



Oxford Cambridge and RSA

Level 3 Alternative Academic Qualification Cambridge Advanced National in Engineering

H127 Unit F131: Materials science and technology

Sample Assessment Material (SAM)

Time allowed: 1 hour 15 minutes

No extra materials are needed.

Please write clearly in black ink. Do not write in the barcodes.

Centre number

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Candidate number

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First name(s)

Last name

Date of birth

D	D	M	M	Y	Y	Y	Y
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INSTRUCTIONS

- Use black ink.
- Write your answer to each question in the space provided. You can use extra paper if you need to, but you must clearly show your candidate number, the centre number and the question numbers.
- In the live exam there might be lined pages at the end of the question paper for you to use if you need extra space. Remember, you must clearly show the question numbers.
- Answer **all** the questions.

INFORMATION

- The total mark for this paper is **50**.
- The marks for each question are shown in brackets [].
- This document consists of **12** pages.

ADVICE

- Read each question carefully before you start your answer.

Section A

For questions 1 to 5 put a tick (✓) in the box next to the **one** correct answer for each question.

- 1 Which material property means the ability of a material to resist being scratched, eroded or abraded?

Tick (✓) **one** box.

Corrosion resistance

Hardness

Malleability

Toughness

[1]

- 2 Which of these is a thermoplastic polymer?

Tick (✓) **one** box.

Epoxy resin

Polyester resin

Polypropylene

Urea formaldehyde

[1]

- 3 Which of these describes how an increase in the pressing force during sintering affects the properties of a ceramic component?

Tick (✓) **one** box.

It decreases the density of the component

It decreases the strength of the component

It increases the density of the component

It increases the mass of the component

[1]

4 Which of these would increase the risk of a metal component failing due to creep?

Tick (✓) **one** box.

A decrease in the applied load

A decrease in the toughness of the material

An increase in the cross-sectional area of the component

An increase in the operating temperature

[1]

5 Which of these materials has a smart property that does **not** involve a change in its physical dimensions?

Tick (✓) **one** box.

Photochromic pigment

Piezoelectric crystals

Quantum tunnelling composite

Shape memory alloy

[1]

6 Explain the difference between physical properties and mechanical properties.

.....

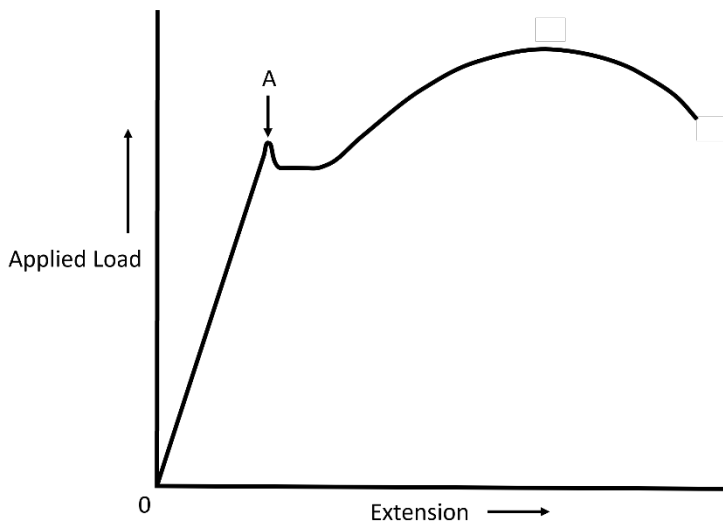
.....

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[2]

7 This is a load-extension graph from a tensile test carried out on a low carbon steel.



(a) Identify the characteristic shown by the letter **A**.

..... [1]

(b) Explain the importance of using a load-extension graph when deciding if a material is suitable for an engineering application.

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..... [3]

8 Explain **one** difference between the heat treatment processes of normalising and annealing.

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.....
.....
.....[2]

9

Paint is to be applied to a large outdoor steel footbridge to prevent corrosion.



(a)

Explain why this type of corrosion prevention would be most suitable to use.

.....
.....
.....
.....[2]

(b) State **three** types of corrosion prevention, other than paint, that could be used to protect steel.

- 1.
- 2.
- 3.

