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Sample assessment material

LEVEL 3 ALTERNATIVE ACADEMIC QUALIFICATION CAMBRIDGE ADVANCED NATIONAL IN

ENGINEERING

Certificate H027

Extended Certificate H127

For first teaching in 2025

Unit F130: Principles of engineering

Version 1.0 (June 2024)

Introduction

This is Sample Assessment Material (SAM) which has been produced for the qualification OCR Level 3 Alternative Academic Qualification Cambridge Advanced National in Engineering.

The SAM is an example exam paper that we publish alongside a new specification to help illustrate its intended style and structure when a qualification is first launched. We wanted to share the story of our assessment approach with you so when you look through the paper you will find we have pointed out certain features and explained the decisions we have made.

Resources to help support in teaching different areas of content can be found on the Cambridge Advanced National in Engineering webpage under 'Planning and teaching'.

Our exam papers are developed with our accessibility principles in mind. The Understanding the assessment guide tells you a little more about the principles and rationale underpinning our approach for the qualifications. The 'Command Words' are in both the Understanding the Assessment guide and the specification. These tell you what we mean by each command word and how students should approach the question and understand its demand.

Appendix B of the specification: Command Words, gives detail about what is expected of each command word that will be included in exams and mark schemes. You can include teaching around the expectations of these as part of your teaching.

You said, we did

During the development of this qualification, we talked extensively with teachers, subject experts, higher education institutions and our senior assessment teams to influence its structure, content and assessment materials. We then shared our final materials with teachers to make sure that they met their needs.

You told us that you wanted a general engineering qualification to help students progress to all types of engineering and product design undergraduate degrees. We have done this by ensuring the mandatory units cover, as far as possible, both mechanical engineering and electrical/electronic engineering content and assessment. This is because mechanical engineering and electrical/electronic engineering are two of the main branches of engineering that provide a foundation for many other specialist types of engineering, for example automotive, aerospace, medical and manufacturing.

You told us that you wanted the external assessment to be similar to the external assessment in the current Cambridge National in Engineering qualifications. We have tried to do this by using a familiar tone and style of questioning.

You told us that you wanted fewer exams, so we have reduced the number of mandatory examined units to two.

You told us that you wanted most of the mathematical content to be assessed within an engineering context. We have done this by assessing most of the mathematical skills as part of the mechanical engineering questions and electrical/electronic engineering questions in the exam.

You told us that scenarios used within external assessment should be accessible and easy for students to understand. We have therefore tried to use common engineering applications, using everyday objects and products where possible. Scenarios are kept as short as possible, and diagrams are used where it is appropriate to do so.

Examples of comments received are placed against the relevant sections/questions.

All students will sit the exam at the same time on the same day.

The time allowed is designed to give students approximately one minute per mark plus reading time.

If students require additional answer space, lined paper may be available at the end of the answer booklet in a live question paper. Remember the question number(s) must be clearly shown.

Each exam will ask at least one question from each Topic Area in the unit. Questions will not necessarily be in the same order as the teaching content. Students should answer all questions.

The exam will always have 70 marks and consist of two sections, with each section having a total of 35 marks

OCR
Oxford Cambridge and RSA

<<Date>> – <<Morning/Afternoon>>

Level 3 Alternative Academic Qualification Cambridge Advanced Nationals in Engineering

H027/H127 Unit F130: Principles of engineering

Sample Assessment Material (SAM)

Time allowed: 1 hour 30 minutes

You must have:

- The Formula Booklet for Unit F130 (inserted)
- a ruler (cm/mm)

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

Centre number | Candidate number

First name(s)

Last name

Date of birth D D M M Y Y Y Y

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- 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.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**
- This document consists of **22** pages.

ADVICE

- Read each question carefully before you start your answer.

Turn over

This exam will always be set and marked by us. Exams will be available in January and June each year. Students can resit this unit and the best result will be used to calculate the certification result.

A formula booklet is provided for this exam.

Students should show their working since marks may be awarded for correct method, even if their answer is wrong.

Students should give non-exact numerical answers correct to 3 significant figures unless a question states otherwise.

