SPOT-ON Observers Guide

Met Office

Welcome

Welcome to the SPOT-ON Observers Guide, the Met Office's updated guide to observing practices for the UK land-based observing network.

You may be familiar with the problem of not having all the information you need to make, code and send observations. You may have access to certain reference books, while a nearby observing station has different ones. How do you know where to find the most up-to-date information? How can you be sure that your observations are the best they can be?

This guide is the answer. It is designed to help you make, code and send weather observations — quickly and easily. By ensuring all observers have access to this guide, we hope to reduce the possibility of mistakes. This will enable you to make high-quality observations every time.

You will see the ✓ symbol wherever there is key information to help you make **SPOT-ON** observations.

SPOT-ON means

- ✓ ***S**tandard* — use standard equipment and exposure to ensure accuracy
- ✓ ***P**recise* — keep your instruments in good condition to help ensure high-quality measurements
- ✓ ***O**n **T**ime* — make sure your observations are sent by the time they are needed
- ✓ ***O**rderly* — be methodical in providing an ideally complete set of expected measurements
- ✓ ***N**o errors* — always check your measurements before you send them: your quality control is vital

All your high-quality observations are valuable and may be used in many different ways, for example:

- as input to supercomputer forecasting models, which produce local/global weather forecasts;
- to help with any weather-related issues, e.g. aviation safety;
- for climatological analysis, e.g. frequency of extreme events, such as gales or heavy rain;
- to answer legal enquiries, where data may have to be presented in a law court.

This guide is quite brief — it avoids technical detail — providing enough information to get you started, prompt you or simply to serve as a quick refresher. It is not meant to teach you about meteorology or about the Met Office, and it only covers instruments and methods that are *widely* used.

The notes assume that your station, equipment and computer programs have already been set up correctly, and that you know what observations your station should provide and when. If this is not the case, please use the contact detail on page 4.

Your station has been sent the parts of the guide that relate to the observations you make. If you think your station is missing some part(s), please use the contact detail on page 4.

Universal Time Co-ordinated (UTC) is the international time standard replacing Greenwich Mean Time (GMT). All times quoted in this guide are in UTC unless otherwise stated. UTC is the same as British clock time in winter and is one hour behind British clock time in summer.

The guide is ideal for outdoor use, being resistant to water and usual wear and tear. The loose-leaf format will allow any necessary changes to be made at a later date.

UK land-based observing network

The network consists of synoptic (including auxiliary), climatological (including health resort) and rainfall stations. The classification of each station depends on the observations it makes.

Synoptic observations are the most frequent and most detailed observations. These are coded for sending straight away and are typically done each hour by Met Office observers, but less often at most auxiliary stations.

Climatological observations are normally made once a day at 0900 UTC and make a significant contribution to assessing the long-term climatology of the British Isles. The observation includes maximum and minimum air temperature and total rainfall for the 24 hours to 0900 UTC. However, where there is a Met Office requirement, stations also measure other agreed elements. Most stations send in a month's worth of observations at the start of the following month. This is done on handwritten forms or by entering data on a computer that e-mails the observations to the Met Office.

Health resort stations are climatological stations that make an extra observation at 5 p.m. This is sent to the Met Office via an automated telephone system and collated into a bulletin that is issued to the press.

Climatological stations fall into three broad categories, as explained below.

- **Authorities with a real need for daily observations**

  Sponsors of stations within this group (e.g. agricultural stations and health resorts) have a self-interest in making daily observations.

- **Authorities with an interest but no real need for observations every day**

  The sponsor is usually an organisation. These include schools and public bodies (such as National Trust, Nature Conservancy and Forest Enterprise).

- **Private individuals**

  These observers have a personal interest in the weather but usually have no vested interest in the data.

Rainfall-only observations are made at approximately 4,500 stations throughout the UK. These are vital for water authorities, drainage departments, engineers, public-health departments, agriculturists, farmers and foresters, and many more. It is essential to have rain gauges situated across the whole of the UK to properly study the rainfall distribution. Rainfall amounts should be measured at 0900 UTC.

