Pearson Level 3 Alternative Academic Qualification BTEC National in Construction and the Built Environment (Extended Certificate)

Unit 1: Construction Principles

Sample Assessment Materials

First teaching September 2025
First certification from 2026
Issue 1

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Contents

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Learner Registration Number

Pearson Level 3 Alternative Academic Qualification BTEC National Extended Certificate

Sample assessment material

Time 1 hour 45 minutes

Paper reference XXXXX/XX

Construction and the Built Environment

UNIT 1: Construction Principles

You must have:
Formulae Booklet (enclosed),
non-programmable scientific calculator, pencil, rule, eraser.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and learner registration number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Pearson

SECTION A

Answer ALL questions. Write your answers in the spaces provided.

1 Float glass has good levels of light transmission.

State **one** other property of float glass.

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(Total for Question 1 = 1 mark)

2 (a) State **one** drawback of extracting materials for making steel.

(1)

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(b) Explain **one** way that steel can be disposed of that would increase its environmental sustainability.

(2)

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(Total for Question 2 = 3 marks)

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3 An inspection chamber needs to be installed at the intersection of two drainage runs. The routes of the two drainage runs have been plotted on a map and are represented by the simultaneous equations.

Equation 1 $y = 2x - 8$

Equation 2 $y = x + 3$

Using the method of substitution, calculate the value of y.

You **must** show your working.

y = ...

(Total for Question 3 = 3 marks)

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4 Explain **one** cause of variations of daylight factors within a room.

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(Total for Question 4 = 2 marks)

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5 Table 1 shows the bending moments for two point (concentrated) loads imposed on a 5m long simply supported beam. The simply supported beam is in equilibrium and is supported at each end.

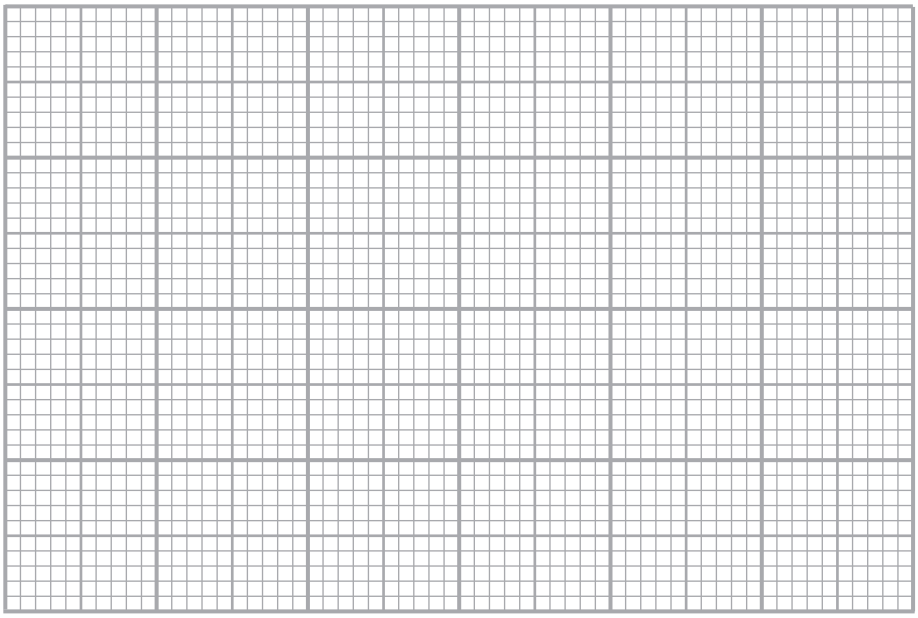
Position of point (concentrated) load from the left-hand support	Bending moment
2m	16kNm
4m	11kNm

Table 1

Draw a bending moment diagram for the beam and its loadings.

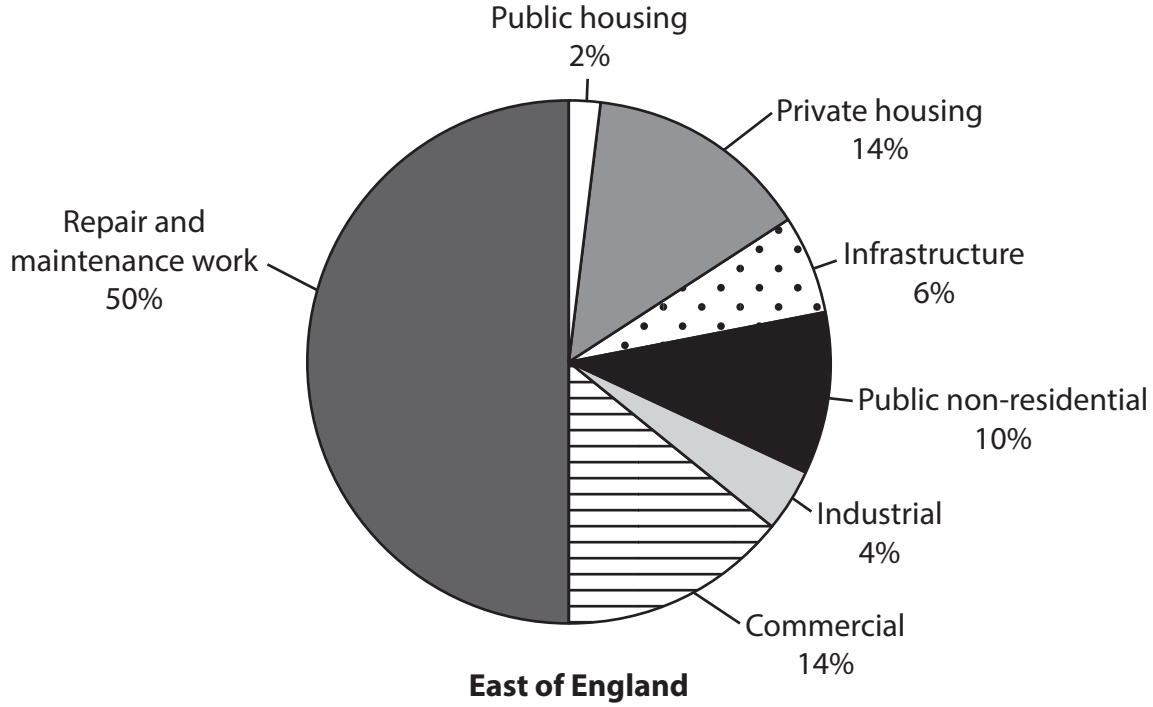
Label your diagram with the value of the bending moment at the positions of:

- the two supports
- the two point (concentrated) loads.

