

Cambridge **TECHNICALS LEVEL 3**

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ENGINEERING

Unit 11

Material Science

Model assignment

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Please note:

You can use this assignment to provide evidence for summative assessment, which is when the learner has completed their learning for this unit and is ready to be assessed against the grading criteria.

You can use this assignment as it is, or you can modify it or write your own; we give more information in this document under Guidance for tutors.

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Guidance for tutors on using this assignment

General

OCR Cambridge Technical model assignments are available to download from our website:

www.ocr.org.uk.

The purpose of this assignment is to provide a scenario and set of tasks that are typical of how engineers would use materials science, to enable you to assess your learner against the requirements specified in the grading criteria. The scenario and its tasks are intended to give a work-relevant reason for applying the skills, knowledge and understanding needed to achieve the unit.

This assignment will not instruct learners how to meet the highest grade. Whether learners achieve a pass, merit or distinction will depend on what evidence they produce.

You can modify the scenario we provide in this assignment to make it more relevant to your local or regional needs. Please refer to the information under 'Modifying the model assignment' later in this section.

You don't have to use this assignment. You can use it as a guide to help you to design your own assignment, and we provide an assignment checking service. You'll find more information on these matters in section 8 of the qualification handbook.

In the tasks, we'll refer to the format of evidence. Learners are **not** required to follow that format **unless** we tell them otherwise.

It's essential that the work every learner produces is their own. Please make sure you read through the information we give on authenticity in section 8 of the qualification handbook and make sure that your learners and any staff involved in assessment understand how important authenticity is.

We provide this assignment to be used for summative assessment. You must not use it for practice or for formative assessment.

Before using this assignment to carry out assessment

Learners will need to take part in a planned learning programme that covers the knowledge, understanding and skills of the unit.

When your learners are ready to be assessed, they must be provided with a copy of the following sections of this assignment:

- General information for learners
- Assignment for learners
- Evidence Checklist

They may carry out preparation prior to undertaking the tasks and there is no time limit for this.

When completing the assignment

You should use this assignment in conjunction with the unit specification and qualification handbook.

Please note – if learners are completing this model assignment as part of the Extended Diploma qualification they will be required to complete the synoptic unit 25: Promoting continuous improvement. Before your learners complete this model assignment, you must refer to the specification and model assignment requirements for unit 25, so if applicable you can ensure learners gather the appropriate feedback on their own performance and performance of the system, process or artefact that they will produce in this model assignment.

Resources to complete the tasks

There are resource requirements for this assignment. Every learner will need access to a copy of the scenario and the tasks, along with the following resources:

For task 1, learners will need access to materials and test equipment. They will also require access to a range of products to investigate material suitability.

For task 2a and 2b, learners will need access to examples of engineering components that use different production processes/methods for both metals and non-metals (see LO3 unit content). For task 2a you will need to provide appropriate thermal equilibrium diagrams for ferrous and non-ferrous alloys for learners to analyse.

For task 3, learners will need access to examples of products or components that use different modern and smart materials.

Tutor information to support the tasks

Task 1 covers the taught content for multiple Learning Outcomes. It is therefore important that learners pay particular attention to the checklist at the back of this assignment to make sure they cover all required grading criteria – especially at Pass.

In task 1, for P1 learners should explain the relationships between engineering materials classification, materials structure and how microstructures affect material properties. This should include, where appropriate, atomic structures and bonding, periodicity and crystalline structures of ferrous and, non-ferrous metals and their alloys, as well as ceramics, polymeric and elastomer materials, please refer to the unit specification taught content 1.1.

Health and Safety and the use of resources

Health and safety will need to be considered for any of the tasks, or parts of the tasks that are undertaken as practical activities. This should include appropriate risk assessments, safe working methods statements and the use of appropriate personal protective equipment (PPE). Learners should be encouraged to take part in assessing risk before conducting any practical activity.

Time

You should plan for learners to have 11–16 hours to complete this assignment.

Learners must be allowed sufficient time to complete all the tasks. The amount of time may vary depending on the nature of the tasks and the ability of individual learners. To help with your planning, against each of the tasks we've given an indication of how long it should take.

Learners can produce evidence in several sessions.

Format of evidence

Learners have to produce evidence that demonstrates how they have met the grading criteria. At the very least they must produce evidence that meets **all** of the pass criteria.

Please make sure your learners realise that missing just one pass criterion means they will not pass the unit, even if they have successfully met the merit and distinction criteria.

