

Temperature and relative humidity

The Stevenson Screen houses the thermometers that measure the ambient air temperature. The screen protects them from direct or reflected sunlight but allows air to flow through.

Relative humidity is a derived value calculated using temperature measurements.



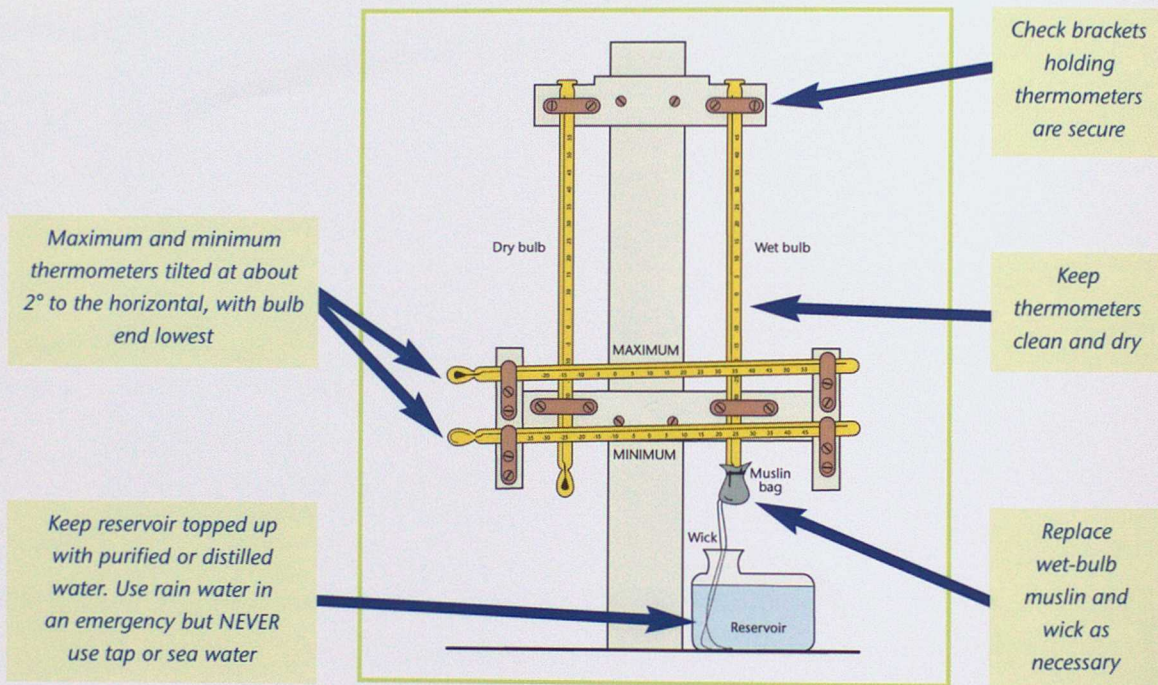
Check fastenings that hold the screen

A typical Stevenson Screen (new screens are made of plastic and painted black inside)

Wash regularly, clean out dust, snow, etc. from louvres; keep painted white and prevent rot

Don't leave objects, such as bottles, in the screen, as airflow is affected

Make sure screen door closes without being banged



Typical thermometer mount inside climate station screen

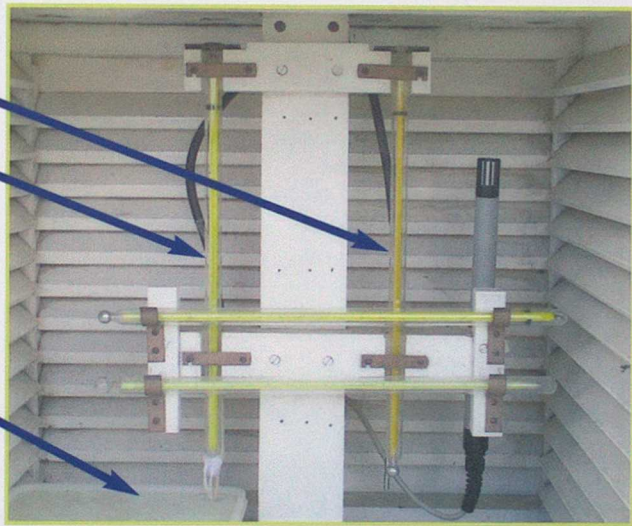
Step 1 Read dry bulb.

Step 2 Read wet bulb.