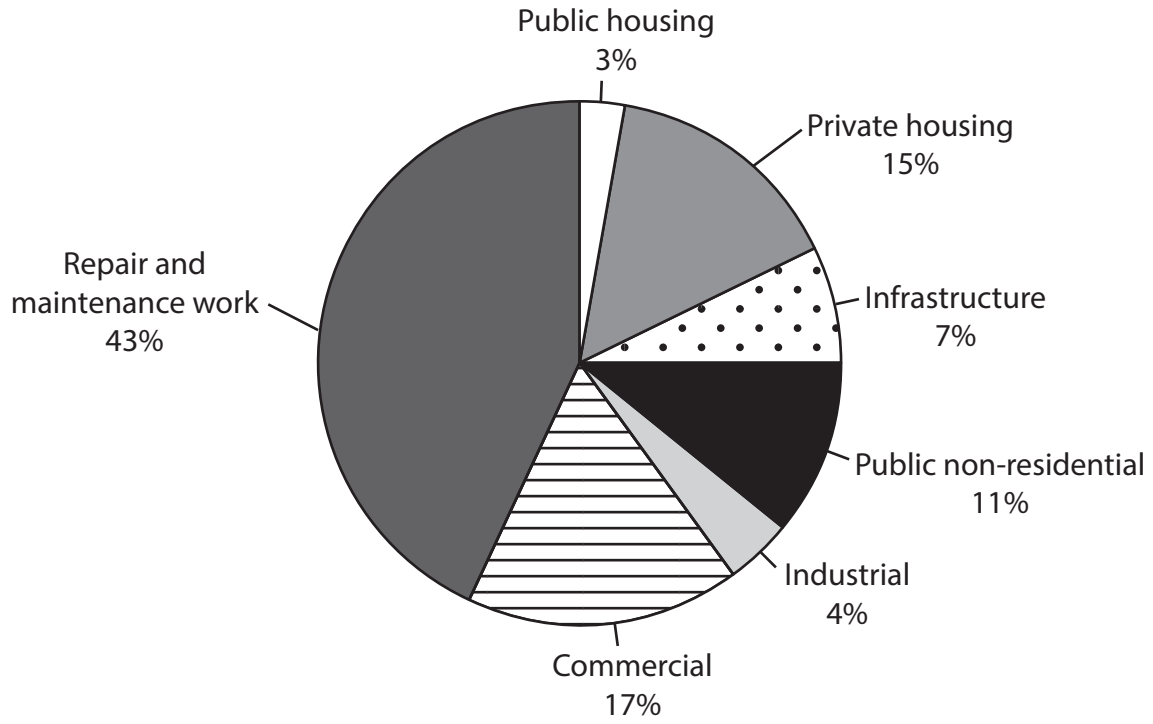


(Total for Question 5 = 3 marks)

6 Figure 1 shows two pie charts which compare activities completed by the construction industry in the East of England compared to the UK totals.



East of England



UK

Figure 1

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(a) Identify **one** activity where the percentage of work activities is the same for both the East of England and the UK.

(1)

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(b) Identify **one** activity where the construction industry for the UK has a difference in market share greater than two percentage points when compared to the East of England.

(1)

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(Total for Question 6 = 2 marks)

7 Explain **one** way that brickwork can fail.

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(Total for Question 7 = 2 marks)

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8 Table 2 shows the results of a range of tensile tests presented as grouped data in ranges.

Tensile Strength (kN/mm2) (ranges)	Frequency (f)	$f(X - X_m)^2$
$1.45 < s \leqslant 1.50$	5	0.066125
$1.50 < s \leqslant 1.55$	5	0.021125
$1.55 < s \leqslant 1.60$	9	0.002025
$1.60 < s \leqslant 1.65$	15	0.018375
$1.65 < s \leqslant 1.70$	6	0.043350

Table 2

(a) Calculate the standard deviation of the results.

(2)

Answer = ...

(b) Calculate the median value of the results.

(2)

Answer = ...

(Total for Question 8 = 4 marks)

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9 Explain **one** way that humidity levels in a bathroom can be controlled.

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(Total for Question 9 = 2 marks)

10 Figure 2 shows a simply supported beam.

The reaction force R_A is 7.87kN and the reaction force R_D is 8.63kN.

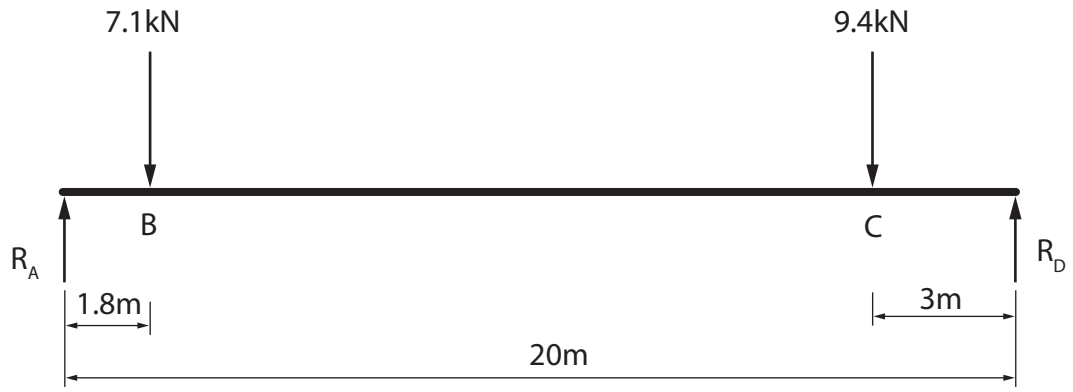

Figure 2

Calculate the value of the bending moment at point B (BM_B) and show the correct units.