We don't have specific requirements for the format of evidence in this assignment. We've said what format the evidence could take for each task. For example, if we say 'You could include a report on ...', the evidence doesn't have to follow any specific reporting conventions. You can modify the format of the evidence, but you must make sure the format doesn't prevent the learner from accessing the grading criteria.

It's possible that certain formats for evidence can naturally cover several grading criteria and avoid the need for excessive amounts of evidence. For example, a report can be a good way to pull together evidence to meet several grading criteria.

For more guidance on generation and collection of evidence, please refer to the section 8 'Internal Assessment', in the qualification handbook.

Group work

This assignment hasn't been written to include group work. If you plan to ask learners to work in a team to complete work for assessment, you need to determine at which point in an assessment task learners can work together.

You must be sure that each learner can produce evidence of their own contribution to each grading criterion. You can give constructive feedback to learners about working as a group and direct them on team working skills because evidence of team working skills is not required by the unit. See our information on authentication, including group work and feedback to learners, in section 8 of the qualification handbook.

If witness statements are used to support learners' evidence, you'll need to complete an individual statement for each learner.

After completing the assignment

Once the learner has submitted their work to you to be assessed, you must judge or 'mark' the work against the grading criteria for the unit and identify one grade for the unit. For further information about assessment, please refer to section 8 of the qualification handbook.

Your assessment decisions must be quality assured across the cohort of learners in your centre who are being entered for the same unit. This must be done through an internal standardisation process. We give information on internal assessment and standardisation in the qualification handbook.

Reworking the assignment

If you and the learner feel they've not performed at their best during the assessment, the learner can, at your discretion, improve their work and resubmit it to you for assessment. If a learner is working on improving their work before it is resubmitted, you and the learner must continue to make sure the work is the learner's own.

Any feedback you give to the learner must not direct them on how to improve their work. You can identify what area of the work could be improved but you cannot give the learner any details about

how they could improve it. You must follow the guidelines given in section 8 of the qualification handbook under 'Authenticity of learner work'.

Modifying the model assignment

The tasks in this assignment allow learners access to the full range of grades detailed in the grading criteria of this unit.

If you modify this assignment you must **not** change the grading criteria provided in the tasks for the learner or in the evidence checklist. These grading criteria are taken from the unit.

You can modify the scenario to suit your local or regional needs and the tasks may be contextualised to match any changes you have made to the scenario. If you supply your own schematic diagram to support a different scenario, this must be sufficiently detailed for learners to complete the tasks.

You can modify the type of evidence and the format it takes, unless we expressly state that evidence must take a specific format.

You must also make sure that you avoid discrimination, bias and stereotyping and support equality and diversity. For more information, please see the section 'Designing your own assignments for internally assessed units' in section 8 of the qualification handbook.

If modifications are made to the model assignment, whether to the scenario alone, or to both the scenario and individual tasks, it's your responsibility to make sure that all grading criteria can still be met and that learners can access the full range of grades.

If you're using this model assignment and delivering the Foundation Diploma, Diploma or Extended Diploma you have an opportunity to secure meaningful employer involvement by working with an employer to modify it.

General information for learners

Q *What do I need to do to pass this assignment?*

A You need to produce evidence to meet the requirements of **all** the pass criteria for the unit this assignment relates to. If you miss just one pass criterion, you will not achieve this unit and will receive an unclassified result.

Q *What do I need to do if I want to get a merit or distinction for this assignment?*

A For a merit, you need to produce evidence to meet the requirements of **all** the pass criteria for the unit this assignment relates to **and** you need to produce evidence to meet **all** the merit criteria.

For a distinction, in addition to the above, you also need to meet **all** the distinction criteria for this unit.

Q *What help will I get?*

A Your tutor will support you when completing this assignment and will make sure that you know what resources or facilities you need and are allowed to use. We've given your tutor information about how much support they can give you.

Q *What if I don't understand something?*

A It's your responsibility to read the assignment carefully and make sure you understand what you need to do and what you should hand in. If you are not sure, check with your tutor.

Q *I've been told I must not plagiarise. What does this mean?*

A Plagiarism is when you take someone else's work and pass this off as your own, or if you fail to acknowledge sources properly. This includes information taken from the internet.

It's not just about presenting a whole copied assignment as your own; you will also be plagiarising if you use the ideas or words of others without acknowledgement, and this is why it's important to reference your work correctly (see Q&A below for more information on referencing).

Plagiarism has serious consequences; you could lose the grade for this unit or you may not be allowed to achieve the whole qualification.