Step 3 Read maximum and minimum, if required, then reset. (Check for bubbles in minimum – see page 11 to reset.)

Step 4 Top up water reservoir.

- ✓ Make sure the maximum and minimum temperatures are close to the dry-bulb temperature once reset.
- ✓ Note your readings quickly because your body heat could affect the temperatures, especially in cold weather.
- ✓ In fog or high humidity, water drops may collect on the dry bulb. Remove with a clean tissue a few minutes before reading the temperature.

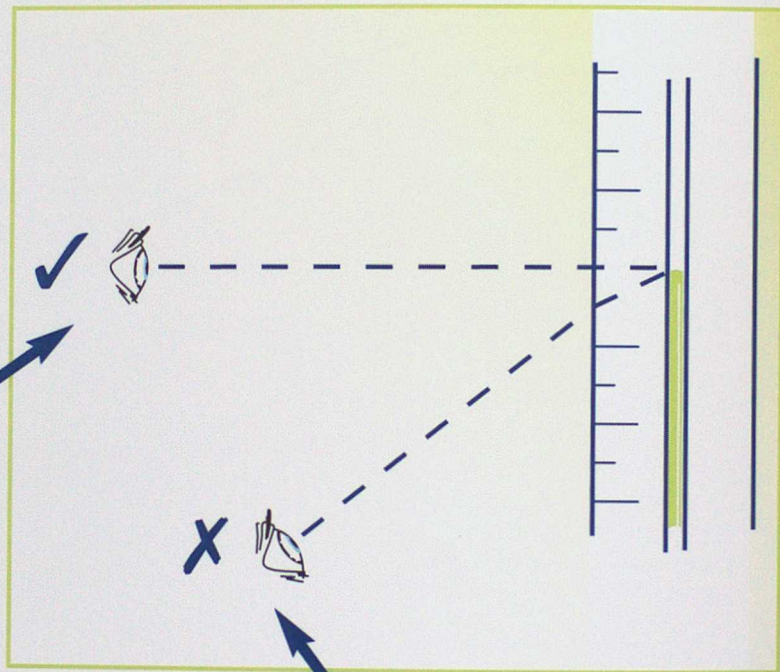


Thermometer mount inside an automatic station screen

- ✓ Read and record all temperatures in degrees ($^{\circ}\text{C}$) and tenths.

The thermometers are only marked with whole and half degrees, so take care when estimating tenths. Make sure your eye is level with the top of the mercury column or the end of the index furthest from the bulb to avoid *parallax errors*.

Correct viewing angle



Viewing from this angle will give an incorrect reading

Ice bulb

If the wet-bulb thermometer is below 0.0°C , the wet bulb should have a thin coating of ice rather than water in order to produce an ice-bulb temperature. This may be difficult to achieve, but the following method should help you get true measurements.

- ✓ About 30 minutes before the observation time, check the muslin and wick to see if they have a thin coating of ice.
- If they are dry, or just the wick is frozen, use a small camel-hair brush to moisten the muslin with cold, distilled water.
- If this water does not freeze readily, try and encourage it by touching the wick and muslin with a bit of hoar frost (e.g. on a grass stalk) or snow or ice fragment. When freezing begins, the temperature will rise to 0°C and will stay there until freezing is complete.
- After a couple more minutes, the wet bulb should start to work as an ice bulb, showing a steady reading by the time you do your observation.
- ✓ Never allow an excessive build-up of ice on the muslin, as this will lead to false measurements.

Electrical resistance thermometers

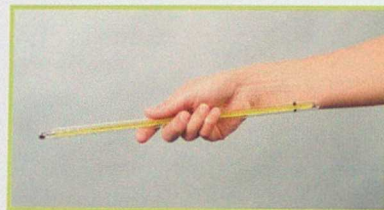
Electrical resistance thermometers (ERTs) are often used to regularly measure dry- and wet-bulb temperatures automatically. The readings are shown on a digital display (in $^{\circ}\text{C}$ and tenths).

