Engineering 2019 v1.1

IA2: Sample assessment instrument

Examination — short response (25%)

This sample has been compiled by the QCAA to assist and support teachers in planning and developing assessment instruments for individual school settings.

Student name

Student number

Teacher

Exam date

Marking summary

Criterion	Marks allocated	Provisional marks
Engineering knowledge and problem-solving	25	
Overall	**25**	

220464

Conditions

Technique   Examination

Unit   Unit 3: Statics of structures and environmental considerations

Topic/s   Topic 1: Application of the problem-solving process in Engineering
Topic 2: Civil structures and the environment
Topic 3: Civil structures, materials and forces

Time   2 hours + 10 minutes perusal

Seen / unseen   Unseen questions

Other
- only the QCAA formula sheet must be provided
- notes are not permitted
- use of technology is required: non-programmable scientific calculator only permitted
- protractor and ruler required.

Instructions

- Answer all questions in the space provided.

- For multiple choice questions, circle the letter next to the correct answer. If you want to change your answer, cross out your initial choice and circle the letter next to your new answer.

- Word length for short-paragraph responses is 100–150 words per answer.

- Write responses using black or blue pen.

- Show all working for questions requiring calculations.

Section 1 — multiple choice, single word and sentence response items

Question 1 (1 mark)

The planned obsolescence of structures is best described as a deliberate policy of developing structures that

A   are poor quality.

B   have a limited lifespan.

C   are inexpensive to construct.

D   do not have an impact on the environment.

Question 2 (1 mark)

Steel-reinforced concrete is used in the construction of multistorey buildings because it has the combined properties of

A   hardness and workability.

B   hardness and tensile strength.

C   compressive and tensile strength.

D   compressive strength and workability.

Question 3 (1 mark)

Which of the following statements best describes the direction of a reaction force acting at a roller support?

A   normal to the supporting surface

B   vertical to the supporting surface

C   parallel to the supporting surface

D   horizontal to the supporting surface

Question 4 (1 mark)

Within the problem-solving process, calculations are most likely used to

A   prioritise solution success criteria.

B   demonstrate project management.

C   predict prototype solution performance.

D   identify significant issues related to a problem.

Question 5 (1 mark)

Within the problem-solving process, success criteria are most likely used to

A   explore a problem.

B   analyse a problem.

C   generate a prototype solution.

D   evaluate and refine ideas and solutions.

Question 6 (1 mark)

You will most likely determine success criteria in the ………………………. phase of the problem-solving process in Engineering.

Question 7 (2 marks)

Laminated veneer lumber (LVL) is an engineered product that has the defined and reliable

material properties of …………………………… and………………………………

Question 8 (1 mark)

The ability of a material to absorb energy and plastically deform without fracturing through

application of predominately tensile stresses is known as ………………………………………………

Question 9 (1 mark)

Figure 1
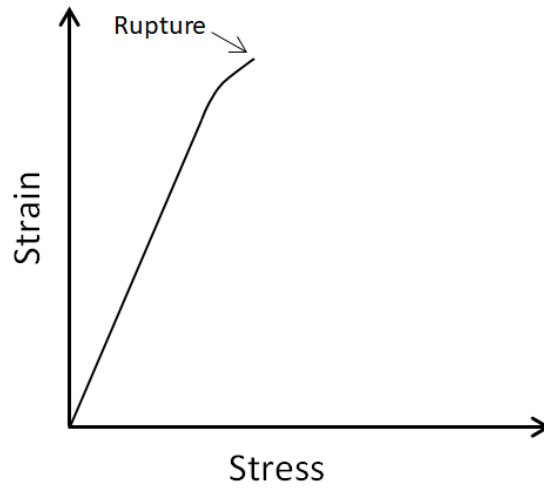
The mechanical property of the material that generated the stress vs. strain graph in Figure 1 is

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Question 10 (1 mark)

………………………………………. would be the most suitable material to use as a sacrificial anode for a steel structure.

