



Pitch Perfect

This activity uses simple mathematics to determine how level your pitch is whilst getting outside and hands on with levelling equipment

🕒 30 – 50 mins

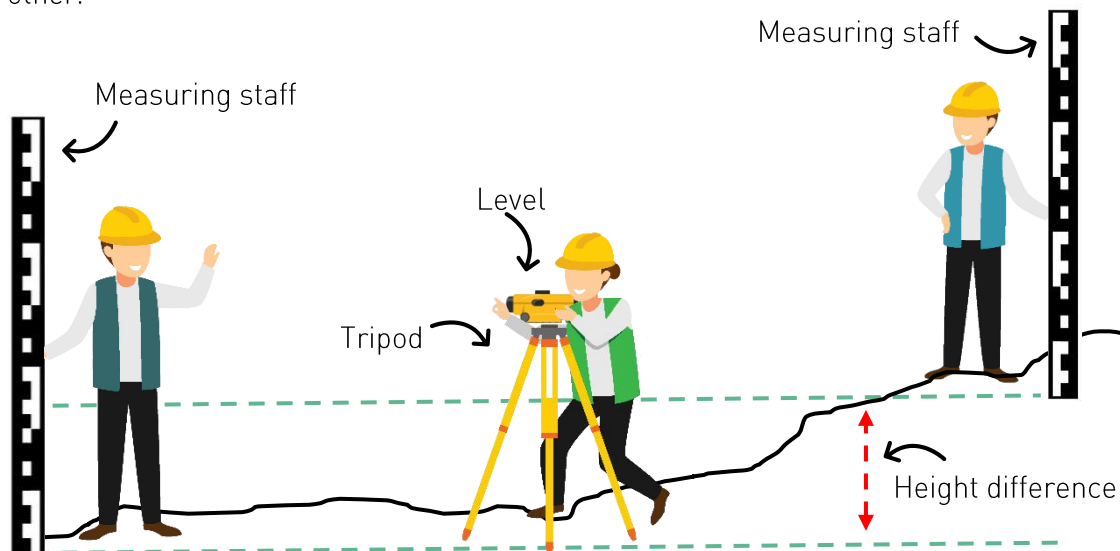
Introduction

This practical will guide students through using levelling equipment to gain the changes in height from one end of a pitch to the other.

What is levelling?

Levelling is the process of determining the difference in height between two points.

A surveyor measures the height from one point and then will rotate to measure the height from the next point. Then they calculate the difference in height by subtracting one from the other.



Why do we need levelling?

Levelling is an important method in surveying. We need it for:

- Finding out which way water flows to prevent flooding.
- Ensuring the ground is flat before building a house.
- Putting contours on a map.
- Finding the depth of a riverbed.
- Monitoring any change or movement in a dam, bridge, or volcano.

Learning Outcomes

In this practical, students will learn how to:

- Set up levelling equipment: level, tripod, measuring staff and change plate
- Use levelling equipment
- Record measurements and improve notetaking
- Conduct maths calculations to gain height information
- Plot height and distances on a graph
- Communicate as a team

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Section 1: Setting Up the Equipment

If you require levelling equipment, please book our Pitch Perfect workshop at:
<https://stem.ncl.ac.uk/workshops/pitch-perfect/>.

1.1. What You Will Need

Level



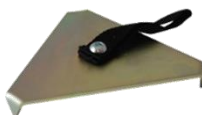
Tripod



Measuring Staff



Change Plate



Pencil



Calculator



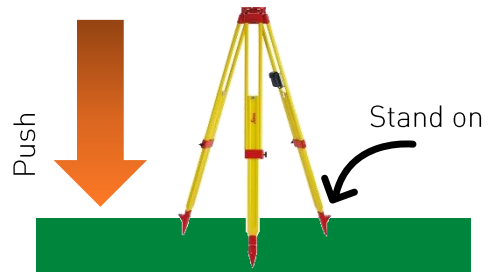
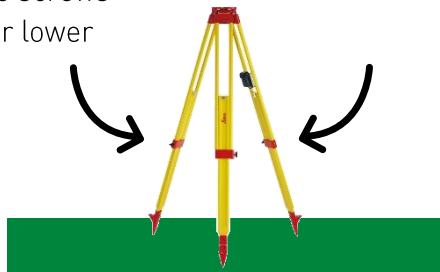
Table for recording information (you can use the table on Page 10)