Resetting the maximum thermometer

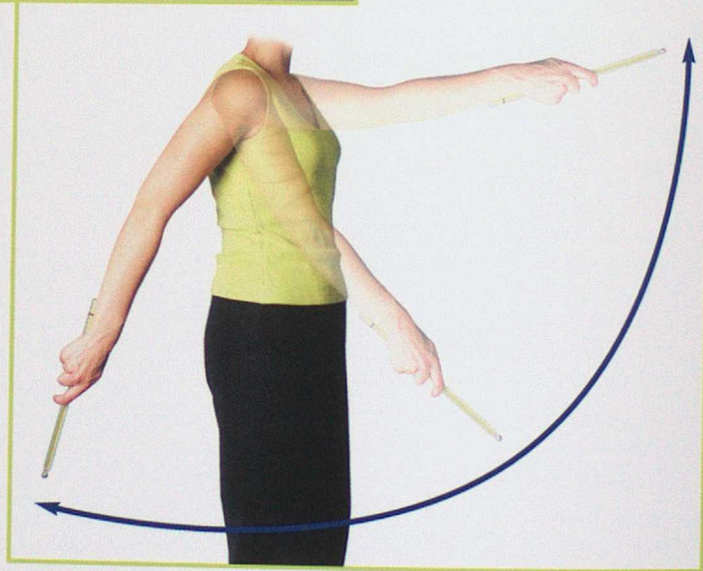
The mercury-in-glass maximum thermometer reads the highest air temperature reached since the instrument was last read and reset.

- ✓ Reset the thermometer immediately after you've read it — this should take it to about the same value as the dry bulb. Reset the thermometer by taking a firm hold of it in the middle, with the bulb end downwards and, avoiding loose clothing or anything else, swing it smoothly in an arc at arm's length to force the mercury back past the constriction.

Report the highest temperature as the maximum temperature. Sometimes this may come from the dry-bulb rather than the maximum thermometer. When this happens, report the higher dry-bulb temperature.



How to hold the thermometer



Reset the maximum thermometer, keeping your arm straight

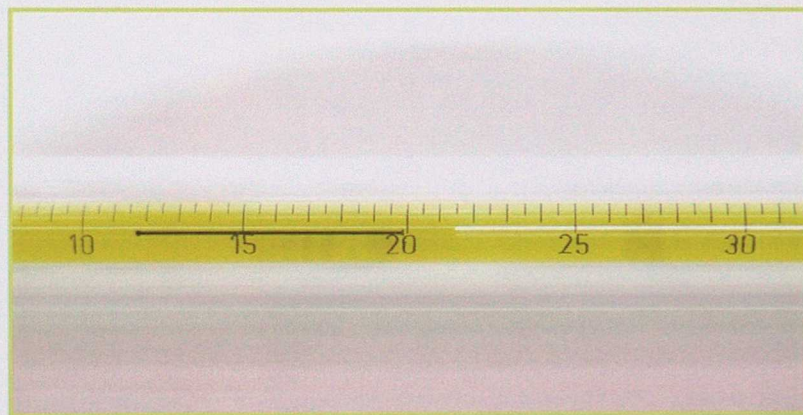
Resetting the minimum thermometer

The alcohol-in-glass minimum thermometer reads the lowest air temperature reached since the instrument was last read and reset. The right-hand end of the index, the end furthest from the bulb, indicates the minimum temperature recorded.

- ✓ Once read, reset the thermometer by tilting it so that the bulb end is highest. The index will then slide down towards the top end until the alcohol meniscus stops it. It will then read about the same value as the dry-bulb temperature.

The minimum temperature to be reported is the lowest temperature recorded during the period under consideration. The minimum

thermometer normally gives this reading, but sometimes one of the dry-bulb temperatures reported during the period is lower than the minimum temperature. When this happens, report the lower dry-bulb temperature as the minimum.



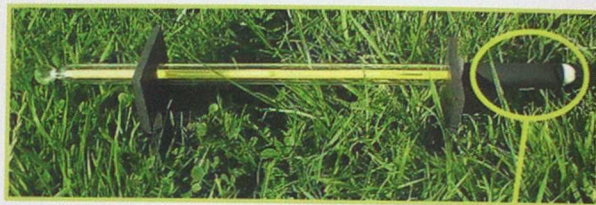
- ✓ Read end of the index furthest from the bulb. In this example, the correct reading is 19.9 °C

Grass minimum thermometer

The grass minimum thermometer is used to record the lowest temperature reached during the night over short grass freely exposed to the sky. However, at many stations where the grass minimum thermometer is left out all day, the grass minimum temperature recorded will be for the full 24-hour period.

This thermometer is the same as the minimum thermometer but is fitted with a black anti-condensation shield that covers the thermometer at the end furthest from the bulb. The shield absorbs more heat from the sun than the rest of the thermometer and is therefore at a higher temperature, preventing vapour from the alcohol condensing in the stem near the shield. Any condensation that does take place will be near the alcohol. The shield makes it possible to leave the thermometer out all day at stations that are not open in the evening when the thermometer would normally be put out.

