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Book

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books used

External assessment 2023

Question and response book

# Engineering

## Time allowed

- Perusal time — 10 minutes
- Working time — 120 minutes

## General instructions

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

## Section 1 (10 marks)

- 10 multiple choice questions

## Section 2 (30 marks)

- 5 short response written questions

## Section 3 (45 marks)

- 6 short response calculation questions



**DO NOT WRITE ON THIS PAGE**  
**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
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	A	B	C	D
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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.
  - 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 five questions and is worth 30 marks.
- 

### QUESTION 11 (4 marks)

State four contemporary engineering applications for acrylonitrile butadiene styrene (ABS).

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

### QUESTION 12 (5 marks)

Explain how the gearing system on a bicycle provides a mechanical advantage to a cyclist moving up an incline, and the system's effect on the work done on the pedals. Sketch the mechanical components involved to support your response.

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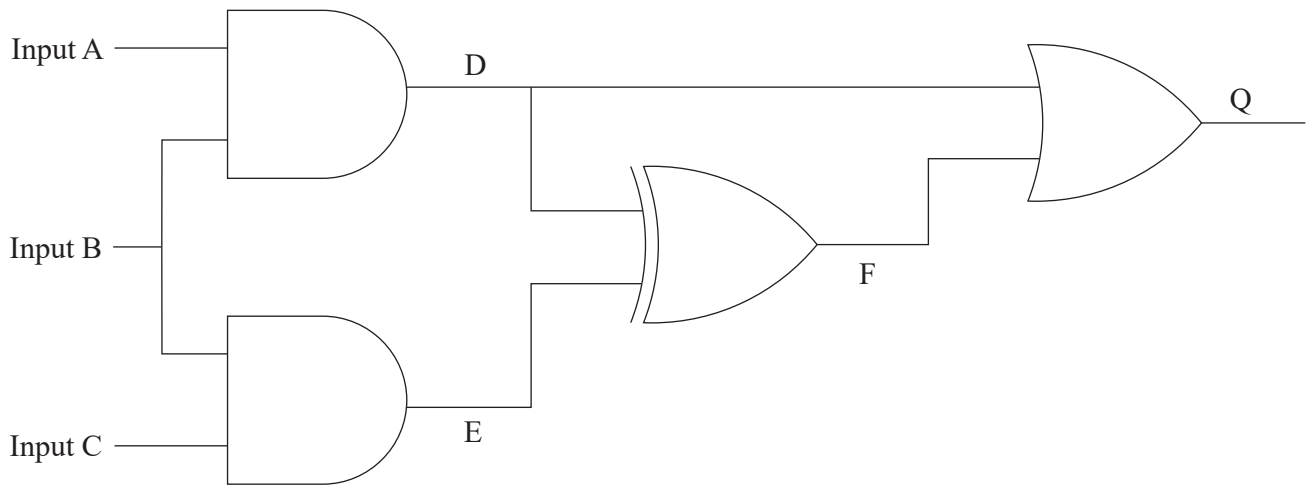


**Note:** If you make a mistake in the sketch, cancel it by ruling a single diagonal line through your work and use the additional response space at the back of this question and response book.

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**QUESTION 13 (8 marks)**

This logic circuit operates an electric motor driven using solar or wind power.



**Key**      Input A — solar panel                  Input B — timer                  Input C — wind turbine

- a) Complete the corresponding truth table. All inputs to the system are 1 for ON and 0 for OFF.

[4 marks]

A	B	C	D	E	F	Q
0	0	0				
0	0	1				
0	1	0				
0	1	1				
1	0	0				
1	0	1				
1	1	0				
1	1	1				

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

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b) Explain how the logic circuit determines which source of power drives the electric motor under each condition for all possible inputs.

[4 marks]

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**QUESTION 14 (5 marks)**

Explain how a mechanical engineer might use the problem-solving process to develop a solution for automotive components in a production line to be automatically pressed and moved. Support your response with two areas of engineering expertise the engineer could draw on.