Always remember that the work you produce must be your own work. You will be asked to sign a declaration to say that it is.

Q *What is referencing and where can I find out more information about it?*

A Referencing is the process of acknowledging the work of others. If you use someone else's words and ideas in your assignment, you must acknowledge it, and this is done through referencing.

You should think about why you want to use and reference other people's work. If you need to show your own knowledge or understanding about an aspect of subject content in your assignment, then just quoting and referencing someone else's work will not show that **you** know or understand it. Make sure it's clear in your work how you are using the material you have referenced **to inform** your thoughts, ideas or conclusions.

You can find more information about how to reference in *The OCR Guide to Referencing* available on our website: <http://www.ocr.org.uk/Images/168840-the-ocr-guide-to-referencing>.

Q ***Can I work in a group?***

A Yes. However, if you work in a group at any stage, you must still produce work that shows your individual contribution. Your tutor can advise you how to do this.

Q ***Does my work for each task need to be in a particular format?***

A You can present your work in a variety of ways – it can be handwritten, word-processed, on video or in digital media. What you choose should be appropriate to the task(s) and your tutor can advise you. There may be times when you need proof that you have completed the work yourself: for example, if you do something during work placement that you want to use as evidence, the tutor might ask the employer to provide a witness statement.

Make sure you check the wording in each task carefully. For each task, we'll tell you if your evidence has to be in a specific format:

- If we say use the word '**must**', for example 'You must produce a report' or 'Your evidence/work must include a diagram', then you must produce the work in the stated format.
- If we use the word '**could**', for example 'You could include sketches of your ideas' or 'You could do this by annotating your diagram', this means that you are not required to follow the format we have given, but you must make sure that the work you do produce allows you to demonstrate the requirements of the grading criteria.

If you are unsure about what evidence you need, please ask your tutor.

Q ***Can I ask my tutor for feedback on my work?***

A Yes, but they can't give you detailed feedback.

We have given your tutor instructions on what kind of feedback they can give you. For example, they are **not** allowed to tell you exactly what to do to make your work better, but they **can** remind you about what they've taught you and you can use this additional learning to try and improve your work independently. They can say what they've noticed might be wrong with your work, for example if your work is descriptive where an evaluation is required, but your tutor can't tell you specifically what you need to do to change it from a description to an evaluation – you will need to work out what you need to do and then do it for yourself.

Q ***When I have finished, what do I need to do?***

A If you have included the personal details (such as name, address or date of birth) of someone other than yourself in your work, this must be blanked out (anonymised) – your tutor will tell you how to do this. You don't need to do this for information contained in references.

You can complete the evidence checklist to show your tutor where they can find the evidence for each grading criterion in your work.

You should make sure your work is labelled, titled and in the correct order for assessing.

Hand in the work that you've completed for each task to your tutor. They might ask to see your draft work, so please keep your draft work in a safe place.

Q ***How will my work be assessed?***

A Your work will be marked by someone in your centre who has been authorised to do so. They will use the information in the grading criteria to decide which grade your work meets. The grading criteria are detailed in each unit and are also given in the tasks within this assignment. Please ask your tutor if you are unsure what the grading criteria are for this assignment.

Assignment for learners

Unit 11: Materials Science

Scenario

Task 1 – OCR Materials Ltd – Research Department

The research department of OCR Materials Ltd is dedicated to addressing industrial problems through the application of fundamental science and engineering in material research. The research department work to support engineering designers and manufacturers during the development of new and existing products, they use their knowledge, experience and extensive testing equipment to investigate materials and their properties.

You have been commissioned by OCR Materials Ltd to produce a technical report that introduces engineering materials to an audience who are unfamiliar with material science.

You will also need to carry out testing on a variety of materials to assess their suitability for a range of uses.

Task 2a – OCR Materials Ltd – Metal Products

The metal products department provides technical support to the engineering industry on the use of metals (ferrous and non-ferrous) in products. It specialises in products manufactured by a range of techniques that include forging, casting and rolling.

The department has a number of new apprentices joining them and the Chief Research Officer wants a report or guide on material (metals) processing techniques that can be used for reference purposes to help the new starters.

Task 2b – OCR Materials Ltd – Non-metal Products

The non-metal products department provides technical support to the engineering industry on the use of non-metal materials including thermo plastics and thermo setting materials. It specialises in products manufactured by a range of techniques that include heating and forming.

The department has a number of new apprentices joining them and the Chief Research Officer wants a report or guide on material (thermo plastics and thermo setting materials) processing techniques that can be used for reference purposes to help the new starters.