Automatic stations also make observations. These are often located in difficult terrain and are useful for times when an observer is not available. They may be needed for continuing a valuable climate record when an observer retires from a long-term station. A typical automatic station has a set of weather sensors connected to a central data logger, which provides data, measurement, processing and storage for several weeks worth of data. However, some stations can give hourly or 10-minute information as soon as the data are measured, typically temperature and rainfall.

Changes to stations

Always let us know of any changes or intended changes at your station as soon as possible. This includes changes to exposure of the site; moving, removing, or replacing any instruments; and any changes to the observing programme.

Contact information

For comments or suggestions about this guide, or if you want to request a change, have problems or queries, please e-mail: **SPOT-ON@metoffice.com**

If you have any problems or queries, call the **Customer Centre on 0845 300 0300**. Please give your station name and number, stating that it relates to the 'Spot-On Observers Guide'. The Customer Centre will pass your details onto the Surface Networks Section for a response.

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Designed and produced by the Met Office.

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.

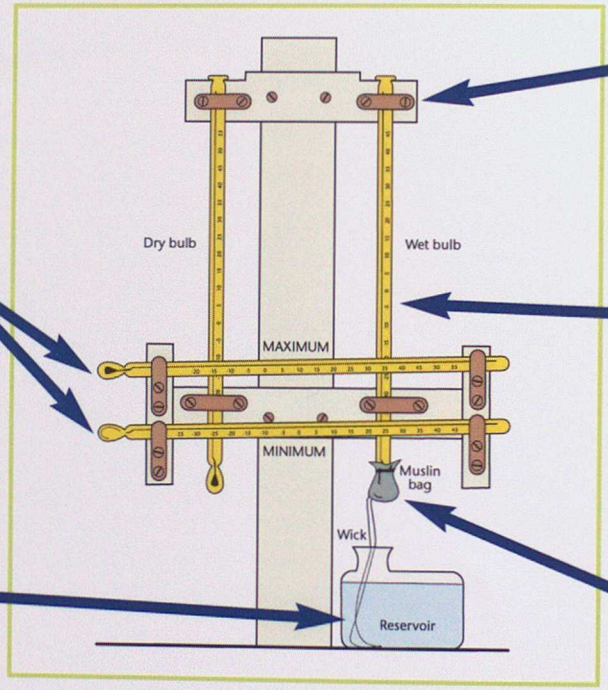
A typical Stevenson Screen (new screens are made of plastic and painted black inside)

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

Check fastenings that hold the screen



Check brackets holding thermometers are secure

Maximum and minimum thermometers tilted at about 2° to the horizontal, with bulb end lowest

Keep thermometers clean and dry

Keep reservoir topped up with purified or distilled water. Use rain water in an emergency but NEVER use tap or sea water

Replace wet-bulb muslin and wick as necessary

Typical thermometer mount inside climate station screen

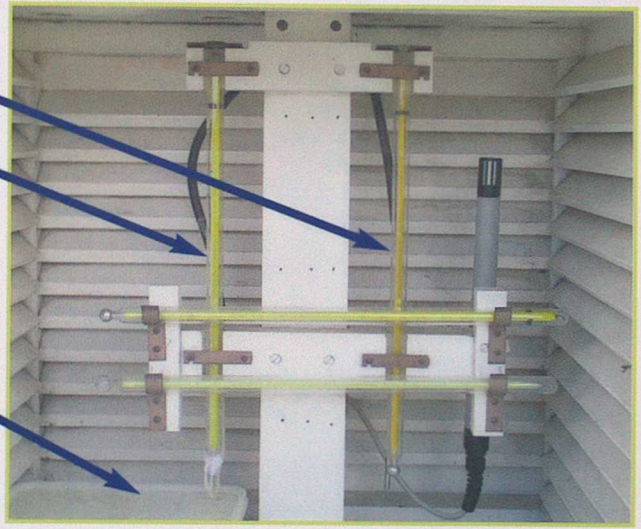
Step 1 Read dry bulb.

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.