Each section contains mandatory questions totalling 35 marks. 'Section A' covers mechanical engineering based questions and 'Section B' covers electrical/electronic based questions, with content from Topic Area 1 Mathematical principles assessed throughout the exam paper.

Most questions will have a vocational context.

Question types include:
- Forced choice/controlled response questions
- Short answer, closed response questions
- Short answer, calculation questions
- Extended calculation questions

These allow us to assess the following Performance Objectives:
- PO1 – Show knowledge and understanding
- PO2 – Apply knowledge and understanding
- PO3 – Analyse and evaluate knowledge, understanding and performance.

The questions will sample content from across all Topic Areas; at least one question (or sub-part) will relate to each Topic Area. Sub-content topic areas will be sampled across exam papers, over time.

Section A

1 Which quantity is defined as an external agent capable of changing a body's state of rest or motion?

Tick (✓) **one** box.

- Displacement ☐
- Energy ☐
- Force ☐
- Velocity ☐

[1]

2 Which quantity is defined as the straight-line distance between two points in a given direction?

Tick (✓) **one** box.

- Displacement ☐
- Height ☐
- Length ☐
- Work done ☐

[1]

3 Using an SI prefix the ultimate tensile strength of a material is given as 415 MNm^{-2}.

Which is the equivalent quantity expressed using engineering notation?

Tick (✓) **one** box.

- 415 x 10^{-9} Nm^{-2} ☐
- 415 x 10-6 Nm^{-2} ☐
- 415 x 10^{6} Nm^{-2} ☐
- 415 x 10^{9} Nm^{-2} ☐

Students should put a tick (✓) in the box to show their response for multiple choice questions

A small number of questions, such as question 3, assess content from just Topic Area 1 Mathematics.

[1]

4 A cylindrical storage tank is 2.2 m high with a radius of 0.8 m.

Calculate the external curved surface area of the tank.

external curved surface area = ….....m^2

[2]

5 A steel cable with a diameter of 0.05 m supports a load of 22×10^3 N.

Calculate the direct tensile stress (σ) in the cable.

Ignore the weight of the cable.

direct tensile stress (σ) = ...Nm^{-2}

[3]

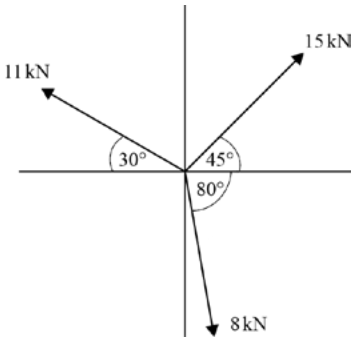
Where contexts are used, information will be concise and specific to the question.

This sentence has been included to appropriately simplify the question for students and it means that there is sufficient information given to answer the question.

This sentence has been included because we do not want students to calculate the answer graphically, but instead undertake a numerical calculation using the information provided.

6 This free body diagram represents a system of coplanar concurrent forces.

Diagram is not to scale.



Diagrams have been used to help students understand the question and to reduce the number of words in the scenario. They are often used for higher mark tariff questions.

(a)

(i) Calculate the sum of the vertical components of the forces (F_v).

sum of forces (F_v) = ….....kN

[3]

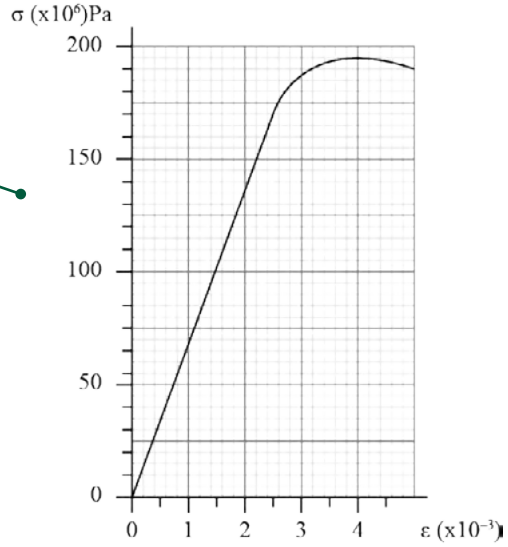
(ii) The sum of the horizontal components of the forces is 2.47 kN.

