Exercise set 2:
The 3 point problem

To view this exercise just press **F5** now. Then click the mouse to continue through the slides.

The 3 point problem

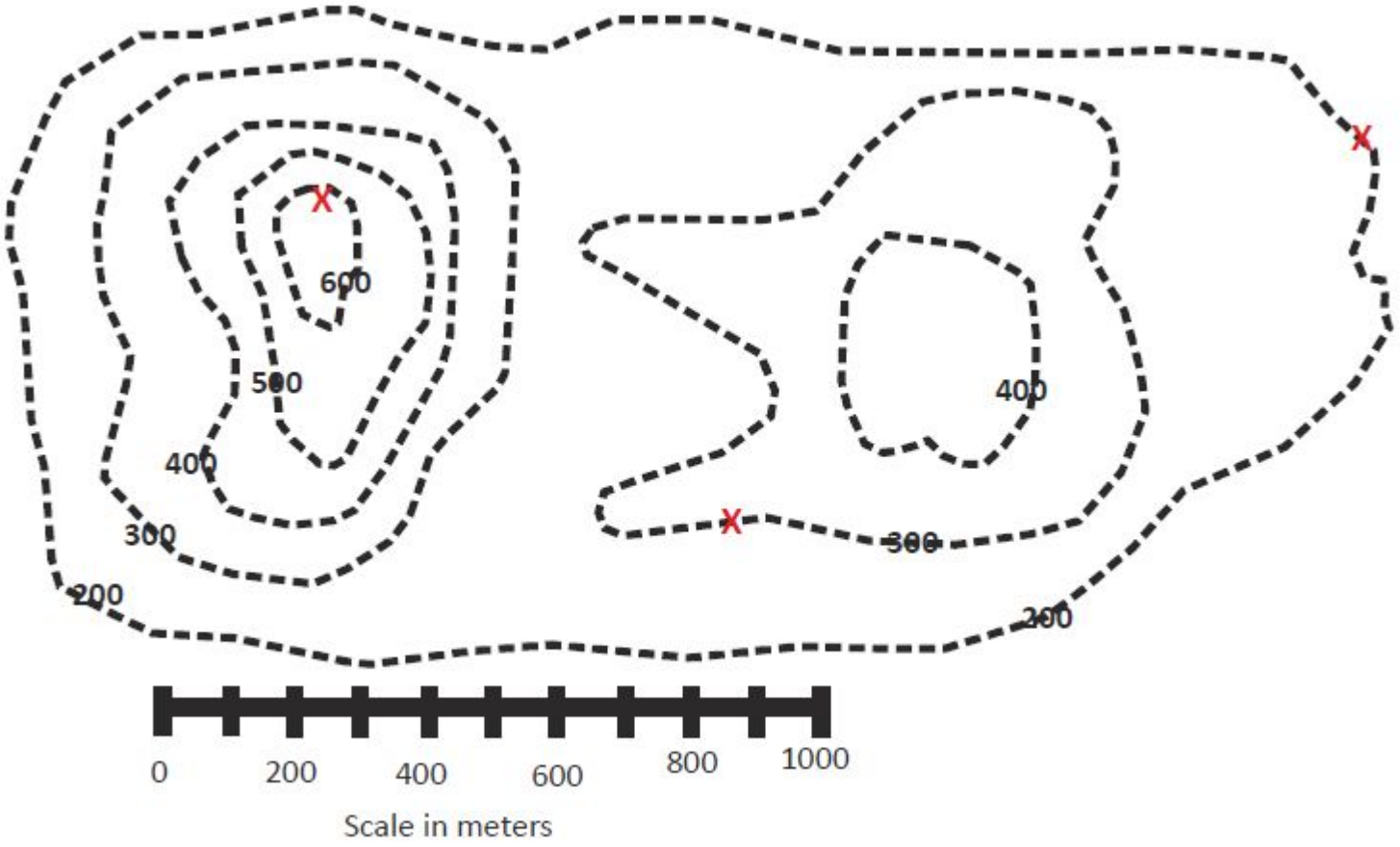
- This presentation is to be completed in conjunction with exercise sheet 2.

Objectives:

- By the end of this section you should be able to find the direction of strike and calculate the dip (provided it is uniform), if the height of a bed is known at 3 or more locations.

The 3 point problem: Example

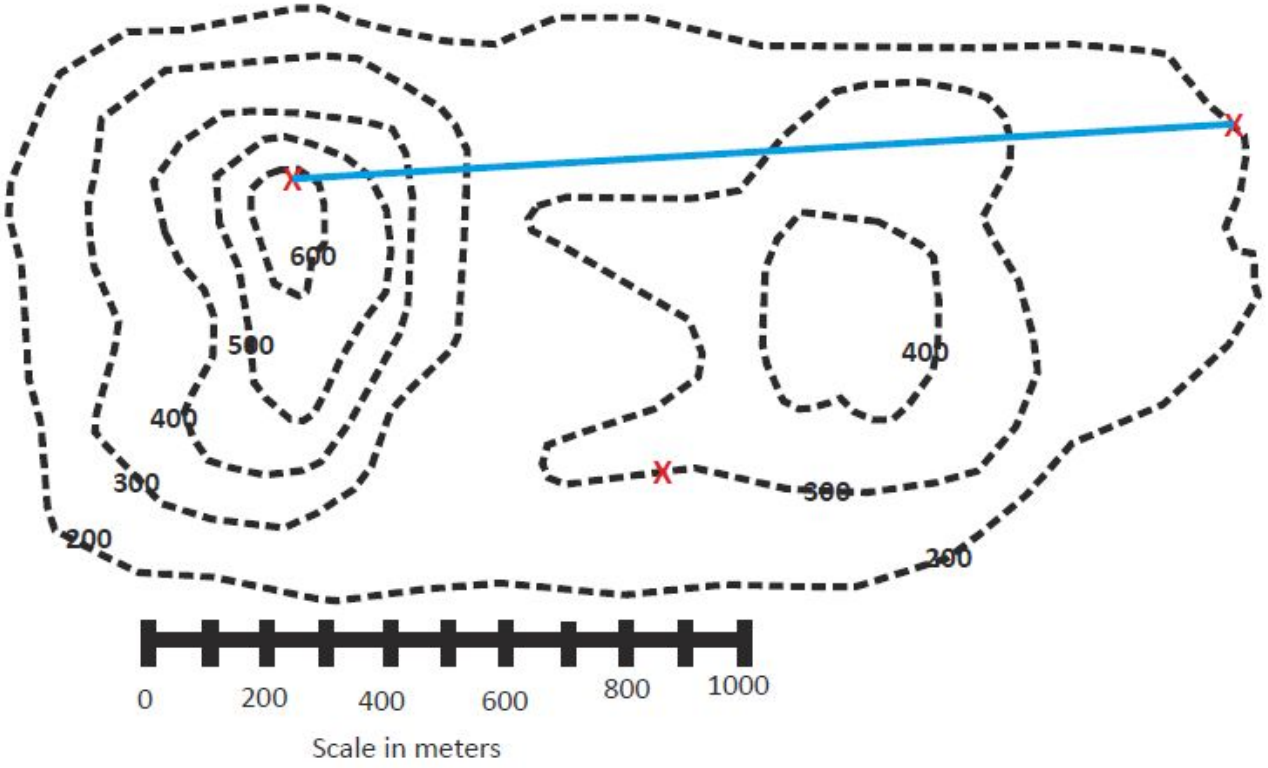
- Here is our original map. Fill in the example on exercise sheet 2 as we run through it.
- We want to find the strike and dip of a thin coal seam that outcrops at the three X's.



The 3 point problem: Example

Step 1:

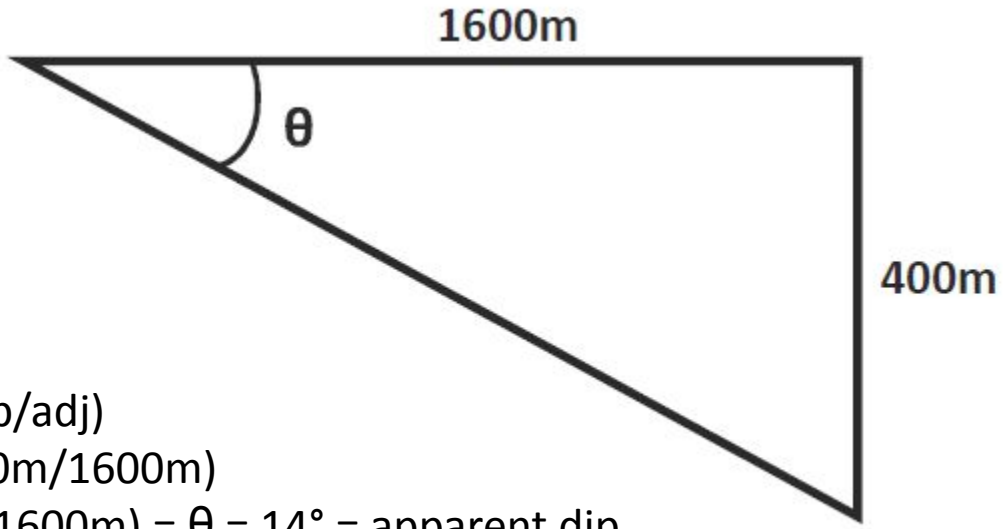
- Draw a line between the outcrop at the highest elevation and the outcrop at the lowest elevation.
- If you have two outcrops at the same elevation (which does not apply to this particular problem), then draw a line between them instead. That is your strike line and you can skip ahead to step 4.