Question 11 (2 marks)

Dry corrosion of metals is evident when …………..………………………………………………………

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Question 12 (2 marks)

Figure 2

Force (F)

X ———————————— X
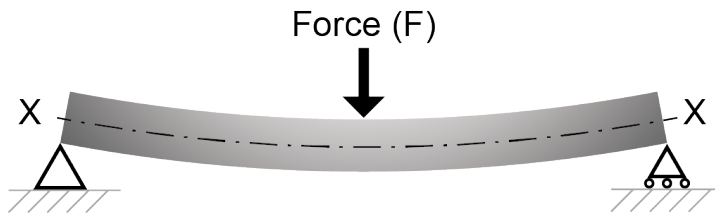
The beam represented in Figure 2 is loaded by force F. Describe the effect of the applied force F on the length of the beam's neutral axis X-X.

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Question 13 (4 marks)

Name two civil engineering sub-disciplines and briefly describe the scope of each one.

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Section 2 — short paragraph and calculation items

Question 14 (4 marks)	Up to 150 word response

Civil structures are constructed using a variety of materials. Select one commonly used construction material and analyse the environmental implications of that material's growth or extraction, manufacture and use. Your response must include a brief description of the material's life cycle.

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Question 15 (8 marks)   **Up to 150 word response**

Technological developments are changing the way structures are developed and constructed.

Figure 3

Analyse the mechanics, materials science and engineering technology developments of the dome structures in Figure 3. Use your analysis to describe the benefits of this type of structure for a community experiencing extreme weather conditions.

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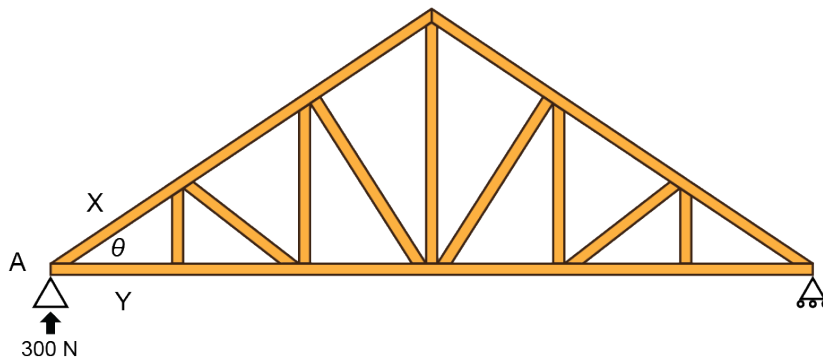
Figure 4

Figure 4 is a diagram of a truss structure in static equilibrium. If the reactive force at support A is 300 N and θ is 30°, determine the force in members X and Y and state whether the members are in tension or compression. Include a free-body diagram with your working.

Question 17 (4 marks)

Figure 5

100 kN

R_1 R_2
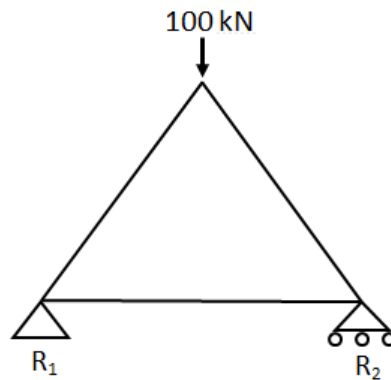
Determine the reaction at supports R_1 and R_2 for the simple truss in Figure 5. The length of each member is 2.5 metres. Include a free-body diagram with your working.

Question 18 (6 marks)   **Up to 150 word response**
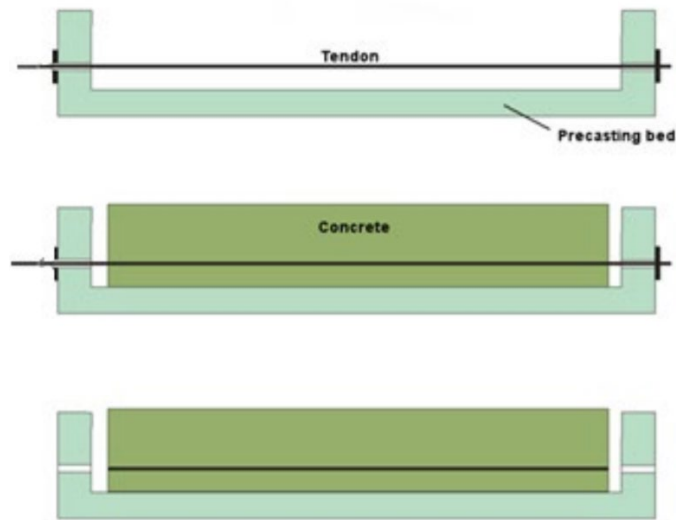
Figure 6

Refer to Figure 6 to explain why and how concrete beams are prestressed and use a sketch to graphically represent the forces present in the cured prestressed beam.