Calculate the magnitude of the resultant force (F_R) that is equivalent to this system of forces.

resultant force (F_R) = ….....kN

[2]

7 This is a stress versus strain graph for a material used to manufacture engineering components.



Calculate the modulus of elasticity (E) of the material.

modulus of elasticity (E) = ……Pa

[2]

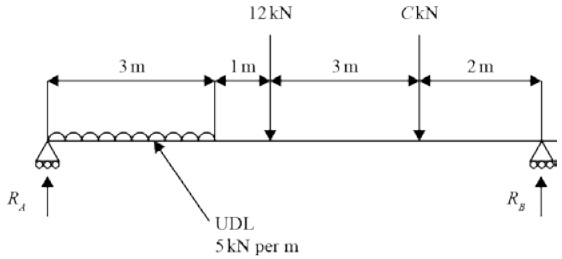
For some questions information must be interpreted from a graph before a calculation can be completed.

The number of marks assigned to a question will always be given at the end of the question and will always be right aligned.

8 This diagram shows a simply supported beam under load. The beam is in static equilibrium.

Ignore the weight of the beam.

Diagram not to scale.



(a) Calculate the magnitude and position of the single point load that is equivalent to the uniformly distributed load (UDL).

Magnitude = ….....kN

Distance from R_A =….....m

[2]

(b) The reaction force acting at R_B is 22.3 kN.

Determine the magnitude of the applied point load *C*.

You must show your working.

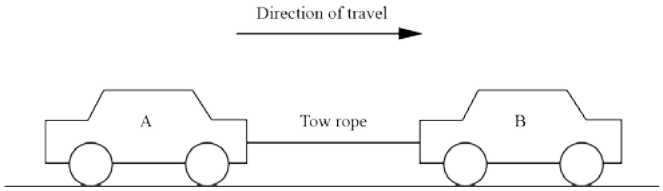
Magnitude of point load (*C*) =…….....kN

[4]

Appendix B in the specification contains a glossary of Command Words which will be used in our exams. The glossary tells you what we mean by each command word.

This sentence informs students that they cannot obtain full marks without showing sufficient working. It means that if a student just writes down the correct answer, they will not be awarded full marks. A command verb of 'determine' or 'show that' will usually be used in this situation.

9 Vehicle A has mass 1450 kg and is being towed by vehicle B along a level road.



A constant dynamic friction force of 240 N resists the motion of vehicle A as it is being towed.

The tow rope joining the two vehicles has a maximum safe working load of 3 kN.

Determine the maximum acceleration (a) vehicle A can achieve without exceeding the safe working load of the tow rope.

Give your answer in an appropriate unit.

You must show your working.

maximum acceleration (a) = …….. unit ……

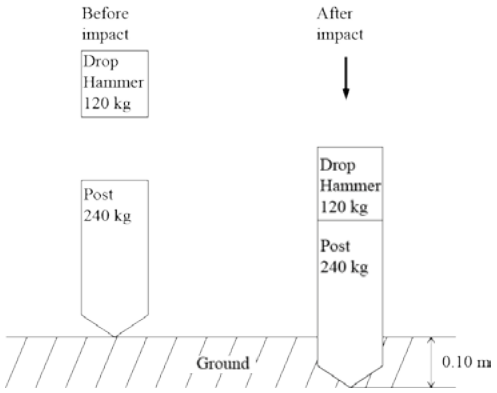
[6]

This sentence informs students to provide an appropriate unit of measure on the answer line. At least one question in each section will require students to provide an appropriate unit of measure.

A slightly longer and more complex engineering scenario or context may be used for higher tariff questions.

As a general rule, the demand of questions will increase as you progress through each section of the exam paper.

10 A drop hammer with a mass of 120 kg strikes a steel post being driven into the ground.



The drop hammer reaches a velocity of 10.85 ms^{-1} immediately before hitting the post.

After impact the drop hammer and post move together in a straight-line without any rebound.

The post has a mass of 240 kg and moves into the ground by 0.10 m after being struck.

(a) Show that the velocity (v) of the combined drop hammer and post immediately after impact is 3.62 ms^{-1}.

