

# — Public use —

LUI

Venue code

School name

Given name/s

Family name

Attach your  
barcode ID label here

Sample assessment 2020

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.
- QCAA formula sheet provided.
- Protractor and ruler required.
- Unless stated, express answers to calculations to the nearest whole unit.
- Planning paper will not be marked.

## Section 1 (10 marks)

- 10 multiple choice questions

## Section 2 (27 marks)

- 6 short response questions

## Section 3 (48 marks)

- 8 short response questions



## Section 1

### Instructions

- Choose the best answer for Questions 1–10.
- 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.
- 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:	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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	A	B	C	D
1.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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5.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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## 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 six questions and is worth 27 marks.
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### QUESTION 11 (2 marks)

Describe how one feature of a bicycle provides the rider with a mechanical advantage.

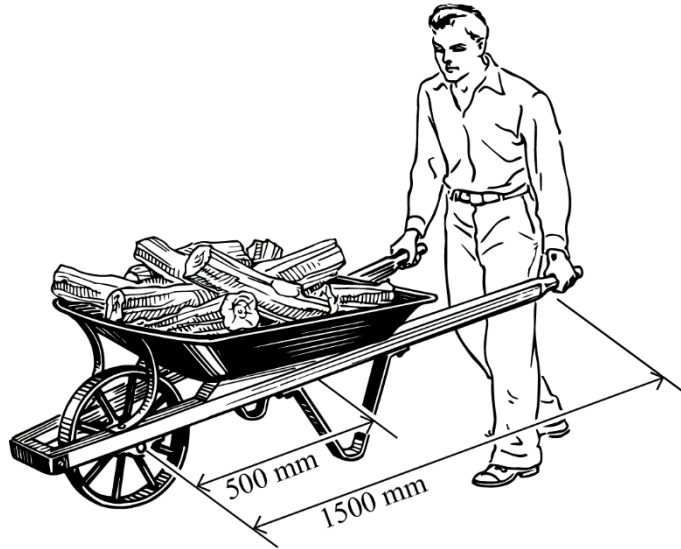
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QUESTION 12 (3 marks)



The wheelbarrow in the figure above is used by the operator to raise a 100 kg load of firewood from the ground. The weight of the load is located 500 mm from the wheel axle.

Explain the relationship between the load and the effort required to raise the load. Use mathematical reasoning to support your explanation.

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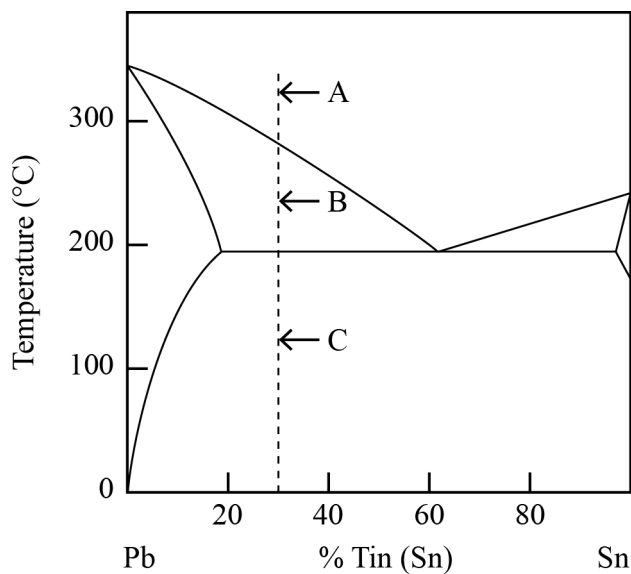
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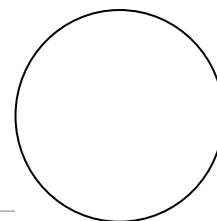
**QUESTION 15 (6 marks)**



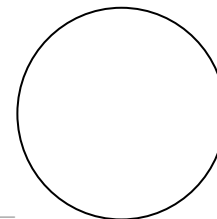
Interpret the lead–tin phase diagram above to identify the mixture formed at the positions indicated by the letters A, B and C. Sketch each in the space provided below.

**Note:** If you make a mistake in these sketches, cancel them by ruling a single diagonal through your work and use the additional space on page 22 of this question and response book.

