

Module # 2(a)

Measurement devices (Dew point):-

- * A hygrometer is a sensor that senses the amount of evaporated water in air by a mechanical or electronic method.
- * A hygrometer is an instrument used for measuring the moisture content in the atmosphere.
- * The first practical hygrometer was invented by polymath Johann Heinrich Lambert in 1755.

Types of hygrometers:-

① Metal/pulp coil sensor:-

- * Composed of metal and paper coil.
- * Coil expands/contracts as humidity changes.
- * Amount of expansion is calibrated to correspond with actual amount of humidity.
- * Used to show humidity on a dial display.
- * Quite accurate, differences between similar coils are 10% to 20%.



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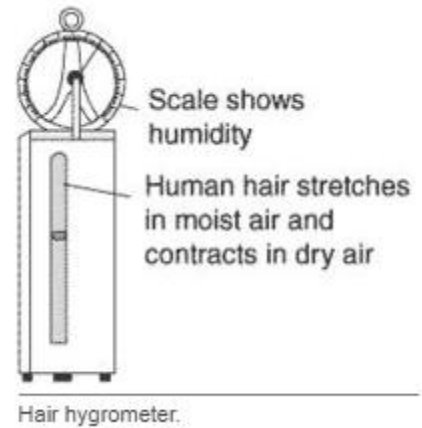
The metal paper coil hygrometer is very useful for giving a dial indication of humidity changes.

* Water vapour is absorbed by a salt-impregnated paper strip attached to a metal coil, causing the coil to change shape. These changes cause an indication on a dial.

(2) Hair Tension:-

These devices use a human and animal hair under tension.

The hair length changes with humidity and the length change may be magnified by a mechanism and indicated on a dial or scale.



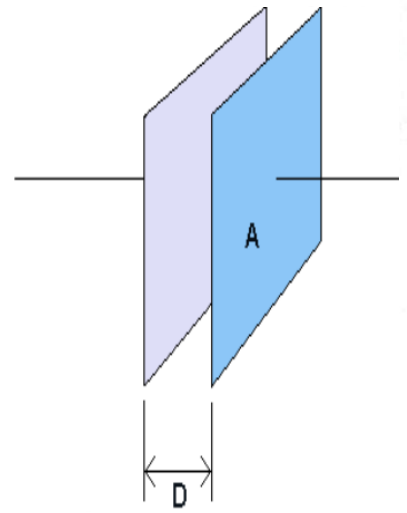
The pulley is connected to an index which moves over a graduated scale. The instrument can be made sensitive by removing oils from the hair, such as by first soaking the hair in diethyl ether.

(3) Electronic Capacitive Sensors

A capacitor is like a short-term battery where static charge can be built up and stored between two metal plates.

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Depending on the moisture b/w the two plates, more or less charge can be built up between them. This amount of charge is referred to as the dielectric constant.



In Capacitive hygrometers, the effect of humidity on metal oxide material is measured. With calibration these sensors have an accuracy of $\pm 2\%$ RH in the range 5-95% RH.

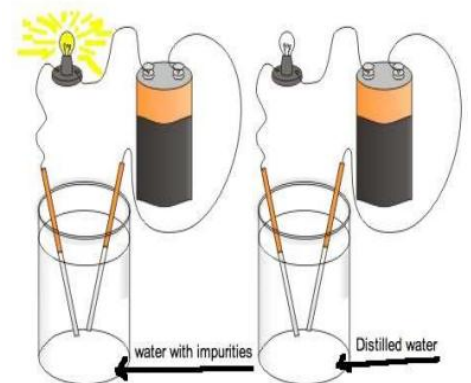
Electronic capacitive hygrometers are low cost, small, and durable. They perform well in environments where temperatures fluctuate frequently.

4) Electronic Resistive Sensors:-

They are also called resistive hygrometers, the change in electric resistance of a material due to humidity is measured.

Typical materials are salts and

conductive polymers. Resistive sensors are less sensitive than capacitive sensors. The change in material properties is less, so they require more complex circuitry.



