Using A Level

The level is an instrument that allows us to measure the height of a feature or a spot. To use it, you will need two people, one to place the measuring staff on the feature and the other to make and record the reading through the sight.

Setting up the level

In order to work correctly, the level needs to be horizontal to the ground (or level). Note that this is the fiddly bit, once you've mastered the technique, everything else is straight-forward.

The procedure for setting up the level is as follows:

1. Set up the tri-pod in a convenient place, and so that it's mounting plate is at a comfortable height for you to look through the level.
2. Ensure that the mounting plate is reasonably level – either by eye or by using a small spirit level
3. Clamp the level onto the mounting plate using the large threaded bolt held in place under the tripod mounting plate. The level itself is mounted on a Tri-Bach, which has 3 adjustment knobs which allow you to make fine adjustments to the level. Align the 3 knobs so that they are over the 3 corners of the mounting plate.
4. There is bubble spirit level to the left hand side of the eye-sight (if you're looking through the sight). The instrument is level if the bubble is in the middle of the circle.
5. If the tri-pod allows, adjust the length of the legs until the bubble is in the centre of the circle. Note that if the bubble is to one side of the circle, moving the opposite leg will make it move. When you are satisfied, make sure that the tri-pod feet are firmly in the ground.
6. Align the level so that it is pointing away from one corner of the mounting plate and try to adjust the tri-bach knobs so that the bubble is in the centre. Again, adjusting the knob on the opposite side of the circle to the bubble will move it.
7. To be certain that you have got the instrument level, rotate it to align with the other 2 corners and adjust the tri-bach knobs if necessary.

Taking a reading

To take a spot level reading, one member of the levelling team needs to hold the measuring staff on top of the spot, whilst another member aligns the sight on the level with the staff and notes the number on the staff where the centre cross wire cuts across the staff. The staff needs to be as upright and straight as possible in order to get an accurate reading, so the team needs to develop a sign language to indicate how the staff should be adjusted, and to indicate when the reading has been noted.

The level sight may also need to be adjusted in order that:

- The operator can see the cross wires – focus ring on the eye-piece
- The operator can see the staff – use the gun sight to align the eye piece with the staff
- The staff is in focus – use the focus knob to adjust

The measurements you make will be based on the site datum point, which ideally should have an above sea level height levelled in from an OS datum (see the section on setting up a datum).

Some Technical Terms

In the literature, you will see the following technical terms:

Collimation level – This is the actual height above sea level of the level's cross wires (Collimation because we are using a monocular column based optical system, otherwise known as a telescope).

Back-sight – This is a reading made from a reference height point to attain the collimation level. A back-sight reading is **added** to the reference height to obtain the collimation height.

Fore-sight – This is a reading made to get a specific spot level based on the collimation height of the instrument. A foresight reading is **subtracted** from the collimation level in order to get the actual height of the spot above sea level.

Initial Setup

The first measurement you should make is the height of the instrument relative to the datum. To do this take a level placing the staff on the datum point and make a note of the reading. Adding the staff reading to the datum point's height will give the height of the level above sea level. The technical term for this measurement is the **collimation** level. The level is now calibrated and any further spot height readings made from this position can be referenced to the site datum. If the level is moved, or set-up again, then this process must be repeated.

For instance:

If the site datum is 250 M above sea level and the level measured with the staff at the datum point is 1.53 M, then the cross wire of the level sight is at 250 + 1.53 M = 251.53 M above sea level. The 251.53 M level should be noted, since all other readings made will be relative to this level when the instrument is in this position.

When other spot height readings are made around the site, the reading made from the staff should be subtracted from the collimation level to get the actual level of the spot height.

For instance:

Assuming that the collimation level is 251.53 M, and that the reading on the staff at the spot height is 2.68 M, then the level of the spot is 251.53 – 2.68 M = 248.85 M.

Using the level form

In order to keep a record of levels taken on-site, and also to make it easier to work out the spot heights we use a form:

Datum Height	*352·16*			
Back-sight	*1·23*			
Collimation level	*353·39*			
For-sight	**Spot level**	**Plan id**	**Spot id**	**Comment**
1·57	*353·39 - 1·57 = 351·82*	*UN001*	*6*	*NE Pier 1 corner*
2·32	*353·39 – 2·32 = 351·07*	*UN001*	*7*	*SE Pier 1 corner*
5·34	*353·39 – 5·34 = 348·05*	*UN002*	*1*	*Mixing Floor level*

Setting Up A Datum

Check the locality for an OS benchmark. They are often to be found on the sides of Churches, stone bridges etc and they are usually marked on the larger scale OS maps. If there is one within a reasonable distance from the site, then it should be used. Otherwise, all the readings will have to be made from an arbitrary datum, which is good enough for most practical purposes.

The datum should either be the top of a stake driven into the ground at a convenient place on the site, or some other convenient fixed point, for instance the top of a fence post or a place on top of a wall. Remember that it will be important to find the datum again. If you drive a stake in the ground, write its height above sea level on the sides of the stake.

If you have a convenient OS benchmark, you will have to perform a traverse with the level to your datum point. At the start of the traverse, set up the level and measure its collimation level using a backsight to the benchmark using the staff. Then the person with the staff should move to a point closer to the desired site of the datum and a foresight reading should be taken for the new staff position. Then the level is moved to a point between the staff and the final datum and a new back-sight reading taken. The staff is then moved and a new fore-sight measurement taken. The process repeats itself until the datum point is reached.

The easiest way to calculate the datum height is to add up all the back-sight readings and add them to the benchmark height, then subtract the sum of all of the fore-sight readings to get the actual datum height. To make this easier we use a form to keep track of the readings:

Example Traverse		
Benchmark Level: *150 M*	Back-sight readings	Fore-sight readings
	3·18	*1·29*
	2·67	*1·52*
	1·15	*1·54*
	2·95	*3·75*
Totals	*9·95*	*8·1*
Spot height at datum	*150 + 9·95 – 8·1 M = 151·85 M*	

Other references:

http://www.levelling.uhi.ac.uk/index.html