[3]

10 Explain **two** different ways that the circular economy could be implemented for a toaster.

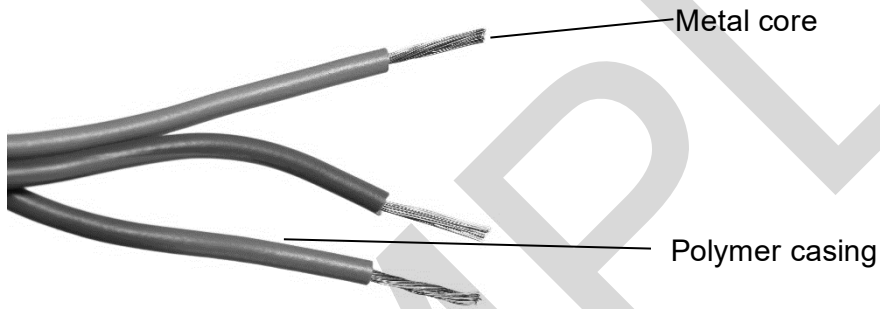
1

2

[2]

Section B

11 Electrical wires, such as those shown below, have a metal core and a polymer casing.



(a) Identify **one** suitable metal to use for the core.

Give **two** reasons for your choice.

Metal:

Reason 1:

Reason 2:

[3]

(b) Describe the bonding mechanism within the metal core.

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[4]

(c) Explain why the electrical wire casing is made from a thermoplastic polymer rather than a thermosetting polymer.

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[2]

12 A manufacturer of high-performance racing bicycles is changing the material used to make the frames from a metal alloy to carbon reinforced polymer (CRP) composite material.

(a) Explain the difference between a metal alloy and a composite material.

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[2]

(b) Explain **one** reason why a designer may prefer carbon reinforced polymer (CRP) to a metal alloy as the material for the bicycle frames.

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.....[2]

(c) Describe the lay-up process that would be used to make the bicycle frame from carbon reinforced polymer (CRP).

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.....[4]

(d) Explain how the alignment of the fibre reinforcement will affect the properties of the carbon reinforced polymer (CRP) when used in the bicycle frame.

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.....[4]

13 Car headlights have a transparent lens on the front. These lenses could be made from glass or polymer.

Discuss which of these materials is the most sustainable choice for this application.



In your answer you **must** write about:

- the **advantages** of using each material for a car headlight lens.
- the **disadvantages** of using each material for a car headlight lens.
- **which** material you would recommend **and** the reasons why.

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[9]

SAMPLE

SAMPLE

END OF QUESTION PAPER

This is sample assessment material for our specification. It is to help show how the live assessment materials will look. During the lifetime of the qualification you might see small adjustments to the assessment materials. This is part of continuous improvement, designed to help you and your students. We recommend you look at the most recent set of past papers where available.

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Level 3 Alternative Academic Qualification Cambridge Advanced Nationals in Engineering

Unit F131: Materials science and technology

SAMPLE ASSESSMENT MATERIAL

MARK SCHEME

This document has **10** pages.

SAMPLE

MARKING INSTRUCTIONS

Crossed-out answers

If a student has crossed out an answer and written a clear alternative, do **not** mark the crossed-out answer.

If a student has crossed out an answer and **not** written a clear alternative, give the student the benefit of the doubt and mark the crossed-out answer if it's readable.

Multiple choice question answers

When a multiple choice question has only one correct answer and a student has written two or more answers (even if one of these answers is correct), you should **not** award a mark.

When a student writes more than one answer

1. Questions that ask for a set number (including 1) of short answers or points

If a question asks for a set number of short answers or points (e.g. **two** reasons for something), mark only the **first set number** of answers/points.

First mark the answers/points against any printed numbers on the answer lines, marking the **first** answer/point written against each printed number. **Then**, if students have not followed the printed numbers, mark the answers/points from left to right on each line and **then** line by line until the set number of answers/points have been marked. Do **not** mark the remaining answers/points.

2. Questions that ask for a single developed answer

If a student has written two or more answers to a question that only requires a single (developed) answer, and has **not** crossed out unintended answers, mark only the first answer.

3. Contradictory answers in points-based questions

When a student has written contradictory answers, do **not** award any marks, even if one of the answers is correct.

Levels of Response marking

1. **To determine the level** start at the highest level and work down until you reach the level that best describes the answer

2. **To determine the mark within the level**, consider the following:

Quality of the answer	Award mark
Consistently meets the criteria for this level	At the top of the level (6 and 9 mark questions)
Meets the criteria but with some inconsistency	At the middle of the level (9 mark questions)
On the borderline of this level and the one below	At the bottom of the level (6 and 9 mark questions)

ANNOTATIONS

Annotation	Meaning

SAMPLE

MARK SCHEME

(See the **EA Item Types** document for examples)