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The material properties also tend to depend both on humidity and temperature. The accuracy against condensation vary depending on the chosen resistive material.

Condensation-resistant sensors exist with an accuracy of up to $\pm 3\%$ RH.

⑤ Thermal hygrometers:-

In thermal hygrometers the change in thermal conductivity of air due to humidity is measured. These sensors measure absolute humidity rather than the relative humidity.

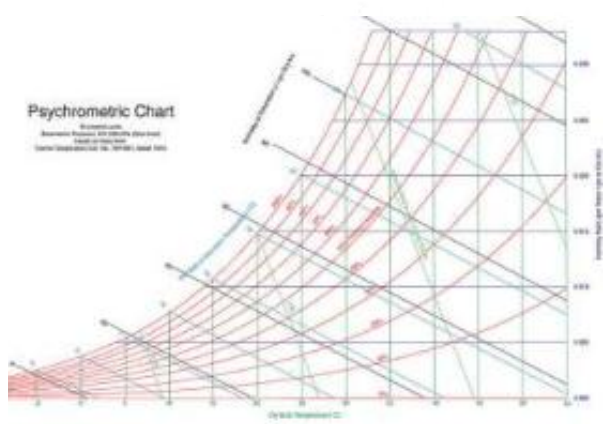
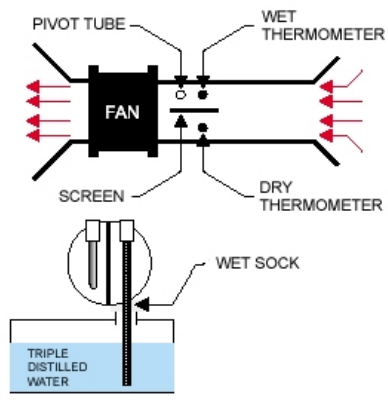


⑥ Psychrometer (wet and dry bulb hygrometer)

A psychrometer is a device that is made up of two thermometers that are placed in two different mediums.

One thermometer is placed in a wet location and is entitled the "wet bulb" thermometer. When above freezing this is the colder thermometer - when below freezing this is the warmer.

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Another thermometer is placed in a dry environment in similar location and is called "dry bulb" thermometer. This thermometer is usually open. Basically Dry bulb temperature represents the measured air temperature.

The readings from each thermometer are plotted on a "psychrometric chart" and the corresponding humidity can be found based on the altitude. - Some times internally calculated and displayed directly by modern psychrometers.

Vapour Pressure:-

It is the pressure that vapor would exert in the absence of other gases.

- * It also known as partial pressure.
- * It is usually denoted by "e" and expressed in millibar.

Saturation Vapor Pressure:-

When a sample of air holds the maximum quantity of water vapors at a particular temperature it is said to be saturated.

- The pressure exerted by water vapors, when the air is fully saturated with water vapors is known as the saturated vapour pressure.

Meteorological Instruments:-

Various instruments are in use for measurement of meteorological elements observations. The most desirable requirement of instruments are Accuracy, reliability, simplicity of design, convenience of operation and maintenance and strength of construction.

1) Accuracy:- It is defined as the closeness of an observed value to the true value. The accuracy requirements change with the purpose - world Meteorological standards are discussed:

Element	Range of Accuracy	Element	Range of Accuracy
Pressure	± 0.1 to ± 0.5 mb	Humidity	± 2 to ± 3 %
Temperature	± 0.1 to ± 1.0 °C	Wind speed	± 0.5 miles/sec
Radiation	± 1 cal/cm ² /hr	Sunshine	± 0.1 hour

(2) Reliability:-

It means that the instrument should maintain a known accuracy over a long period of time.

(3) Simplicity of Design:-

The design of instrument should be simple.

(4) Convenience of operation and Maintenance:-

These are important since most meteorological instruments are in continuous use year in and may be situated far away from good repair facilities.

(5) Strength of Construction:-

Strong construction is especially desirable for those instruments, which are wholly or partially exposed to the weather.

