Engineering 2025 v1.2

IA2 sample marking scheme

June 2025

Examination — combination response (25%)

This sample has been compiled by the QCAA to model one possible approach to allocating marks in an examination. It matches the examination mark allocations as specified in the syllabus (~ 60% simple familiar, ~ 20% complex familiar and ~ 20% complex unfamiliar) and ensures that a balance of the objectives are assessed.

Assessment objectives

This assessment instrument is used to determine student achievement in the following 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 propose possible structural solutions.

Note: Objectives 4, 6, 7 and 8 are not assessed in this instrument.

Queensland Government
Queensland Curriculum & Assessment Authority
250551

Marking scheme

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

Question	Response
1	C
2	A
3	C
4	A
5	A
6	D
7	B
8	B
9	B
10	C

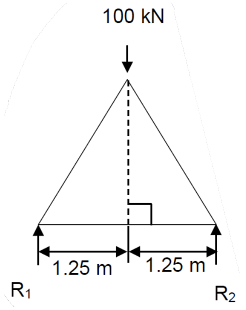
Q	Sample response	The response	Notes
11	strength and stiffness	• identifies suitable material properties of LVL including – strength **[1 mark]** – stiffness **[1 mark]**	Accept: • tensile strength • compressive strength
12	oxidation occurs without the presence of moisture	• identifies that – corrosion is caused by oxidation **[1 mark]** – the oxidation occurs when there is no moisture/water present **[1 mark]**	Accept chemical attack Accept presence of water

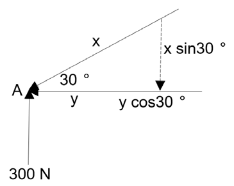
Q	Sample response	The response	Notes
13	Force F has no effect on the beam's neutral axis.	• identifies that the applied force will not affect the neutral axis of the beam **[1 mark]**	Accept other suitable response consistent with a reasonable understanding.
14	Coastal engineering The sub-discipline that deals with structures, such as canal developments, docks or wharves, or any type of development that occurs within the coastal zone near or at the shoreline. Water resource engineering The sub-discipline that deals with the planning, development, management and supply of water resources. Water resource engineers also calculate water inflows and removal in areas of structural development.	• identifies one civil engineering sub-discipline **[1 mark]** • describes the scope of the sub-discipline appropriately **[1 mark]** • identifies a second civil engineering sub-discipline **[1 mark]** • describes the scope of the sub-discipline appropriately **[1 mark]**	Suitable sub-disciplines include: • construction engineering • environmental engineering • structural engineering • transport engineering.

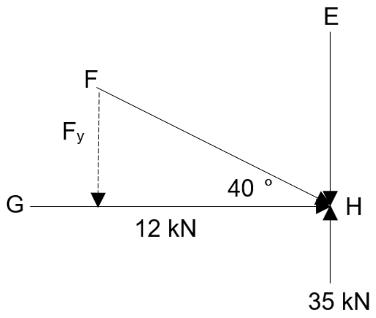
Section 2 — short paragraph and calculation items

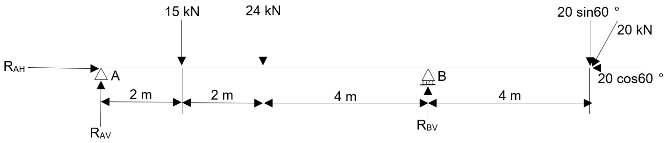
Q	Sample response	The response	Notes
15	In the domestic building industry, treated softwood is a commonly used construction material. They are plantation grown and considered renewable; however, the plantations destroy natural environments and impact on local Indigenous flora and fauna populations due to the machines used for stripping branches and removing logs for milling causing soil and undergrowth erosion and loss of habitat. Off-cuts of treated softwood create on-site disposal hazards and worker health and safety concerns regarding handling and machining of chemical laden timber.	• identifies a commonly used construction material **[1 mark]** • describes one effect on the environment that occurs during the material's life cycle **[1 mark]** • describes one effect on society that occurs during the material's life cycle **[1 mark]**	Suitable construction materials include: • glass • bricks • laminates • polymers • concrete • steel. Accept other suitable response consistent with a reasonable understanding.
16	Concrete beams are cast into a mould that allows steel cables/tendons to be fixed at one end of the mould. Tension is applied to them by stretching them within their elastic limit before the concrete is poured. When the concrete has cured, the tension applied to the tendons is released and they shorten in length resulting in the inclusion of compressive forces in the beam. Concrete beams are prestressed to improve on their capacity to resist the tensile forces applied when under load because concrete is extremely weak in tension but stronger in compression.	• describes how concrete beams are prestressed using wording that indicates – tension is applied to the steel cables/tendons before the concrete is poured **[1 mark]** – tension is released on the steel cables/tendons after the concrete is cured **[1 mark]** – the shortened steel cables/tendons increase the compressive forces in the beam **[1 mark]** • explains why the concrete beams are prestressed including – to improve on their capacity to resist the tensile forces applied when under load **[1 mark]** – recognition that concrete is weak in tension but strong in compression **[1 mark]**	Accept other suitable response consistent with a reasonable understanding. Accept other suitable response consistent with a reasonable understanding.