You **must** show your working.

Answer = ... kNm

(Total for Question 10 = 3 marks)

11 Explain the cause of interstitial condensation in buildings.

(Total for Question 11 = 2 marks)

12 The location of a new house is in a part of town that is designated for further development.

Explain **one** drawback of using the source-path-receiver approach when specifying sound insulation for a new residential property.

(Total for Question 12 = 3 marks)

13 An architect has been commissioned to design a new retail clothing shop.

The retail clothing shop is located on a busy road in a town centre.

Explain **two** reasons why glare needs to be considered when designing the new retail clothing shop.

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(Total for Question 13 = 6 marks)

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14 A retailer has commissioned an architect to design a new supermarket on a brownfield site in a town centre.

They would like to use sustainable construction methods and materials in the new design.

The retailer has stated that they do not want supporting columns in the retail space, and that the construction should be completed within a short time scale.

Once constructed the retailer would prefer minimal maintenance to the structure of the building.

It is proposed that Glulam beams or reinforced cast in-situ concrete beams are to be used in the new supermarket.

Discuss the factors that need to be considered when deciding whether to use glulam beams or reinforced cast in-situ concrete beams for the new supermarket.

(9)

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(Total for Question 14 = 9 marks)

TOTAL FOR SECTION A = 45 MARKS

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SECTION B

Answer ALL questions. Write your answers in the spaces provided.

15 State **one** cause of heat loss in buildings.

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(Total for Question 15 = 1 mark)

16 State **two** ways of controlling flanking sound.

1 .....

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2 .....

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(Total for Question 16 = 2 marks)

17 Explain **one** remedial measure that can be used to prevent timber from decaying.

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(Total for Question 17 = 2 marks)

18 Structural engineers need to consider dead and live loads when designing road bridges that will be constructed as frameworks consisting of columns, struts, ties and beams.

Explain **two** reasons why structural engineers need to consider permanent (dead) and quasi-permanent (live) loads when designing bridges.

1 .....

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2 .....

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(Total for Question 18 = 4 marks)

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19 Explain **two** reasons why laminated glass is a suitable material to use in glazed curtain walls for commercial buildings.

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(Total for Question 19 = 6 marks)

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20 A concrete column has a length of 12m and a square cross-sectional area of 0.16m^2.
The column supports the roof and the upper floor of a shopping mall.

Explain **two** ways that the concrete column could fail.

1 .....

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2 .....

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(Total for Question 20 = 4 marks)

21 The rate at which a tipper truck unloads sand is represented by the function shown where t is the time duration in seconds.

$$\frac{dy}{dt} = t\frac{t\left(t^2\right)}{3}$$

By integrating the expression shown calculate the volume of sand unloaded (y) between the time t = 0 and t = 3 seconds.

Answer = ...

(Total for Question 21 = 4 marks)

22 Explain **one** reason why it is important to consider reverberation time when designing school classrooms.

(Total for Question 22 = 3 marks)

23 Explain **two** advantages of using graphene reinforced concrete rather than steel reinforced concrete for buildings.

1

2

(Total for Question 23 = 4 marks)

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24 Water storage tanks are made from single sheets of metal that are folded and welded.

The tanks have an open top and are made by cutting equal sized squares from each corner and folding up the sides as shown in Figure 3.

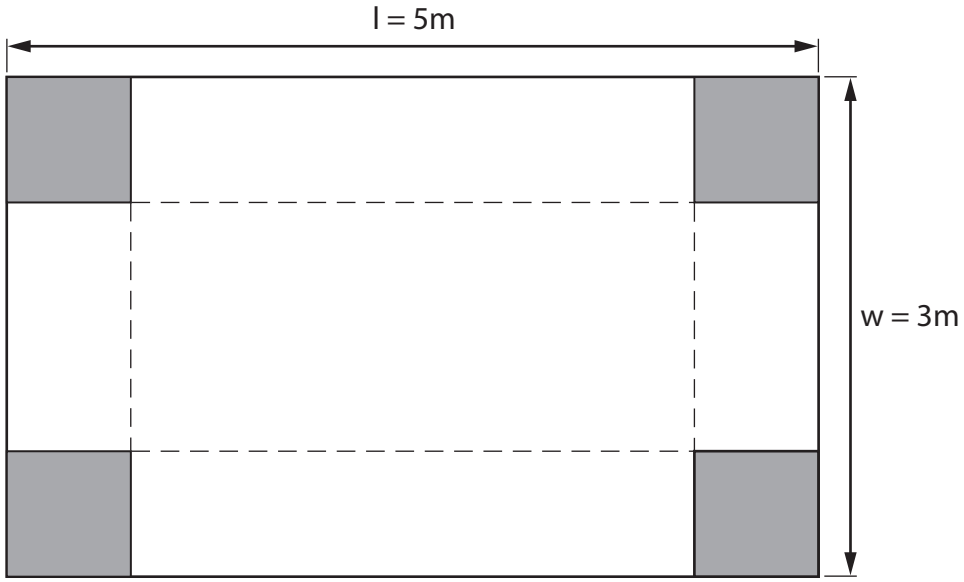

Figure 3

Calculate the maximum volume of the water storage tank.

Answer = ...

(Total for Question 24 = 6 marks)

25 An architect has been commissioned to design a new restaurant.

The restaurant is to be located on a retail development site on the edge of a town which also incorporates a number of large retail units and entertainment venues. The new restaurant will have buildings on all sides, although there will be some open spaces.

The client would like the restaurant to be a welcoming venue where customers can relax and enjoy their meals and want to revisit. It is planned that the restaurant will be open from 10am until 11pm each day.

To provide illumination the architect will consider the use of natural and artificial light sources and that these sources are to enhance the interior of the restaurant.

Discuss the factors that need to be considered when selecting natural and artificial light sources which will provide an effective illumination for the restaurant.