Types of Meteorological Instruments:-

Meteorological instruments are classified as

(1) Non-recording instruments:-

The Non-recording instruments are read at some standard time.

(2) Recording Instruments:-

The recording instruments give a continuous record of the observation for 24 hours.

Meteorological weather station at
Malakandhar Farm.

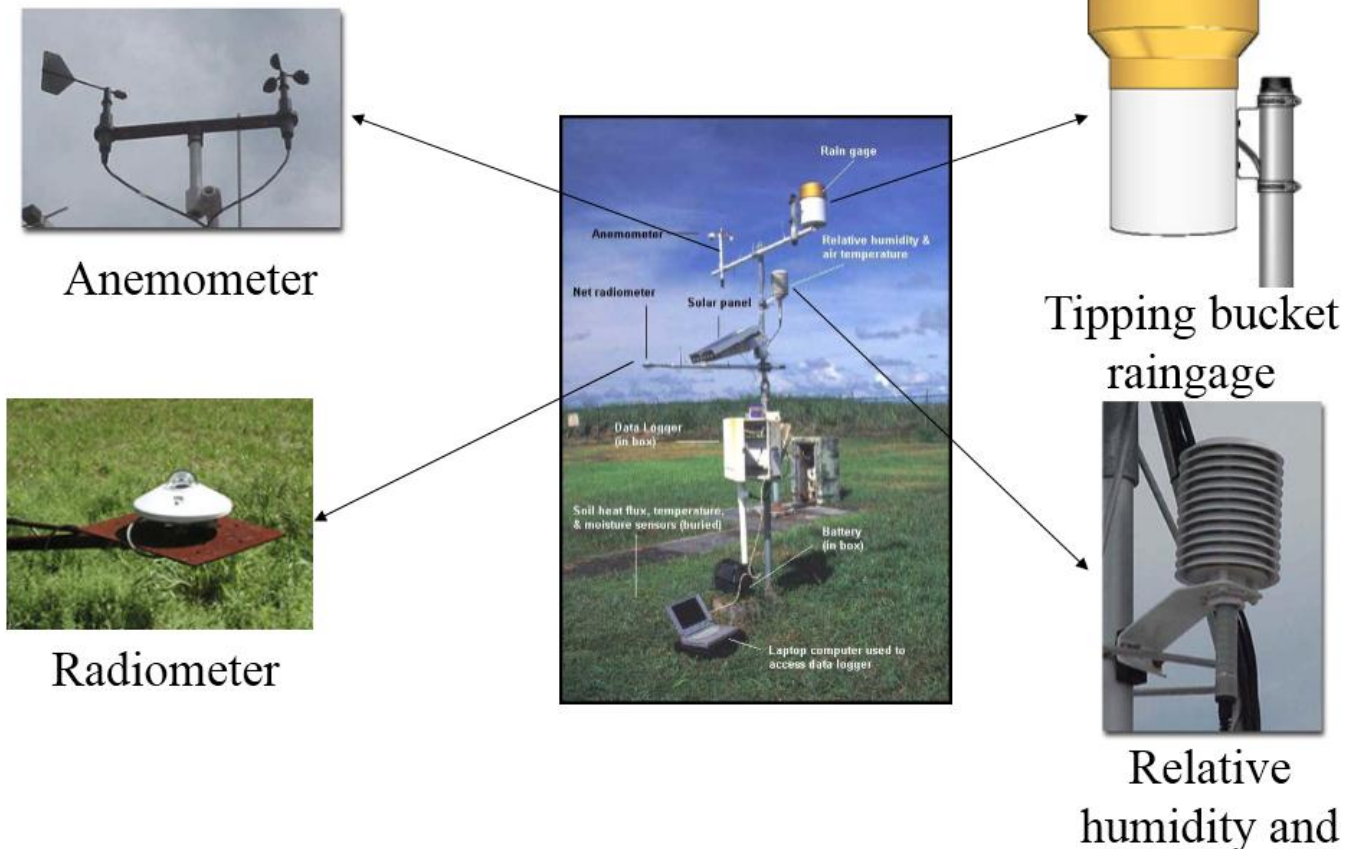


Weather/Climate Station:-

Following variable are recorded.