Use the principle of conservation of momentum for perfectly inelastic collisions between two bodies.

You must show your working.

The answer is provided in the question stem, which is why there is no answer line, and what students need to do is to show the method (steps) required to calculate the answer.

This approach means that any student who cannot answer Q10a could still achieve full marks for Q10b.

[2]

The word ‘hence’ informs students to use the answer from 10a to help answer question 10b.

9

(b) Hence, determine the average force (F) that decelerates the post as it moves into the ground.

You must show your working.

force (F) =.....N

[6]

Marks are usually awarded for mathematical operations and for interpreting principles to solve problems. They include for example:

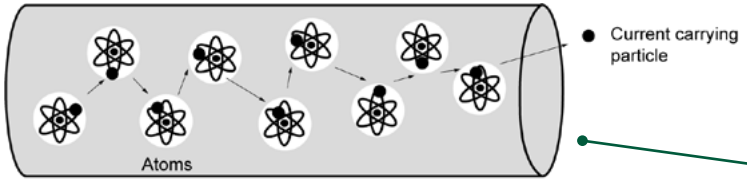
- Converting between units of measure (only if necessary)
- Substitution of values into equations
- Rearranging equations
- Numerical answers
- Unit of measure (when not given)
- Setting up an equation
- Recognition of connecting principles in a multistep problem and/or interpretation of the scenario/principles.

Multiple choice questions will always have four response options listed in alphabetical or numerical order. The four response options will consist of the correct answer and three distractors.

Section B

Questions in Section B will be on mathematics and electrical/electronic principles.

11 This diagram shows current flowing through a conductor.



Images will always be greyscale.

What is the name of the current carrying particle shown in the diagram?

Tick (✓) **one** box.

- Cell ☐
- Electron ☐
- Nucleus ☐
- Voltage ☐

[1]

12 An engineer is converting an angle in degrees into radians.

What is the 330° angle when measured in radians?

Tick (✓) **one** box.

- 3.67 radians ☐
- 5.50 radians ☐
- 5.76 radians ☐
- 11.5 radians ☐

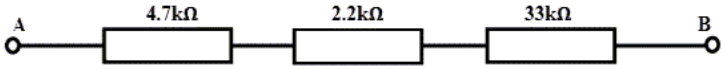
[1]

13 Which circuit symbol represents a capacitor with a capacitance of 22×10^{-9} Farads?

Tick (✓) **one** box.

[1]

14 Calculate the total resistance (*RT*) between points A and B of the network of resistors shown below.



total resistance (*RT*) = ... **kΩ**

[2]

15 A coil has 200 turns of copper wire which produces a magnetic flux of 0.01Wb. A steady 50 A current is being passed through the coil.

Calculate the inductance (L) of the coil.

We will provide appropriate space for students to show their working.

We will always state the abbreviation of the quantity being assessed in brackets in the question and on the answer line to help students navigate the formulae booklet.

Inductance (L) =..... H

[2]

16 A circuit has a single 50Ω lamp which draws a current of 10mA.

(a) Calculate the power dissipated (P) in the lamp.

power dissipated (P) =…..... W
[3]

(b) What is the waste electrical energy converted into?

..... **[1]**

(c) Calculate the length of time that a 2500 mAh battery would be able to power this circuit until it was fully discharged.

time = …..... hours
[2]

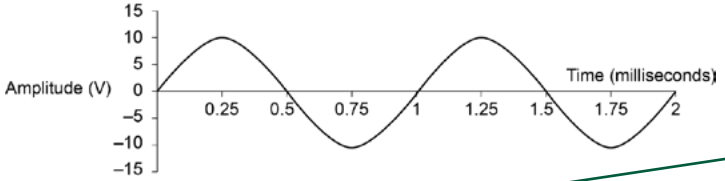
Follow through (ft) or error carried forward (ecf) may apply which means that a student may gain credit for subsequent working, following on from an earlier mistake.

A small number of questions may require a written response and the vast majority of questions involve numerical calculation.

In this question, students need to show their knowledge and understanding (PO1) of how to calculate the power dissipated.

This question assesses PO2, apply knowledge and understanding, and student responses must be applied to the lamp.