Task 3 – OCR Materials Ltd – Modern and Smart Materials Department

The modern and smart materials department provides technical support to the engineering industry on the applications and benefits of using modern and smart materials when designing new or modifying existing products.

The department has a number of new apprentices joining them. The Chief Research Officer wants a report or guide on the use and application of modern and smart materials that can be used for reference purposes to help the new starters.

You will need to investigate how modern and smart materials can be used as an alternative to traditional materials.

Task 1: Research materials to test suitability for different applications

(This task should take between 3-5 hours.)

Learning Outcome 1: 'Understand material structure and classification', **Learning Outcome 2:** 'Understand properties, standard forms and failure modes of materials' and **Learning Outcome 5:** 'Be able to test the suitability of materials for different applications' are assessed in this task.

Your first task is to produce a technical report to show your understanding of material structure and classification, properties, standard forms and failure modes.

In your report you will need to:

- Explain the relationships between engineering materials classification, materials structure and how microstructures affect material properties. You should consider; ferrous and, non-ferrous metals and their alloys, as well as ceramics, polymeric and elastomer materials.
- Analyse the effect of periodicity on material properties.
- Define the following properties of engineering materials:
 - hardness
 - toughness
 - elasticity/plasticity
 - ductility
 - malleability
 - stiffness
 - conductivity/resistivity
 - machinability
 - fusibility
 - corrosion resistance
 - compressive strength
 - tensile strength
 - shear strength
 - torsional strength
- Describe the available standard forms in which materials are supplied and explain how these are influenced by their material properties.
- Use examples to outline:
 - engineering safety factors and why they are required
 - Failure Mode and Effects Analysis (FMEA).
- Use examples to outline modes of failure (work hardening, overstressing, fatigue, creep, sudden loads, expansion, thermal cycling and degradation) and explain the causes and effects of difference modes of failures of materials.

Your second task is to carry out tests to prove the suitability of a range of materials for their intended use in applications, tests should include:

- abrasion resistance
- resistance to corrosion
- electrical conductivity/resistivity
- thermal conductivity
- toughness
- thermal expansion.

For this task, you can choose your own application(s) or select from the list below but you must make sure your choice allows you to consider a range of materials that cover the tests above.

- Electronic toy/game
- Mobile phone
- Hair dryer
- Power tool
- Electric kettle with thermostatic switch.

You should use your test results to support an evaluation into the suitability of the different materials in the applications considered.

You should also justify the use of alternative materials for an application(s) considered previously.

Pass	Merit	Distinction
P1: Explain the relationship between material structure and classification.	M1: Analyse the effect of periodicity on the properties of materials.	
P2: Define the properties of materials.	M2: Explain how standard forms in which materials are available are influenced by their material properties.	
P3: Describe the standard forms in which materials are available.		
P4: Outline safety factors and modes of failure of materials.	M3: Explain the causes and effects of different modes of failures of materials.	
P10: Carry out tests to prove the suitability of a range of materials for their intended applications.	M6: Evaluate the suitability of a selection of materials for their intended applications.	D3: Justify the use of alternative materials for their intended applications.
Evidence		
Your evidence could be in the form of a written report or presentation with detailed speaker notes. You could include in your report appropriate data, figures, tables and annotated photographs.		

Task 2a: Understanding machinability and manufacturing processes of metals.

(This task should take between 4-5 hours.)

Learning Outcome 3: ‘Understand material processing techniques’ related to metals is assessed in this task. Please see Task 2b for material processing techniques related to thermo plastics and thermo setting materials.

Your first task is to produce a report or guide that describes the effects of different forming methods on the grain structures, properties, composition and machinability of metals.

Your report or guide must consider:

- different casting methods
- press forming of sheet metal
- hot forged components compared with cold formed or wasted component manufacture
- extrusion.

Your report or guide must also analyse the effects of the following on the condition of the metal including crystal forms/grain structures:

- the effects on alloying on melting points and strength
- heat treatment (annealing/normalising, hardening, tempering, case hardening).

Your second task is to use examples of engineering components and justify how these have benefitted from a specific production process. Examples should show your understanding of different production processes.

Your final task is to include in your report or guide an interpretation of thermal equilibrium diagrams for ferrous and non-ferrous alloys. These will be supplied by your Tutor.