- Wind velocity/direction.
- Rain fall.
- Relative humidity and temperature.
- Radiation.

Components of Weather Station



Measurement of Atmospheric Elements:-

- 1 - Pressure .
- 2 - Air temperature .
- 3 - Relative humidity .
- 4 - Wind Direction and Speed .
- 5 - Solar Radiation .
- 6 - Duration of Sunshine .
- 7 - Rainfall .
- 8 - Evaporation .

① Pressure :-

The Non-recording instrument for the measurement of atmospheric pressure is the barometer and the recording one is the barograph

A barograph is a recording aneroid barometer. It produces paper or foil chart called barogram that records the barometric pressure over time.

The most common type of barometer used is the aneroid barometer shown in figure.

* Inside this instrument is small, flexible metal capsule called aneroid cell.

In the construction of the device, a vacuum is created inside the capsule so that small changes in outside



air pressure cause the capsule to expand or contract.

- The size of the aneroid cell is then calibrated and any change in its volume is transmitted by springs and levers to an indicating arm that points to the corresponding atmospheric pressure on dial.

(2) Air Temperature:-

The non-recording instruments used for the measurements of air temperature are maximum and minimum thermometers, which give the extreme values of daily air temperature.

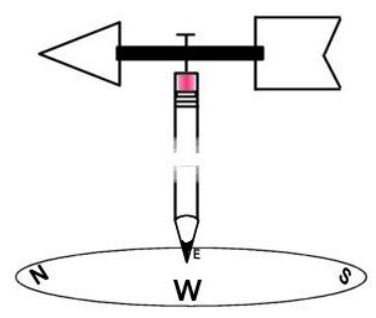


- The top thermometer contains alcohol and is used to determine daily minimum temperature.
- The lower thermometer uses mercury to determine the daily maximum temperature.
- Thermometers found inside the instrument shelter are mounted approximately 1.5 meters above the ground surface.

Thermographs are used as recording instruments to get a continuous record of air temperature.

③ Wind direction:-

Knowing the direction of wind is an important part of predicting weather because wind bring us our weather.



A wind vane also called a weather vane, is a tool for measuring wind direction and was probably one of the first weather instruments ever used. To determine wind direction a wind spins and points in the direction from which the wind is coming and has generally two ends/parts - one that is usually shaped like an arrow and turns into wind and one end that is wider so that it catches the breeze.

The arrow will point to the direction the wind blowing from. If it is pointing east it means that the wind is coming from the east.

To use a wind vane you must know north, south, east and west directions - which is usually taken from compass.

④ Wind Speed:-

Anemometer is a type of weather instrument that measures wind speed. Some of these instruments measure both wind speed and wind direction.



Anemometers are common at weather stations. A cup anemometer is type of instrument that uses three or four hemispherical cups mounted on horizontal arms on a vertical rod. The wind pushes the cups and causes the arms to rotate at a rate proportional to the wind speed.

Some scientific anemometers use the speed of sound to measure the wind speed more precisely in three dimension.

⑤ Solar Radiation:-

The solar radiation passes through the earth's atmosphere, some of it is absorbed or scattered by air molecules, water vapors, aerosols and clouds.

The solar radiation that passes through directly to the earth's surface is called Direct Solar Radiation. Direct radiation is measured by Pyrheliometer.



⑥ Duration of Sunshine:-

The duration of sunshine (hourly and daily totals) is measured with Sunshine Recorder.

The instrument consists of a glass sphere about 10cm in diameter mounted concentrically in a section of a spherical bowl, the diameter of which is such that the sun rays are focused sharply on a card held in grooves in the bowl.

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This instrument uses heat radiation from the sun to burn a trace in the chart. The length of the trace give length of bright shine hours.