HIGHER

4.17H Plans and Elevations: Higher Tier Practice

Total Marks

EDEXCEL Edexcel 1MA1 · Calculator allowed · about 75 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A solid is made from 8 identical unit cubes arranged as a 2 by 2 by 2 cube. Sketch or describe the top plan, front elevation and side elevation. Give the number of visible unit-square faces in each view.

(a) State how many unit-square faces are visible in the top plan. **(1)**

(b) State how many unit-square faces are visible in a front elevation (one face of the cube facing the viewer). **(1)**

(Total for Question 1 is 2 marks)

---

2 A model is built from cuboids on a 1 cm grid. From above (plan) it appears as a 3 by 3 square. From the front elevation it appears as a 3 by 2 rectangle. From the right-side elevation it appears as a shape with three columns of heights 1 cm, 2 cm and 1 cm (from left to right). What is the total volume, in cubic centimetres, of the model?

(Total for Question 2 is 3 marks)

3 A solid is made by stacking cuboids on a base of 4 squares by 2 squares (each square is 1 cm by 1 cm). The height is the same all the way through the 2 cm depth: from left to right, the first two columns (columns 1 and 2) are 3 cm tall and the last two columns (columns 3 and 4) are 1 cm tall, in both rows of the depth. Give the right-side elevation and then work out the total surface area of the solid (including all faces), in cm^2.

(a) State the right-side elevation, given that the height is the same throughout the depth. **(1)**

(b) Calculate the total surface area including areas of top faces, all visible side faces and the base. **(3)**

.....

(Total for Question 3 is 4 marks)

---

4 A 3D object is built from unit cubes with side 1 cm, on a base 4 squares wide (left to right) by 3 squares deep (front to back). The height of each of the 12 base squares is:
Row 1 (front): 2, 2, 2, 2
Row 2 (middle): 2, 3, 3, 3
Row 3 (back): 2, 2, 2, 2
(columns given left to right within each row). Show that the total number of cubes used is 27, and show that these heights are consistent with a front elevation that is a 4 by 3 rectangle with a 1 by 1 square missing from its top-left corner, and a right-side elevation showing three heights of 2, 3 and 2 (front to back).

(Total for Question 4 is 6 marks)

5 A solid has plan shown as a 3 by 4 grid (3 rows front to back, 4 columns left to right). The front elevation (viewed from the front, across the 3-row depth) shows heights (left to right) 2, 3, 2, 1. The right-side elevation (viewed from the right, across the 4-column width) shows three columns of heights (front to back) 3, 2, 1. Using these elevations, determine the height of each cell in the plan (a 3 by 4 matrix), then calculate (a) the total number of unit cubes used, and (b) the total external surface area including base, in cm^2. Show your working.

(a) Determine the height of each of the 12 plan cells and give the total number of unit cubes used. **(3)**

(b) Calculate the total external surface area of the solid, including the base, in cm^2. Show working. **(3)**

.....

(Total for Question 5 is 6 marks)

6 A stepped block sits on a 5 by 1 base (five positions in a row). The front elevation (looking along the row) shows heights 1, 2, 3, 2, 1 (left to right). From the plan there is only one row so the plan is 5 by 1 and all five cells are present. (a) Work out the total volume in unit cubes. (b) Find the total external surface area including base. (c) How many cubes have at least one face on the base? Show working.

(a) Work out the total volume in unit cubes. **(2)**

.....

(b) Find the total external surface area including the base. **(4)**

.....

(c) How many cubes have at least one face on the base? **(2)**

.....

(Total for Question 6 is 8 marks)

7 Three elevations of a model on a 4 by 4 plan are given. The front elevation (viewing across the depth) shows left-to-right heights 3, 2, 2, 1. The right-side elevation (viewing across the width) shows front-to-back heights 2, 3, 1, 2. The plan shows that every of the 16 cells is present. (a) Find the minimum possible number of unit cubes that could make the model and the maximum possible number, consistent with the three elevations. (b) For your minimum configuration, give one possible matrix of heights and calculate its total number of cubes. (c) For your maximum configuration, explain briefly how you achieved the maximum and give its total number of cubes. Full justification is required.

(a) Find the minimum and maximum possible number of unit cubes consistent with the three elevations. Give the numbers. **(4)**

.....