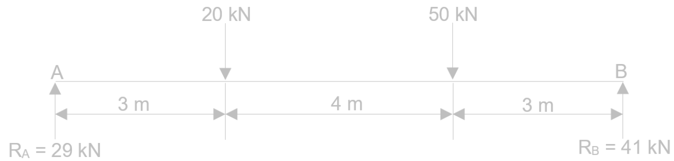
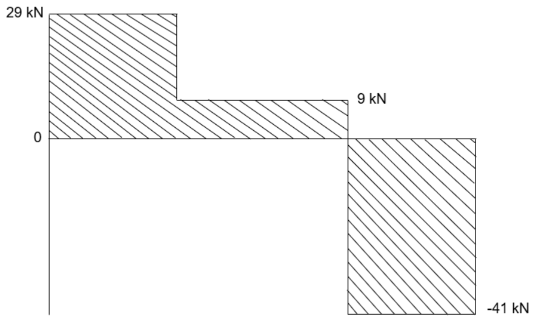
Q	Sample response	The response:	Notes
17	The large dome structure provides an artificial environment that would suit a community that experiences extreme cold, snow fall and blizzards. The structure is created using hexagonal frames that interconnect to create a self-supporting network that transfers the tensile and compressive forces applied to the structure to the foundation. The dome shape is aerodynamic, which would resist the strong wind forces and blizzard conditions experienced at the location. The membrane that covers the dome would need to be insulating to retain the heat inside the dome and made from a strong polyethylene type material with transparent properties to allow as much light and radiant heat as possible to pass through into the dome, which is vital in areas with reduced sunlight during winter. The dome structure can be prefabricated to enable rapid assembly, ideal for remote and harsh environments to reduce the amount of time construction workers are exposed to the elements. The solar gain from the structures will reduce the energy consumption of traditional heating and lighting. A benefit for the community of these structures is that they can be multi-functional, providing housing, with the potential for year-round indoor agricultural to sustain the community through winter.	• recognises a community that experiences extreme weather conditions **[1 mark]** • analyses the developments of dome structures to include – one valid example from mechanics **[1 mark]** – a second valid example from mechanics **[1 mark]** – one valid example from materials science **[1 mark]** – a second valid example from materials science **[1 mark]** – one valid example from engineering technology **[1 mark]** – a second valid example from engineering technology **[1 mark]** • describes a valid benefit for the community **[1 mark]**	Suitable mechanics examples include: • snow would slide off the structure which means that less weight force is supported by the dome in blizzard conditions. Suitable materials examples include: • self-cleaning properties of the membrane as the snow slides off • membrane materials is strong and resistant to cracking/warping under thermal stress. Suitable engineering technology examples include: • modular design can be easily interconnected and expanded. Suitable community benefits include: • economic benefits due to reduced energy consumption and durable construction. Or other suitable response consistent with a reasonable understanding.