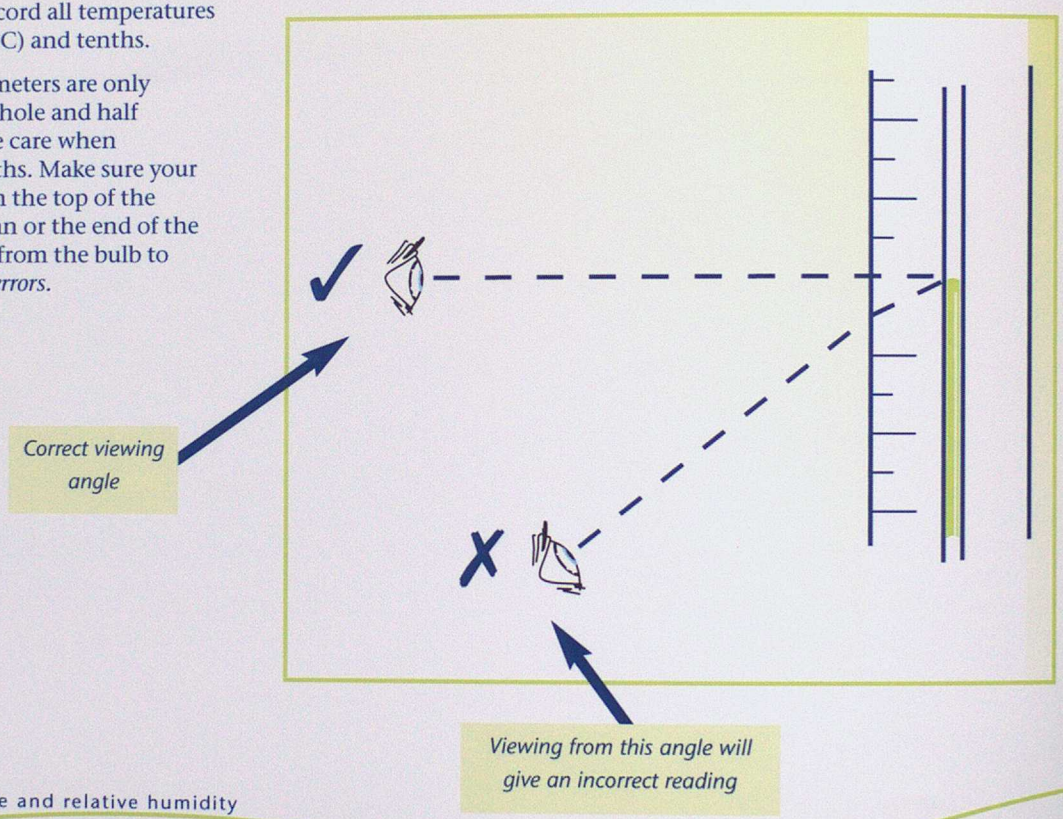
- Make sure the maximum and minimum temperatures are close to the dry-bulb temperature once reset.
- Note your readings quickly because your body heat could affect the temperatures, especially in cold weather.
- In fog or high humidity, water drops may collect on the dry bulb. Remove with a clean tissue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



Thermometer mount inside an automatic station screen

✔ Read and record all temperatures in degrees (°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*.



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

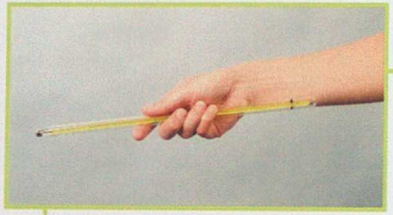
Electrical resistance thermometers (ERTs) are often used to regularly measure dry- and wet-bulb temperatures automatically. The readings are shown on a digital display (in °C and tenths).

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

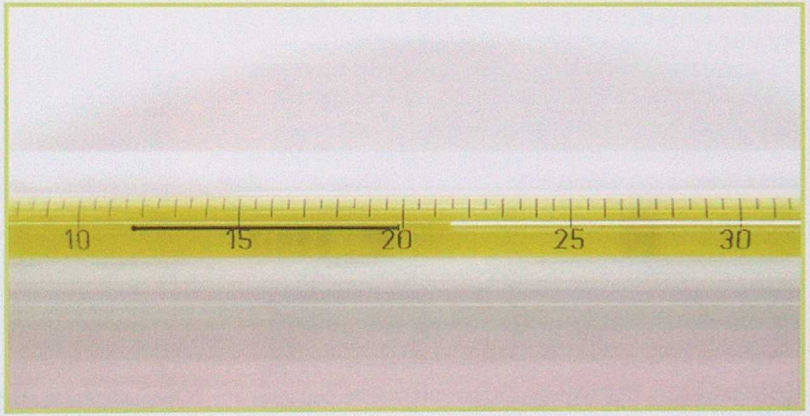
Reset the maximum thermometer, keeping your arm straight

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.