The 3 point problem: Example

Step 1 continued:

- Measure the map distance of that blue line with your ruler (about 1600m).
- Set up a triangle with the map distance and elevation difference at two ends to calculate **apparent dip**.
- The apparent dip tells you that the true dip has to be at **least** that value, it cannot be less.



$\tan(\theta) = (\text{opp}/\text{adj})$

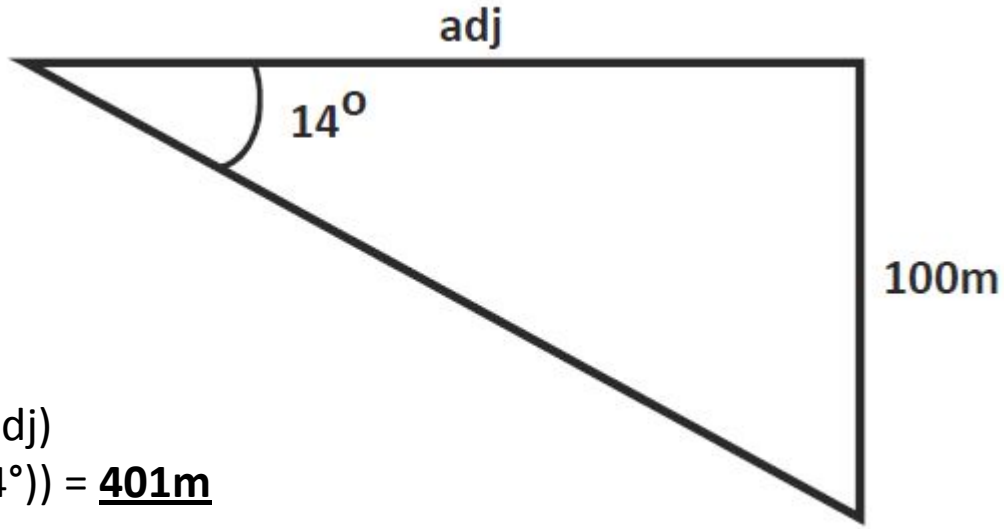
$\tan(\theta) = (400\text{m}/1600\text{m})$

$\tan^{-1}(400\text{m}/1600\text{m}) = \theta = 14° = \text{apparent dip}$

The 3 point problem: Example

Step 2:

- Now, along the blue line you drew, you want to find out where the elevation of the third point, for this case 300m, would lie (ignore the elevation contours along the blue line).
- Take the difference of elevation between the third point and one of the other given points.
- We'll use the outcrop at 200m (300m outcrop – 200m outcrop).
- Now set up another triangle using the apparent dip angle.



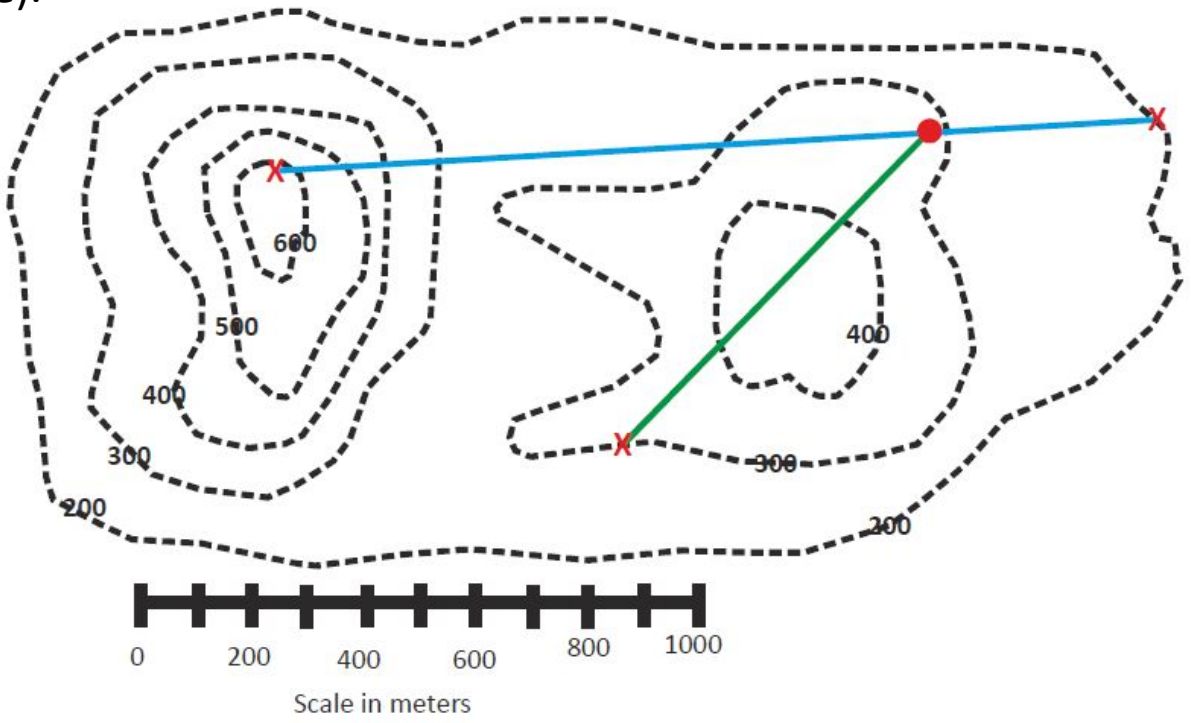
tan(14°) = (100m/adj)

adj = (100m/tan(14°)) = **401m**

The 3 point problem: Example

Step 3:

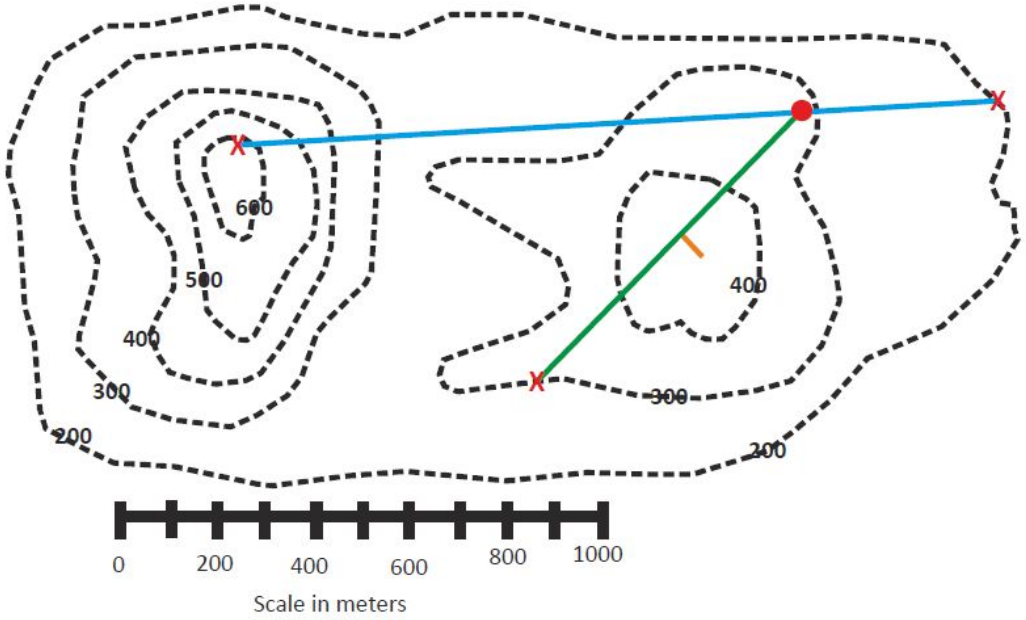
- Now, measure 401m along the blue line away from the outcrop at 200m (if you used the outcrop at 600m as one of your other given points in step 2, then adj= 1199m and you would move 1199m along the blue line from the outcrop at 600m and end up at the same place) and make a mark (the red circle).
- Now connect that line from the red circle to the third outcrop point – that is your strike (the green line).

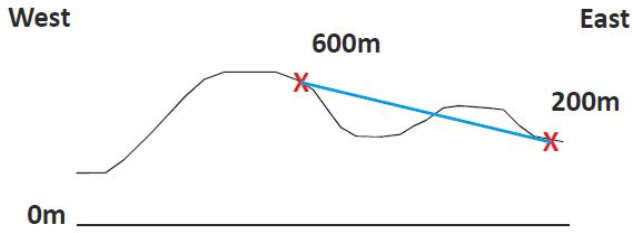


The 3 point problem: Example

Step 4:

- The dip is perpendicular (at a right angle) to the strike line. The dip direction will be in the general direction of the lower elevation.
- To help understand this, just picture a cross section in your head. With a high point on the left side and a low point on the right side, the bed would have to be dipping from the left to the right. (Or be an incredibly thick bed, but we are told it is a thin coal seam).
- So in this case the dip is in the SE direction (the orange line).