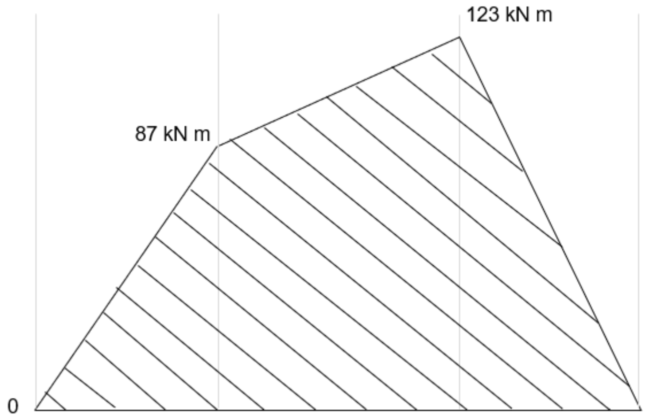
Q	Sample response	The response:	Notes
18	Force diagram  $\Sigma M = 0$ $\therefore 0 = 100 \times 1.25 - R_2 \times 2.5$ $0 = 125 - 2.5R_2$ $R_2 = \frac{125}{12.5}$ $R_2 = 50\ kN \uparrow$ $\Sigma F_y = 0$ $0 = R_1 - 100 + 50$ $\therefore R_1 = 100 - 50$ $R_1 = 50\ kN \uparrow$	• includes a force diagram that indicates – an equilateral triangle with all sides 2.5 m and all angles 60 ° **[1 mark]** – 100 kN force applied vertically downwards on the apex of the triangle and reaction forces R_1 and R_2 are applied upwards on the bottom two corners of the triangle **[1 mark]** • calculates the reaction at R_2 **[1 mark]** • calculates the reaction at R_1 **[1 mark]**	Accept reactions labelled at R_A and R_B Accept forces without direction; however, units must be provided. Allow FT mark Accept a statement that indicates that R_1 = 50 kN because the forces are balanced/the truss is in equilibrium.

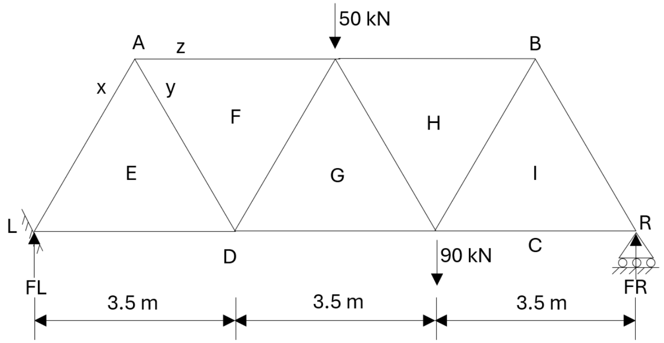
Q	Sample response	The response:	Notes
19	Force diagram  $\Sigma F_y = 0 = 300 - x sin 30°$ $\therefore x = \frac{300}{\sin 30°} = 600\ N$ C $\Sigma F_x = 0 = -x cos 30° - y$ $\therefore y = -600 \cos 30° = -519.6\ N \approx 520\ N$ T	• provides a force diagram with all forces shown **[1 mark]** • calculates the force in member x **[1 mark]** • determines that member x is in compression **[1 mark]** • calculates the force in member y **[1 mark]** • determines that member y is in tension **[1 mark]**	Accept member y drawn in the opposite direction (left to right) to show that it is in tension (after force y has been calculated). Allow FT marks Accept y in the range 519.615–520 N inclusive.
20	$\Sigma M_A = 0$ $\therefore 0 = (8 \times 2) + (4 \times 4) - (R_2 \times 5)$ $0 = 32 - 5R_2$ $R_2 = \frac{32}{5} = 6.4\ kN \uparrow$ $\Sigma F_y = 0$ $\therefore 0 = R_1 - 8 - 4 + R_2$ $0 = R_1 - 12 - 6.4$ $0 = R_1 - 5.6$ $\therefore R_1 = 5.6\ kN \uparrow$	• calculates the reaction force R_2 **[1 mark]** • determines that R_2 is in an upward direction **[1 mark]** • calculates the reaction force R_1 **[1 mark]** • determines that R_1 is in an upward direction **[1 mark]**	Allow FT marks