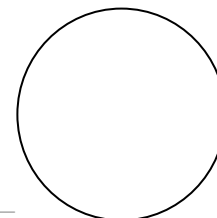
A \_\_\_\_\_



B \_\_\_\_\_



C \_\_\_\_\_







### Section 3

#### Instructions

- Write using black or blue pen.
  - Respond showing full working for calculations.
  - 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 eight questions and is worth 48 marks.
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**DO NOT WRITE ON THIS PAGE**  
**THIS PAGE WILL NOT BE MARKED**

## QUESTION 17 (6 marks)

The engine room on a cruise ship has been fitted with several sensors to help detect and suppress fires. These include heat (H), smoke (S), flame (F) and door (D) sensors. The door sensor informs the system when personnel are in the engine room.

A fire alarm that includes a flashing light, siren and fire team notification has been installed. There is also a carbon dioxide (CO<sub>2</sub>) fire suppression system in the engine room that is used to extinguish detected fires. While CO<sub>2</sub> can be effective in suppressing fires, it is dangerous to people when used in confined spaces such as a cruise ship's engine room.

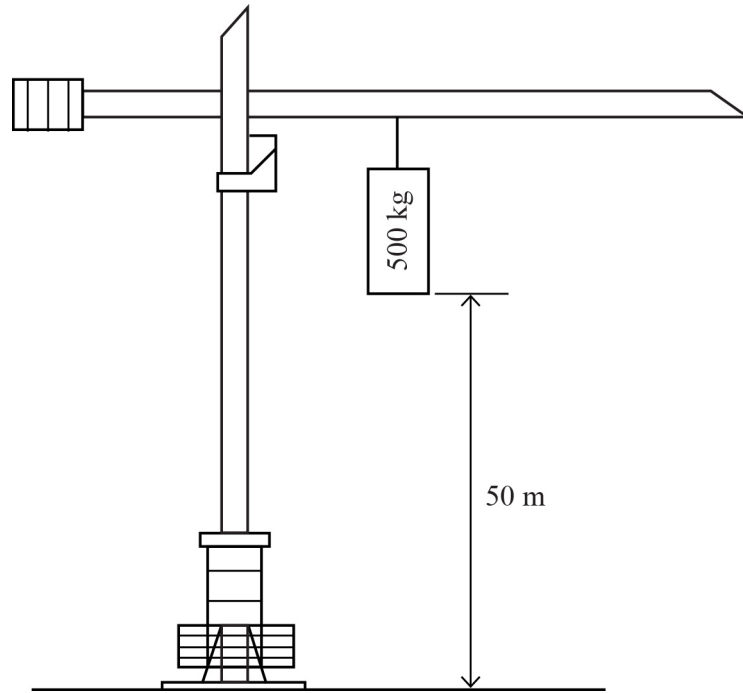
The value of any sensor in the fire detection and suppression system is 1 when activated and 0 when not activated.

The sensor systems need to be configured using the following specifications:

- If smoke and flame are present with no door sensor activated — alarm sounds and CO<sub>2</sub> suppression.
- If smoke, flame and heat are present with no door sensor activated — alarm sounds and CO<sub>2</sub> suppression.
- If the door sensor is activated — alarm sounds but no CO<sub>2</sub> suppression.

Develop a logic gate circuit to control the fire detection and suppression system as defined in the specifications. The logic circuit will need to receive input from all of the sensors and be able to activate both the fire alarm and CO<sub>2</sub> fire suppression systems independently. Logic gates will have a maximum of two inputs only. Annotate your logic circuit to demonstrate the flow of data when all sensors are activated.

QUESTION 18 (4 marks)



During construction of an apartment block, a crane elevates a 500 kg payload to a vertical distance of 50 m in 59 seconds at a constant speed, as represented above.

- a) Calculate the work done by the crane during the vertical lift. *[2 marks]*

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- b) Determine the power generated by the crane. *[2 marks]*

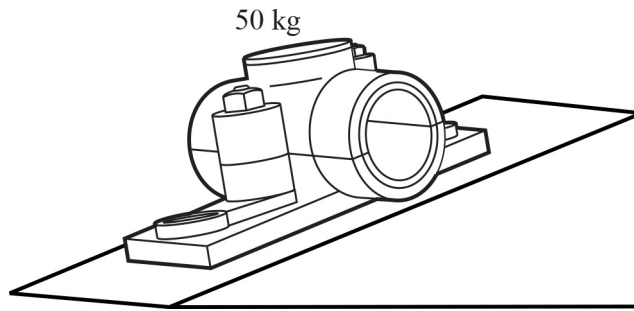
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**QUESTION 19 (6 marks)**



The diagram above shows a 50 kg bearing block sitting motionless on the verge of sliding on an inclined plane.