Pass	Merit	Distinction
P5: Describe the effects of different forming methods in relation to materials properties, composition and machinability.	M4: Justify how engineering components benefit from being subject to a specific production process.	D1: Interpret a thermal equilibrium diagram for ferrous and non-ferrous alloys.
P6: Analyse the effects of different heat treatment methods on material and component characteristics.		
Evidence		
Your evidence could be in the form of a written report/guide or a presentation with detailed speaker notes.		
For D1 you must include the thermal equilibrium diagrams, which could be annotated as part of your interpretation.		

Task 2b: Understanding the production processes of thermo plastics and thermo setting materials.

(This task should take between 2-3 hours.)

Learning Outcome 3: 'Understand material processing techniques' related to thermo plastics and thermo setting materials is assessed in this task. Please see Task 2a for material processing techniques related to metals.

Your task is to produce a report or guide to describe the effects of heating and forming production methods on the material properties of thermo plastic and thermo setting materials.

You should use examples of components made from thermo plastics and thermo setting materials to support your investigation.

Pass	Merit	Distinction
P7: Describe the effects of common processing methods for forming thermo setting and thermo plastic materials.		
Evidence		
Your evidence could be in the form of a written report/guide or a presentation with detailed speaker notes.		

Task 3: Investigate modern and smart materials and their applications.

(This task should take between 2-3 hours.)

Learning Outcome 4: 'Know the applications and benefits of modern and smart materials' is assessed in this task.

Your task is to produce a report that describes modern and smart materials and their applications with reference to their features and characteristics.

Your report should cover applications that use the following:

Modern materials:

- Glass Reinforced Plastic
- Carbon fibre
- MDF
- Composites

and

Smart materials:

- Shape-memory alloys
- Shape-memory plastics
- Quantum Tunnelling Composite (QTC)
- Nano materials
- Conductive polymers
- Self-healing polymers.

Choose a product or component that incorporates a modern material and, a product or component that incorporates a smart material. For these products analyse how each material has replaced a traditional material.

You could look at products or components from the following areas or choose an area that interests you:

- Textiles
- Ceramics
- Graphics
- Micro-encapsulation
- Plastics
- Composites
- Memory materials.

Pass	Merit	Distinction
P8: Describe typical applications of modern materials with reference to their features and characteristics.	M5: For a given product or component analyse how a modern material has replaced a traditional material.	D2: For a given product or component analyse how a smart material has replaced a traditional material.
P9: Describe typical applications of smart materials with reference to their features and characteristics.		
Evidence		
Your evidence could be in the form of a written report/guide or a presentation with detailed speaker notes.		

Evidence Checklist

OCR Level 3 Cambridge Technicals in Engineering Unit 11: Materials Science

LEARNER NAME:

For Pass have you: (as a minimum you have to show you can meet every pass criterion to complete the unit)	Where can your tutor find the evidence? Give page no(s)/digital timings, etc.
Explained the relationship between material structure and classification. (P1)	
Defined the properties of materials. (P2)	
Described the standard forms in which materials are available. (P3)	
Outlined safety factors and modes of failure of materials. (P4)	
Described the effects of different forming methods in relation to material properties, composition and machinability. (P5)	
Analysed the effects of different heat treatment methods on material and component characteristics. (P6)	
Described the effects of common processing methods for forming thermo setting and thermo plastic materials. (P7)	
Described typical applications of modern materials with reference to their features and characteristics. (P8)	
Described typical applications of smart materials with reference to their features and characteristics. (P9)	
Carried out tests to prove the suitability of a range of materials for their intended applications. (P10)	

For Merit have you:	Where can your tutor find the evidence? Give page no(s)/digital timings, etc.
Analysed the effect of periodicity on the properties of materials. (M1)	
Explained how standard forms in which materials are available are influenced by their material properties. (M2)	

Explained the causes and effects of different modes of failure of materials (M3)	
Justified how engineering components benefit from being subject to a specific production process. (M4)	
For a given product or component analysed how a modern material has replaced a traditional material. (M5)	
Evaluated the suitability of a selection of materials for their intended applications. (M6)	

For Distinction have you:	Where can your tutor find the evidence? Give page no(s)/digital timings, etc.
Interpreted a thermal equilibrium diagram for ferrous and non-ferrous alloys. (D1)	
For a given product or component analysed how a smart material has replaced a traditional material (D2)	
Justified the use of alternative materials for their intended applications. (D3)	

To find out more

ocr.org.uk/engineering

or call our Customer Contact Centre on **02476 851509**

Alternatively, you can email us on **vocational.qualifications@ocr.org.uk**



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