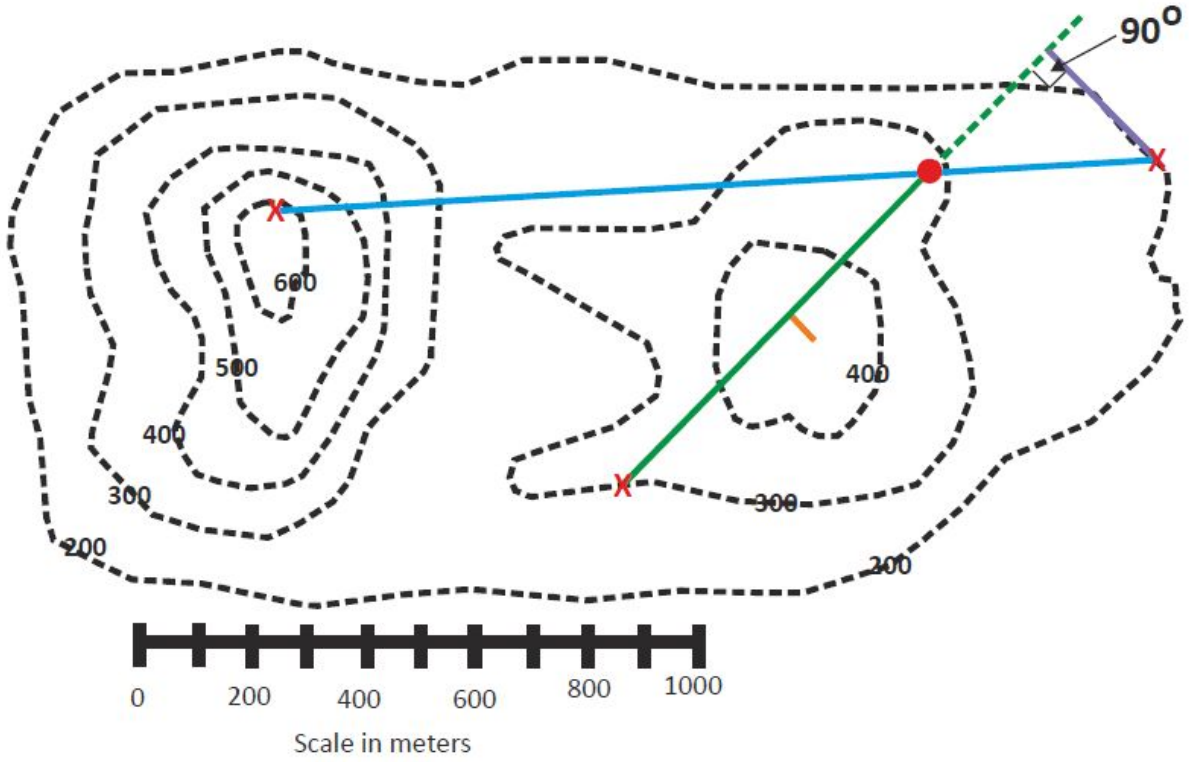




The 3 point problem: Example

Step 5:

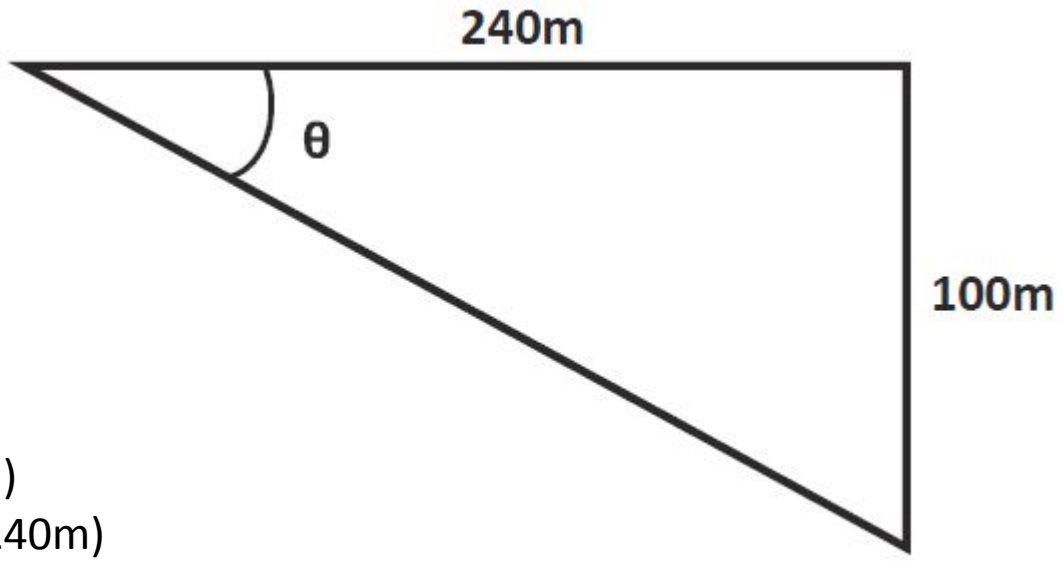
- To figure out the true dip angle, extend the 300m strike line.
- Connect that strike line to the 200m outcrop so that the line is perpendicular to the 300m line.
- Measure the distance of that purple line with your ruler (about 240m).



The 3 point problem: Example

Step 5 continued:

- Set up another triangle with the elevation difference being 100m (300m strike line – 200m outcrop elevation). The tan of that angle is the true dip.



$\tan(\theta) = (\text{opp}/\text{adj})$

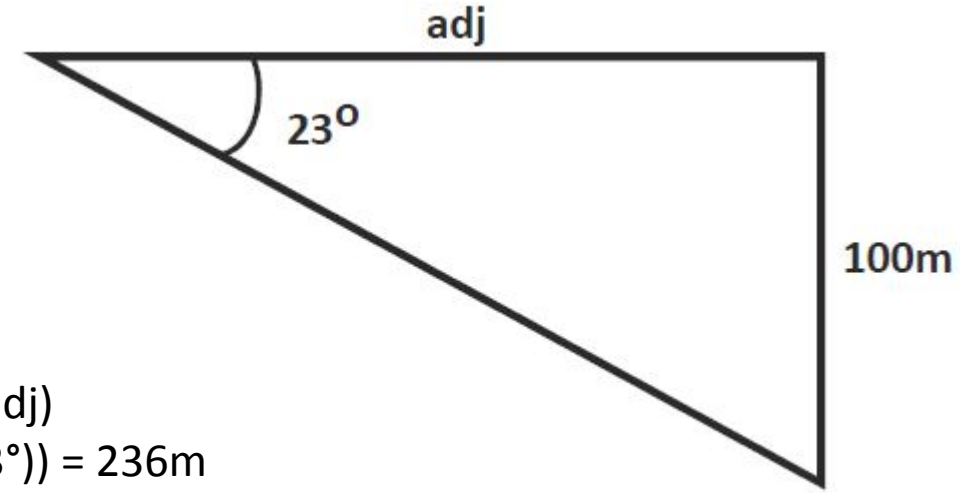
$\tan(\theta) = (100\text{m}/240\text{m})$

$\tan^{-1}(100\text{m}/240\text{m}) = \theta = 23° = \text{true dip}$

The 3 point problem: Example

Step 5:

- To figure out the outcrop pattern, continue making strike lines with 100m contours.
- Set up another triangle with the elevation 100m and the dip angle 23° to solve for side adjacent to the angle.
- That is how far apart your strike lines should be spaced.