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Page **13** of 26
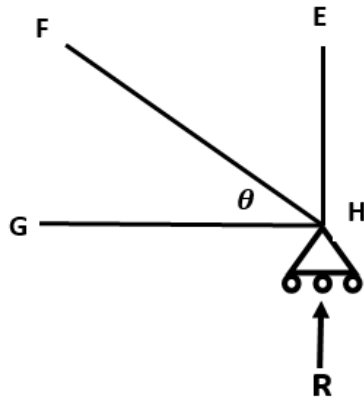
Figure 7

The roller joint in Figure 7 has a reaction R of 35 kN. The compressive force in member GH is 12 kN and θ is 40°. Determine the force in member EH and state whether the member is in tension or compression. Include a free-body diagram with your working.
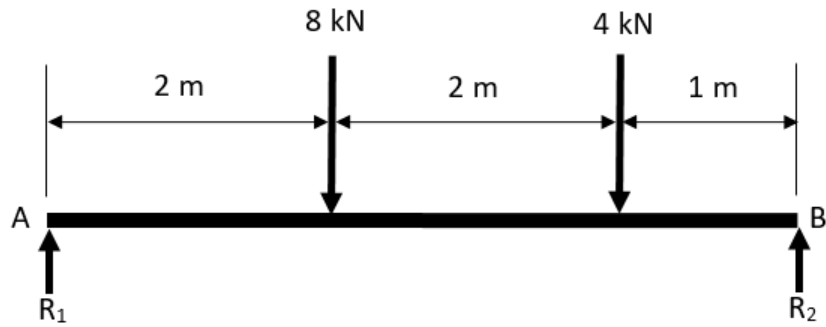
Question 20 (4 marks)

Figure 8

Calculate the reactions at supports R_1 and R_2 in Figure 8. Assume that the beam is without mass.

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Question 21 (4 marks)

Figure 9
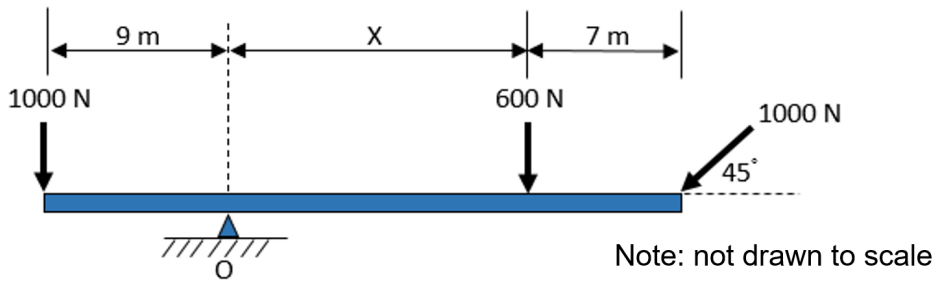
The beam in Figure 9 is balanced at point O. Determine the total length of the beam. Assume that the beam is without mass.

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Question 22 (5 marks)

Figure 10
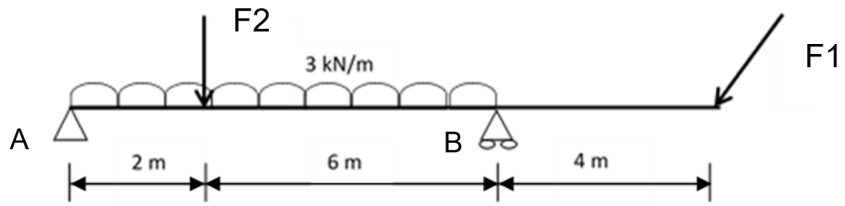
The beam shown in Figure 10 is without mass. F1 = 20 kN at 60° from the horizontal and F2 = 15 kN. Calculate the reactions at supports A and B and include a free-body diagram with your working.