(9)

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(Total for Question 25 = 9 mark)

TOTAL FOR SECTION B = 45 MARKS
TOTAL FOR PAPER = 90 MARKS

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General marking guidance

- All students must receive the same treatment. Examiners must mark the first student in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Students must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved. Examiners should also be prepared to award zero marks if the student's response is not rewardable according to the mark scheme.
- Where judgement is required, a mark scheme will provide the principles by which marks will be awarded.
- When examiners are in doubt regarding the application of the mark scheme to a student's response, a senior examiner should be consulted.
- Crossed out work should be marked unless the student has replaced it with an alternative response.
- Accept incorrect/phonetic spelling (as long as the term is recognisable) unless instructed otherwise.

Points-Based Mark Scheme Guidance

Points-based mark schemes are made up of:

1) Mark scheme rubric:
   A mark scheme rubric instructs an examiner as to how each mark is awarded.
2) Example Responses:
   These demonstrate the type of acceptable responses that a student might provide and where each mark is awarded.
3) Additional marking Guidance:
   This informs examiners about any parameters which should be applied e.g. 'accept any other appropriate/alternative responses.'

Applying the points-based mark scheme guidance

Examiners should follow the mark scheme rubric and use the example responses as a guide for the relevance and expectation of the responses. Students must be credited for any appropriate response. Should candidates provide answers that meet the rubric but in an alternative order, credit should be given.

Levels-Based Mark Scheme Guidance

Levels-based mark schemes (LBMS) have been designed to assess students' work holistically. They consist of two parts:

1) Indicative content:

   Indicative content reflects content-related points that a student might make but is not an exhaustive list. Nor is it a model answer. Students may make some or none of the points included in the indicative content as its purpose is as a guide for the relevance and expectation of the responses. Students must be credited for any appropriate response.

2) Levels-based descriptors:

   Each level is made up of a number of traits which when combined together articulate the quality of response that a student needs to demonstrate. The traits progress across the levels to demonstrate the different expectations of each level. When using a levels-based mark scheme, the 'best fit' approach should be used.

Applying the levels-based descriptors

Examiners should take a 'best fit' approach to determining the mark.

- Examiners should first make a holistic judgement on which level most closely matches the student's response. Students will be placed in the level that best describes their answer. Answers can display characteristics from more than one level, and where this happens markers must use any additional guidance (e.g. weighting of traits) and their professional judgement to decide which level is most appropriate.
- The mark awarded within the level will be decided based on the quality of the answer and will be modified according to how securely all traits are displayed at that level:
  - Marks will be awarded at the top of that level if the student has evidenced each of the descriptor traits securely.
  - Where the response does not securely meet all traits, the marks should be awarded based on how closely the descriptor has been met.

Mathematical Processes Mark Scheme Guidance

This mark scheme uses the following types of marks:

- M marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- A marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- B marks: are unconditional accuracy marks (independent of M marks).
- Marks should not be subdivided.

Abbreviations:

- ECF – error carried forward
- ft – follow through
- cao – correct answer only
- cso – correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC – special case
- oe – or equivalent (and appropriate)
- dp – decimal places
- sf – significant figures.

Section A

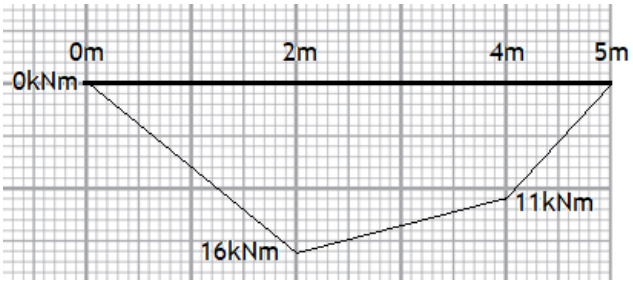
Question Number	Answer	Mark
1	Award **one** mark for a correctly stated property from: • Has good levels of hardness / scratch resistant (1) • Resistant to degradation / chemicals (1) • Resistant to changes in temperature (1) • Ability to be produced in a range of colours (1) • Ability to be produced in a range of opacities (1) Do **not** accept 'transparent' as this is applicable for all types of glass and is also given in the question.	1

Question Number	Answer	Mark
2a	Award **one** mark for a correctly stated drawback from: • Visual pollution (caused by extraction) (1) • Air pollution (caused by extraction or delivery of raw materials) (1) • Loss of habitats (caused by extraction of raw materials) (1) • Damage to local environment (due to extraction) (1)	1

Question Number	Answer	Mark
2b	Award **one** mark for a correct way that steel can be disposed of (1) and one mark for a justification for that way (1), up to a maximum of two marks. • Recycling increases its environmental sustainability (1) because this will reduce the amount of new steel needed to be manufactured/ it reduces the amount of steel going to landfill (1) • Reuse increases its environmental sustainability (1) because it reduces the amount of steel going to landfill/ this will reduce the amount of new steel needed to be manufactured (1) Marking points may be reversed/given in any order.	2

Question number	Marking guidance	Mark
3	Award **three** marks for the correct answer: y = 14 **Method 1** If the answer is incorrect: - award **one** method mark for the correct rearrangement of equation 2 to make x the subject of the equation x = y-3 - award **one** method mark for the correct substitution of 'their' rearranged equation 2 into equation 1 y = 2(y-3) – 8 - award **one** accuracy mark for the correct simplification of 'their' equation to calculate the correct value of y y = 2y - 6 - 8 y = 2y - 14 y = 14 **Method 2** If the answer is incorrect: - award **one** method mark for the substituting equation 2 into equation 1 x + 3 = 2x - 8 - award **one** method mark for the correct rearranging x's and numbers onto the correct sides 3 + 8 = 2x - x - award **one** accuracy mark for the correct simplification of 'their' equation to calculate the correct <u>value of x</u> having re-arranged x and substituted back into the equation 1 or 2 <u>to find y</u> x= 11 So y = 2x – 8 = 14 or So y = x + 3 = 14	3