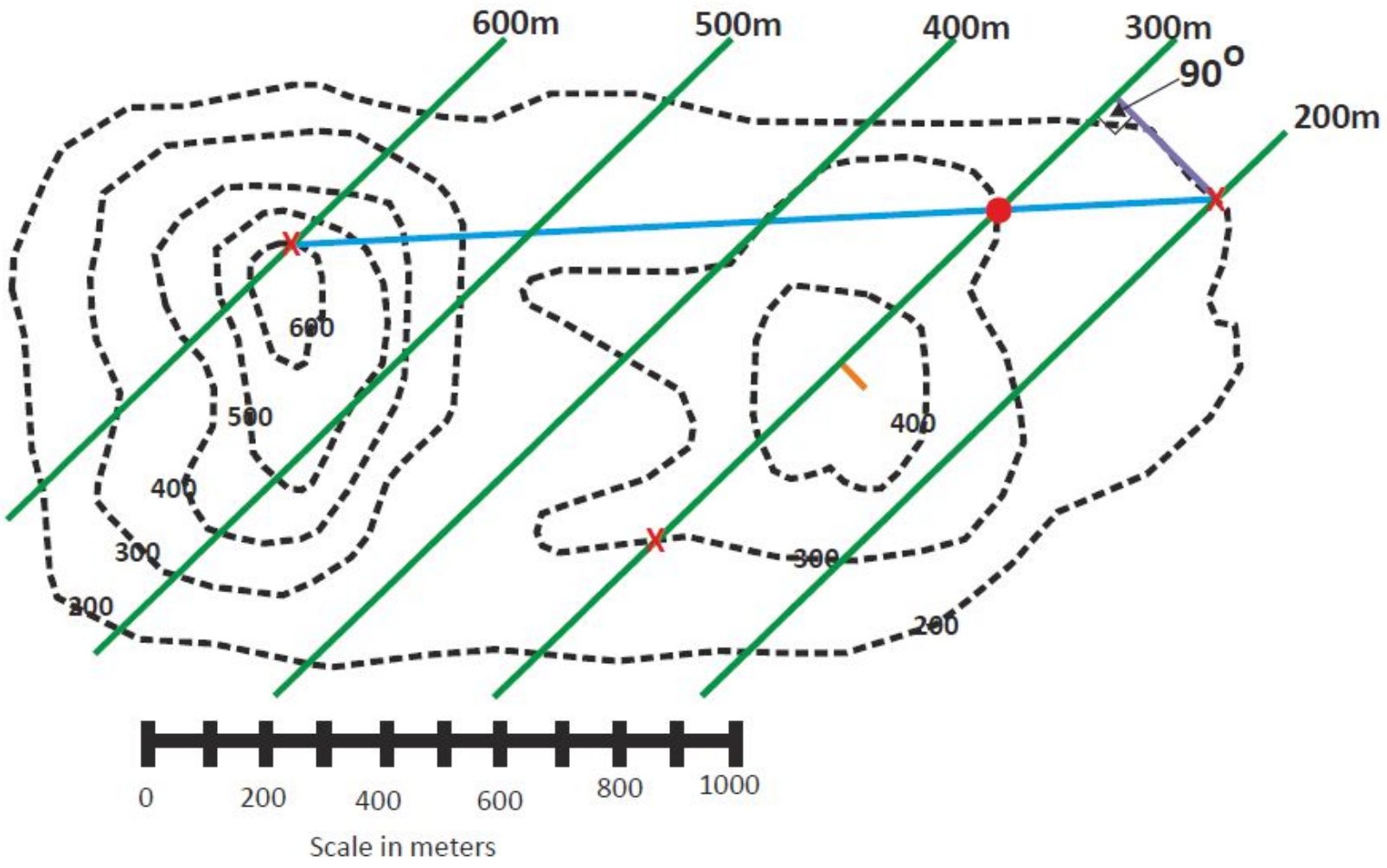


Tan(23°) = (100m/adj)
adj = (100m/tan(23°)) = 236m

The 3 point problem: Example

Step 5 continued:

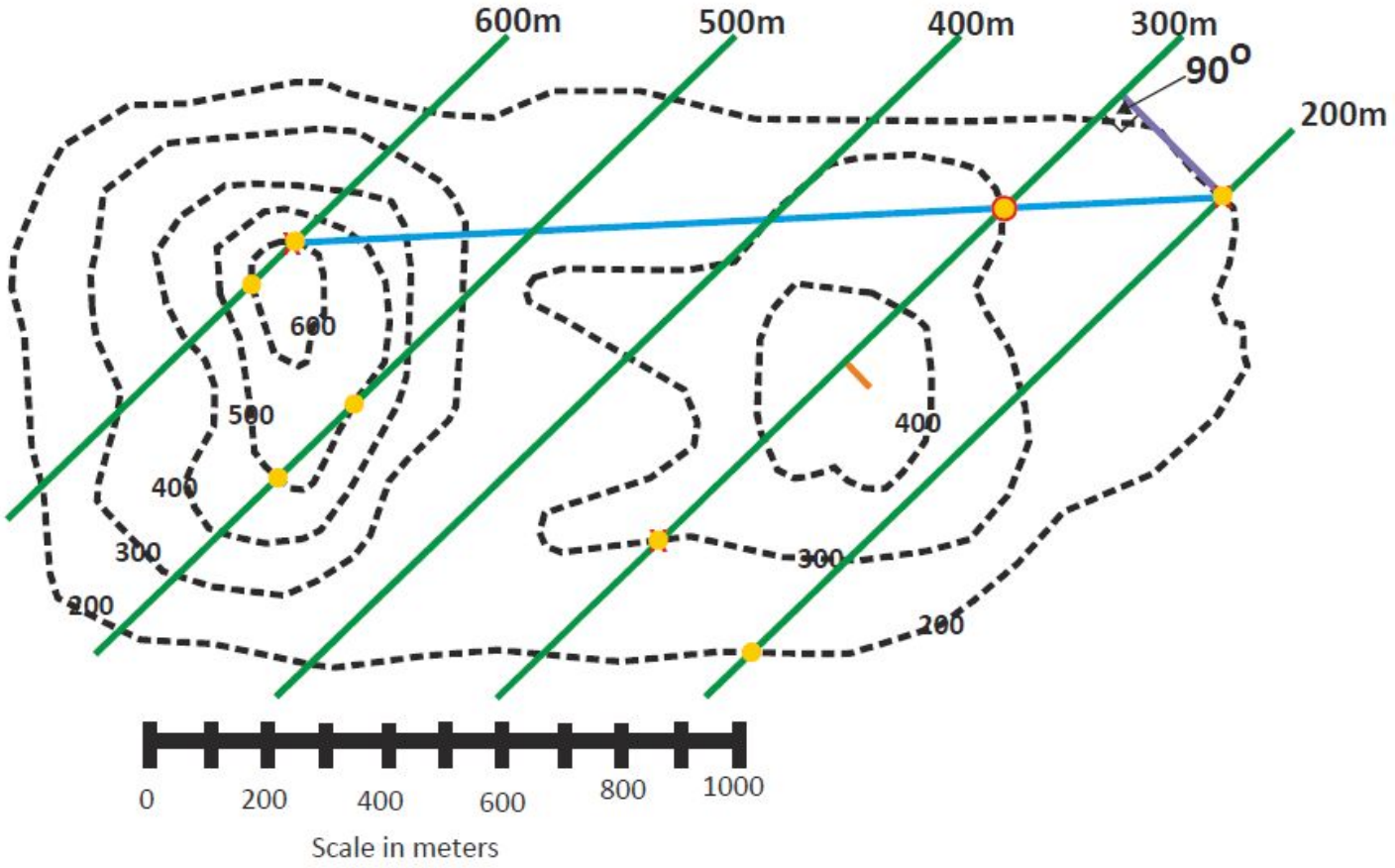
- Now draw in your structure contours.



The 3 point problem: Example

Step 5 continued:

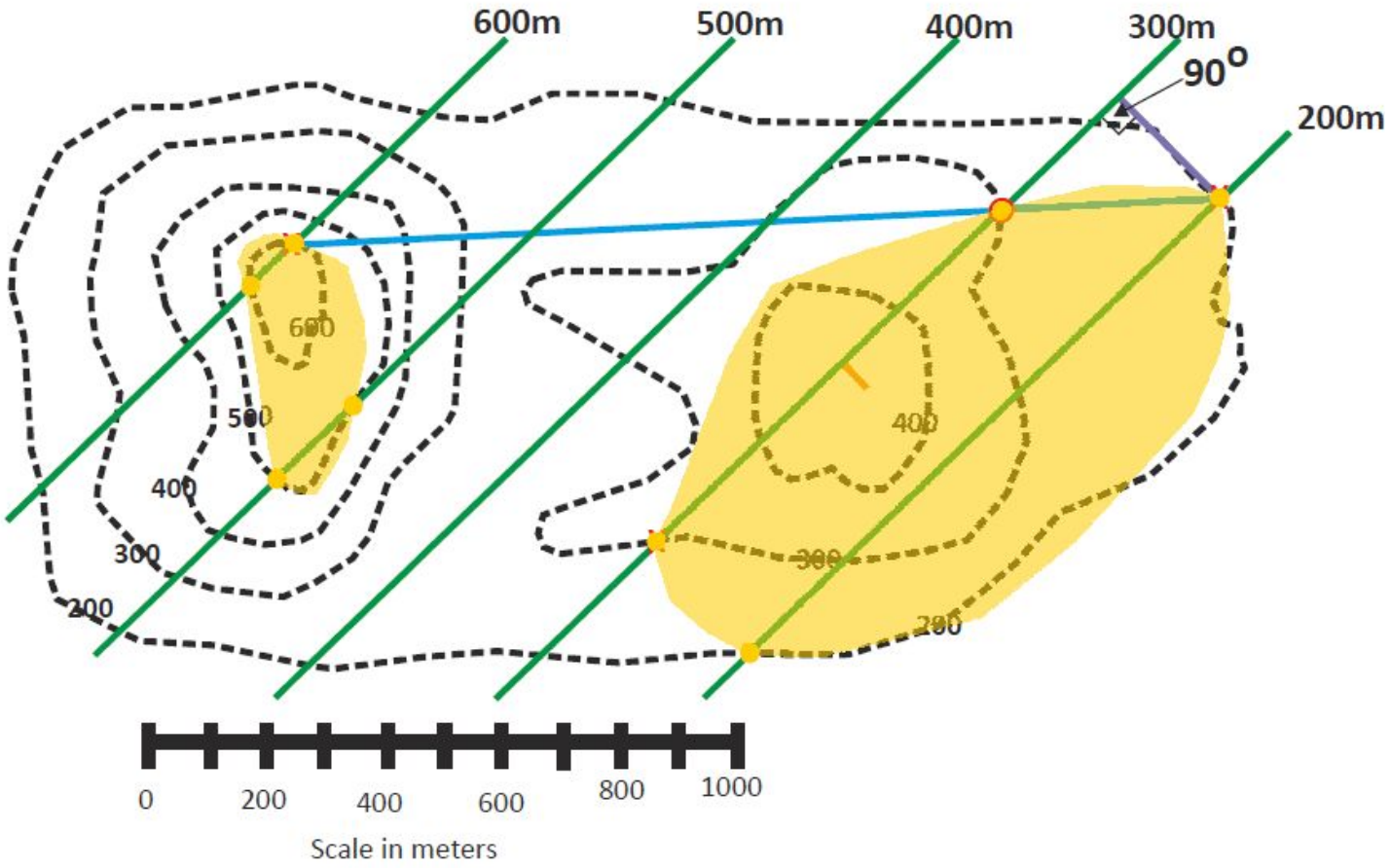
- After you've drawn in your structure contours (they should be evenly spaced), make a mark (the yellow dots) every time a structure contour crosses a topographic contour of the same value.