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Figure 11

20 kN   50 kN

3 m   4 m   3 m
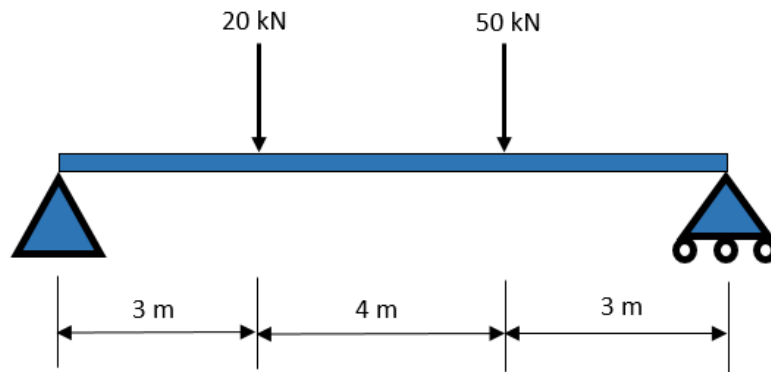
Draw shear force and bending moment diagrams for the beam in Figure 11. Show your calculations. Assume that the beam is without mass.

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Question 24 (6 marks)

Figure 12
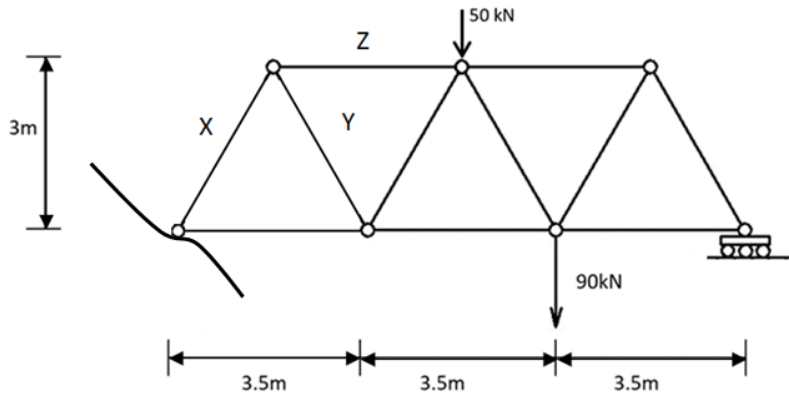
For the truss displayed in Figure 12, determine the forces in members X, Y and Z and state whether the members are in tension or compression. Include a free-body diagram with your working.

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Figure 13

Tom and his younger sister Jess, who has a mass of 30 kg, play on the 6 m long seesaw illustrated in Figure 13.

Scenario 1:

Jess sits at one end of the seesaw and Tom's 8 kg school backpack is placed 1.5 m in front of Jess, towards the seesaw pivot. To balance the seesaw, Tom must sit a distance (X) from the pivot on the opposite side of the seesaw to Jess.

Scenario 2:

When Jess is wearing the 8 kg school backpack and sitting at the end of the seesaw, Tom notices that he needs to move 200 mm further away from the pivot than in Scenario 1.

Sketch a suitable free-body diagram for each scenario and determine Tom's mass and the distance (X). State any assumptions you made.

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Examination marks summary

Question number	Simple familiar (SF)	Complex familiar (CF)	Complex unfamiliar (CU)	
Section 1				
1	1			
2	1			
3	1			
4	1			
5	1			
6	1			
7	2			
8	1			
9	1			
10	1			
11	2			
12	2			
13	4			
Section 2				
14	4			
15			8	
16	4			
17	4			
18		6		
19	4			
20	4			
21	4			
22		5		
23	4			
24		6		
25			9	
Totals	**47**	**17**	**17**	**81**
Percentage	**58%**	**21%**	**21%**	**100%**

Instrument-specific marking guide (IA2): Examination — Short response (25%)