Staff Position	Backsight (BS)	Foresight (FS)	Difference (BS - FS)	Height
1				100.000 m
2				
3				
4				
Totals				

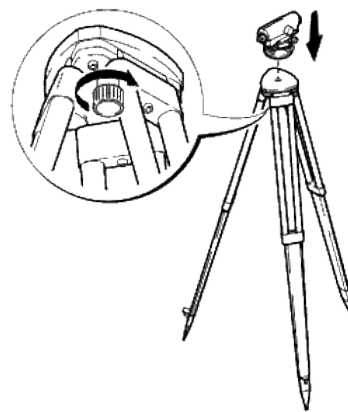
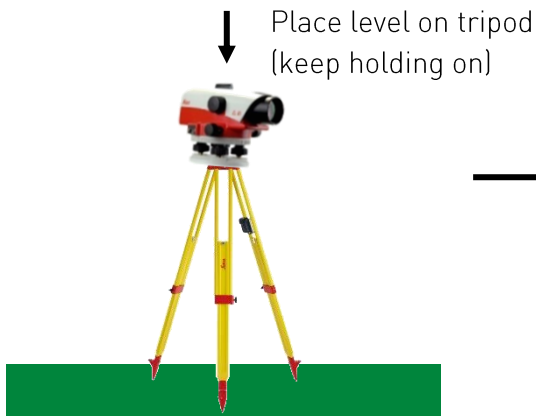
1.2. How to Set Up

- Set up the tripod and make sure that it reaches chest height by extending the tripod legs. Then push the legs into the ground by standing on the feet.

Use these screws to raise or lower each leg



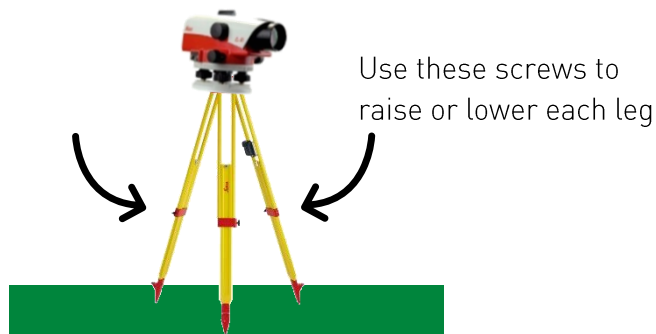
- Screw the level to the top of the tripod (the baseplate), making sure that it is firmly screwed on before letting go.



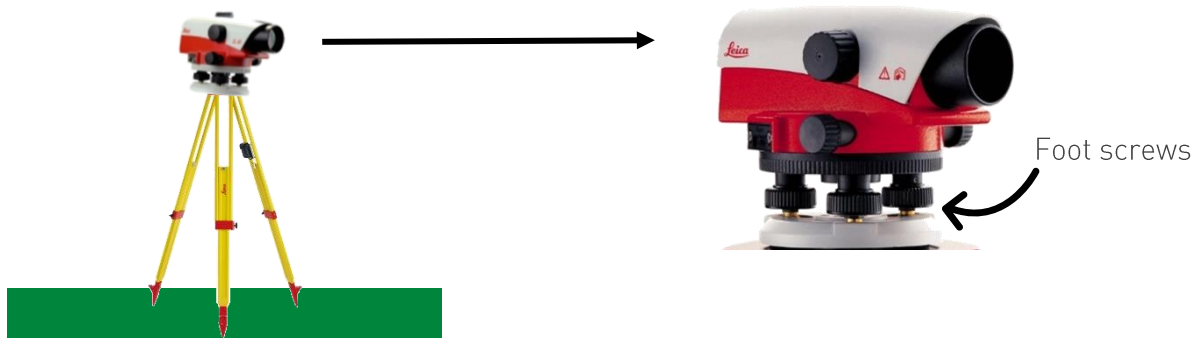
Reach from below the tripod to find the screw

While holding the level, screw it into place

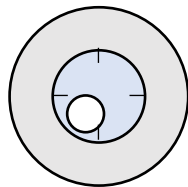
- Adjust the tripod legs to make the bubble (on the side of the level) roughly centred.