The thermometer is placed over short grass in an open position, held by special supports that keep its bulb above the ground and in contact with the tips of



Anti-condensation shield — replace it if it's not black

the grass blades. These special supports are made of stiff black rubber and are designed so that, when they are correctly fitted to the thermometer, it is tilted at about 2° to the horizontal with the bulb end lower. The holes in the blocks are off-centre so that you can choose which side to rest the blocks on to ensure that the bulb is always touching the tips of the grass blades.

- ✓ Check daily for bubbles in the alcohol, which can occur more often in thermometers situated in direct sunlight.
- ✓ Keep the grass clipped short — the bulb should just touch the grass tips.

- ✓ If snowfall buries the thermometer, retrieve it as soon as you can (e.g. once the snow has ceased falling) and rest it on the rubber supports on top of the snow. Do NOT sweep away the snow.

If you find the thermometer under snow when you make your observation, note the reading but treat it as suspect and make a note of this.

Concrete slab minimum

The concrete slab thermometer is identical to the grass minimum thermometer, but it is exposed with its bulb in the centre of, and in contact with, an approved concrete slab. The thermometer is held in place by a clip so that the wind can't move it. The clip should hold it just below the shield. Read and care for this thermometer in the same way as the grass minimum thermometer, except that the concrete slab and thermometer **MUST be kept clear of snow**.

This is best done once the snow has stopped falling.

Soil temperature

To measure the temperature 5 cm, 10 cm and 20 cm in the soil, bent-stem thermometers are used. These are liquid-in-glass thermometers that have a right-angled bend in the stem so that, when the body of the

thermometer is lying flat on the ground, the bulb is at 5 cm, 10 cm or 20 cm below the ground surface.

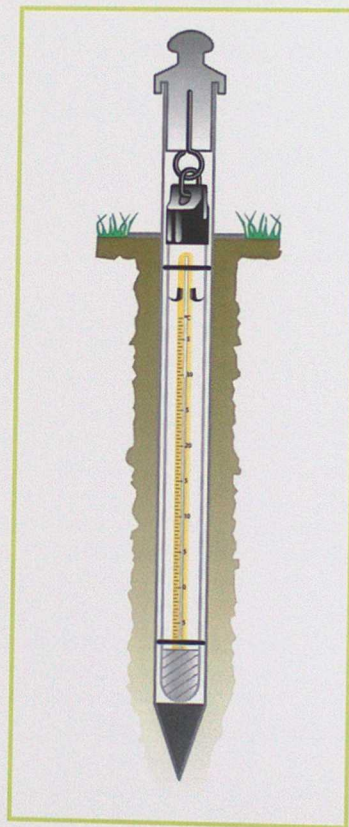
If the thermometer scale markings fade, use lamp black or shoe polish to enhance them.

- ✓ Don't take bent-stem thermometers out of the ground — read them in situ. Don't put any strain on the bend, as it is **EXTREMELY** fragile.
- ✓ Leave the soil around the thermometer as undisturbed as possible to avoid any damage to the thermometer stem and so that the readings are as representative as possible of the surrounding soil. If the sun is making it difficult to take a reading, shade the stem with your hand.
- ✓ Occasionally, the horizontal stem is resting on the soil surface. If necessary, top up the soil surface with local representative soil. Any cracking around the bent-stem thermometer can be avoided by lightly raking the ground.

Deep soil

Deep soil thermometers are used for measuring temperatures at 30 cm, 50 cm and 100 cm under a short grass surface. These thermometers hang by thin chains in steel tubes in the ground. Raise the thermometer out of the tube to read it. The bulb is covered in beeswax to slow down the reaction of the thermometer so that you can take an accurate reading.

- ✓ If there is precipitation falling while you are taking the reading, or there is deep snow cover, make sure that it doesn't get into the tube.
- ✓ Carefully shield the thermometer from the sun while taking your reading.
- ✓ Should you experience any problems (e.g. water in the tube), please contact the Customer Centre (see 'Welcome' booklet for details).



Deep soil thermometer

Removing bubbles

Bubbles in the minimum thermometers (screen, grass, concrete slab) can be a big problem. Sometimes a bubble can form on the index itself, shown up by the index not moving freely when the thermometer is tipped. Alternatively, a detached bead of alcohol can form completely above the index or between it and the thermometer bulb.