Q	Sample response	The response	Notes
21	Force diagram  $\Sigma F_x = 0 = 12 + FHcos40°$ $-12 = FHcos40°$ $\frac{-12}{\cos 40°} = FH$ $\therefore FH = -15.7\ kN \approx 16\ kN$ T $\Sigma F_y = 0 = 35 + 16sin40° - EH$ $EH = -45.28 \approx 45\ kN$ C	• provides a force diagram with all forces shown **[1 mark]** • correctly calculates the force in member FH **[1 mark]** • determines that member FH is in tension **[1 mark]** • calculates the force in member EH **[1 mark]** • determines that member EH is in compression **[1 mark]**	Accept member FH drawn in the opposite direction (up to the left) to show that it is in tension (after the force has been calculated). Accept FH in the range 15.66–16 kN inclusive. Allow FT marks Accept EH in the range 45–45.28 kN inclusive.
22	$\Sigma M_o = 0$ ↻+ve $\therefore 0 = (-1000 \times 9) + (600 \times x) + (1000sin45° \times (7 + x))$ $= -9000 + 600x + (707.1 \times 7) + 707.1x$ $= -4050.3 + 1307.1x$ $\therefore x = \frac{4050.3}{1307.1} = 3.1\ m$ $\therefore total\ length\ of\ the\ beam = 9 + 3.1 + 7 = 19.1 \approx 19\ m$	• recognises that the beam is in equilibrium and therefore the length of x can be determined through the sum of the moments about O **[1 mark]** • recognises that the vertical component of the 1000 N force acting at 45 ° to the beam must be determined using trigonometry **[1 mark]** • calculates the length of x **[1 mark]** • calculates the total length of the beam **[1 mark]**	Allow FT marks

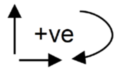
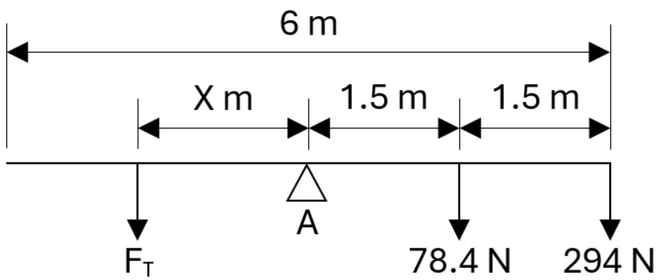
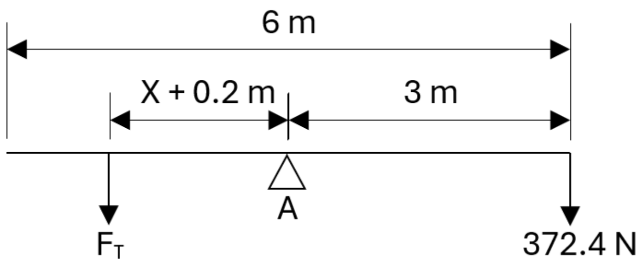
Q	Sample response	The response	Notes
23	UDL of 3 kNm over 8 m is equivalent to a point load of 24 kN in the centre of the 8 m section Force diagram  $\Sigma F_H = 0 \rightarrow -^{ve}$ $\therefore 0 = R_{AH} - 20cos60°$ $R_{AH} = 10\ kN\ \rightarrow$ $\Sigma M_A = 0 ↻+^{ve}$ $\therefore 0 = (15\ \times 2) + (24\ \times 4) - (R_{BV}\ \times 8) + (20sin60°\ \times 12)$ $0 = 333.85 - 8R_{BV}$ $R_{BV} = \frac{333.85}{8} = 41.7\ kN\ \uparrow$ $\Sigma F_A = 0\ \uparrow\ +^{ve}$ $\therefore 0 = R_{AV} - 15 - 24 + R_{BV} - 20sin60°$ $0 = R_{AV} - 15 - 24 + 41.7 - 20sin60°$ $R_{AV} = 15 + 24 - 41.7 + 20sin60°$ $R_{AV} = 14.6\ kN\ \uparrow$	• correctly calculates the point load equivalent of the UDL **[1 mark]** • includes a force diagram showing all required forces **[1 mark]** • calculates the horizontal reaction at support A **[1 mark]** • calculates the vertical reaction at support B **[1 mark]** • calculates the vertical reaction at support A **[1 mark]**	Allow FT marks

Q	Sample response	The response	Notes
24	 $\Sigma M_A = 0 \circlearrowright +^{ve}$ $\therefore 0 = (20 \times 3) + (50 \times 7) - (R_B \times 10)$ $0 = 410 - 10R_B$ $R_B = \frac{410}{10} = 41\ kN \uparrow$ $\Sigma F_y = 0 \uparrow +^{ve}$ $\therefore 0 = R_A - 20 - 50 + R_B$ $0 = R_A - 70 + 41$ $0 = R_A - 29$ $R_A = 29\ kN \uparrow$ Shear force diagram (scale 1 cm = 1 m and 1 cm = 10 kN) 	• calculates the reaction at B **[1 mark]** • calculates the reaction at A **[1 mark]** • includes a shear force diagram showing all forces **[1 mark]**	Allow FT marks