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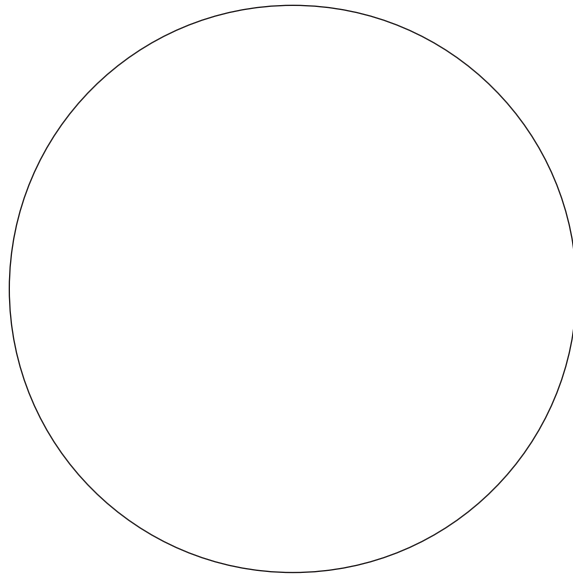
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**QUESTION 15 (8 marks)**

- a) Provide an annotated sketch of the microstructures of medium carbon steel at room temperature.

[4 marks]



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

- b) Explain how the microstructures of medium carbon steel demonstrate two mechanical properties that make it a suitable material for train rails.

[4 marks]

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## **Section 3**

### **Instructions**

- Respond showing full working for calculations.
  - This section has six questions and is worth 45 marks.
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### **QUESTION 16 (5 marks)**

A crane lowers a storage container off the back of a truck at a velocity of 1.5 m/s, giving the container a kinetic energy of 850 J.

Calculate the total mechanical energy of the lowering system when the base of the storage container is 2 m above the ground. Answer to the nearest whole unit.

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**QUESTION 17 (9 marks)**

A threaded rod with a pitch of 2.5 mm and an outside diameter of 30 mm is used as a mechanism to vertically raise a 40 kg load with a potential energy of 980 J. The threaded rod is directly driven by a variable-speed electric motor with an efficiency of 62%.

Determine the power required from the motor to raise the load in 15 seconds. Answer to one decimal place.

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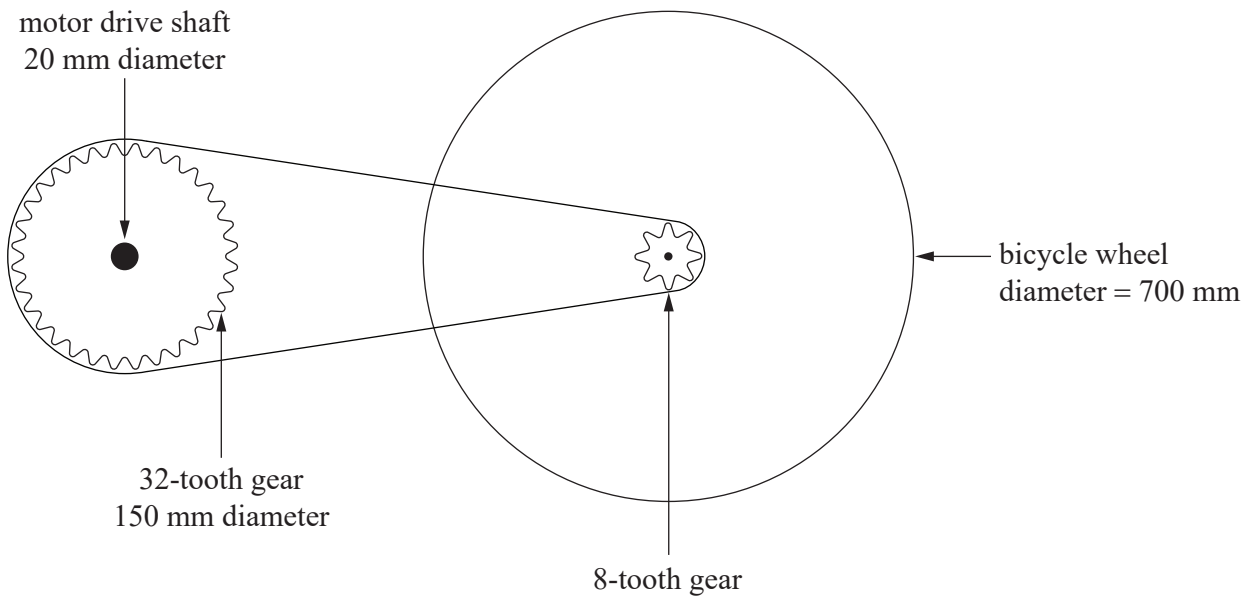
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**QUESTION 18 (7 marks)**

An electric motor with an output force of 600 N is attached to the driver gear of an electric-powered bicycle using a 20 mm diameter drive shaft.