1	
Max mark	1 (PO1)
Answer	Hardness
Guidance	Correct answer only

2	
Max mark	1 (PO1)
Answer	Polypropylene
Guidance	Correct answer only

3	
Max mark	1 (PO1)
Answer	It increases the density of the component
Guidance	Correct answer only

4	
Max mark	1 (PO1)
Answer	An increase in the operating temperature
Guidance	Correct answer only

5	
Max mark	1 (PO1)
Answer	Photochromic pigment
Guidance	Correct answer only

6	
Max mark	2 (PO1)
Answer	Physical properties are inherent/constant/characteristic properties of the material/not affected by external stimuli [1] whereas mechanical properties are a response to an externally applied force/can be changed [1]
Guidance	Accept any of the points separated by the / Do not accept "are not" or similar for second mark = too vague. Opposite point needs to be explained.

7(a)	
Max mark	1 (PO1)
Answer	Yield strength/elastic limit/limit of proportionality
Guidance	Do not award strength on its own.

7(b)	
Max mark	3 (PO1)
Answer	<ul style="list-style-type: none"> • It tells you the maximum load a material can withstand before permanent deformation of the material would occur [1] • It tells you the range of loads a material will deform over and return to its original size once the load is removed [1] • It tells you the ultimate tensile strength which is the greatest applied load the material can withstand before failure [1] • It tells you the point at which the material fractures/breaks [1]
Guidance	Accept any three points Accept alternative wording Accept alternative correct responses

8	
Max mark	2 (PO2)
Answer	Annealing involves allowing the metal to cool slowly/in a furnace [1] whereas normalising involves faster cooling/in air at room temperature [1] Alternatively: Normalising is the heat treatment process used for ferrous metals [1] whereas annealing is used for non-ferrous metals [1]
Guidance	Accept either

9(a)	
Max mark	2 (PO2)
Answer	<ul style="list-style-type: none"> • Most practical in terms of access [1] • Can re-coat the structure in place/situ rather than take it apart [1] • Most cost-effective treatment for a large structure [1]
Guidance	Accept any two points Accept alternative wording Accept alternative correct responses

9(b)	
Max mark	3 (PO1)
Answer	Polymer/powder coating Electroplating Galvanising Cathodic protection
Guidance	Accept “coatings” for 1 mark if no named coating methods are given Do not award paint (already given in the question)

10	
Max mark	2 (PO1)
Answer	<ul style="list-style-type: none"> • use materials which can be easily recycled [1] • use the same/interchangeable components in various models [1] • design (the toaster) for disassembly and reassembly/repair/refurbishment [1] • make replacement components available for use in repairs [1]
Guidance	Accept any two points Accept alternative wording Accept alternative correct responses

11 (a)	
Max mark	3 (PO2)
Answer	Metal: Copper [1] Reasons: High electrical conductivity [1] High ductility/ability to be drawn into wires [1] Any other appropriate reason.
Guidance	Award 1 mark for the material and 1 mark each for two reasons.

11(b)	
Max mark	4 (PO2)
Answer	<ul style="list-style-type: none"> • Metals have metallic bonding • The electrons are delocalised/shared • Between the positively charged nuclei • As an ‘electron cloud’/‘electron sea’ • Which means that the electrons are free to move within the material structure Any other relevant point.
Guidance	Credit answers presented as a diagram if suitably labelled

11 (c)	
Max mark	2 (PO2)
Answer	Thermoplastic polymers are more flexible than thermosetting polymers [1] as they are not cross-linked/and will not break when bent [1] Alternatively: Thermosetting polymers are very rigid/stiff [1] and would break when wires were bent [1]
Guidance	Accept either form of response.

12 (a)	
Max mark	2 (PO1)
Answer	Metal alloys contain constituents mixed at a chemical level [1] whereas a composite material is made from different material types that can still be distinguished separately within its structure [1]
Guidance	Do not award a mark just for composites are made from different types of material.

12 (b)	
Max mark	2 (PO2)
Answer	Lower mass/lower density/higher strength to weight ratio [1] meaning the bicycle will be lighter/will move faster/will be easier to transport [1] Any other relevant point
Guidance	Accept alternative correct responses

12 (c)	
Max mark	4 (PO1)
Answer	A mould is manufactured in the shape required [1] and a release agent applied [1]. The fibre reinforcement is placed into the mould in the shape required [1]. A resin is painted/sprayed on to soak into the fibre matrix [1]. The process of adding fibre and resin may be repeated to build up the required thickness [1]. The assembled material may be subject to heat/pressure to cure it [1]. Any other relevant point.
Guidance	Award marks as indicated up to a maximum of 4 marks. Steps must be presented in the correct order for the award of subsequent marks

12(d)	
Max mark	4 (PO2)
Answer	The orientation of the fibres will determine the degree of anisotropy of the properties [1] which means that the CRP frame will be stronger in certain directions [1]. If fibres are all oriented in the same direction the mechanical properties/strength of the CRP frame will be highest in this direction [1] and lowest normal/at 90° to this direction [1]. If fibres are randomly oriented then the properties should be uniform in all directions [1]. Any other relevant point.
Guidance	Award marks as indicated up to a maximum of 4 marks.