	$M = Fd$ $M_1 = 29 \times 3 = 87\ kN\ m$ $M_2 = 9 \times 4 + M_1 = 123\ kN\ m$ $M_3 = -41 \times 3 = -123\ kN\ m$ Bending moment diagram (scale 1 cm = 1 m and 1 cm = 20 kN) 	• calculates the bending moments **[1 mark]** • includes a bending moment diagram showing all moments **[1 mark]**	

Q	Sample response	The response:	Notes
25	 All internal angles ≈ 60° Assume all members are in compression $\Sigma M_L = 0 \circlearrowright +^{ve}$ $\therefore 0 = (50 \times 5.25) + (90 \times 7) - (FR \times 10.5)$ $10.5\ FR = 892.5$ $FR = \frac{892.5}{10.5} = 85\ kN$ $\Sigma M_R = 0 \circlearrowright +^{ve}$ $\therefore 0 = (-90 \times 3.5) - (50 \times 5.25) + (FL \times 10.5)$ $-10.5\ FL = -577.5$ $FL = \frac{-577.5}{-10.5} = 55\ kN$ Joint AED $\Sigma F_y = 0$ $0 = 55 - x sin60°$ $x sin60° = 55$ $x = \frac{55}{sin60°} \approx 63.5\ kN\ compression$	• includes a force diagram **[1 mark]** • calculates the reaction force FR **[1 mark]** • calculates the reaction force FL **[1 mark]** • calculates the force in member x **[1 mark]**	Allow FT marks

	Joint AFB $\Sigma F_y = 0$ $0 = 63.5 \times sin60° + ysin60°$ $-ysin60° = 55$ $-y = \frac{55}{sin60°} \approx 63.5$ $\therefore y = -63.5\ kN\ compression$ $\therefore y = 63.5\ kN\ tension$ $\therefore force\ in\ X = 63.5\ kN\ compression$ $\therefore force\ in\ Y = 63.5\ kN\ tension$ $\therefore force\ in\ Z = 63.5\ kN\ compression$	• calculates the force in member y **[1 mark]** • calculates the force in member z **[1 mark]**	

Q	Sample response	The response:	Notes
26	Assumptions • Let F_T be the weight force of Tom		
	Weight force of the 8 kg backpack: $F = 8 \times 9.8 = 78.4\ N$ Weight force of Jess: $F = 30 \times 9.8 = 294\ N$	• calculates the weight force of the backpack **[1 mark]** • calculates the weight force of Jess **[1 mark]**	
			
	Scenario 1 	• provides a force diagram for scenario 1 **[1 mark]**	
	$\Sigma M_A = 0$ $\therefore 0 = (-F_T \times X) + (78.4 \times 1.5) + (294 \times 3)$ $F_T X = 999.6\ N$	• solves for $F_T X$ in scenario 1 **[1 mark]**	Allow FT marks
	Scenario 2 	• provides a force diagram for scenario 2 **[1 mark]**	

	$\Sigma M_A = 0$ $\therefore 0 = (-F_T \times (X + 0.2)) + (372.4 \times 3)$ $F_T X = -F_T \times 0.2 + 1117.2$ Substitute scenario 1 into scenario 2 $999.6 = -F_T \times 0.2 + 1117.2$ $-117.6 = -F_T \times 0.2$ $F_T = \frac{117.6}{0.2} = 588\ N$ $\therefore \textit{the mass of Tom is } \frac{588}{9.8} = 60\ kg$ Substitute F_T into scenario 1 $588X = 999.6$ $X = \frac{999.6}{588}\ 1.7\ m$ $\therefore \textit{the distance X from the seesaw pivot is } 1.7\ m$	• solves for $F_T X$ in scenario 2 **[1 mark]** • substitutes scenario 1 into scenario 2 **[1 mark]** • calculates the mass of Tom **[1 mark]** • calculates the distance X **[1 mark]**	Accept distance in mm