17 This diagram shows the voltage in an AC circuit over time.



(a) Find the periodic time (T) of the waveform.

periodic time (T) =……ms

[1]

(b) Calculate the frequency (f) of the waveform.

Give your answer in an appropriate unit.

frequency (f) =…..... unit……**[3]**

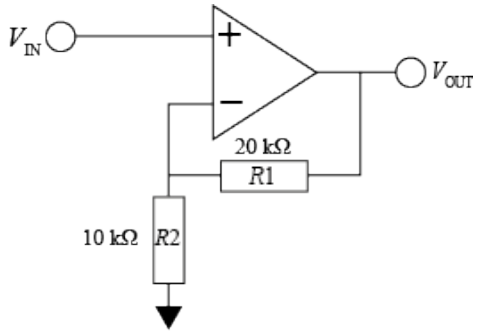
Where the unit of measurement is included as part of the question, it will be included on the answer line. Students should provide their answer in the same units of measure as given on the answer line.

We will tell students when they should give the unit of measure for their answer and provide a dedicated answer line for them to write their final answer and an appropriate unit.

THIS PAGE HAS BEEN LEFT INTENTIONALLY BLANK

Where a question requires students to use a visual stimuli, we may leave a blank page so the stimuli is on view for all question parts.

18 The following circuit is a non-inverting amplifier.



(a) Calculate the voltage gain (A_v) for the above circuit.

voltage gain (A_v) = ...

[2]

(b) This amplifier is cascaded with another amplifier with a gain (A_v) of 0.5.

Calculate the overall voltage gain of the system in dB.

overall voltage gain of the system = ...dB
[3]

Where students need to answer in a table it will be centered on the page.

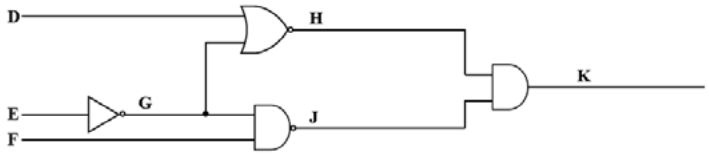
19 An engineer is given the partially complete truth table for an **AND** gate.

(a) Complete the truth table by filling in column **Q**.

A	B	Q
0	0	
0	1	
1	0	
1	1	

[1]

(b) The diagram shows a logic gate circuit.



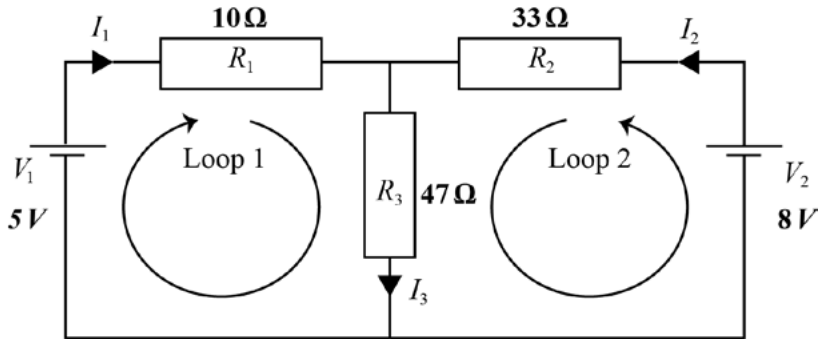
Complete the truth table for this circuit.

D	E	F	G	H	J	K
0	0	0				
0	0	1				
0	1	0				
0	1	1				
1	0	0				
1	0	1				
1	1	0				
1	1	1				

[4]

19

20 The diagram shows a network of resistors that is connected to two DC power sources.



Determine the current (I_1) flowing through R_1.

You must show your working.

Current (I_1) flowing through R_1 = ... **A**

[8]

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Turn over

Where there is more than one method to solve a question, we will accept alternative methods of working.

This question will assess PO3 - Analyse and evaluate knowledge, understanding and performance. Responses will need to translate the diagram into a mathematical process.

The highest mark tariff questions usually require calculations with multiple steps which may connect principles together.

20

END OF QUESTION PAPER

Indicates to students there are no more questions to answer.

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I like this **I dislike this**

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