Question Number	Answer	Mark
4	Award **one** mark for a correct cause of variation in daylight factors (1) and one mark for a justification for that cause (1), up to a maximum of **two** marks. • Distance from openings/windows (1) because the daylight factor in the room reduces the further away from the window you are (1) • Interior finishes to walls (1) because light can either be absorbed or reflected within the room (1) • Interior layout / furniture placement inside the room (1) because some areas of the room will be shaded compared to others (1) • Location of windows (1) because some might be obscured by other buildings/trees (1) • Number of window openings/area (1) because more window openings/area means more daylight (1) Marking points may be reversed/given in any order. Do not accept reference to orientation or direction of windows since these are not factors relating to daylight factors.	2

Question number	Answer	Mark
5	Award **three** marks for the correct answer.  If the answer is incorrect: - award **one** accuracy mark for plotting a bending moment of 16 kNm at 2m - award **one** accuracy mark for plotting a bending moment of 11 kNm at 4m - award **one** accuracy mark for the correct form of bending moment diagram with straight lines connecting points	3

Question Number	Answer	Mark
6a	Award **one** mark for a correctly identified construction activity from: • industrial (1)	1

Question Number	Answer	Mark
6b	Award **one** mark for a correctly identified construction activity from: • Repair and maintenance work (1) • Commercial (1)	1

Question Number	Answer	Mark
7	Award **one** mark for a correct way in which brickwork can fail (1) and **one** mark for a justification for that mode of failure (1), up to a maximum of **two** marks. • Brickwork can suffer from spalling/crumbling (1) because the brickwork suffers frost attack (1) • Mortar can crack/crumble (1) because it is subject to sulphate attack/exposure to sea water conditions (1) • Stepped cracking of the mortar joints (1) because there is settlement/differential settlement/heave (1) • Compression failure (1) which could result in failure paths through mortar (1) • The wall could buckle/bulge (1) because moisture can lead to a build-up of pressure behind the wall/pressure form retained material where weepholes have not been included (1) • Mortar can be damaged/loosened/eroded causing brickwork failure (1) because it has been exposed to adverse weather (1) Marking points may be reversed/given in any order.	2

Question number	Answer	Mark
8a	Award **two** marks for the correct answer: $\sigma = 0.061$ If the answer is incorrect: Award **one** mark for recognising that Σ requires: the values of $f(X - Xm)^2$ to be summed together and the frequency values to be summed together. Standard deviation: $\sigma = \sqrt{\frac{\sum(X-X_M)^2}{\sum f}}$ ○ $\Sigma f(X - X_m)^2$ ○ 0.066125 + 0.021125 + 0.002025 + 0.018375 + 0.04335 ○ 0.151 ○ $\Sigma f = 5 + 5 + 9 + 15 + 6$ ○ $\Sigma f = 40$ Award **one** mark for the correct answer for standard deviation using students' own values $\sigma = \sqrt{\frac{0.151}{40}}$ $\sigma = 0.061$	2

Question number	Answer	Mark
8b	Award **two** marks for the correct answer: Median = 1.605 kN/mm^2 If the answer is incorrect: Award **one** mark for recognising that the median lies between the 20th and the 21st value (i.e. value 20.5) which lies in the 1.60 to 1.65 frequency class. 1st value of 15 Award **one** mark for the correct answer for standard deviation using students' own values. Median = 1.5/15 x 0.05 + 1.6 Median = 1.605 kN/mm^2	2

Question Number	Answer	Mark
9	Award **one** mark for a correct way in which relative humidity can be controlled (1) and **one** mark for a justification for that way (1), up to a maximum of **two** marks. • Install mechanical ventilation (1) because this will help to remove moist air from showers and baths to the outside (1) • Air conditioning (1) because it will control quality of the air in the bathroom (1) • Maintain higher temperatures in the bathroom (1) because this will raise the dew point / prevent condensation forming on cold surfaces/mirrors/windows (1) • Maintain higher temperatures in the bathroom (1) because this will raise the dew point / prevent condensation forming on cold surfaces/mirrors/windows (1) • Reduce the temperature of the hot water in the bathrooms (1) because this will lower the amount of moisture in the air (1) • Passive ventilation (1) because opening windows will allow warm air to escape (1) Do not accept generic responses that are not applied to the context of the scenario such as: - remove the source of humidity	2

Question number	Answer	Mark
10	Award **three** marks for the correct answer: BM_B = 14.17KNm If the answer is incorrect: Award **one** mark for the correct load for times lever arm BM=1.8x7.87 Award **one** mark for the correct value of 14.17 Award **one** mark for the correct units of moments indicated KNm This mark can be awarded independent of any calculations.	3

Question Number	Answer	Mark
11	Award **one** mark for a correct cause of interstitial condensation in buildings (1) and **one** mark for a justification for that cause (1), up to a maximum of **two** marks. • Interstitial condensation can be caused by the dew point being reached in some materials but not in others (1) because the materials that make up the structure have different structural temperature profiles (1) Accept any other appropriate/alternative response.	2

Question Number	Answer	Mark
12	Award **one** mark for an appropriate drawback of the source-path-receiver approach (1), **one** mark for a justification for that drawback (1), and **one** mark for an expansion of the justification (1) up to a maximum of **three** marks. • It will not be possible to identify with any accuracy the sources of noise during the life of the residential properties (1) because the town is still being developed and the use of land may vary from the local plan (1) which could result in sound insulation being under/over specified (1) • It will not be possible to determine with accuracy transmission paths of airborne sound in the future (1) because these vary depending on local topography / buildings / vegetation (1) which could cause sound to be either diverted away from the new residential property or be reflected towards it as the town develops (1). Marking points may be reversed/given in any order. Do not accept generic responses that are not applied to the context of the scenario such as: - drawbacks related to existing locations and structures - drawbacks related to other types of project.	3