The 3 point problem: Example

Step 5 continued:

- Now roughly connect up your yellow dots and you have an estimated outcrop pattern!



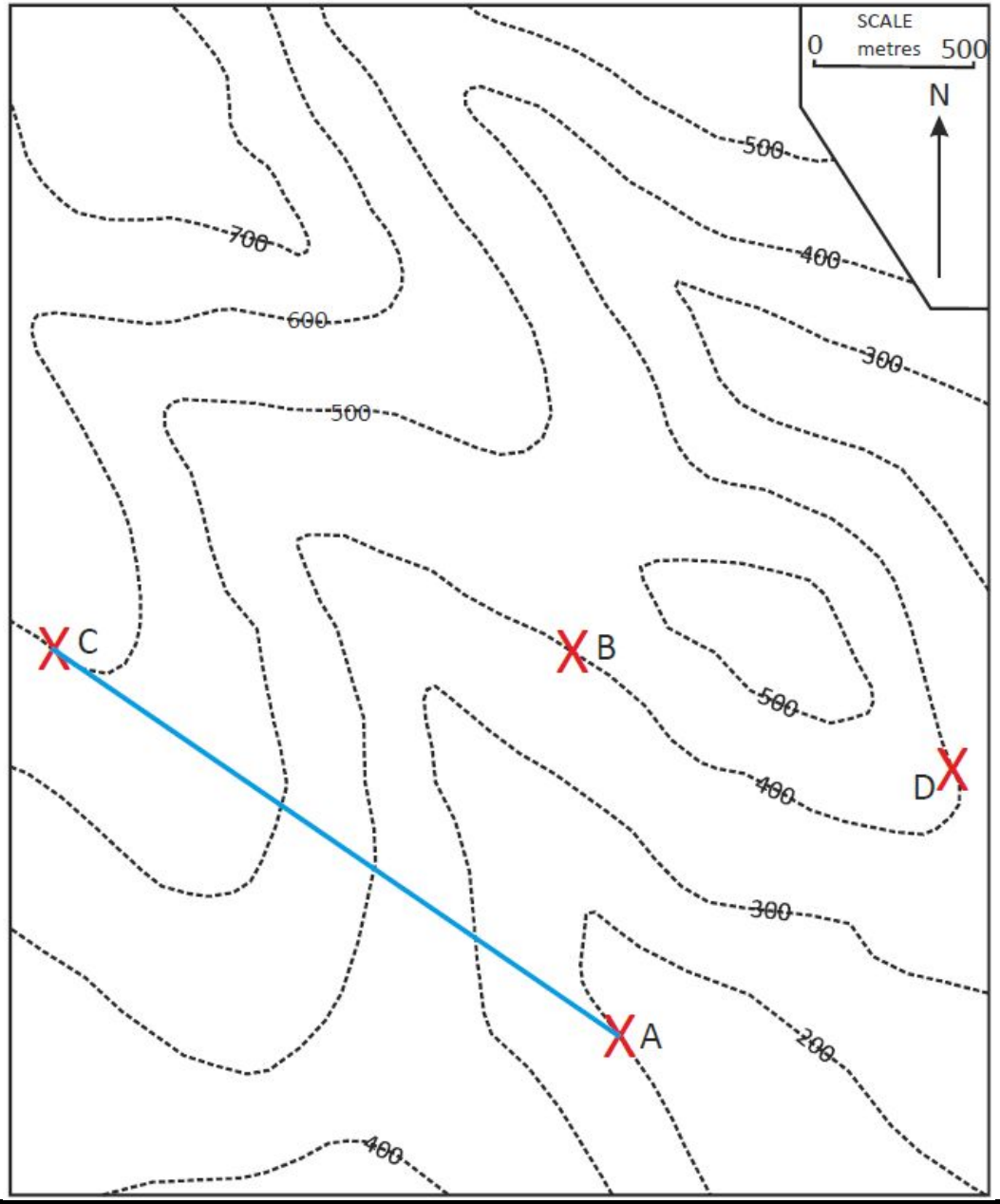
The 3 point problem: Problem

- Now have a go at the next problem by yourself, by filling in the problem map on exercise sheet 2.
- Then check your answers on the following slides.

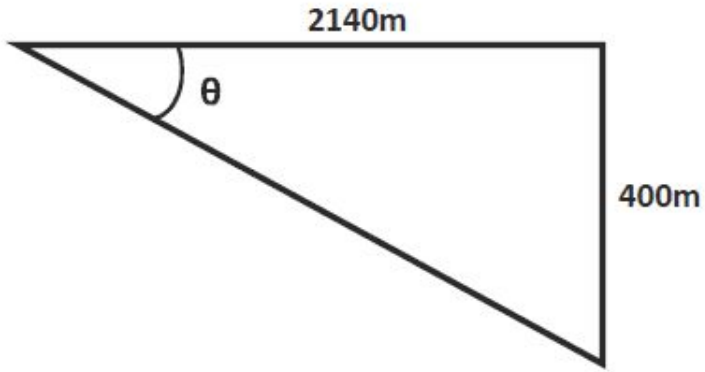
Questions

- Deduce the strike and dip of the coal seam which is seen to outcrop at points A, B and C.
- Fill in the outcrop pattern.
- At what depth would the coal be encountered in a borehole at D?

