DOCUMENT
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DOCUMENT TITLE

METEOROLOGY FOR AUSTRALIA

CHAPTER 5 – HUMIDITY

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HUMIDITY

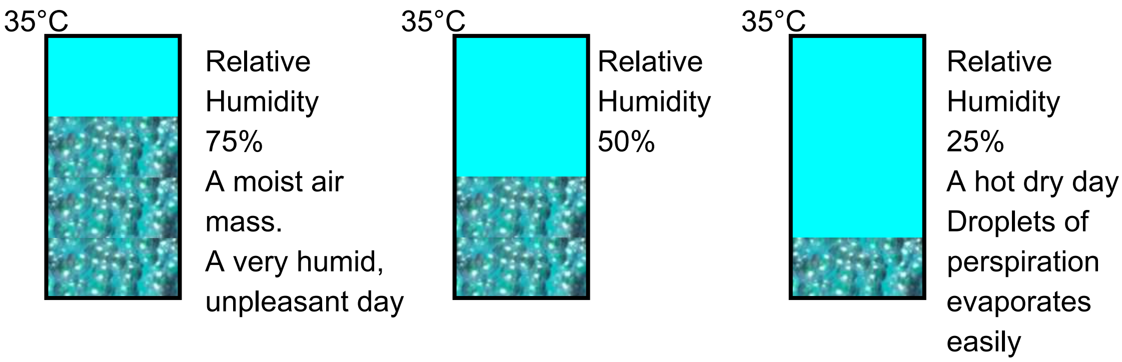
Air contains water but you can not always see it because it may be in a gaseous form, which is invisible, not in a liquid form.

When water evaporates it changes from a liquid into a gas called water vapour. The amount of water vapour in the atmosphere is called humidity. A humid day is a day when there is a lot of water vapour in the air.

RELATIVE HUMIDITY

The relative humidity (RH) is a ratio (expressed as a percentage) of the actual amount of water vapour a sample of air holds compared with the potential amount of water vapour it could hold **at that temperature**.. Some air masses may have the same temperature but the amount of water vapour in them varies.

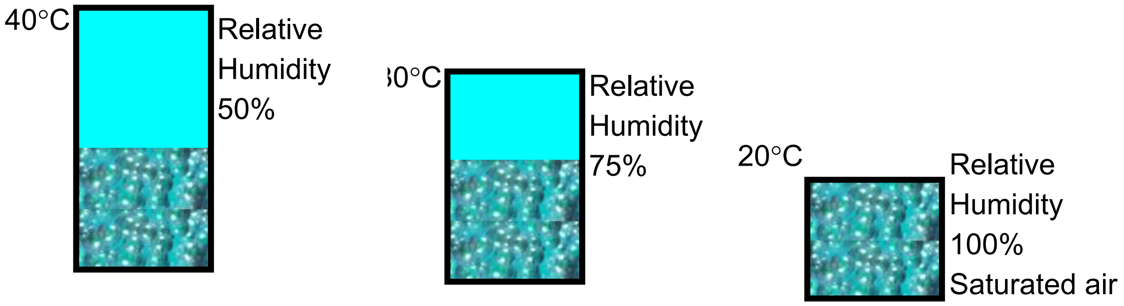
$$\text{R.H.} = \frac{\text{Actual amount of water vapour in the air}}{\text{Potential amount of water vapour it could hold at that temperature}} \times 100\%$$



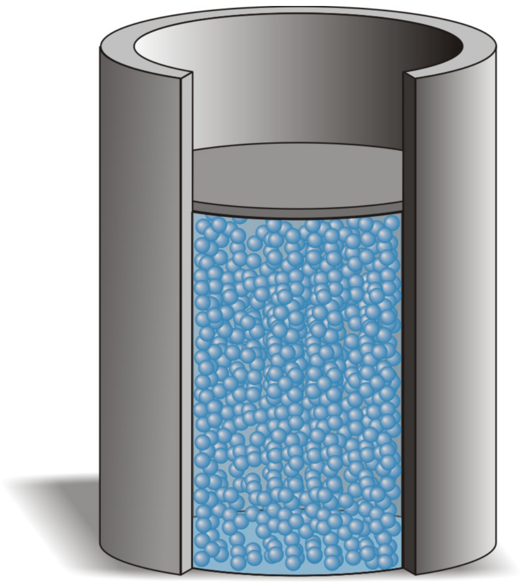
If the temperature remains constant but the amount of water vapour decreases, the relative humidity will fall

5.a. Relative Humidity (i)

The amount of water vapour the air can hold depends on the temperature; this in turn affects the relative humidity. A warm air mass can hold a lot of water vapour but as the air mass becomes cooler, it can not hold as much. If a mass of air has a certain amount of water vapour in it and the temperature drops, the relative humidity will rise.