Determine the normal force between the bearing block and the inclined plane if the force opposing motion of the block down the incline is 245 N. Include a force diagram with your working.

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**QUESTION 20 (5 marks)**

An electric motor and winch are used to lift 500 kg of soil in a 150 kg steel hopper a distance of 5 m in 20 seconds with uniform velocity. The energy efficiency of the winch is 75%.

Calculate the input power required to lift the soil in the steel hopper.

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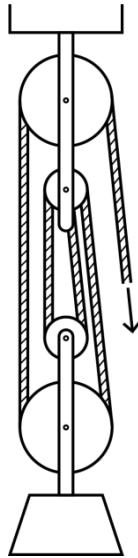
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QUESTION 21 (4 marks)



Calculate the effort required to lift a load of 1 tonne using the pulley system in the diagram above. The pulley system has an efficiency of 85%.

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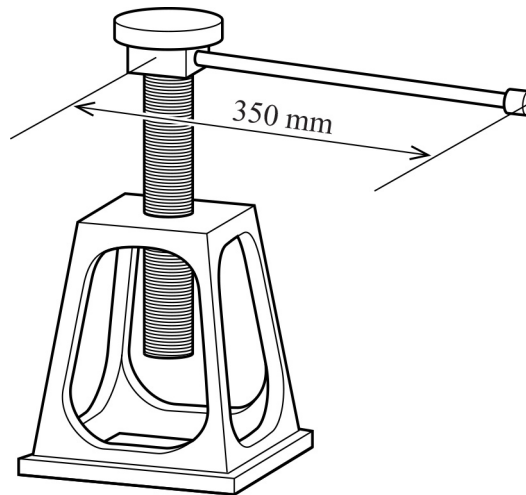
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**QUESTION 22 (8 marks)**



The car jack shown above has a single start thread of effective diameter 30 mm and a 6.5 mm pitch. A force is applied to the lever handle of the car jack at a point 350 mm from the axis of the thread to lift a 2.5 tonne car 100 mm in half a minute. The jack has an efficiency of 45%.

Determine the power required to lift the car to the nearest whole unit.

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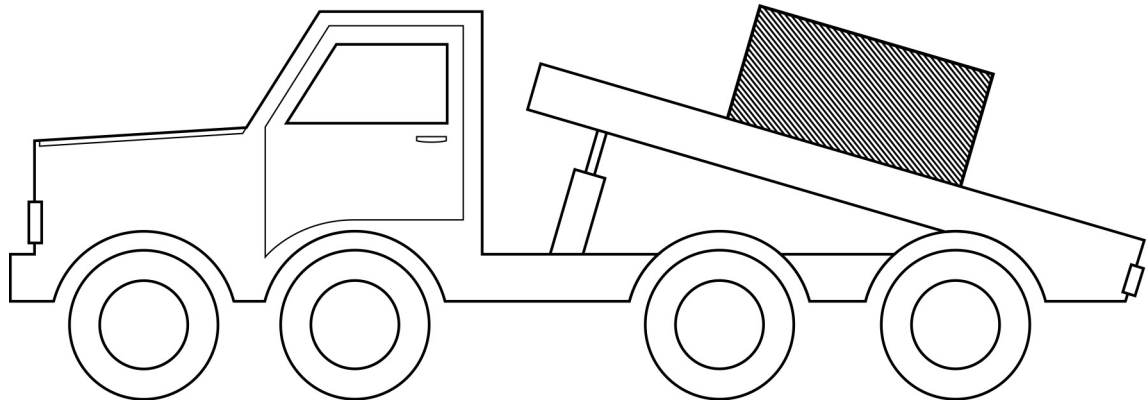
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QUESTION 23 (10 marks)



A truck slowly raises its 8 m long tray until its 1.5 tonne load begins to slide, as shown above. Once the load begins to slide, the tray is lowered until the load stops sliding freely.

- a) Calculate the angle at which the load just begins to slide and the angle at which it stops sliding if the coefficients of static and kinetic friction are 0.5 and 0.4 respectively.

[2 marks]

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b) If the tray locks at 23 degrees with the load moving at 1.2 m/s, calculate the velocity of the load after it has slid a further 3 m down the tray. Include a force diagram to support your solution. State any assumptions made.

