LUI | | | | | | | | | | |

School code | | | | |

School name

Given name/s

Family name

Attach your barcode ID label here

Book | | of | | books used

External assessment 2026

Question and response book

Clear zone — margin trimmed off after completion of assessment

Engineering

Time allowed

- Perusal time — 5 minutes
- Working time — 120 minutes

General instructions

- Answer all questions in this question and response book.
- Non-programmable scientific calculator permitted.
- Protractor and ruler required.
- QCAA formula book provided.
- Planning paper will not be marked.

Section 1 (10 marks)

- 10 multiple choice questions

Section 2 (34 marks)

- 6 short response written questions

Section 3 (35 marks)

- 6 short response calculation questions
- Total: 79 marks. Predicted paper written by Tangent Tuition. Not QCAA material.

THIS PAGE WILL NOT BE MARKED

Section 1

Instructions

- This section has 10 questions and is worth 10 marks.
- Use a 2B pencil to fill in the A, B, C or D answer bubble completely.
- Choose the best answer for Questions 1–10.
- If you change your mind or make a mistake, use an eraser to remove your response and fill in the new answer bubble completely.

	A	B	C	D
Example:	●	○	○	○

	A	B	C	D
1.	○	○	○	○
2.	○	○	○	○
3.	○	○	○	○
4.	○	○	○	○
5.	○	○	○	○
6.	○	○	○	○
7.	○	○	○	○
8.	○	○	○	○
9.	○	○	○	○
10.	○	○	○	○

Ensure you have filled an answer bubble for each question.

Do not write outside this box.

Section 2

Instructions

- Write using black or blue pen.
- Responses are limited to 150 words per question.
- If you need more space for a response, use the additional pages at the back of this book.
  - On the additional pages, write the question number you are responding to.
  - Cancel any incorrect response by ruling a single diagonal line through your work.
  - Write the page number of your alternative/additional response, i.e. See page …
  - If you do not do this, your original response will be marked.
- This section has six questions and is worth 34 marks.

QUESTION 11 (4 marks)

Explain how a screw jack provides a mechanical advantage when raising a car. Include a sketch to support your response.

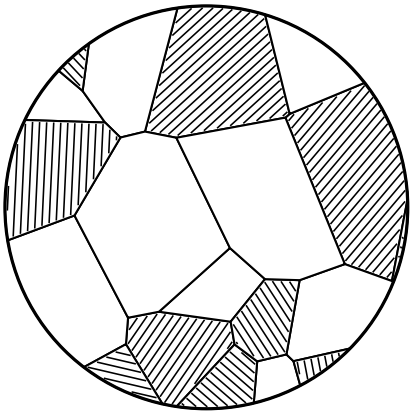
Note: If you make a mistake, cancel it by ruling a single diagonal line through your work and use the additional response space at the back of this book.

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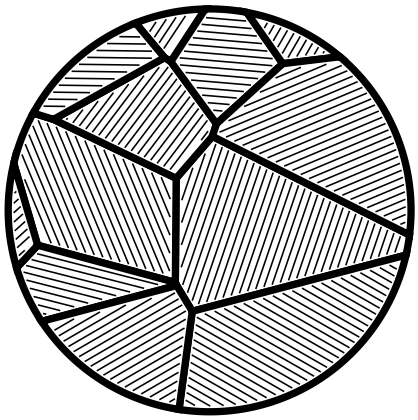
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QUESTION 12 (5 marks)

The microstructures of two plain-carbon steels at room temperature are shown.



Steel X



Steel Y

The steels are being considered for railway carriage wheels, which are subject to repeated impact loads.

Identify the microstructure of each steel. Determine the most appropriate steel for the wheels. Justify your choice with reference to the microstructures.

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QUESTION 13 (6 marks)

Two identical bars of eutectoid steel (0.83% carbon) are heated to 800 °C. Bar 1 is then quenched in water. Bar 2 is cooled slowly inside the furnace.

a) Explain how the cooling rate affects the microstructure and the mechanical properties of each bar.

[4 marks]

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b) Bar 1 is to be used as a punch in a metal fabrication workshop. Explain why Bar 1 is tempered before it is used. *[2 marks]*

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QUESTION 14 (5 marks)

A table comparing the properties of polycarbonate (PC) and acrylonitrile butadiene styrene (ABS) is shown.