Step 1



Scale= 500m/2.5cm = 20m per mm;
Therefore distance from C to A = 107mm= 2140m



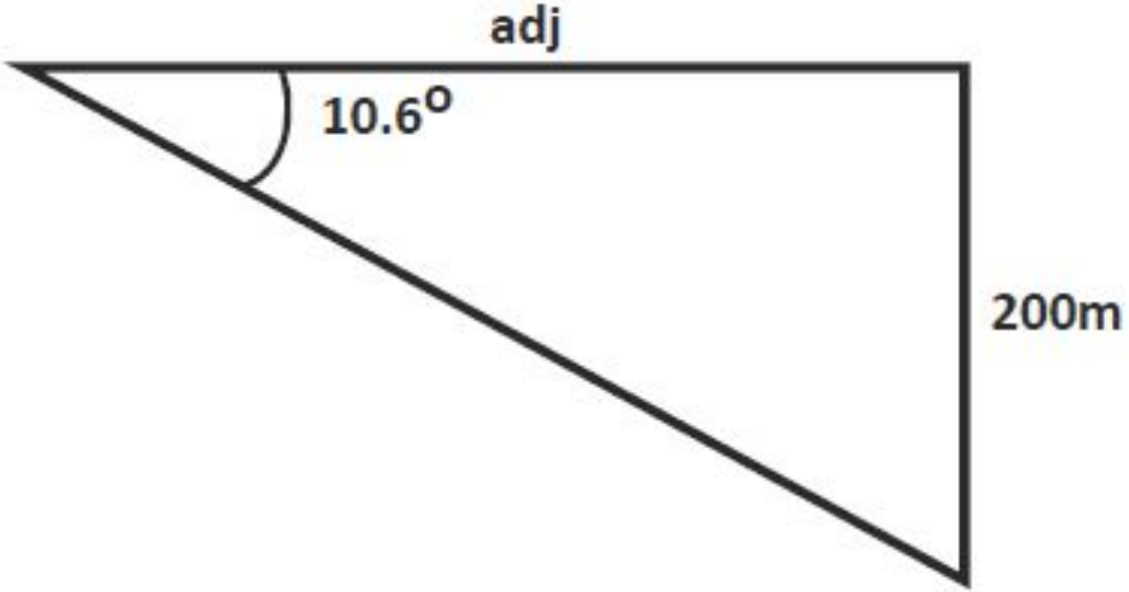
$\tan(\theta) = (\text{opp/adj})$

$\tan(\theta) = (400\text{m}/2140\text{m})$

$\tan^{-1}(400\text{m}/2140\text{m}) = \theta = 10.6°$

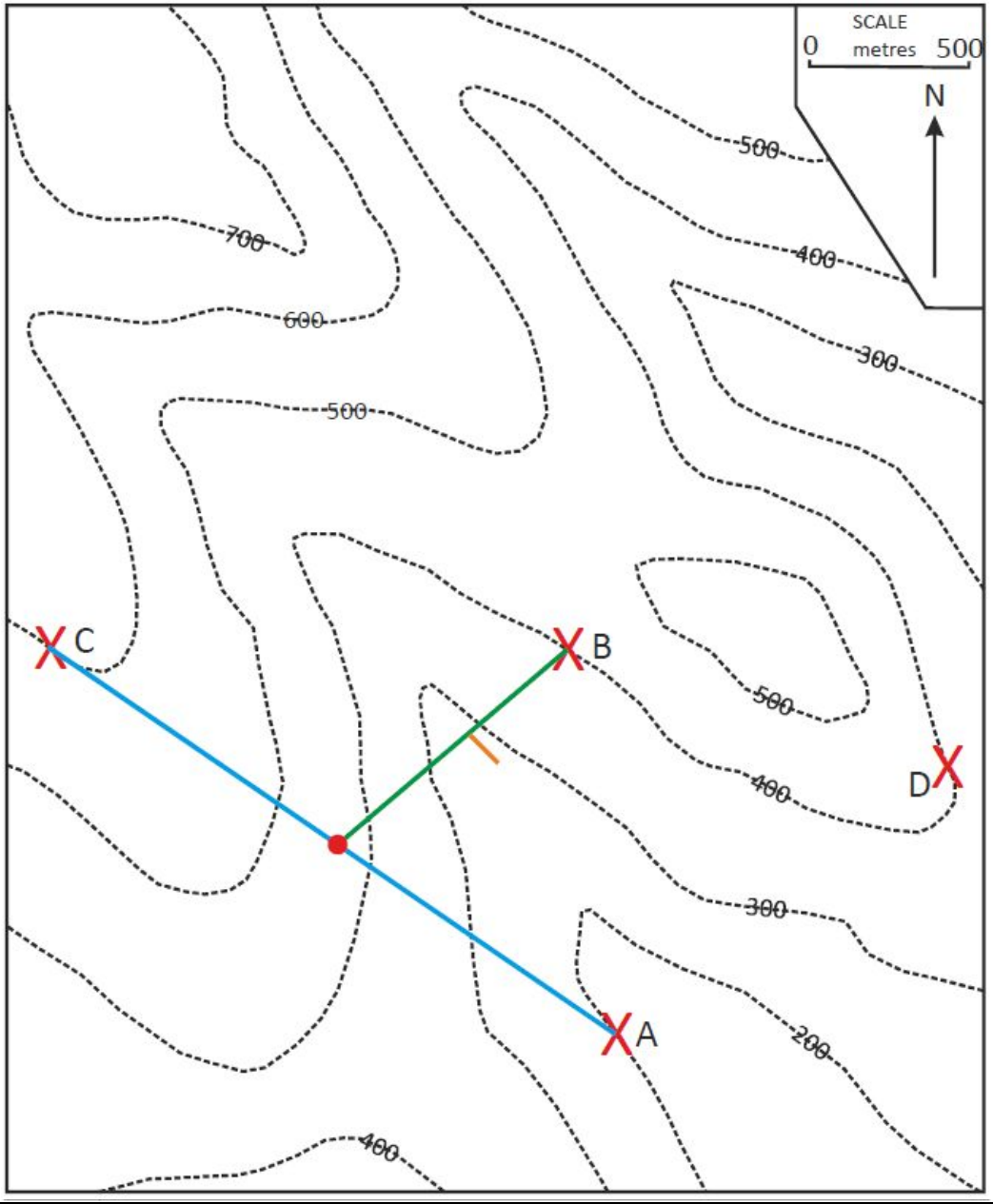
Apparent dip = **<u>10.6°</u>**

Step 2



tan(10.6°) = (200m/adj)
adj = (200m/tan(10.6°)) = **1069m**

Step 4


SCALE
0 metres 500
N
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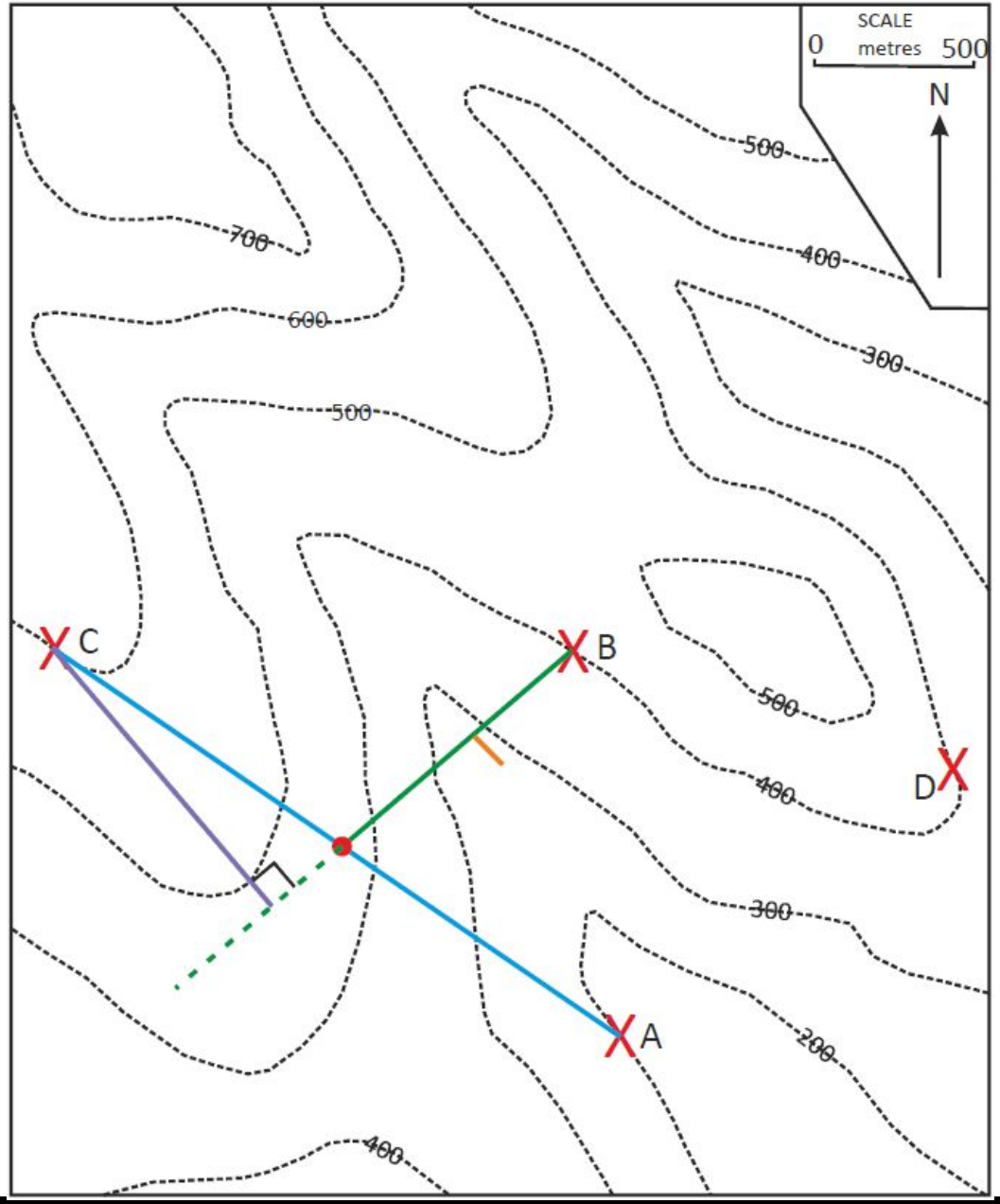
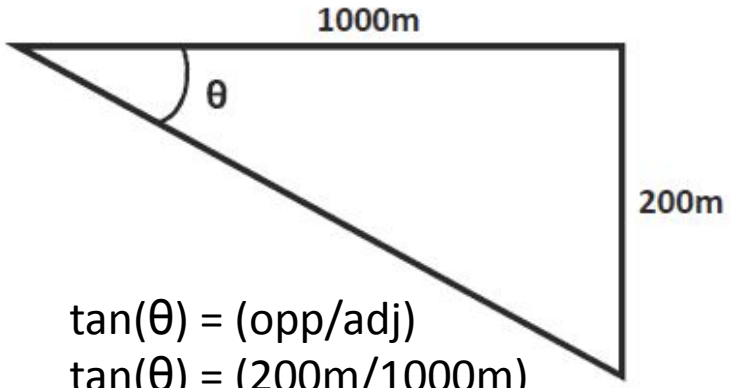
C
B
500
D
400
300
200
A
400