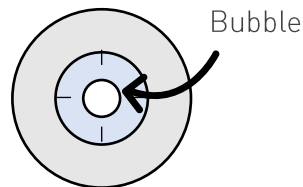
- d. Turn the foot screws on the base of the level to get the bubble exactly centred. This may take a bit of time, but it is an essential step before moving on!



Not centred



Centred

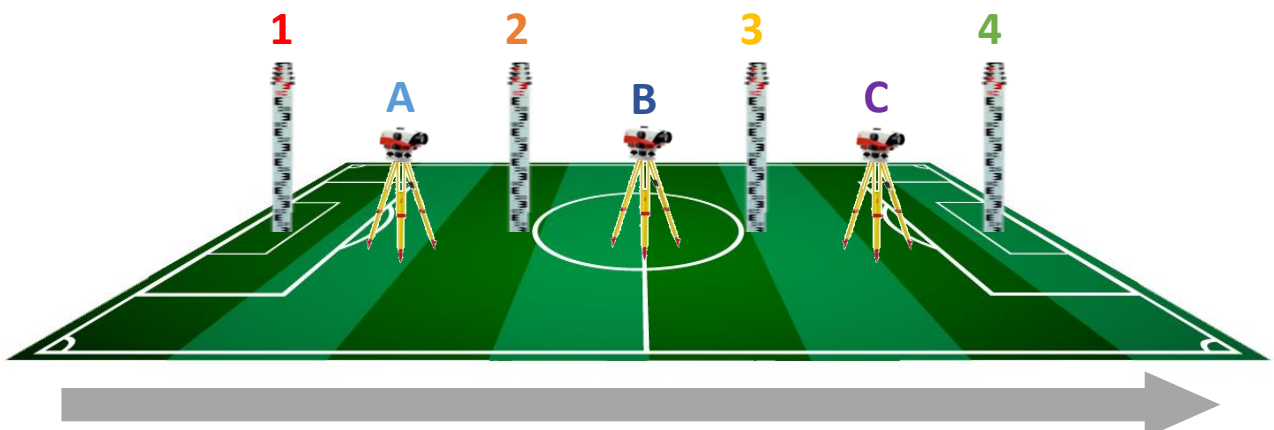


Section 2: What to Do

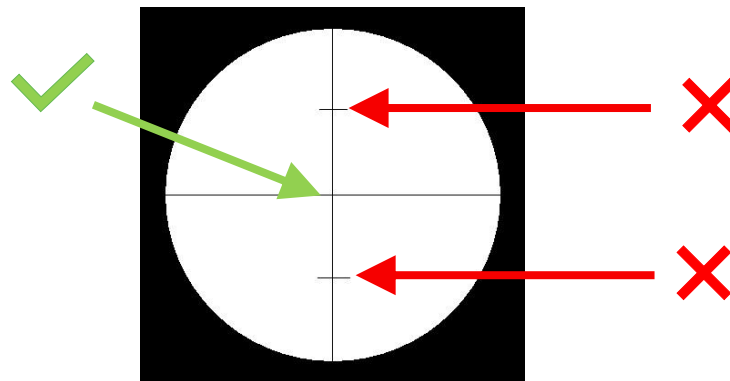
This section will explain what you must do step by step. Please read this section first before starting the exercise yourself.

2.1. Step by Step

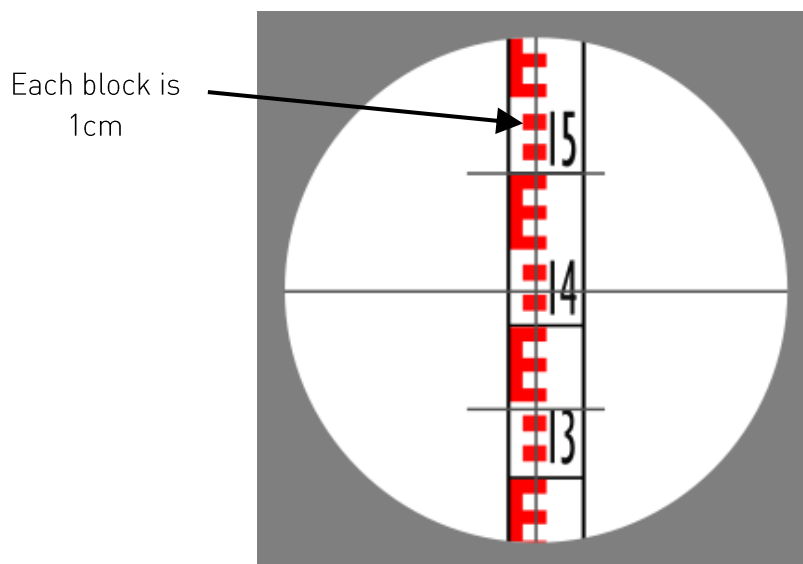
- Today, we are going to find out if your pitch is perfect! We're going to use levelling to find out if your pitch is really flat.
- To do this, we are going to **traverse** across the pitch, taking measurements at certain points along the way.