Properties	**Polycarbonate (PC)**	**Acrylonitrile butadiene styrene (ABS)**
Mechanical	very high impact resistance; tough; rigid; good dimensional stability	high impact resistance; tough; hard; rigid; lightweight
Impact strength (notched Izod)	600–850 J/m	200–300 J/m
Optical	transparent	opaque; takes colour and gloss finishes well
Light transmission (3 mm sheet)	88–90%	0%
Maximum service temperature	115–130 °C	80–90 °C
Chemical	good resistance to water and dilute acids; attacked by petrol and many solvents	good resistance to water, acids and alkalis; attacked by some solvents
Manufacturing cost	moderate	low

Analyse the information in the table to determine whether PC or ABS is the most suitable material for the visor of a motorcycle helmet. Justify your response with four properties from the table.

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QUESTION 15 (8 marks)

A boom gate at a railway level crossing has two train sensors, one on each side of the crossing. The boom must be lowered when either sensor detects a train. The crossing operator can also lower the boom using a manual switch, but the manual switch only works when the maintenance key is not inserted in the control box.

Key

Input A = Train sensor 1 (train detected = 1)
Input B = Train sensor 2 (train detected = 1)
Input C = Manual switch (on = 1)
Input D = Maintenance key (inserted = 1)
E and F are intermediate input/output signals to the logic gates.
Output X = Boom (boom lowered = 1)

Construct a logic gate circuit for the boom gate, clearly labelling all inputs and outputs. Complete columns F and X of the corresponding truth table on the next page.

Note: If you make a mistake, cancel it by ruling a single diagonal line through your work and use the additional response space at the back of this book.

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Truth table for the boom gate

Inputs				Intermediate signals		Output
A	**B**	**C**	**D**	**E**	**F**	**X**
0	0	0	0	0		
0	0	0	1	0		
0	0	1	0	0		
0	0	1	1	0		
0	1	0	0	1		
0	1	0	1	1		
0	1	1	0	1		
0	1	1	1	1		
1	0	0	0	1		
1	0	0	1	1		
1	0	1	0	1		
1	0	1	1	1		
1	1	0	0	1		
1	1	0	1	1		
1	1	1	0	1		
1	1	1	1	1		

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QUESTION 16 (6 marks)

Falls at home are a major cause of injury and hospital admission for older people, and many older people lose their independence after a fall. Families and health services need ways to help older people keep living safely in their own homes.

Explain how biomechanical engineers have used their expertise in mechanics, materials science and control technology to develop a device that reduces the risk of falls for older people living at home. Include two benefits to the community in your response.

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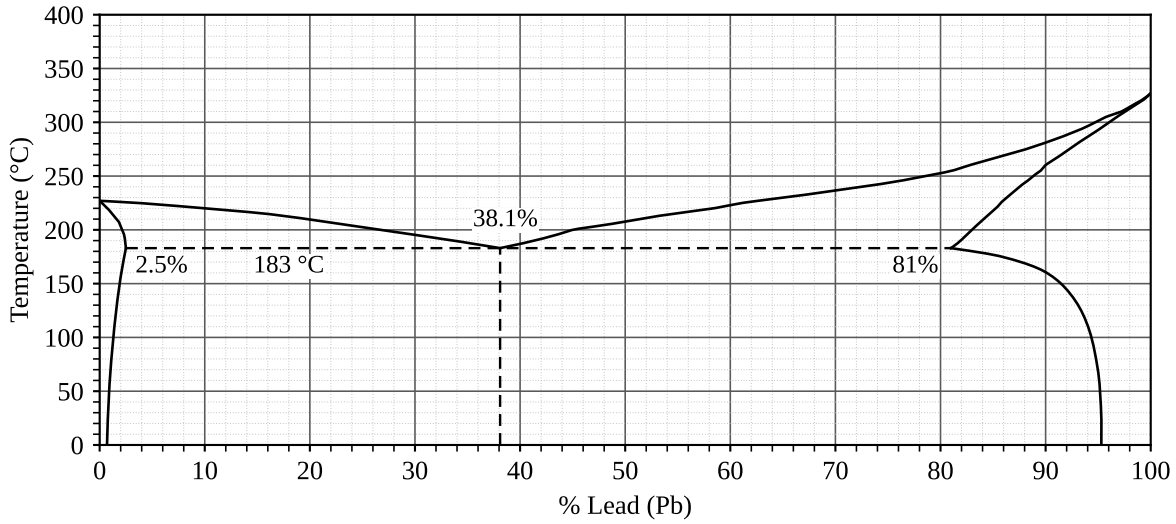
Section 3

Instructions

- Respond showing full working for calculations.
- This section has six questions and is worth 35 marks.

