

# Hydrology (SES 103)

## Precipitation

# Precipitation

- Precipitation is the release of water from the atmosphere to reach the surface of the earth.
- The term 'precipitation' covers all forms of water being released by the atmosphere, including snow, hail, sleet and rainfall. It is the major input of water to a river area and as such needs careful assessment in any hydrological study.

# Formation of precipitation

- There are four basic conditions which are to be satisfied for the precipitation to occur:
- 1. Accumulation of moisture of sufficient intensity to account for the observed rates of precipitation.
- 2. Cooling of air to the dew point temperature to produce saturation condition.
- 3. Condensation.
- 4. Growth of small water droplets to precipitable size.

# Accumulation of moisture

- It is evaporation which feeds moisture to the atmosphere.
- The simple principle of conservation of mass requires that a balance must be maintained between the evaporation and precipitation.
- So, it is by evaporation that the moisture accumulates in the atmosphere.

# Cooling of the atmosphere

- Cooling of the atmosphere may take place through several different mechanisms occurring independently or simultaneously. The most common form of cooling is from the uplift of air through the atmosphere.
- The ability of air to hold water vapour is temperature dependent: the cooler the air the less water vapour is retained. If a body of warm, moist air is cooled then it will become saturated with water vapour and eventually the water vapour will condense into liquid or solid water. The water will not condense spontaneously however; there need to be minute particles present in the atmosphere, called condensation nuclei, upon which the water or ice droplets form.

# Condensation nuclei

- Condensation nuclei are minute particles floating in the atmosphere which provide a surface for the water vapour to condense into liquid water upon.
- They are commonly less than a micron (i.e. one millionth of a metre) in diameter.
- There are many different substances that make condensation nuclei, including small dust particles, sea salts and smoke particles.

# Water droplet growth

- Water or ice droplets formed around condensation nuclei are normally too small to fall directly to the ground; that is, the forces from the upward draught within a cloud are greater than the gravitational forces pulling the microscopic droplet downwards.
- In order to overcome the upward draughts it is necessary for the droplets to grow from an initial size of 1 micron to around 3,000 microns (3 mm).