Question Number	Answer	Mark
13	Award **one** mark for a correct reason why glare needs to be considered (1), **one** mark for a justification for that reason (1), and **one** mark for an expansion of the justification (1) up to a maximum of **six** marks. • Glare can cause physical discomfort to staff working in the new retail clothes shop (1) because it reduces contrast / makes screens difficult to see (1) which would make it difficult to carry out tasks/result in lower productivity of workforce/can make some staff have headaches or feel ill (1) • Glare could increase running costs for the owners of the new retail clothes shop (1) because it could result in the need to install blinds/curtains (1) which could mean needing to install artificial lighting to maintain acceptable lighting levels (1). • Glare could be created in the surrounding environment (1) because light reflects off the external surfaces of the retail clothes shop (1) which could lead to distraction/accidents for members of the public (1)Glare could be created in the surrounding environment (1) because light reflects off the external surfaces of the building (1) which could lead to distraction/accidents for members of the public (1) Do **not** accept reference to glare caused by direct lighting.	6

Question number	Indicative content	Mark
14	Responses will be credited according to the student's demonstration of knowledge and understanding of the material, using the indicative content and level descriptors below. **<u>Benefits of glulam beams over reinforced concrete beams in this scenario</u>** • Timber for the beams can be sourced from renewable resources, which means that the beams are more sustainable than reinforced concrete. This is because Glulam beams have lower embodied energy and lower embodied carbon than reinforced concrete since the process of mining and extracting materials used in reinforced concrete is more damaging to the environment than the process of sustainable forestry. • Glulam beams are manufactured from solid pieces of wood and therefore have a natural wood appearance making them attractive to look at. They can be varnished/stained to enhance the grain properties to be a feature of the building whereas although concrete beams can have different surface textures, the appearance is quite uniform. • Glulam beams are manufactured off-site to the specific dimensions required for the building which reduces the amount of waste that is produced during the manufacturing process and also improves the quality of the product compared to a reinforced concrete beam which could be cast on site and therefore be susceptible to temperature variations which could affect performance over time. • As glulam beams are manufactured offsite and form part of a prefabricated structure, the onsite activity is quicker compared to cast in-situ concrete beams which require time to cure, which would allow for a faster completion time for the supermarket since the glulam beams only need to be assembled together to form the structure of the supermarket which would allow for an earlier opening time than a concrete structure.	9

	Disadvantages of glulam beams compared to reinforced concrete beams in this scenario • The price of Glulam timber beams is typically higher than that of reinforced concrete beams which would add to the development cost of the new supermarket which may mean that the use of glulam requires them to cut costs in other parts of the design of the new supermarket. • Glulam beams would require more maintenance than reinforced concreter in order to check the adhesive joints remain tight and that there is no failure of the beams or connections unlike reinforced concrete beams which would not need maintenance unless there was accidental damage to them. • Glulam beams are large and heavy which could make transport to the town centre difficult as access might be limited due to surrounding buildings in comparison to reinforced concrete beams which could be cast in-situ and therefore only need deliveries of concrete to site using concrete mixers. • Glulam beams lack the same level of fire resistance that can be achieved by reinforced concrete beams which could have implications with respect to the capacity of the supermarket in that there might be a limit on the number of customers allowed on site, or the use of the floor area, unless additional fire protection materials were applied to the beams which would increase cost and potentially remove the aesthetic appeal of the beams. **Benefits of reinforced concrete beams over glulam beams in this scenario** • Decorative textured finishes can be applied to the surface of concrete beams or they can be cast to have abstract profiles which would allow them to be incorporated into the design of the building as decorative features which could offer more versatility in the shape of the beams compared to the glulam alternative. • Disruption to the local community and neighbouring properties would be reduced because concrete can be delivered to site when it is needed and the beams cast in-situ (on site) which reduces the impact on neighbouring properties compared to the need for large delivery vehicles and cranes to bring glulam beams on to the site	

	• Reinforced concrete is virtually maintenance free when used for buildings since the outer surface is durable and unlikely to be damaged as part of the structure of the supermarket which will reduce maintenance requirements compared to glulam beams where periodic inspections are needed to check the structural integrity of the material. Reinforced concrete can be recycled at the end of its life and used as aggregates, which is in line with the clients need for a sustainable design. **Drawbacks of reinforced concrete beams compared to glulam beams in this scenario** • Reinforced concrete has high levels of embodied energy and embodied carbon which does not meet the needs of a sustainable design, as the steel, cement and aggregates use a large amount of energy during their production and require finite materials to be used in their production unlike glulam beams where timber can be sourced sustainably. • Reinforced concrete requires a long time to cure in order to achieve its design strength which would extend the construction time of the supermarket compared to glulam beams which are prefabricated and then assembled on site. This would not allow for a quicker opening time of the supermarket because the roof could not be installed until the beams have cured. • Reinforced concrete requires aggregates and cement which need to be extracted by quarrying and then transported from the quarry to either the site or a concrete batching plant. This increases the environmental impact of the material because quarrying removes finite resources and carbon emissions will be released during transportation.	

Level	Mark	Descriptors
The second trait (application) carries twice as much weighting as trait 1 (analysis).		
	0	No rewardable material
1	1 - 3	• Demonstrates a basic analysis of the situation by superficially breaking down the different aspects into their component parts. • Demonstrates basic application of knowledge and understanding that is partially relevant to the context of the question and may consider only one side of the context.
2	4 - 6	• Demonstrates a good analysis of the situation by breaking down the different aspects into their component parts. • Demonstrates good application of knowledge and understanding that is relevant to the context of the question and considers both sides of the context.
3	7 - 9	• Demonstrates a thorough analysis of the situation by comprehensively breaking down the different aspects into their component parts. • Demonstrates comprehensive application of knowledge and understanding that is consistently relevant to the context of the question and considers both sides of the context in a balanced way.