Step 5



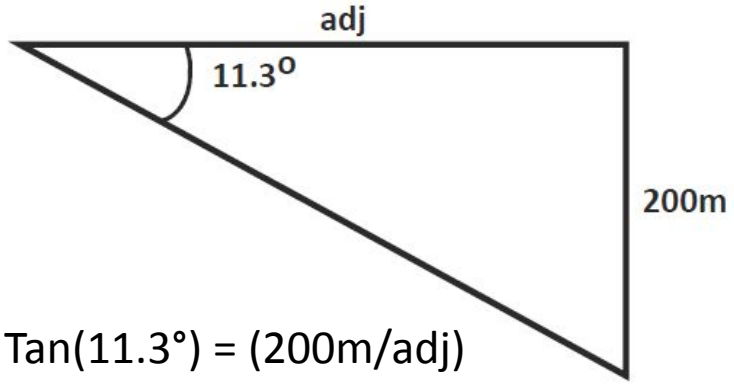
$\tan(\theta) = (\text{opp/adj})$

$\tan(\theta) = (200\text{m}/1000\text{m})$

$\tan^{-1}(200\text{m}/1000\text{m}) = \theta = 11.3°$

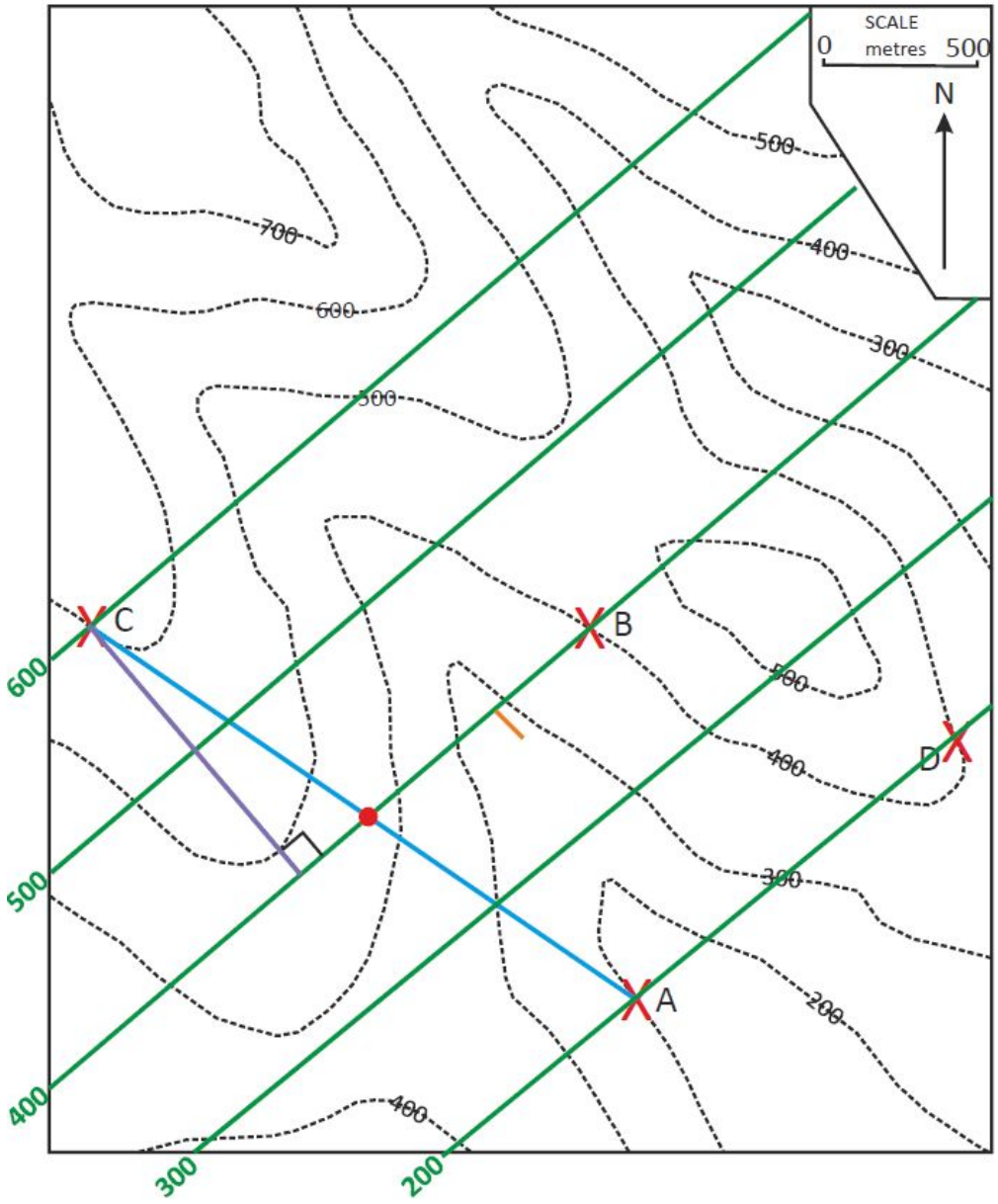
True dip= 11.3°

Then:



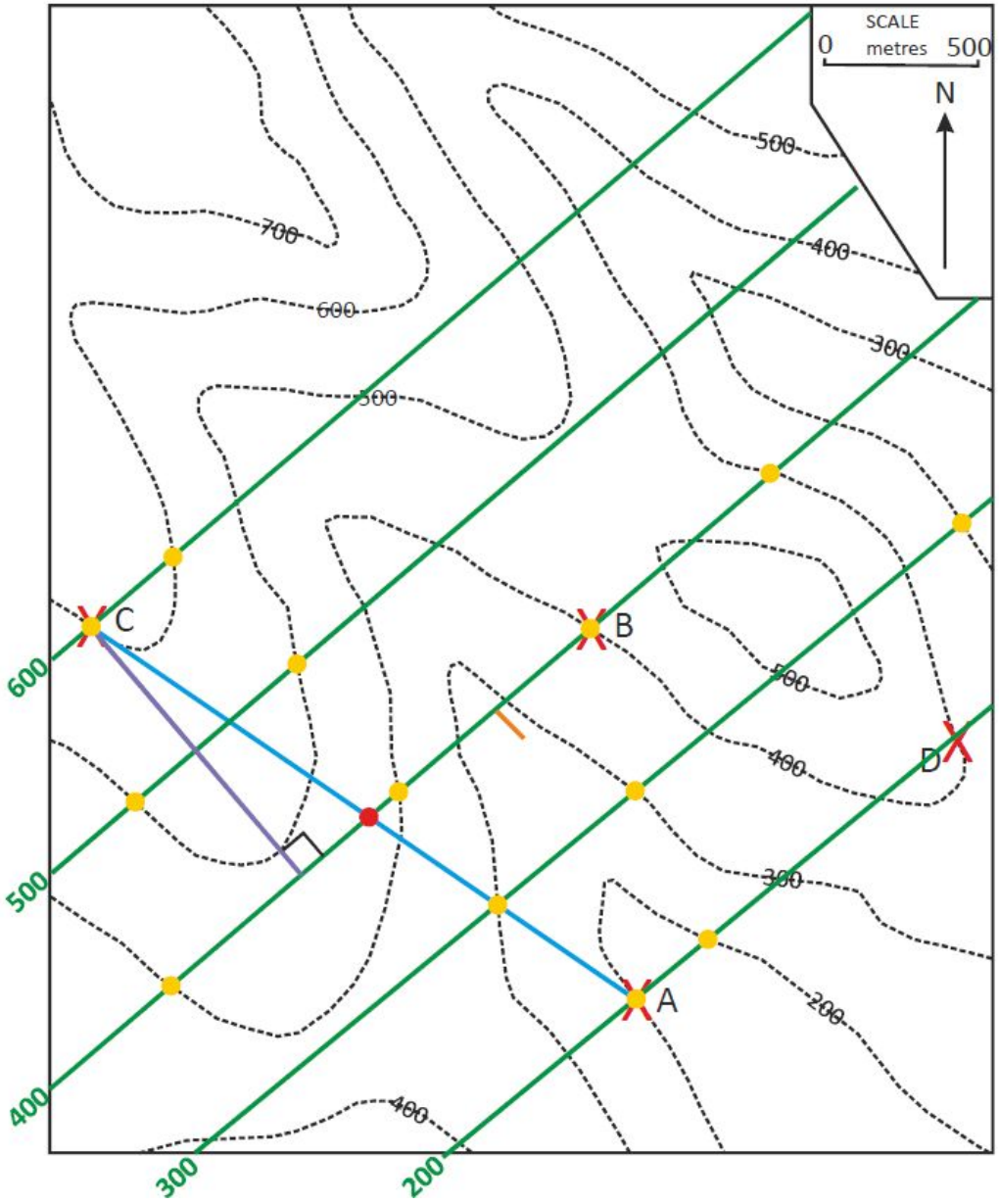
$\text{Tan}(11.3°) = (200\text{m}/\text{adj})$