- c. You will need to work in groups of at least 3.
- d. Set up your tripod and level at [Station A](#).
- e. Another person in your team should stand at [Point 1](#), holding the measuring staff.
- f. Look through the level at the measuring staff. Read the staff where the two long lines meet in the centre.



- g. On the measuring staff, each block is one centimetre. Since we want to measure to the nearest millimetre (three decimal places), we must estimate. In the following example, try to figure out the correct reading:



Answer: 1.422 m

- h. The person holding the staff should rock it slowly back and forth. The person looking through the level should write down the lowest value they read.

- i. Once you have taken a reading from **Station A** to **Point 1**, write your answer in the table provided on Page 10. This measurement is called the '**backsight**' because it is the first staff reading after the levelling instrument has been set up.
- j. Now the person holding the measuring staff should move to **Point 2**. They should set the **change plate** down before resting the measuring staff on it. It is very important that the tripod and level **DO NOT MOVE** at this stage.
- k. Look through the level at **Station A** to **Point 2** and write your measurement in the table. This measurement is called the '**foresight**' because it is a reading looking "forward" along the line of progress.
- l. To calculate the difference in height between **Point 1** and **Point 2**, subtract the foresight from the backsight. Then record this number in the table.
- m. Next, keep the measuring staff at **Point 2** but move the tripod and level to **Station B**. It is very important that the measuring staff **DOES NOT MOVE** at this stage.
- n. Look through the level at **Station B** to **Point 2** and write your measurement in the table. This will now be your 'backsight'.
- o. Now the person holding the measuring staff should move to **Point 3**. They should set the **change plate** down before resting the measuring staff on it. It is very important that the tripod and level **DO NOT MOVE** at this stage.
- p. Look through the level at **Station B** to **Point 3** and write your measurement in the table. This measurement will be your 'foresight'.
- q. To calculate the difference in height between **Point 2** and **Point 3**, subtract the foresight from the backsight. Then record this number in the table.
- r. Next, keep the measuring staff at **Point 3** but move the tripod and level to **Station C**. It is very important that the measuring staff **DOES NOT MOVE** at this stage.
- s. Look through the level at **Station C** to **Point 3** and write your measurement in the table. This will now be your 'backsight'.
- t. Now the person holding the measuring staff should move to **Point 4**. They should set the **change plate** down before resting the measuring staff on it. It is very important that the tripod and level **DO NOT MOVE** at this stage.
- u. Look through the level at **Station C** to **Point 4** and write your measurement in the table. This measurement will be your 'foresight'.
- v. To calculate the difference in height between **Point 3** and **Point 4**, subtract the foresight from the backsight. Then record this number in the table.

- w. Now it's time for some calculations! Calculate all the totals in the 'Totals' row. Don't fill out the dark grey boxes.

Staff Position	Backsight (BS)	Foresight (FS)	Difference (BS – FS)	Height
1	<i>Observation 1</i>			<i>100.000 m</i>
2	<i>Observation 3</i>	<i>Observation 2</i>	<i>Obs 1 – Obs 2</i>	<i>Last Height - Diff 1</i>
3	<i>Observation 5</i>	<i>Observation 4</i>	<i>Obs 3 – Obs 4</i>	<i>Last Height - Diff 2</i>
4		<i>Observation 6</i>	<i>Obs 5 – Obs 6</i>	<i>Last Height - Diff 3</i>
Totals	<i>Total backsight</i>	<i>Total foresight</i>	<i>Total difference</i>	<i>Last Height – First Height</i>

- x. The number in the 'Last Height – First Height' box is the difference in height between the two ends of the pitch, e.g., Point 1 to Point 4.