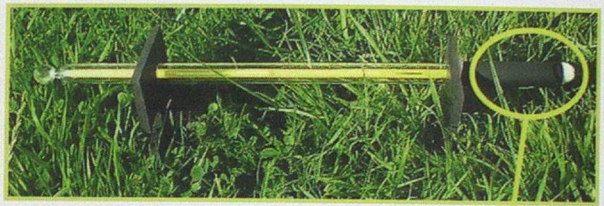
- Read end of the index furthest from the bulb. In this example, the correct reading is 19.9 °C

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 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.



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

- 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.

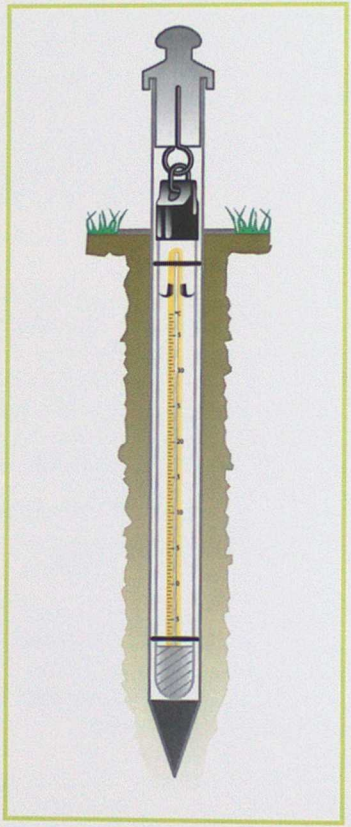
If the thermometer scale markings fade, use lamp black or shoe polish to enhance them.

- 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.

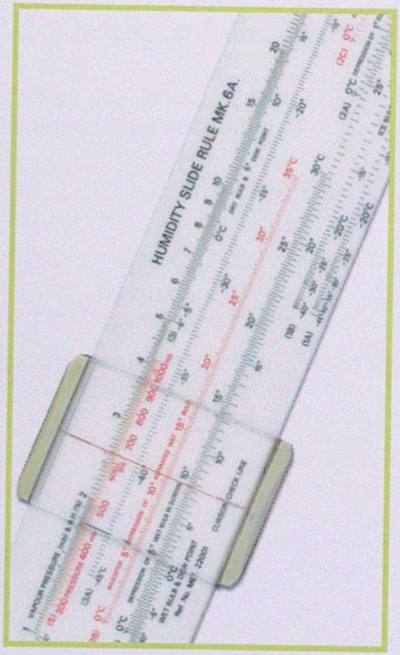
Step 2) Read the relative humidity (a percentage value) using the table on the next page. For 3.5 °C wet-bulb depression and dry bulb of 10.2 °C, the relative humidity from the table is about 57% (between 50 and 62). Relative humidity (RH) is the ratio of the amount of water vapour contained in a sample 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.

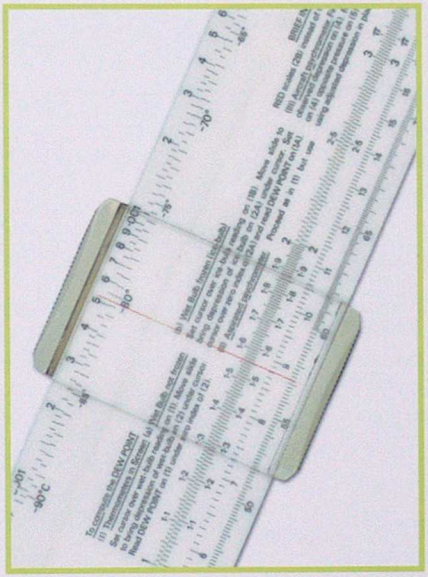
(i) Set the cursor over the ice-bulb value on scale 1B.

(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