technique for evaluating the worth of an idea, for more information see: http://www.mindtools.com/pages/article/newTED_08.htm

Sustainability rating system – a series of criteria, related to sustainability, that allows a comparison between products. Sustainability could focus on construction, life cycle, use or a combination. The ratings could be numerical or based on high – medium – low.

Delivering the project holistically

This project should be delivered in conjunction with other resources available on the OCR website. www.ocr.org.uk/cambridgenationals in the teaching and learning resources area.

Teaching and learning resources

Teaching and learning resources for each Cambridge National in Engineering are:

- the Delivery Guide
- Lesson Elements
- Resource Links
- Sample assessment materials
- Cambridge Nationals in Engineering – Mapping to Mathematics and Science
- Skills Guides www.ocr.org.uk/i-want-to/skills-guides/.

Use the delivery guide and lesson elements to enhance teaching and learning through each module in the project approach.

The example below shows how Unit R101: Engineering principles LO1: Understand physical properties and mechanical principles can be delivered through the use of these resources.

Learners could study relevant Siemens resources bank (http://www.siemens.co.uk/education), Learners could research, create and deliver a presentation explaining the different principles involved in producing power. Comparisons between wind, thermal generation and hydro power would demonstrate the shared and different principles at work.

They could for example, be taught in mathematics to use tables and graphs (both linear and non-linear) and apply this knowledge to inform a detailed and comprehensive conclusion.

Building up research skills and applying appropriate mathematics and science, learners could use resource links documents web sites such as the Siemens resources 'Blowing in the Wind' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks3.htm) and 'Underwater Energy' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) provide useful background information on the different forms of energy production as part of their research.

Use the OCR guide to research to develop learners' research skills.

http://www.ocr.org.uk/i-want-to/skills-guides/

Examples showing how the resources available from the OCR website can be used with this project approach

Unit R101: Engineering principles

LO1: Understand physical properties and mechanical principles

	Unit	Learning Outcome (LO)
Module 1	R101	LO1 LO3 LO2

The Project Approach

Activity 1 (R101 – LO1)

Learners could research, create and deliver a presentation explaining the different principles involved in producing power. Comparisons between wind, thermal generation and hydro power would demonstrate the shared and different principles at work.

The Delivery Guide (R101 – LO1)

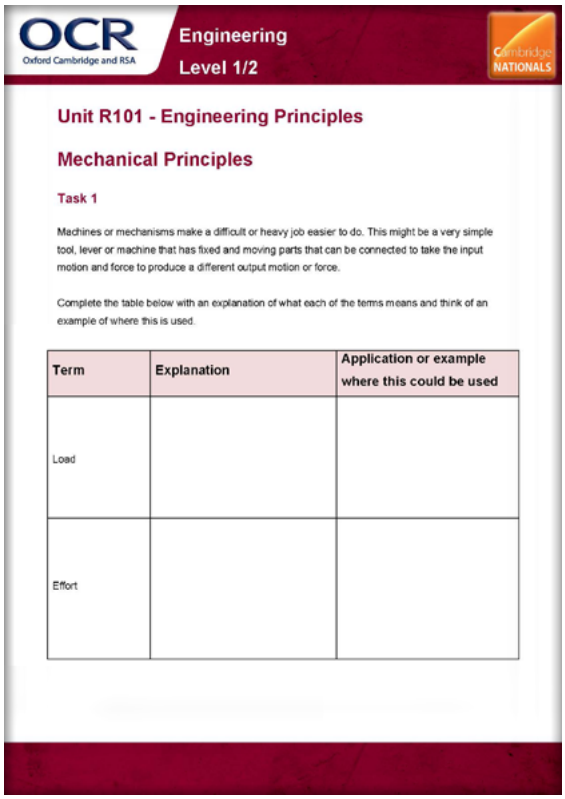
Suggested content	Suggested activities	Suggested timings	Possible relevance to
Physical Properties	Learners could be introduced to the physical properties as energy in the form of mechanical, electrical, chemical, light, sound, and heat by the teacher. Learners could be asked to work in groups to discuss examples of where the physical properties of energy forms are evident, such as a bicycle in use. Working in groups, learners could identify examples of kinetic energy and conversion of the bicycle being pedalled, the types of energy used and resulting from the brakes being applied, the use of lighting on a bicycle and two ways how the light energy could be produced.	2 hours	

Lesson Element (R101)

Mechanical Principles

This lesson element enables learners to understand about basic mechanical principles.

http://www.ocr.org.uk/qualifications/cambridge-nationals-principles-in-engineering-and-engineering-business-level-1-2-award-certificate-j830-j840/



OCR Oxford Cambridge and RSA

Engineering

Level 1/2

Cambridge NATIONALS

Unit R101 - Engineering Principles

Mechanical Principles

Task 1

Machines or mechanisms make a difficult or heavy job easier to do. This might be a very simple tool, lever or machine that has fixed and moving parts that can be connected to take the input motion and force to produce a different output motion or force.

Complete the table below with an explanation of what each of the terms means and think of an example of where this is used.

Term	Explanation	Application or example where this could be used
Load		
Effort		

Cambridge Nationals in Engineering – Mapping to (mathematics) and science

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

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

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

	Keywords/Themes	Theme	Foundation Initial	Foundation Bronze
LO1	Mechanical principles using calculation of: – levers (Class 1, 2 and 3) pulleys and gears (simple and compound) static and moving bodies	Understand physical properties and mechanical principles	FIN4 Multiply and divide a three-digit number by a two-digit number. Multiply numbers with up to two decimal places by an integer.	FBA2 Substitute positive numbers into simple algebraic formulae. Derive a simple formula.

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

The Skills Guides.

Learners could use the OCR guide to research skills and the OCR guide to presentation skills to help them develop these skills.
http://www.ocr.org.uk/i-want-to/skills-guides/

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