The preferred way to remove a bubble is to carefully dip the bulb in water hot enough to disperse the bubble.

When the bubbles have been removed, leave the thermometer in an upright position, bulb downwards, to drain — preferably for 24 hours if possible.

*Dipping the
bulb of the
thermometer
into warm
water*



*Removing the
bulb from the
warm water*



Calculating relative humidity and dew point without a slide-rule

Use your dry-bulb and wet-bulb readings to calculate the amount of moisture in the air — the relative humidity — as follows.

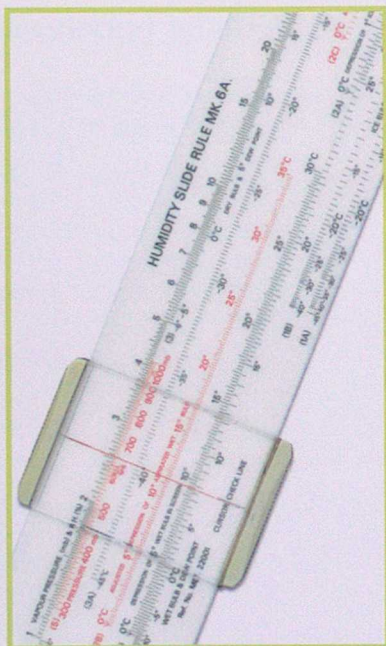
- Step 1)** Work out the difference between the readings, e.g. dry bulb 10.2°C and wet bulb 6.7°C gives a difference of 3.5°C . This is called the wet-bulb depression and indicates how much moisture is in the air. If the air is dry, rapid evaporation takes place and the difference is large (your washing dries very quickly!). If the air is moist, the difference is small, (e.g. in fog or drizzle), little evaporation takes place and the wet bulb will register the same or almost the same temperature as the dry bulb.
- Step 2)** Read the relative humidity (a percentage value) using the table on the next page. For 3.5°C wet-bulb depression and dry bulb of 10.2°C , the relative humidity from the table is about 57% (between 50 and 62). Relative humidity (RH) is the ratio of the amount of water vapour contained in a sample of air to the amount required to saturate it, expressed as a percentage.

You may also read the dew-point temperature from the table. In the example above, the dew point would be about 2°C . This is the temperature to which the air must be cooled, without any change in pressure, so that it becomes saturated with respect to water. It is important for predicting fog and for indicating different air masses.

- ✓ Ideally, the RH should be more than 95% (depression of less than 0.5 °C) to report mist or fog, although it is likely to be close to 100% (little or no depression) for fog.

Dry bulb (°C)	Wet-bulb depression (°C)									
	1	2	3	4	5	6	7	8	9	10
30	29 (93)	27 (85)	26 (78)	24 (72)	23 (65)	21 (59)	19 (53)	17 (47)	16 (42)	13 (36)
28	27 (92)	25 (85)	24 (77)	22 (70)	20 (64)	19 (57)	17 (51)	15 (45)	13 (39)	10 (33)
26	25 (92)	23 (84)	21 (76)	20 (69)	18 (62)	16 (55)	14 (49)	12 (42)	10 (36)	7 (30)
24	22 (91)	21 (83)	19 (75)	18 (68)	16 (60)	14 (53)	12 (46)	9 (39)	7 (33)	4 (27)
22	20 (91)	19 (82)	17 (74)	15 (66)	13 (58)	11 (51)	9 (43)	6 (36)	3 (29)	0 (23)
20	18 (91)	17 (81)	15 (73)	13 (64)	11 (56)	9 (48)	6 (40)	3 (33)	0 (25)	-5 (18)
18	16 (90)	15 (80)	13 (71)	11 (62)	8 (53)	6 (45)	3 (36)	-1 (28)	-5 (16)	-11
16	14 (89)	12 (79)	10 (69)	8 (60)	6 (50)	3 (41)	-1 (32)	-5 (24)	-10	-19
14	12 (89)	10 (78)	8 (67)	6 (57)	3 (47)	0 (37)	-4 (28)	-10	-18	-43
12	10 (88)	8 (76)	6 (65)	3 (54)	0 (43)	-4 (32)	-9 (22)	-16	-33	
10	8 (87)	6 (74)	3 (62)	0 (50)	-4 (38)	-8 (27)	-15	-27		
8	6 (86)	3 (72)	0 (59)	-3 (46)	-7 (33)	-13	-23			
6	4 (85)	1 (70)	-2 (55)	-6 (41)	-11	-20	-29			
4	1 (83)	-2 (67)	-5 (51)	-10	-14	-24				
2	-1 (82)	-4 (64)	-8 (49)	-13	-21					
0	-3 (80)	-7 (61)	-11	-18	-32					
-2	-6 (77)	-10	-15	-25						
-4	-8 (72)	-13	-20	-39						
-6	-11	-17	-27							
-8	-14	-21	-39							
-10	-17	-26								