Not to scale

- a) Calculate the number of driver gear rotations required for the bicycle wheel to move 15 m. Answer to one decimal place.

[2 marks]

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b) Calculate the number of motor drive shaft rotations required for the bicycle wheel to move 15 m. Answer to the nearest whole unit.

[2 marks]

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c) Determine the output power of the electric motor if the bicycle wheel takes 2 seconds to travel 15 m. Answer to the nearest whole unit.

[3 marks]

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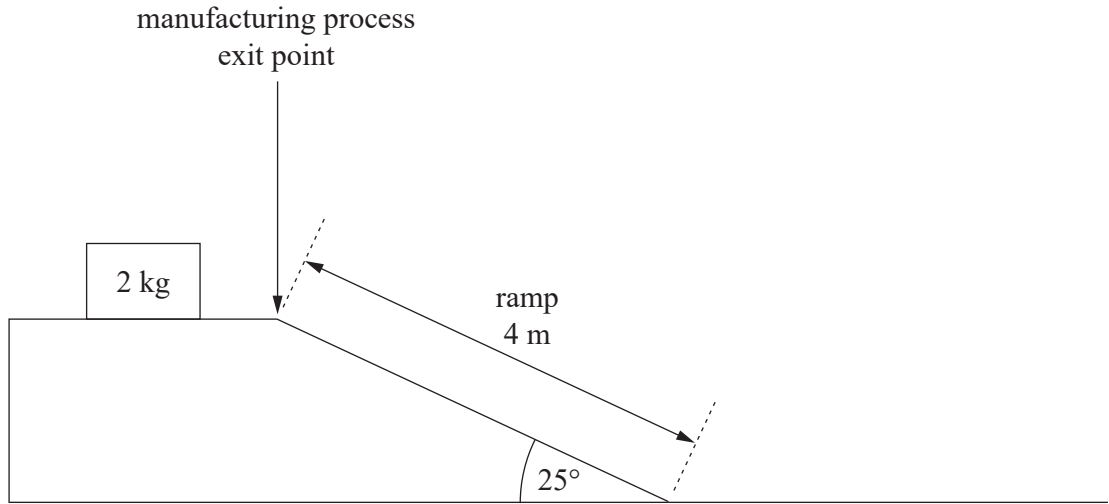
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**QUESTION 19 (9 marks)**

A 2 kg box exits a manufacturing process at a velocity of 0.5 m/s and then slides down a ramp onto a horizontal surface as shown.



Not to scale

Determine the distance the box slides along the horizontal surface before coming to a complete stop if the coefficient of kinetic friction between the box and all surfaces is 0.35. Answer to the nearest whole unit.

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**QUESTION 20 (5 marks)**

A 20 kg trolley is pushed up a  $10^\circ$  incline using a force of 160 N.

Determine the coefficient of friction between the trolley and the incline if the trolley is travelling at a uniform velocity. Answer to two decimal places.

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**QUESTION 21 (10 marks)**

A factory uses a two-pump system to vertically lift water into a main reservoir.

The first pump is 80% efficient and lifts 500 litres of water per minute into a holding tank 6 m above the ground. The second pump is 75% efficient and lifts 500 litres of water per minute from the holding tank into the main reservoir 10 m above the ground.

This current system is being replaced with a single-pump system that is 90% efficient and has the same power input as the two-pump system. Determine the rate at which the new system will lift water into the main reservoir. Answer to the nearest whole unit (litres per minute).

**Note:** 1 litre of water has a mass of 1 kg.

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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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**ADDITIONAL PAGE FOR STUDENT RESPONSES**

Write the question number you are responding to.

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**ADDITIONAL PAGE FOR STUDENT RESPONSES**

Write the question number you are responding to.

Do not write outside this box.

## ADDITIONAL PAGE FOR STUDENT RESPONSES

If you want this truth table to be marked, rule a single diagonal line through your original response.

A	B	C	D	E	F	Q
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0	0	1				
0	1	0				
0	1	1				
1	0	0				
1	0	1				
1	1	0				
1	1	1				

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