# Formation of precipitation

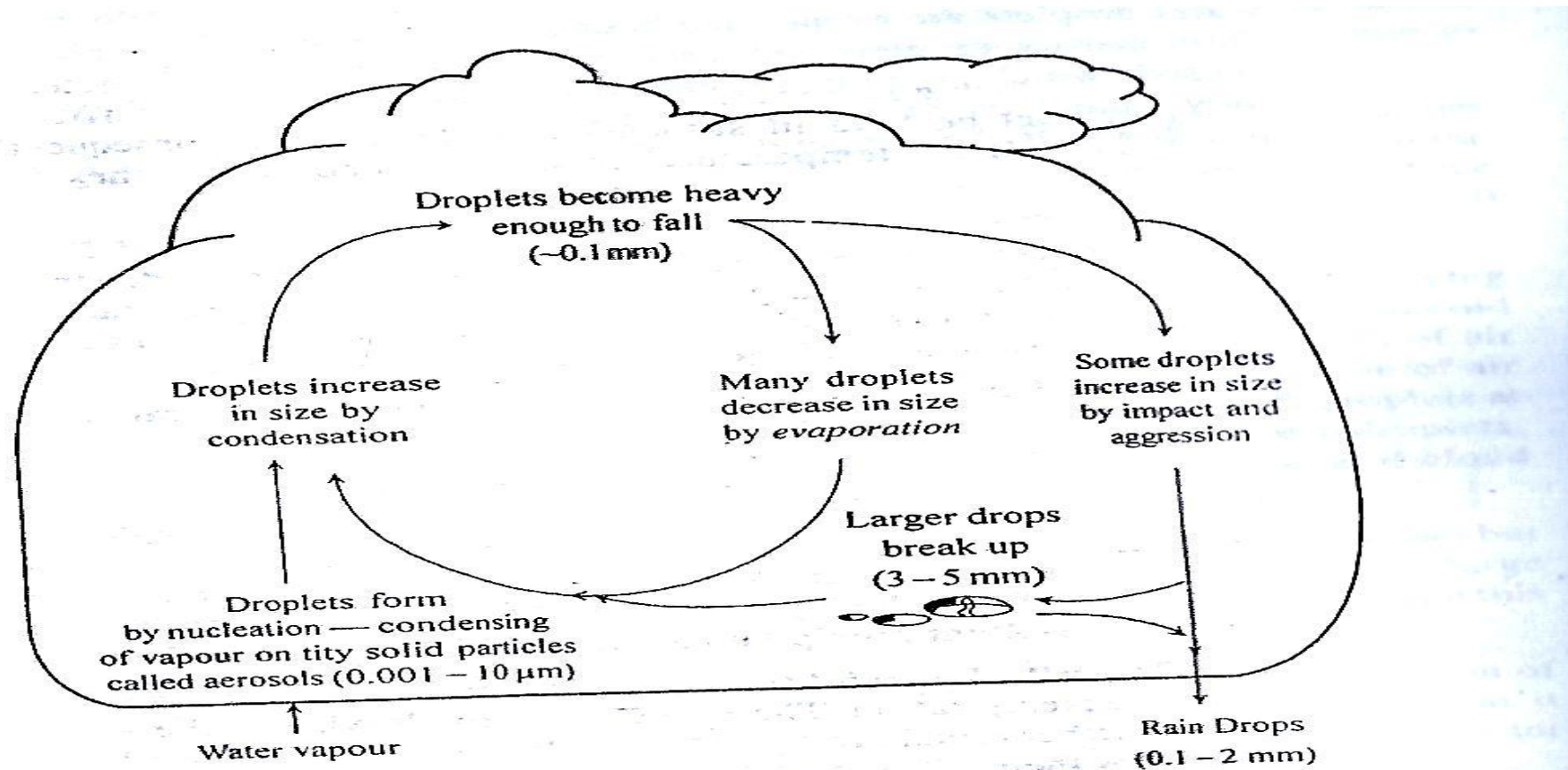


Fig : 5.3 : "Formation of water droplets in clouds by nucleation of vapour on aerosols, then go through many condensation-evaporation cycles as they circulate in the clouds, until they aggregate into large enough drops to fall through the cloud base"—(Source : After : V.T. Chow, D.R. Maidment and L.W. Mays, 2014.)"



# Forms of precipitation

- The number of different forms of precipitation is very large. Only common types are described here:
- **Drizzle:** It is fine sprinkle of very small and rather uniform water drops with diameters between 0.1 and 0.5 mm. The drops are so small that they seem to float in air. To qualify as drizzle (also called mist sometimes), the drops must not only be small but they must also be very numerous. The intensity of drizzle rarely exceeds 1 mm/h.
- **Rain:** Rain is the precipitation of liquid water in which the drops are generally larger than 0.5 mm in size. The maximum size of a raindrop is about 6 mm. It is the principle form of precipitation.

# Types of rain

- On the basis of its intensity, rainfall is classified as:

Type	Intensity
1. Light rain	Trace to 2.5 mm/h
2. Moderate rain	2.5 mm/h to 7.5 mm/h
3. Heavy rain	Greater than 7.5 mm/h

# Forms of precipitation (Drizzle)







# Forms of precipitation (Rain)





# Forms of precipitation (Glaze)

- Glaze: The ice coating formed when rain or drizzle freezes as it comes in contact with the cold objects at the ground is called glaze.