Criterion: Engineering knowledge and problem-solving

Assessment objectives

1. recognise and describe structural problems, engineering technology knowledge, and mechanics and materials science concepts and principles in relation to structures

2. symbolise and explain ideas and solutions in relation to structures

3. analyse structural problems and information in relation to structures

5. synthesise information and ideas to predict possible structural solutions

The student work has the following characteristics:	Cut-off	Marks
• across the full range of simple familiar, complex familiar and complex unfamiliar situations	> 96%	25
– accurate and discriminating recognition and discerning description of structural problems, knowledge, concepts and principles; adept symbolisation and discerning explanation of ideas and solutions; insightful and accurate analysis of problems and information; coherent and logical synthesis of information and ideas to predict possible solutions.	> 93%	24
• in a comprehensive range of simple familiar, complex familiar and complex unfamiliar situations	> 89%	23
– accurate and discriminating recognition and discerning description of structural problems, knowledge, concepts and principles; adept symbolisation and discerning explanation of ideas and solutions; insightful and accurate analysis of problems and information; coherent and logical synthesis of information and ideas to predict possible solutions.	> 86%	22
• in a comprehensive range of simple familiar situations, and in complex familiar and complex unfamiliar situations	> 82%	21
– accurate recognition and effective description of structural problems, knowledge, concepts and principles; methodical symbolisation and effective explanation of ideas and solutions; considered analysis of problems and information; logical synthesis of information and ideas to predict possible solutions.	> 78%	20
• in a range of simple familiar situations, and in complex familiar and complex unfamiliar situations	> 75%	19
– accurate recognition and effective description of structural problems, knowledge, concepts and principles; methodical symbolisation and effective explanation of ideas and solutions; considered analysis of problems and information; logical synthesis of information and ideas to predict possible solutions.	> 71%	18
• in a range of simple familiar situations and in complex familiar situations – appropriate recognition and description of structural problems, knowledge, concepts and principles; competent symbolisation and appropriate explanation of ideas and solutions; appropriate analysis of problems and information; simple synthesis of information and ideas to predict possible solutions.	> 68%	17
	> 64%	16

The student work has the following characteristics:	Cut-off	Marks
• in a range of simple familiar situations and in some complex familiar situations – appropriate recognition and description of structural problems, knowledge, concepts and principles; competent symbolisation and appropriate explanation of ideas and solutions; appropriate analysis of problems and information; simple synthesis of information and ideas to predict possible solutions.	> 60%	15
	> 57%	14
• in simple familiar situations – appropriate recognition and description of structural problems, knowledge, concepts and principles; variable symbolisation and appropriate explanation of ideas and solutions; appropriate analysis of problems and information; simple synthesis of information and ideas to predict possible solutions.	> 53%	13
	> 50%	12
• in simple familiar situations – variable recognition and superficial description of structural problems, knowledge, concepts and principles; variable symbolisation and superficial explanation of ideas and solutions; superficial analysis of problems and information; rudimentary synthesis of information and ideas to predict possible solutions.	> 46%	11
	> 42%	10
• in some simple familiar situations – variable recognition and superficial description of aspects of structural problems, knowledge, concepts and principles; superficial explanation of ideas and solutions; superficial analysis of problems and information; rudimentary synthesis of information and ideas to predict partial possible solutions.	> 37%	9
	> 33%	8
• in a limited range of simple familiar situations – variable recognition and superficial description of aspects of structural problems, knowledge, concepts and principles; superficial explanation of ideas and solutions; superficial analysis of aspects of problems and information; unclear combination of information and ideas.	> 28%	7
	> 24%	6
• disjointed recognition and statements about aspects of structural problems, knowledge, concepts and principles; identification of a change about ideas, solutions and information; unclear combination of information and ideas.	> 19%	5
	> 14%	4
• statements about aspects of structural problems, knowledge, concepts and principles; statements about ideas, solutions and information; isolated and unclear combination of information and ideas.	> 10%	3
	> 5%	2
• isolated and unclear statements about aspects of structural problems, knowledge, concepts and principles.	> 0%	1
• does not satisfy any of the descriptors above.		0