Section 3: Your Turn

Use the table below to fill out your findings.

3.1. Fill in this Table

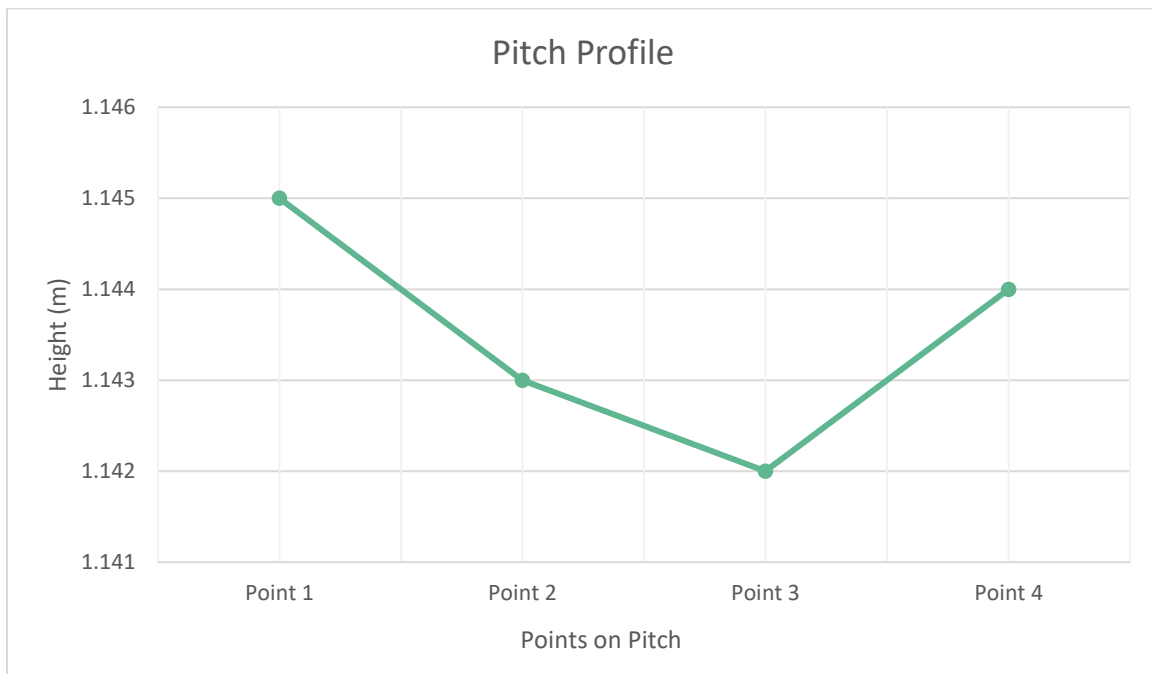
Staff Position	Backsight (BS)	Foresight (FS)	Difference (BS – FS)	Height
1				<i>100.000 m</i>
2				
3				
4				
Totals				

Section 4: Plotting a Profile

We can now use your calculations to create a profile of the pitch. This will make it easier to visualise.

4.1. Add Your Data

- Use the graph paper on the next page to add your own data to show how the height of the pitch changed at each point.
- Your profile should look something similar to the one below.
- Make sure to label your graph!



- Whilst this may look like a big change on the graph, remember the pitch you measured is very long so the differences even out at such lengths.



Section 5: Summary

In this activity, you have learned how to use levelling equipment and mathematics to determine how level your pitch is. You have then converted these measurements into a graphical format – demonstrating the importance of visualising information.

The levelling method you have learned is used in a number of different jobs:



Land Surveyors measure, survey, monitor and map the shape of the land very accurately for instance for construction projects.



£20,000 – £70,000



Building Surveyors measure and map the inside and outside buildings, then advises clients about the design, construction, maintenance and repair of buildings.



£19,000 – £70,000



Cartographers design and prepare maps, plans, charts, models and globes that represent the surface of the Earth.



£18,000 – £47,000

This concludes the exercise.



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