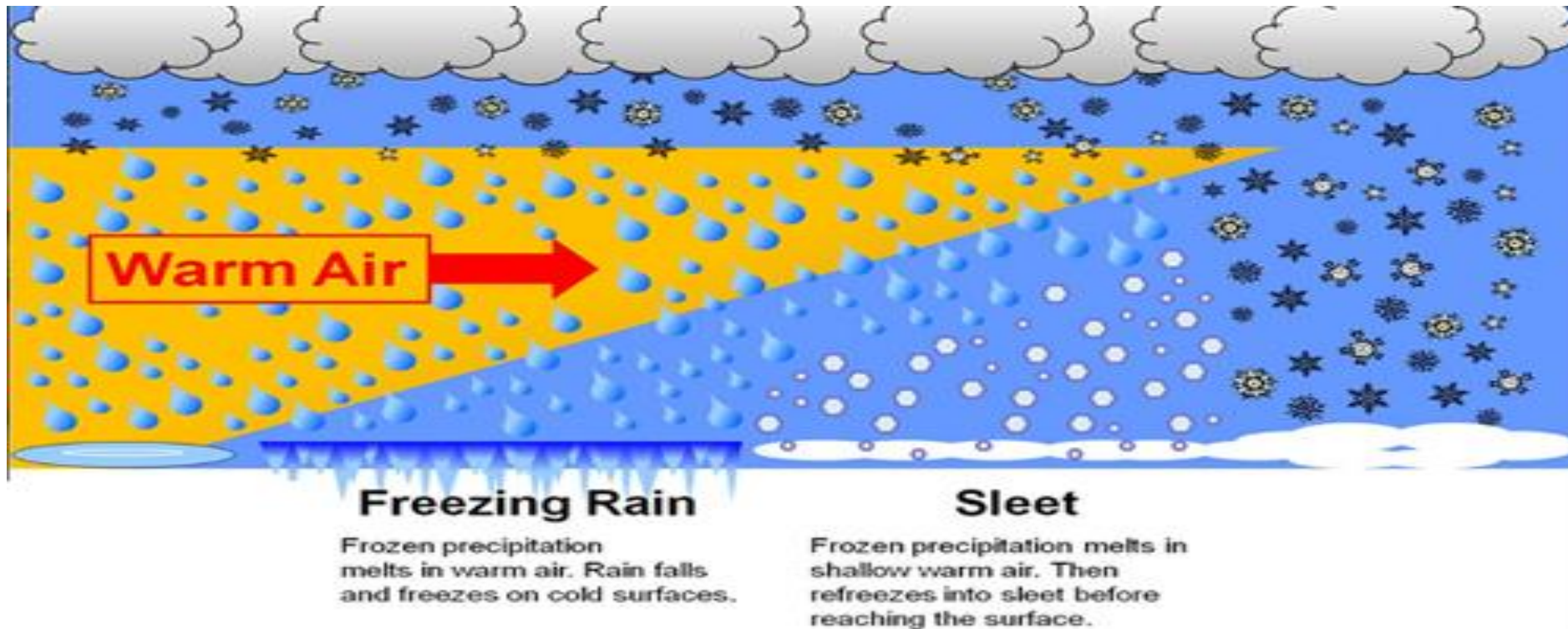
# Forms of precipitation (Glaze)





# Forms of precipitation (sleet)

- **Sleet:** When rain drops are frozen while falling through a layer of subfreezing air (below 0°C) near the earth's surface, transparent globular grains of ice known as sleet or ice pellets are formed. The pellets are generally between 1mm and 4 mm in diameter.





# Forms of precipitation

- Snow: Precipitation in the form of ice crystals is called snow. Snow consists of ice crystals which usually combine to form flakes. When fresh snow has an initial density varying from 0.06 to 0.15 g/cm<sup>3</sup> and it is assumed to have an average density of 0.1 g/cm<sup>3</sup>.

# Forms of precipitation (Snow)





# Forms of precipitation (Hail)

- **Hail:** Precipitation in the form of balls or irregular lumps of ice over 8 mm in diameter is called hail. Hail occurs almost exclusively in violent or prolonged thunderstorms.



# Measurement of precipitation

- Precipitation was probably the first hydrological phenomenon to have been recorded by man.
- All forms of precipitation are essentially measured on the basis of the vertical depth of water that would accumulate on a level surface if the precipitation is retained where it fell.
- Precipitation is usually measured in millimetres and tenth of millimetres.
- A small surface area is taken for the purpose of measurement and the volume of precipitation water collected over that area is divided by the area to give the depth of precipitation.