(b) Give one possible 4 by 4 matrix of heights that achieves the minimum and calculate its total number of cubes. **(4)**

(c) Give a justification and calculation for the maximum possible number of cubes and state one matrix achieving it. **(3)**

(Total for Question 7 is 11 marks)

Mark scheme · 4.17H Plans and Elevations: Higher Tier Practice

Question 1

- (a) **B1** 4 cao
- **(a) Answer: 4**
- (b) **B1** 4 cao
- **(b) Answer: 4**

Question 2

- **M1** interpret side elevation heights as giving column heights across the 3 columns and multiply by plan depth per column
- **M1** calculate volumes of three columns: columns have widths 1,1,1 and depths 3 each, heights 1,2,1 so volumes 3,6,3
- **A1** 12 cm^3 cao
- **Answer: 12 cm^3**

Question 3

- (a) **M1** right-side elevation is a rectangle 2 cm wide and 3 cm tall (both depth positions reach the maximum column height of 3 cm, since the tall columns run the full depth)
- **(a) Answer: A rectangle 2 cm wide and 3 cm tall.**
- (b) **M1** calculate top + base area: footprint is 4 by 2 = 8, so top 8 + base 8 = 16
- (b) **M1** calculate front + back area: each equals the sum of the four column heights (3+3+1+1=8), so front 8 + back 8 = 16; calculate left/right end and internal step area: depth * (leftmost height + |3-3| + |3-1| + |1-1| + rightmost height) = 2* (3+0+2+0+1) = 12
- (b) **A1** 44 cm^2 cao
- **(b) Answer: 44 cm^2**

Question 4

- **M1** recognise the right-side elevation heights 2, 3, 2 match the maximum height in each row: row 1 max 2, row 2 max 3, row 3 max 2
- **M1** recognise the front elevation is 4 by 3 with column 1 only reaching height 2 in every row (never 3), so its overall column maximum is 2, giving the 1 by 1 notch at the top-left of the 4 by 3 envelope, while columns 2-4 reach height 3 in row 2
- **M1** read off the height of each of the 12 cells from the table: row 1 [2,2,2,2], row 2 [2,3,3,3], row 3 [2,2,2,2]
- **M1** sum the heights over the 12 cells: (2+2+2+2) + (2+3+3+3) + (2+2+2+2) = 8 + 11 + 8
- **A1** 27 cubes cao
- **C1** clear explanation linking the front, plan (table) and side data to the column heights, with correct arithmetic
- **Answer: 27**

Question 5

- (a) **M1** use front elevation to give row maxima per column: columns heights left to right 2,3,2,1
- (a) **M1** use right-side elevation to give column maxima per row: rows front to back 3,2,1 and combine with front info to deduce per-cell heights
- (a) **A1** total cubes 19 cao
- **(a) Answer: 19**
- (b) **M1** calculate top area and base area: top equals number of cells with height > 0 (12) and base = 12
- (b) **M1** calculate vertical face area by summing differences between adjacent cells across the grid and perimeter faces
- (b) **A1** total surface area 52 cm^2 cao
- **(b) Answer: 52 cm^2**

Question 6

- (a) **M1** add column heights: 1+2+3+2+1
- (a) **A1** 9 cubes cao
- **(a) Answer: 9**
- (b) **M1** calculate top area = number of columns with height > 0 = 5 and base = 5
- (b) **M1** calculate end faces: two ends each with height 1 so area 2
- (b) **M1** calculate vertical faces between columns: sum of absolute differences between adjacent heights = |1-2|+|2-3|+|3-2|+|2-1| = 1+1+1+1 = 4, multiply by face width 1 gives 4, add perimeter faces giving total vertical 2+4+? combine correctly
- (b) **A1** 34 cm^2 cao
- **(b) Answer: 34 cm^2**
- (c) **M1** recognise each column contributes exactly its height number of cubes touching the base only for the lowest layer
- (c) **A1** 5 cao
- **(c) Answer: 5**

Question 7

- (a) **M1** identify that each cell height must be at most its column max (from front) and row max (from side) and at least the maximum of constraints leading to minima
- (a) **M1** for minimum take each cell = minimum of its row and column maxima
- (a) **M1** for maximum take each cell = maximum value allowed without violating any elevation, i.e. each cell = minimum of its row and column maxima actually gives both bounds; recognise method
- (a) **A1** minimum 20 and maximum 26 cao
- **(a) Answer: Minimum 20, Maximum 26**
- (b) **M1** produce a matrix where each entry = min(column max, row max)
- (b) **M1** show the per-cell numbers summed
- (b) **M1** obtain total 34
- (b) **A1** 20 cao
- **(b) Answer:Example matrix (rows front to back):**
  [1,2,1,1]
  [3,1,1,1]
  [1,1,1,1]
  [1,1,2,1]
  Total 20
- (c) **M1** justify that to maximise, use as many cells as possible equal to the larger of the two maxima where not violating the other; allocate full row maxima in those rows where side allows
- (c) **M1** provide a matrix consistent and sum entries
- (c) **A1** 26 cao
- **(c) Answer:One maximum matrix (rows front to back):**
  [2,2,2,1]
  [3,2,2,1]
  [1,1,1,1]
  [2,2,2,1]
  Total 26