**Activity 2 Worksheet: Using the mid-ordinate rule to calculate the materials for a road embankment**

# Practice question 1

You are constructing a road embankment with a cross-sectional base width of 10 metres as shown below. The embankment will be 15 metres long.

Calculate the amount of fill needed to construct the embankment.

**A graph showing the cross-section of land.
The x-axis goes from 0 to 10, split into 1 metre intervals. It is labelled: distance across embankment (m)
The y-axis goes from 0 to 3. It is labelled height above datum level (m).

The graph is a line graph in red called "existing terrain" starting at the point 0, 0. It connects to 1, 0, then 2, 0, and so on up to 10, 0.
There is a horizontal line, called "proposed finished embankment level" from 1 on the y-axis across the width of the graph, hitting points 0, 1 then 2, 2, then 4, 3, then 6, 3, then 8, 2 and finally 10, 1.**

Remember to work through each step in turn.

**Step 1:** Plot the ‘x’ and ‘y’ co-ordinates on graph paper.

**Step 2:** Divide the base width of the cross-section into equal intervals. (5 would be a good choice)

**Step 3:** Determine the midpoint of each interval.

**Step 4:** Measure the height of the fill at each point.

**Step 5:** Calculate the area of each interval.

**Step 6:** Add up the areas of the segment to get the total area of the cross-section.

**Step 7:** Work out the total amount of material needed by multiplying the area of the cross-section by the length of the embankment.

# Practice question 2

Using the mid-ordinate rule to calculate the cross-sectional area of another road embankment with a base width of 12 metres divided into six equal segments. The heights are as given in the table below.

You can assume that the existing ground level is at 0 metres.

|  |  |
| --- | --- |
| **Position (m)** | **Proposed height (m)** |
| 0 | 2.5 |
| 2 | 3.0 |
| 4 | 5.0 |
| 6 | 5.0 |
| 8 | 5.0 |
| 10 | 3.0 |
| 12 | 2.5 |

Hint: Remember to work through each step in turn, starting by sketching the embankment. Embankments are an engineered structure; they have level tops and slopes which are graded to a specified angle, so you can plot this graph by joining the heights at each position with a straight line.

# Practice question 3

You are designing a road that must pass through uneven terrain. To create a level road, you will need to cut soil from higher areas and fill soil to lower areas. The cross-section of the terrain along a 10-metre stretch of road is given in the table and graph below.

Use the mid-ordinate rule to calculate how much material will need to be removed from site to create a suitable road. The road will be 9 metres wide.

|  |  |  |
| --- | --- | --- |
| **Position (m)** | **Existing elevation (m)** | **Desired elevation (m)** |
| 0 | 3.5 | 3.0 |
| 2 | 3.0 | 3.0 |
| 4 | 3.5 | 3.0 |
| 6 | 3.5 | 3.0 |
| 8 | 2.5 | 3.0 |
| 10 | 2.0 | 3.0 |

A graph showing the cross-section of land.
The x-axis goes from 0 to 10, split into 1 metre intervals. It is labelled: distance across road (m).
The y-axis goes from 0 to 4. It is labelled height above datum level (m).

The graph is a line graph in red called "existing terrain" starting at the point 0, 3.5. It connects to 2, 3, then 4, 3.5, then 6, 3.5, then 8 2.5 and finally 10, 2.
There is a horizontal line, called "proposed new ground level" from 3 on the y-axis across the width of the graph.

Hint: Remember to add in the proposed road level. You will need this to work out the areas of cut and fill.