$\text{adj} = (200\text{m}/\tan(11.3°)) = 1000\text{m}$



Step 5

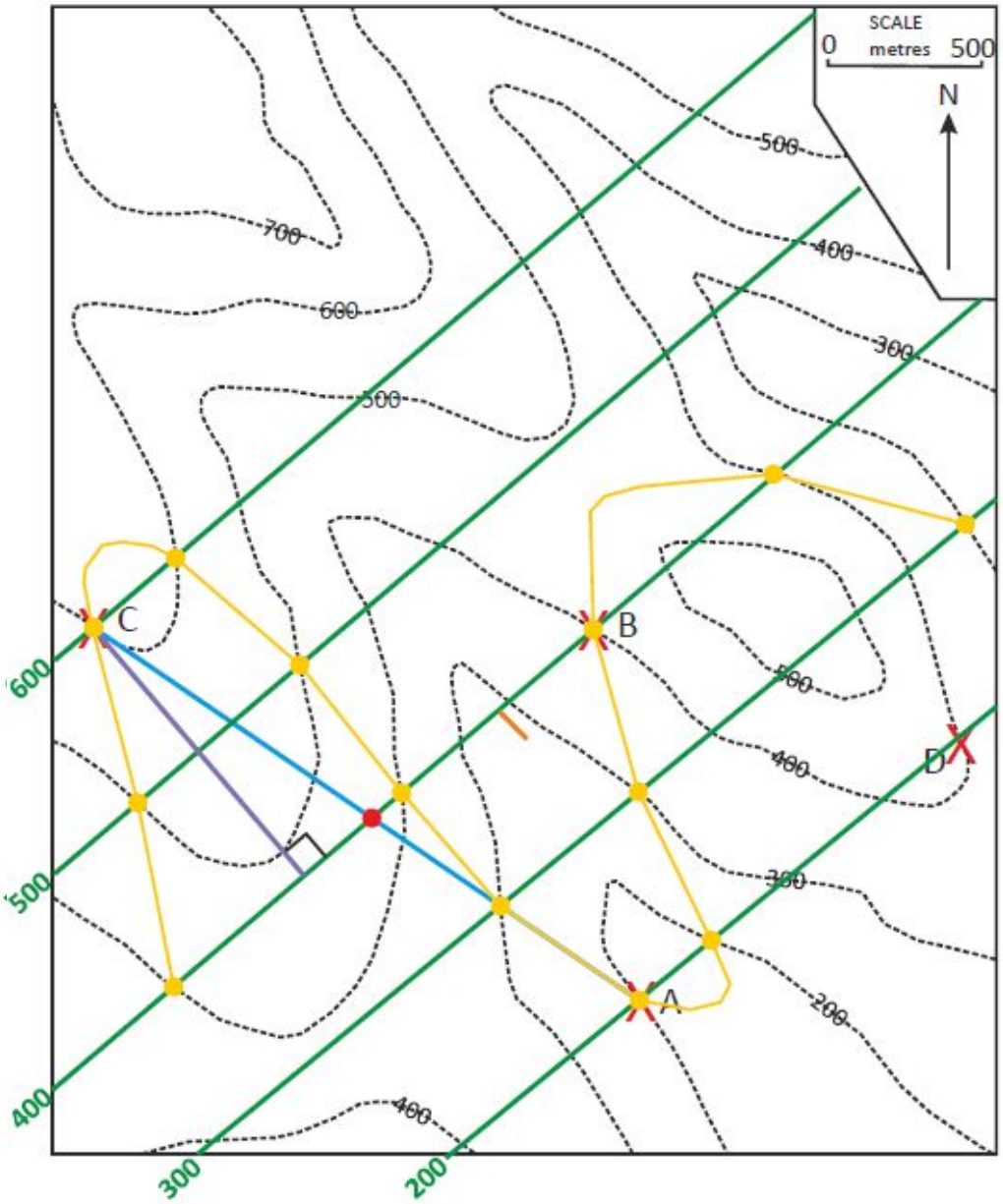
- Now draw in the structure contours.
- As the length of the opposite of the triangle was 200m this is the distance between the contours.
- Therefore halfway between each, add in the 100m contour intervals.



Step 5

- Now add in the areas the coal seam will outcrop at.

Step 5



- Now fill in the outcrop pattern (remembering your Law of "V's").

Questions

- *Deduce the dip and strike of the coal seam which is seen to outcrop at points A, B and C.*

  The **actual dip** was calculated in step 5 as: **11.3°**

  The **strike** is the orientation of the contour lines from North (use a compass or protractor to measure this, it is always the number less than 180. This is calculated as around: **049°**

  Therefore the strike/dip can be written as:

  049/11 SE

- *Fill in the outcrop pattern.*

  This was done in step 5.

- *At what depth would the coal be encountered in a borehole at D?*

  As location D is on/close to the 400m topographic contour and is also on the 200m structure contour, the depth that the coal seam would be encountered in a borehole is:

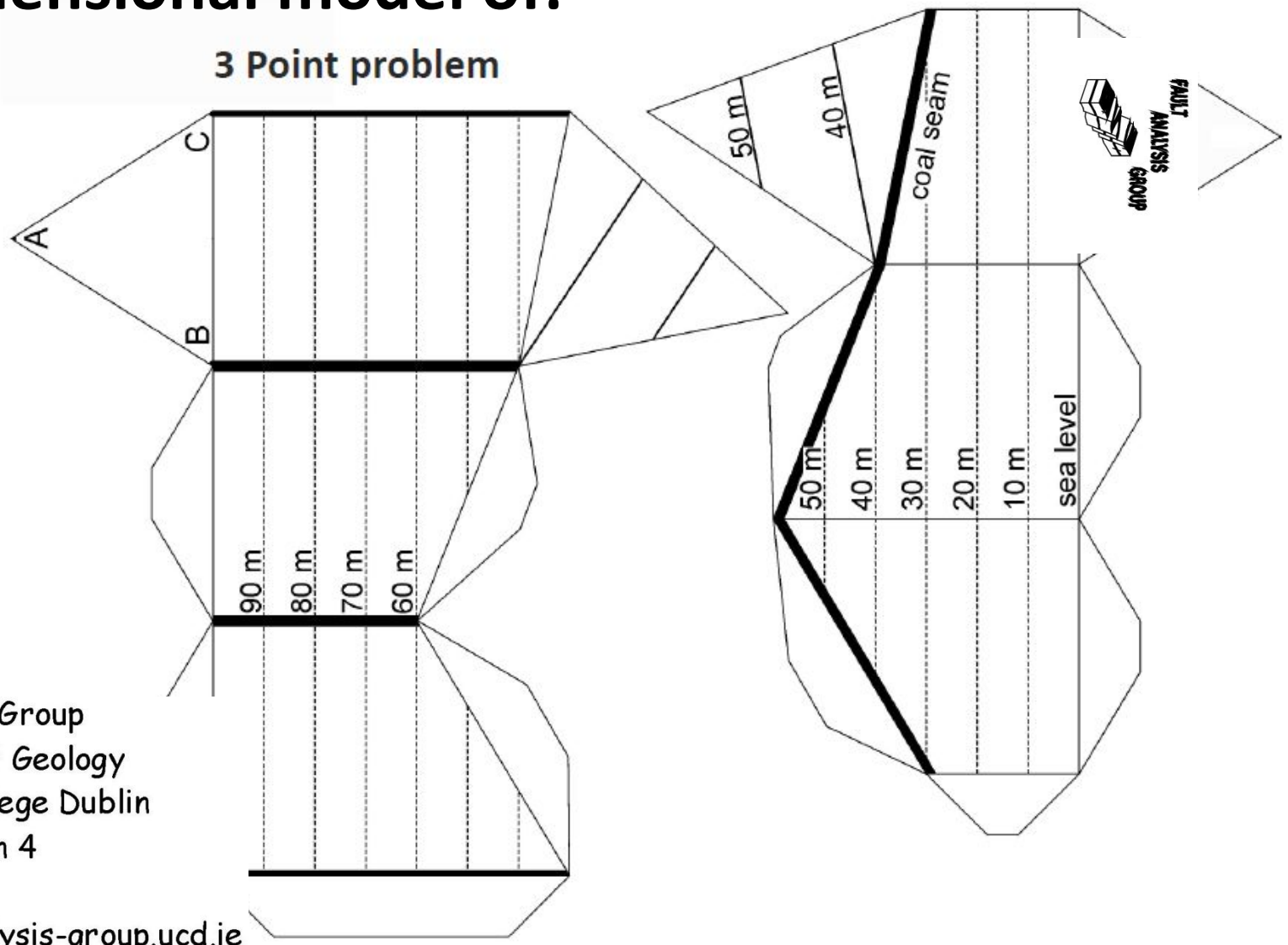
  400m-200m= **200m depth**

Summary

- We have now worked through how to find the direction of strike and calculate the dip (provided it is uniform), if the height of a bed is known at 3 or more locations, using the **3-point problem**.

- If you find this tricky to visualise, there is a 3 dimensional model that can be constructed. This can be found at the back of the worksheet for exercise 2 and on the following slide.

3 dimensional model of:



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