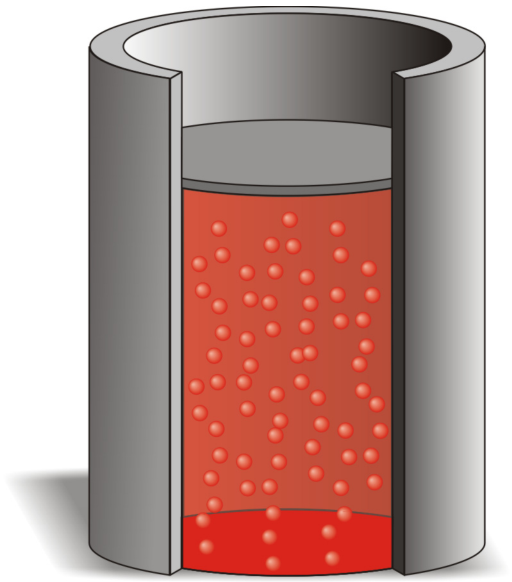


5.b. Relative Humidity (ii)



5.c. Relative Humidity of Cold Air

Cold air is dense. There is not much space between the molecules of air. Cold air can only hold a small amount of vapour. It requires a small amount of vapour to reach 100% RH.



5.d. Relative Humidity of Hot Air

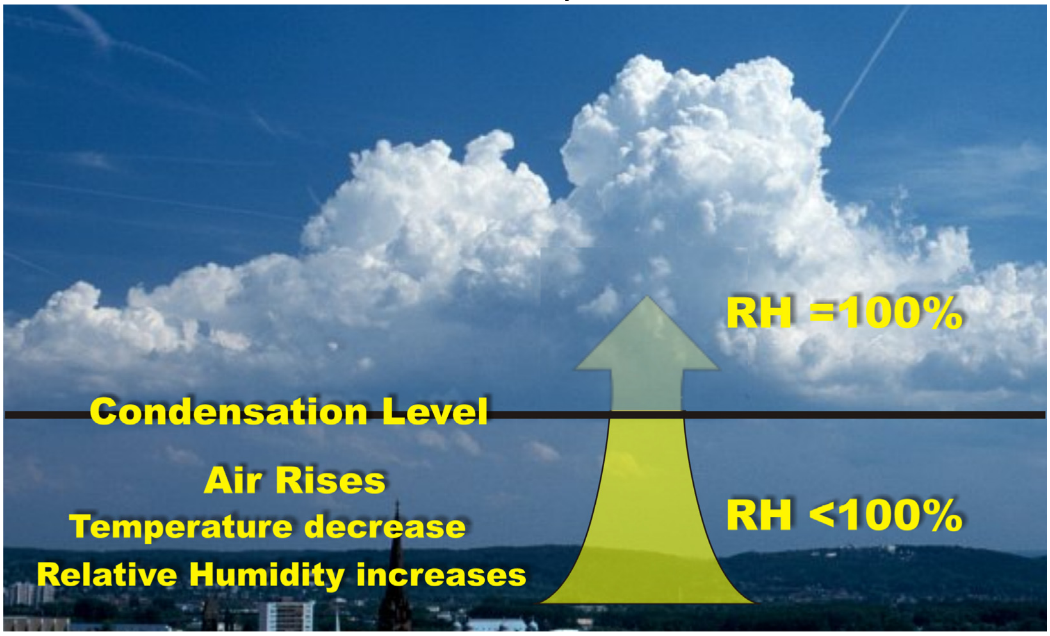
Hot air is less dense. There is a lot of space between the air molecules. Hot air can hold lots of vapour. Hot air needs lots of water vapour to reach 100% RH.

As we said earlier, it is most likely that there is some water vapour in the air. If the air has a relative humidity of 50% it is holding half the water vapour it could hold at its present temperature. If the temperature were to fall, a temperature would be reached when the air could not hold any more water in vapour form. That temperature is called dew point and the air would have a relative humidity of 100% and therefore be completely saturated. If the temperature were to fall even further, the water vapour would condense (ie. change from vapour form into tiny water droplets).

Remember, there are two ways to increase the relative humidity:

1. Add more water or
2. Lower the temperature

If the air rises, it cools, therefore the relative humidity increases.



5.e. Condensation Level

To calculate relative humidity and dew point, a hygrometer (psychrometer) is used. The most common hygrometer is a ”dry and wet bulb thermometer”. They are kept in a Stevenson screen which is placed 4 feet above the ground.

Water evaporating on the wet bulb cools the bulb due to latent heat loss. When the air is dry, a lot of evaporation occurs. When the air is very moist, a small amount of evaporation occurs. If the air is saturated (RH = 100%) no evaporation occurs.

The meteorologist uses the dry bulb temperature, the wet bulb depression (see diagram), and psychrometric tables to calculate the relative humidity and the dew point. **Remember, the wet bulb temperature is not the dew point temperature.**

Two other definitions are common in a discussion on moisture in the air and students need to be familiar with both:

a) **Specific Humidity:** the ratio of the mass of water vapour present to the mass of moist air containing the sample. Units are usually grams/kg.

b) **Mixing Ratio:** the ratio of the mass of water vapour present to the mass of dry air associated with the sample. ie. the moisture has been taken out. Mixing ratio is unaffected by changes in pressure, volume or temperature. Units are usually gms/kg.