13	
Max mark	9 (PO3)
Levels of Response	<p>Level 3 (high) 7-9 marks A thorough discussion which shows detailed evaluation, which includes:</p> <ul style="list-style-type: none"> • a range of points from both sides of the argument • a detailed analysis in the context of the question • a clear conclusion(s) with detailed reasons/justifications • consistent use of appropriate subject terminology. <p>Level 2 (mid) 4-6 marks An adequate discussion which shows sound evaluation, which includes:</p> <ul style="list-style-type: none"> • some points from both sides of the argument • some analysis in the context of the question • an adequate conclusion(s) with relevant reasons/justifications • some use of appropriate subject terminology. <p>Level 1 (low) 1-3 marks A basic discussion which shows limited evaluation, which includes:</p> <ul style="list-style-type: none"> • a few points from the argument • a limited analysis in the context of the question • a brief conclusion(s) with limited reasons/justifications • use of appropriate subject terminology is limited. <p>0 marks Answer is not worthy of credit</p> <p>Level 3 (high) 7-9 marks</p> <p>Very detailed response which includes knowledge recall, supporting understanding and evaluation. The response addresses a wide variety of considerations, such as the characteristics or properties of the two options relative to the context, the relative environmental impact of each option, user preferences and manufacturing requirements. All considerations have supporting explanations related to the requirements of the context. The relative importance of the different considerations is evaluated and conclusions drawn. Responses at the top of this band may include judgements relating to conflicting requirements, such as cost, performance and sustainability.</p>

	<p>Level 2 (mid) 4-6 marks</p> <p>Detailed response which includes both recall of knowledge and understanding. The response addresses a range of considerations, such as the characteristics or properties of the two options relative to the context and the relative environmental impact of each option or manufacturing requirements. Most considerations have supporting explanations related to the requirements of the context. Responses at the top of this band may contain supporting explanations for all of the considerations, related to the requirements of the context.</p> <p>Level 1 (low) 1-3 marks</p> <p>Largely descriptive response based mainly on recall of knowledge. The response is limited to a single area of consideration, such as either the characteristics or properties of the two options relative to the context or the relative environmental impact of each option or manufacturing requirements. Reasoning and explanations are presented in general terms. Responses at the top of this band may contain some supporting explanations relating the presented characteristics to the context.</p> <p>0 marks Answer is not worthy of credit.</p>
<p>Indicative content</p>	<p>Advantages of using polymer as a material for a car headlight lens compared to glass:</p> <ul style="list-style-type: none"> • Polymer lenses have less strength but are more resistant to impact than glass lenses, so may require replacing less often. • The cost of the polymer lens would be substantially less than the cost of the glass lens. • Polymer can be recycled <p>Disadvantages of using polymer as a material for a car headlight lens:</p> <ul style="list-style-type: none"> • Polymer lenses are produced from oil, which is a finite resource. • Drilling for and transporting oil can cause environmental pollution. • Polymers are not biodegradable. <p>Advantages of using glass as a material for a car headlight lens compared to a polymer:</p> <ul style="list-style-type: none"> • Glass is an abundant natural material which can be reused and recycled repeatedly. • Glass lenses also require less energy to produce than polymer lenses <p>Disadvantages of using glass as a material for a car headlight lens:</p> <ul style="list-style-type: none"> • Glass lenses are made from ceramic, which requires a lot of energy for processing. • The energy used in production can cause pollution if generated using non-renewable resources. • Glass lenses would have a greater risk of breakage, which could limit opportunities for reuse and could harm the user. • Glass lenses would weigh more than plastic lenses, which would require more energy for transportation, with resultant effects on pollution. • Disposal at the end of the life of the product – methods and implications of recycling each material, use of landfill or associated disposal (such as incineration for the polymer).

	<p>Example Conclusion</p> <p>The material I would recommend is polymer, because a car headlight lens made from polymer would be more sustainable than one made from a glass. Overall, there are more advantages given above than disadvantages for this choice.</p> <p>Credit other relevant conclusions, points and examples.</p>
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SAMPLE