# Raingauges

- The precipitation is measured by an instrument called a raingauge.
- Raingauge is also known as hyetometer, ombrometer or, pluviometer.
- Raingauges are of two types:
  - a. Non-recording type or, ordinary raingauges
  - b. Recording type or, automatic raingauges.

# Non-recording type

- Also called Symon's gauge.
- It is an indirect process of measurement of precipitation.
- Only amount of precipitation can be known or measured.
- It is less expensive.

# Recording type

- It is direct process of measurement of precipitation.
- Amount, intensity, time of happenings of precipitation can be known or measured.
- It is expensive.

# Symon's gauge: structure

1. **Symon's gauge is essentially consists of a Circular collecting area of 12.7 cm in Diameter.**
2. **The rim of the collector is set in a horizontal Plan at a height of 30.5 cm above the ground level.**
3. **The funnel and receiving vessels are housed in a metalic container.**

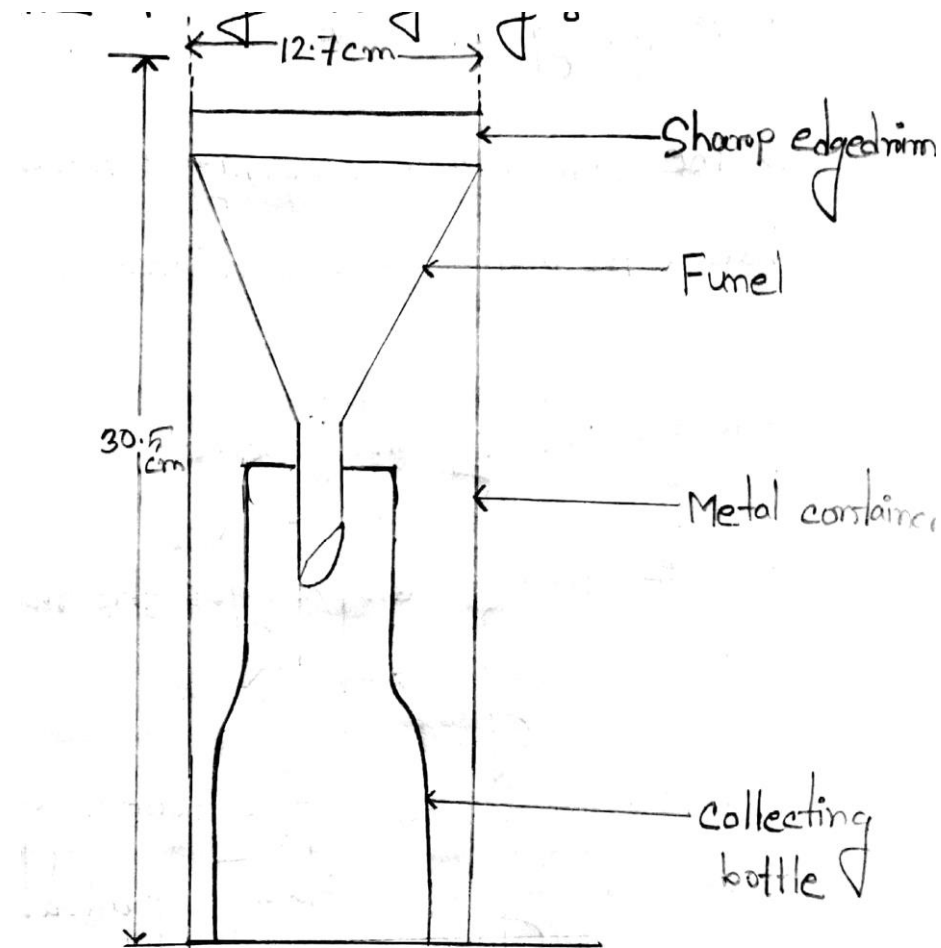


Figure. Non-recording or Symon's gauge



# Function's of Symon's gauge

- 1. The funnel discharges, the rainfall catch into a receiving vessel.
- 2. Water contained in the receiving vessel is measured by a suitably graduated measuring glass with an accuracy up to 0.1 mm.