Approximate dew point (°C) from the dry-bulb and wet-bulb depression (% RH shown in brackets)



Humidity slide rule, front

Using the slide rule to calculate dew-point temperature and RH

With a wet bulb

- (a) Wet-bulb temperature is 0.0°C or more and the station-level pressure is greater than 950 hPa.
 - (i) Set cursor over wet-bulb value on scale 1.
 - (ii) Move slide until wet-bulb depression on scale 2 is under the cursor.
 - (iii) Set the cursor over the zero index (0°C) on scale 2 and read the dew point, in degrees and tenths, on scale 1.
 - (iv) Set RH index (to the right of scale 3) to read 100 on scale 4.
 - (v) Set the cursor over the dew point on scale 3 and read the vapour pressure, in millibars (hPa) and tenths, under the cursor on scale 4. If the dew point is below -6°C , use scale 3A instead of 3, but divide the reading of the vapour pressure by 10.
 - (vi) Without moving the cursor, move the slide until the dry-bulb temperature on scale 3 (or scale 3A if that was used) is under the cursor, and read the RH as a percentage to the nearest whole number on scale 4 at the RH index.

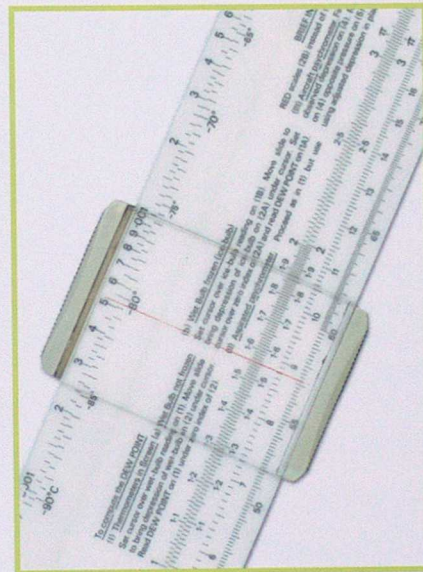
With an ice bulb

- (b) Wet-bulb temperature is less than 0.0°C and the station-level pressure is greater than 950 hPa. It is assumed in this calculation that the reading of the wet-bulb thermometer has been taken with an ice bulb, although, with temperatures just below 0.0°C , this may not actually be the case.
- (i) Set the cursor over the ice-bulb value on scale 1B.
 - (ii) Move the slide until the ice-bulb depression on scale 2A is under the cursor.
 - (iii) Set the cursor over the zero index (0°C) on scale 2A and read the dew point, in degrees and tenths, on scale 1A.

Follow steps (iv), (v) and (vi) in (a) above.

With low station pressure

When pressure at your station equals 950 hPa or less (rarely in the UK), follow the instructions on the back of the slide rule.



Humidity slide rule, back

Quick reference for stations with manual read instrumentation

Temperature	Equipment	Read at... ✓	Reset method ✓	Troubleshooting ✓
Dry bulb (<i>air</i>)	Mercury-in-glass (<i>silver liquid</i>)	Top of meniscus	Do not reset	Check brackets are secure
Wet bulb (<i>air</i>)	"	Top of meniscus	Do not reset	Ensure muslin is wet and clean
Air maximum	"	Top of meniscus	Hold and swing*	
Air minimum	Alcohol-in-glass (<i>colourless liquid</i>)	End of index farthest from the bulb	Tip bulb end up for index to fall	Check for bubbles each time you do a reading
Grass minimum	"	End of index farthest from the bulb	Tip bulb end up for index to fall	Check for bubbles each time you do a reading
Concrete minimum	"	End of index farthest from the bulb	Tip bulb end up for index to fall	Check for bubbles each time you do a reading
Soil	Liquid-in-glass	Top of meniscus	Do not reset	Check wax is intact on bulb
Bent-stem soil	Mercury-in-glass (<i>silver liquid</i>)	End of mercury column	Do not reset	

* In an open space