Section B

Question Number	Answer	Mark
15	Award **one** mark for a correctly stated cause of heat losses from: • fabric heat losses (1) • ventilation heat losses (1) • thermal bridging (1) • air changes / air change rate (1) • surface area of the external shell (1) • exposure and impact of local climatic conditions on a building (1) • temperature difference between inside and outside (1)	1

Question Number	Answer	Mark
16	Award **one** mark for each correctly stated method of controlling flanking sound up to a maximum of **two** marks, from: • Seal gaps in structures/around openings (1) • Avoid back- to-back electrical fittings in adjacent rooms (1) • Reduce gaps at the bottom of doors (1) • Avoid the use of recessed lighting (1) • Use of double/triple/secondary glazing (1)	2

Question Number	Answer	Mark
17	Award **one** mark for a correct remedial measure that can be used to prevent timber from decaying (1) and one additional mark for a justification of that way (1) up to a maximum of **two** marks. • Timber can be painted with a waterproof [paint / varnish] (1) because a waterproof paint will provide an external barrier to moisture (1) • Timber can be treated with a preservative (1) because the preservative will prevent [insect attack / wet rot] (1) Do **not** accept: • generic responses like 'special coatings' • plating or other coatings not appropriate for applying to timber • intumescent paint or other applications which do not serve the purpose of preventing decay of timber.	2

Question Number	Answer	Mark
18	Award **one** mark for an appropriate reason (1) and **one** mark for a justification for that reason (1) up to a maximum of **four** marks. • It could result in the construction of a bridge come in over budget (1) because there is a risk that the structure could be overdesigned if only one type of load was considered (1) • It could result in structural failure of the bridge (1) because structural members will not have been designed for the total load of the bridge and vehicles crossing over it (1) • The bridge might need underpinning in the future (1) because the effects of live loading on the foundations will be different to those if only dead loads are considered (1) Do **not** accept generic responses that are not applied to the context of the scenario such as: • Weights of internal fixtures and fittings • Weight of the room/walls. As these are applicable to buildings not bridges.	4

Question Number	Answer	Mark
19	Award **one** mark for an appropriate reason why laminated glass is used for curtain walls (1), **one** mark for a justification for that reason (1), and **one** mark for an expansion of the justification (1) up to a maximum of **six** marks. Marking points may be reversed/given in any order. • Laminated glass is difficult to break/durable (1) because it is designed to resist impacts/forces (1) because the two panes of glass are bonded to the interlayer (1). • Laminated glass reduces the amount of discolourisation of interior furnishings (1) because the amount of UV light passing through is reduced (1) because the interlayer absorbs the UV light (1) • Laminated glass has improved acoustic properties over other types of glass (1) because the layer of resin acts as an insulator (1) which means external noises would be reduced inside the building (1) • Laminated glass minimises the risk of injury (1 because when broken, it will shatter but still hold its form (1) reducing the possibility of injury claims (1) Do not accept generic responses that are not applied to the context of the scenario such as the use of laminated glass for furniture or car windows.	6

Question Number	Answer	Mark
20	Award **one** mark for a correct way that concrete columns can fail (1) and **one** mark for a justification for that way (1), up to a maximum of **two** marks. • The column could fail due to elastic instability (1) because it is long and has a small cross section area it may start to buckle (1) • The column could fail from a compression failure (1) because the loading of the roof could be too high and result in the yield stress of the concrete being reached (1) • The column could fail due to deflections cause by combination of bending and compression (1) because the column will be subjected to axial loads from the roof and lateral loads from the upper (1) Do not accept generic responses that are not applied to the context of the scenario such as: • overturning which would not apply to a concrete column • tensile failure which is not applicable for columns • failure modes not associated with slender columns.	4

Question number	Answer	Mark
21	Award **four** marks for the correct answer: y = 11.25 If the answer is incorrect: - award **one** mark for the correct setting up of the definite integral $$\int_0^3 \left(t + \frac{t(t^2)}{3}\right) dt$$ - award **one** mark for the correct integration - $y = \frac{t^3}{2} + \frac{t^4}{12}$ - award **one** mark for the application of limits when substituting the values in for the lower and upper limits (allow ECF) $$y = \left(\frac{3^3}{2} + \frac{3^4}{12}\right) - \left(\frac{0^3}{2} + \frac{0^4}{12}\right)$$ Award **one** mark for the correct answer y = 11.25	4

Question Number	Answer	Mark
22	Award **one** mark for an appropriate reason why reverberation time needs to be considered when designing classrooms (1), **one** mark for a justification for that reason (1), and **one** mark for an expansion of the justification (1) up to a maximum of **three** marks Marking points may be reversed/given in any order. • Reverberation time needs to be considered to reduce the amount of sound reflecting off surfaces (1) because reflected sounds are unwanted/intrusive noises (1) because they increase the overall level of noise in the room (1) • Reverberation time should be considered so that damping can be implemented (1) which can be achieved by using sound-absorbing panels (1) which will cause sounds to die away quickly (1) Do not accept generic responses that are not applied to the context of the scenario such as: • reverberation in outdoor spaces.	3

Question Number	Answer	Mark
23	Award **one** mark for an appropriate reason for using graphene reinforced concrete for buildings (1) and **one** mark for a justification for that way (1), up to a maximum of **four** marks. • The amount of raw materials needed for the concrete can be reduced (1) because graphene alters the chemistry of the concrete to increase its compressive strength (1) • The amount of steel reinforcement needed is reduced (1) because graphene increases the flexural/bending strength of the concrete (1) • The service life of the concrete is increased (1) because graphene increases the water resistance of the concrete (1)	4

Question number	Working	Mark
24	Award **six** marks for the correct answer: V = 4.104m^3 If the answer is incorrect: • award **one** mark for deriving a formula for the volume of the container - X (l-2x)x(w-2x) - X(5-2x)(3-2x) • award **one** mark for rearranging and simplification - V = X(15-6x-10x+4x^2) - V = 15x – 16x^2 + 4x^3 - V = 4x^3 – 16x^2 + 15x • award **one** mark for differentiating with respect to 'x' - dV/dx = 12x^2 -32x + 15 • award **one** mark for recognising to find the maximum volume dV/dx = 0 - 12x^2 -32x + 15 = 0 • award **one** mark for correctly determining the roots for x for the maximum volume - X = (8 + √19)/6 or (8 - √19)/6 - X = 2.01 or x = 0.61 • award **one** mark for recognition that the minima value is needed since 2x must be less than the shortest dimension - X = (8 - √19)/6 - X = x = 0.61 • award **one** mark for the correct answer for volume using students' own values - V = 0.61 (5-2x0.61)x(3-2x0.61) - V = 0.61 x 3.78 x 1.78 - V = 4.104 m^3	6