QUESTION 17 (4 marks)

A lead–tin thermal-equilibrium diagram is shown.



a) Identify the percentage of tin in the eutectic composition. *[1 mark]*

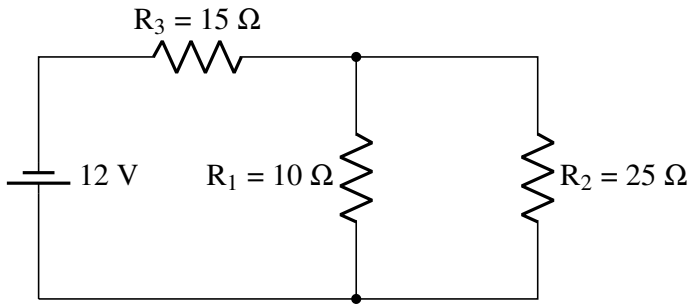
b) Determine the percentages of solid and liquid in a 75% lead 25% tin alloy at 220 °C. Annotate the diagram to support your response. *[3 marks]*

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QUESTION 18 (4 marks)

A heater for a small greenhouse has three heating elements connected to a 12 V battery, as shown.



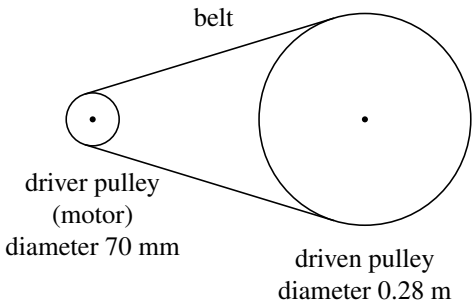
a) Calculate the total resistance of the circuit. *[2 marks]*

b) Calculate the power delivered by the battery. *[2 marks]*

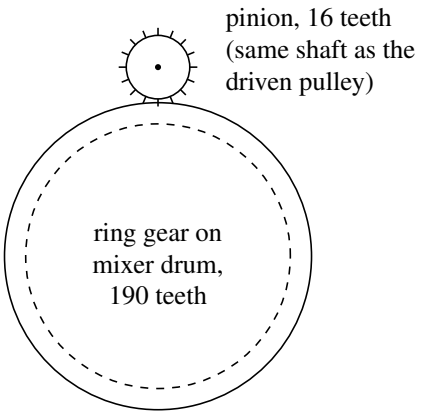
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QUESTION 19 (5 marks)

A concrete mixer is driven by an electric motor through a belt drive and a gear stage, as shown. The motor rotates at 1400 rpm.



Belt drive



Not to scale

Gear stage

a) Calculate the velocity ratio (VR) of the belt drive. *[2 marks]*

b) Determine the rotational speed of the mixer drum in rpm. *[3 marks]*

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QUESTION 20 (4 marks)

A 150 kg crate is at rest on a ramp. The surface of the ramp is 3.2 m long and the top of the ramp is 1.1 m above the ground.

a) Calculate the normal force acting on the crate. *[2 marks]*

b) Determine the minimum coefficient of static friction required to keep the crate at rest. *[2 marks]*

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QUESTION 21 (10 marks)

An electric winch lifts pallets of roof tiles vertically onto a roof at a slow, constant speed. The winch motor is connected to a 240 V supply and draws a current of 10 A. The motor has an electrical efficiency of 85%. The motor drives the winch drum through a gearbox, and the gearbox and drum have a combined mechanical efficiency of 70%.

Each pallet and its lifting cradle have a combined mass of 600 kg and are lifted 12 m from the ground to the roof. Allow 2 minutes after each lift for the cradle to be unloaded and lowered back to the ground.

Determine the maximum number of pallets that the winch can lift to the roof in one hour.

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QUESTION 22 (8 marks)

A parcel with a mass of 12 kg is released from rest at the top of a delivery ramp inclined at 25° to the horizontal. The ramp is 4.5 m long. The coefficient of kinetic friction between the parcel and the ramp is 0.30.

Determine the speed of the parcel at the bottom of the ramp. Include a free-body diagram showing all the forces involved.

Note: If you make a mistake, cancel it by ruling a single diagonal line through your work and use the additional response space at the back of this book.

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END OF PAPER

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ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

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