   It is usually more convenient to determine the mixing ratio from measurements of vapour pressure and total pressure. The importance of humidity mixing ratio is that it is a measure of moisture content and is dependant of temperature and varies only with the addition and removal of water vapour.

   The saturation mixing ratio is defined as the mass of water vapour in a given volume of air saturated with respect to a plane surface of pure water to the mass of dry air.

SATURATION VAPOUR PRESSURE

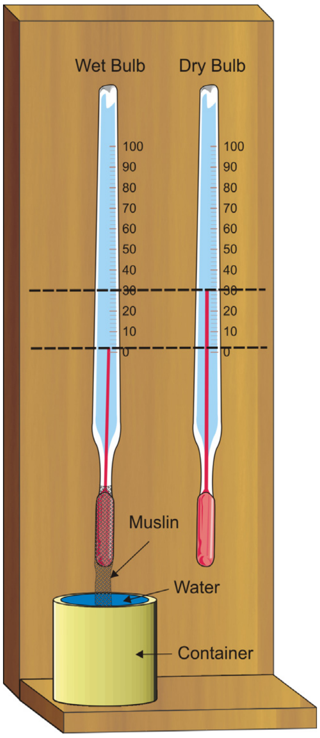
In some circumstances it is convenient to refer to humidity by the term "vapour pressure". Water vapour in the air exerts a pressure. This is referred to as partial pressure because water is a partial constituent of the air. This pressure will be at a maximum when the air is saturated with water vapour. Evaporation takes place initially from a plane water surface to the surrounding air. A state of equilibrium is reached when, at a particular temperature no further exchange takes place between the air and the water. At this stage the air is said to be saturated. The pressure exerted by this saturated air is called the saturation vapour pressure. For a given vapour pressure there is only one temperature at which the air will start to become saturated. This is determined by the dew point temperature of the parcel of air in question. Also, all parcels of air having the same vapour pressure also have the same dew point.

When the air is saturated, further lifting and cooling causes condensation. This reduces the water vapour content and thus the vapour pressure.

The magnitude of the saturation vapour pressure increases with temperature. At 100°C the saturation vapour pressure reaches a pressure of one atmosphere. Boiling point can therefore also be defined as the temperature at which the saturation vapour pressure is the same as the ISA sea level pressure.

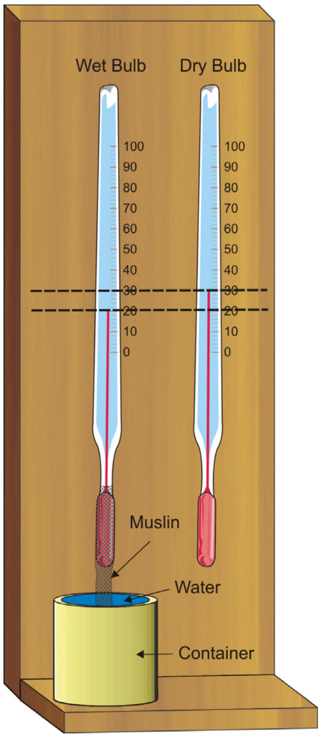
The actual value of the saturated vapour pressure does however vary with the surface over which the air is resting. It is markedly lower over an ice surface than over a water surface. One result of this is sublimation.

If unsaturated air is cooled below 0°C, although the vapour pressure will fall, it can reach the saturated vapour pressure level for ice before it reaches the level for a water surface. In these circumstances the water vapour in the air can change immediately to ice. The result is Sublimation (sometimes referred to as Deposition).



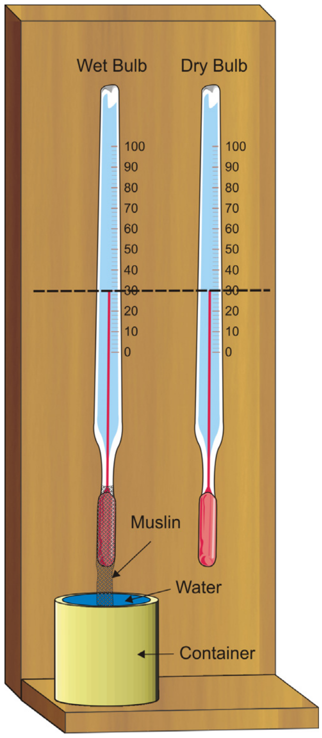
5.f. Hygrometer

Large wet bulb depression
Dry Air
Low Relative Humidity



5.g. Hygrometer

Small wet bulb depression
Moist Air
High Relative Humidity



5.h. Hygrometer

No wet bulb depression
Saturated Air
100% Relative Humidity