Question number	Indicative content	Mark
25	Responses will be credited according to the student's demonstration of knowledge and understanding of the material, using the indicative content and level descriptors below. **Benefits of natural light sources over artificial light sources in this scenario** • The restaurant will be open for a significant part of the day when there will be daylight during the summer months therefore the architect could include large windows in each of the walls, which would allow daylight to enter and provide natural illumination for the restaurant and allow visitors/diners to be more focused on eating their meals and make the experience more enjoyable since daylight has a positive effect on the body • By making use of natural light sources in the design of the restaurant there would be better colour rendition and contrast compared to the use of artificial lighting which would provide a more relaxing and comfortable atmosphere for customers who will be able to see their food better and appreciate the appearance of their meals. • There is potential to make use of skylights or light tubes which would allow for natural light to be provided throughout the restaurant as well as for customers who are close to windows or doors which in turn could be used as decorative design features to make the interior more aesthetically appealing and potentially attract repeat customers. **Drawbacks of natural light sources compared to artificial light sources in this scenario** • If the architect includes windows each of the walls there would be need to provide some form of shading/blinds to prevent discomfort for diners as the sun will change positions during the day and especially in winter months the sun will be very low in the sky and could be irritating if it is shining directly into the eyes of customers.	9

	• The surrounding properties and trees could create shadows over the new restaurant which would reduce the effectiveness of windows and/or skylights since these would block the natural light and reduce the level of illumination in the restaurant meaning additional artificial lighting would be needed. visitors from suffering from glare due to the height of the sun in the sky • Natural light would not be able to effectively illuminate the restaurant throughout the times it is open, especially in the winter, as the sun will set before the restaurant closes meaning that additional artificial lighting will be needed to allow the restaurant to remain open safely. **<u>Benefits of artificial light sources over natural light sources in this scenario</u>** • Artificial lighting can be used to highlight design details that the architect includes in restaurant because artificial lighting is available in a wide range of lighting tones and lux values which means that the lighting would be much more consistent and in line with the clients vision compared to natural light since it would not be affected by external factors such as the shadows created by woodland or surrounding buildings or the time of the day. • The lighting level can be adjusted more easily using artificial light sources and tailored to the needs of diners depending on the time of the day/year where the use of artificial light sources would either complement the light from natural sources or would be the sole type of illumination within the restaurant given the hours it will be open and the potential of overshadowing from external features which might require artificial light in some parts of the restaurant at all times to allow for a comfortable and safe environment. • Artificial lighting is more controllable than natural lighting and can therefore be used as mood lighting to improve the ambiance for diners, for example providing soft subdued lighting at tables compared to potentially harsh bright direct sunlight depending on the time of the day. This would be a more relaxing environment and could encourage customers to revisit the restaurant.	

	<u>Drawbacks of artificial light sources compared to natural light sources in this scenario</u> • Using only artificial lighting would increase the running costs of the restaurant since bulbs will need to be bought and replaced more frequently than if artificial lighting is used to complement natural light sources. There will also be an increase in the amount of energy used to power them which also increases the carbon footprint of the restaurant.	

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Formulae and constants

Surface areas of regular shapes

Total surface area of a cylinder	$TSA = 2\pi rh + 2\pi r^2$
Curved surface area of cone	$CSA = \pi rl$
Surface area of a sphere	$SA = 4\pi r^2$
Area of a sector of a circle	$A = \frac{1}{2}r^2\theta$
Area of a trapezium	$A = \frac{(a+b)}{2}h$

Volumes of regular shapes

Volume of a cylinder	$V = \pi r^2 h$
Volume of sphere	$V = \frac{4}{3}\pi r^3$
Volume of a cone	$V = \frac{1}{3}\pi r^2 h$

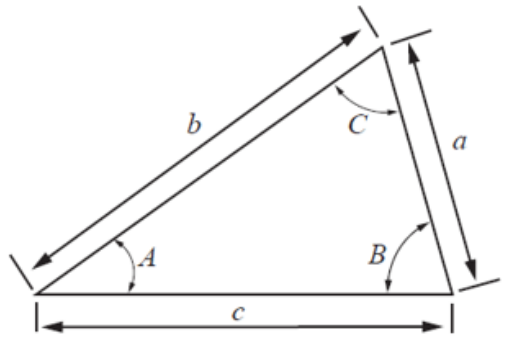
Radians, arc lengths and areas of sectors

Length of an arc of a circle	$s = r\theta$

Graphical techniques

Equation of a straight line	$y = mx + c$

Trigonometric rules



Sine Rule $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$ or $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{Sin\ C}{c}$

Cosine Rule $a^2 = b^2 + c^2 = 2bc\cos A$

Triangular area rule $Area = \frac{1}{2}ab\sin C$

Statistics

Mean $X_m = \frac{\sum X}{n}$

where *x* represents each value in the data set and *n* represents the number of items of data

Standard Deviation $\sigma = \sqrt{\frac{\sum(X-X_m)^2}{n}}$

Forces, stress and strain

Relationship between force (load), mass and acceleration due to gravity, *F= mg*

Direct stress $\sigma = \frac{F}{A}$

- Direct strain $\varepsilon = \frac{\Delta L}{L}$

Resolution of forces in perpendicular directions, $Fx = Fcos\theta,\ Fy = Fsin\theta$

Equilibrium conditions to ensure stability of a beam $\Sigma Fx = 0,\ \Sigma Fy = 0,\ \Sigma M = 0$

Moment of a force: moment = force × distance

Human comfort effect of temperature on construction materials while in situ

Thermal resistance $R_c = \frac{thickness\ of\ material}{thermal\ conductivity}$

$$R_\theta = \frac{thickness}{cross-sectional\ area\ \ x\ \ thermal\ conductivity}$$

U Values $U = \frac{1}{R_c}$

Thermal conductivity $K = \frac{QL}{A\Delta T}$

Acoustics

Reverberation time $T = 0.161\left(\frac{V}{A}\right)$

where V is the volume in m^3 and A is the total absorption surface in m^2

Constants

Acceleration due to gravity, g = 9.81 m/s^2

π = 3.142

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