[8 marks]

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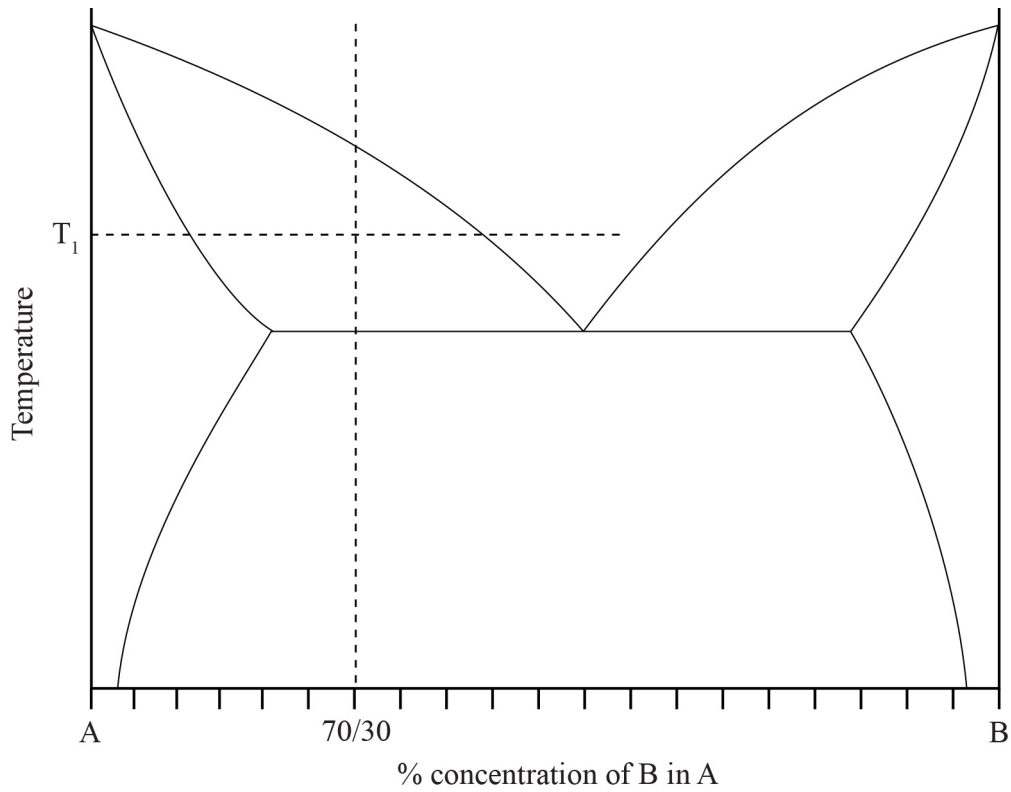
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QUESTION 24 (5 marks)



An alloy of 70% A and 30% B is cooled under equilibrium conditions.

Use the thermal equilibrium diagram shown above to calculate the proportions of solid and liquid for the alloy at  $T_1$ .

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**END OF PAPER**



**ADDITIONAL PAGE FOR STUDENT RESPONSES**

Write the question number you are responding to.

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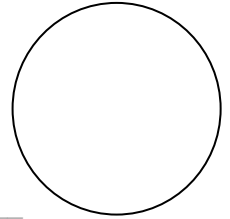
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**ADDITIONAL RESPONSE SPACE FOR QUESTION 15**

If you want these sketches to be marked, rule a diagonal line through the sketches on page 6.

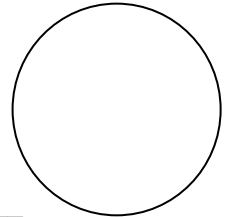
A

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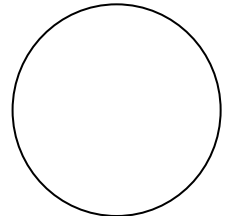
B

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C

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## References

### Question 12

Pearson Scott Foresman, 'Wheelbarrow',  
[https://commons.wikimedia.org/wiki/File:Wheelbarrow\\_\(PSF\).png](https://commons.wikimedia.org/wiki/File:Wheelbarrow_(PSF).png), public domain.

### Question 18

Derived from Coker-Free-Vector-Images 2014, 'Crane engineering site loading',  
<https://pixabay.com/en/crane-engineering-site-loading-311760>, public domain.

### Question 19

Derived from Dodge Manufacturing Company 1912, 'Pillow block bearing',  
<https://commons.wikimedia.org/wiki/File:Pillow-block-bearing.jpg>, public domain.



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