# Advantages and disadvantages

- Advantage:
  1. It is very simple and easy method for the measurement of precipitation.
  2. It is less expensive.

## Disadvantage:

1. It is an indirect method. Intensity and time of happening of precipitation can't be measured by this type of raingauge.

# Recording type raingauge

- Recording raingauge is used to record the beginning and end of the rain and to measure the intensity of rainfall.
- Recording raingauges usually work by having a clock-driven drum carrying a graph on which a pen records the cumulative depth of rainfall continuously.

# Recording type raingauge

- Different types of recording raingauges are:
- A. Tipping bucket type
- B. Weighing bucket type
- C. Float type

# Weighing bucket type

- Weighing bucket raingauge is one kind of recording raingauge where precipitation of an area is measured by recording the weight of rainfall received within a described period.

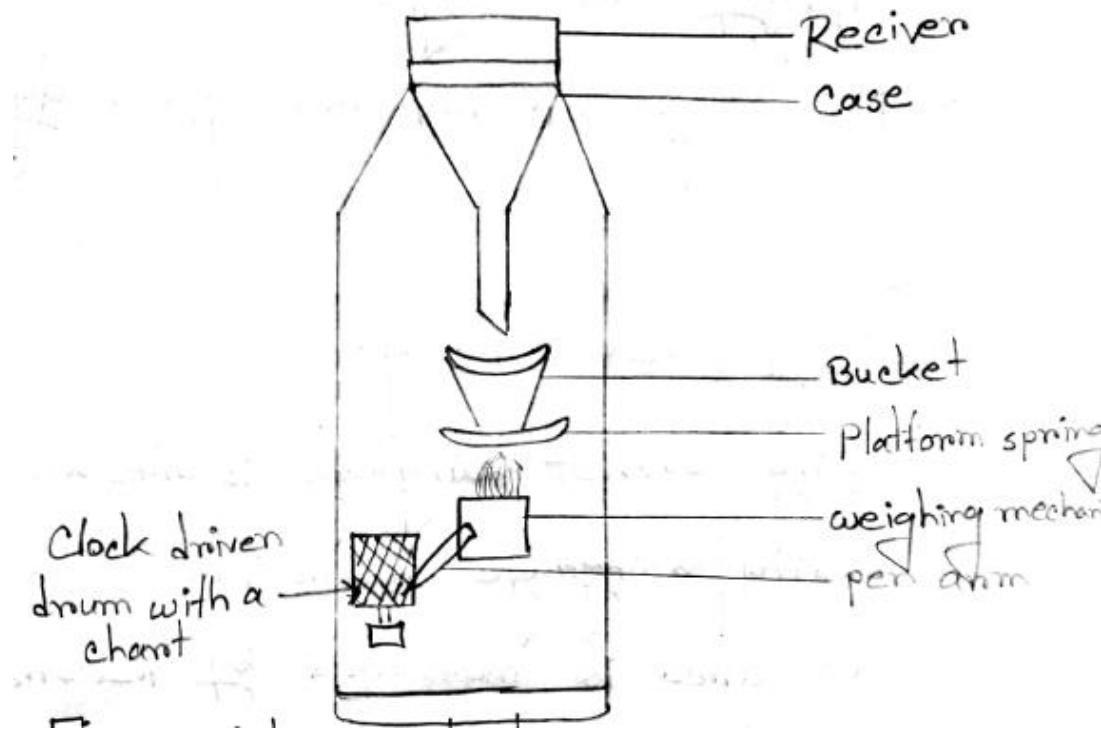
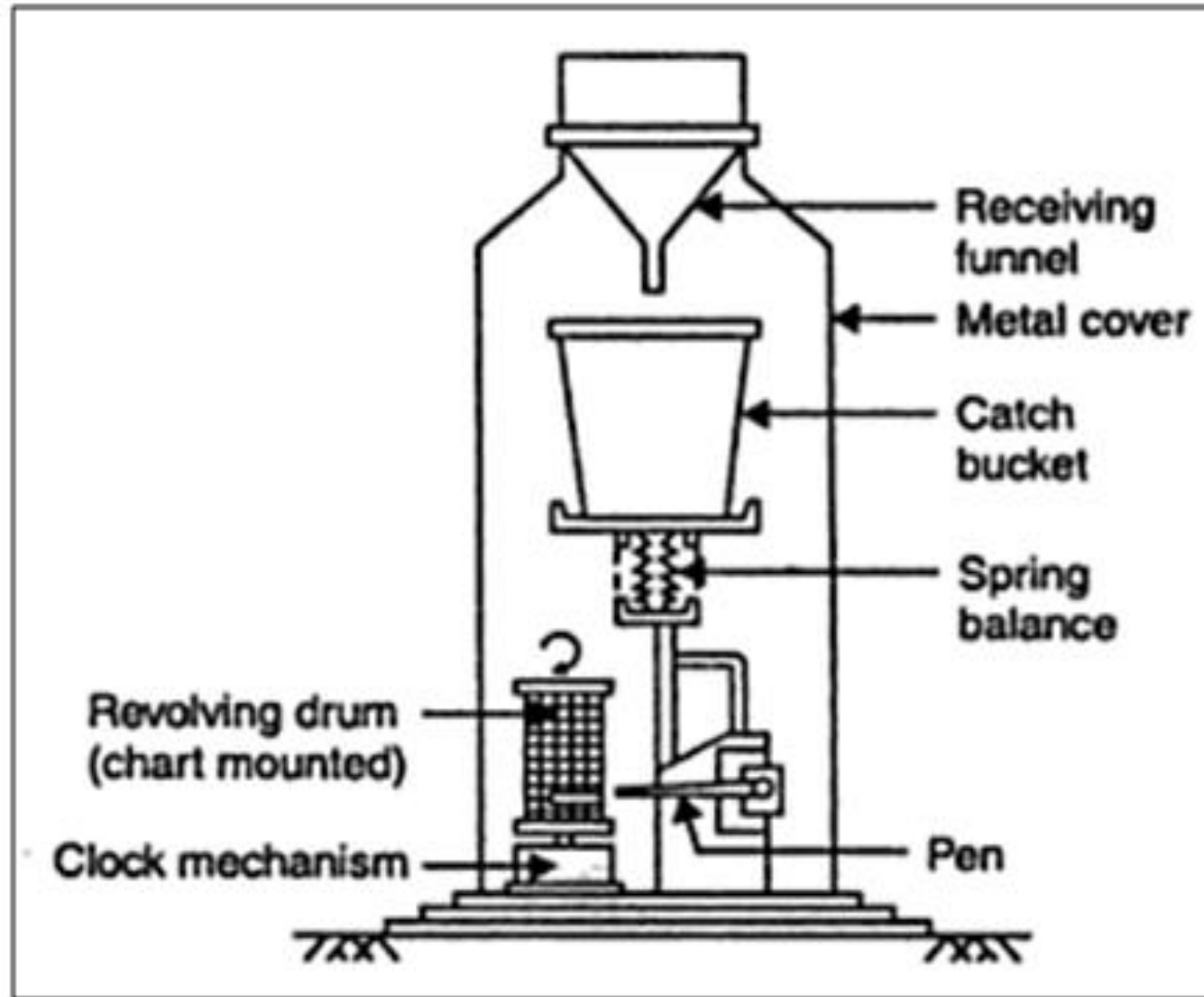


Figure. Weighing bucket raingauge

# Weighing bucket type

- In this type of gauge the rain falling on the receiving area is collected by the funnel and is led into a storage bucket which rests on a weighing platform.
- The weight of the rainfall received since the recording began is recorded continuously by transmitting the movement of the platform through a system of links and levers to a pen which makes a trace on a suitably graduated chart secured around a drum.
- The drum is driven mechanically by a spring clock.
- The drum may be made to revolve once a day, once a week or, once in any other desired period.

# Weighing bucket type (Figure)



# Advantages of weighing bucket type

- It is a direct method for the measurement of precipitation. All forms of precipitation are weighed and recorded automatically.
- It can record snow, hail and mixture of snow and rain.