<center>**TYPES OF THERMOMETERS**</center>

1-Liquid in glass thermometer;

it uses a thermometric property which is, length of the column of liquid to measure the degree of hotness of the body. Liquids usually used are; mercury, alcohol and water.

Procedure

- ✓ Place the bulb in ice and find the length of the mercury column in capillary tube, L_0
- ✓ Place the bulb in steam and find the length of the mercury column in capillary tube, L_{100}
- ✓ Place tthe bulb in contact with the body of an unknown temperature and find the length of mercury column L_θ
- ✓ Calculate the unknown temperature ,θ using

$$\theta = \frac{l_{\theta}-l_0}{l_{100} - l_0} \times 100°C$$

Advantages of a Liquid in Glass Thermometer

- It is easy to use
- It is very cheap
- It is very portable
- It has direct readings

Disadvantages of a Liquid in Glass Thermometer

- It has small range of temperature
- It is not very accurate
- Its fragile so care is needed

N.B:

A liquid in glass thermometer is not very accurate because of the following; .

- ✓ Parallax errors.
- ✓ Non uniformity of the bore of capillary tube.
- ✓ The glass contracts and expands and takes long hours to recover its correct size and shape and therefore spoils the calibration.
- ✓ Gradual creep of the zero mark due to shrinking of the bulb after sometime.

Reasons why mercury is used as thermometric property .

- It doesn't wet the glass
- It is opaque
- It expands uniformly
- It is a good conductor of heat

Reasons why water is not used as thermometric property

- It wets the glass.
- It is not opaque.
- It is a bad conductor of heat.
- It is has non uniform expansion.

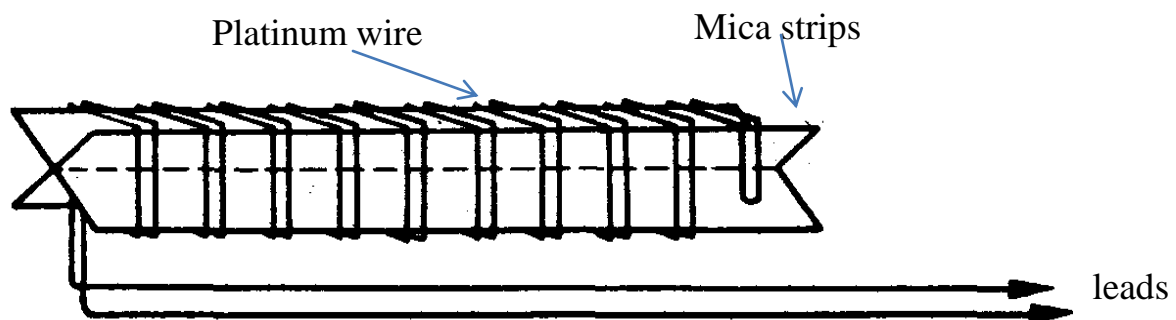**2)-RESISTANCE THERMOMETER [PLATINUM RESISTANCE THERMOMETER]**
A resistance thermometer uses resistance(R) of a metal wire as a thermometric property.

QUALITIES OF A METAL TO BE USED IN A RESISTANCE THERMOMETER

➢ Material of the wire should have a high temperature co-efficient of resistance (R) so that a small change in temperature causes a measurable change in resistance.
➢ The variation of resistance with temperature should be linear.

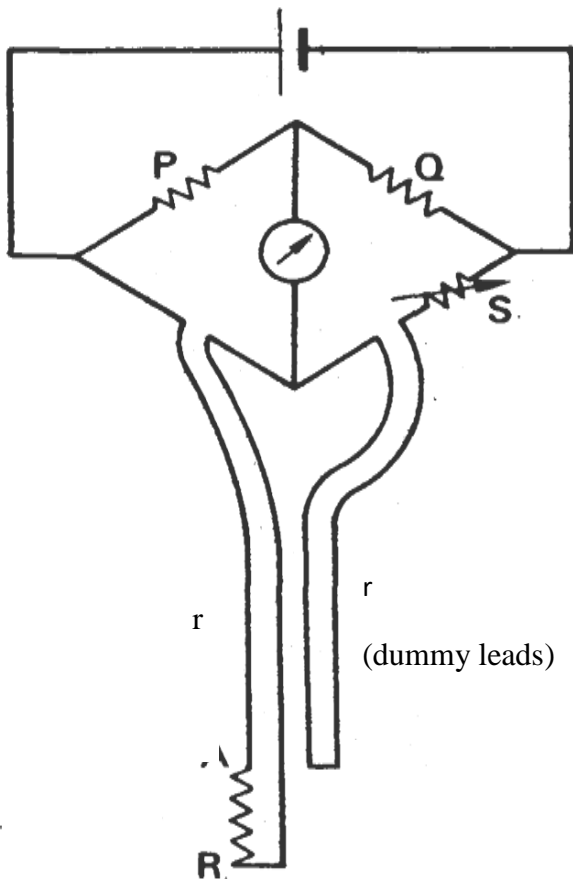Platinum is chosen to be used because it satisfies above 2 conditions.
Construction of the platinum resistance thermometer.

Platinum wire   Mica strips

                                                                          leads

A platinum wire is wound on two strips of mica as shown in the above diagram.

MODE OF OPERATION.

- The platinum wire is connected in one arm of a wheatstone bridge.

(dummy leads)

- The resistance of platinum wire is **R** .
- The resistance of the leads of the thermometer is r .
- Dummy leads which lie alongside the thermometer have resistance r.
- The platinum wire is put in ice and the variable resistor, S varied until galvanometer shows no deflection. Let s_0 be the resistance of s at balance point.
- Then $\dfrac{P}{Q} = \dfrac{R_0 + r}{S_0 + r}$

Where R_0 is the resistance of platinum wire at ice point. In the set up the resistances P and Q are equal hence $R_0 = S_0$.

- The platinum wire is now put in steam and the variable resistor, S varied until galvanometer shows no deflection. The resistance of the wire , R_{100} is equal to the resistance of S and is recorded as S_{100}

- $R_{100} = S_{100}$.

- The platinum wire is now put in contact with a body of unknown temperature and variable resistor, S varied until galvanometer shows no

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deflection . The resistance of the platinum wire, R_θ is equal to the resistance of S and is recorded as S_θ.

- The known temperature can be calculated using.

$$\theta = \frac{S_\theta - S_0}{S_{100} - S_0} \times 100°C$$

ADVANTAGES OF PLATINUM RESISTANCE THERMOMETER

- It is used for measuring small unit temperature.
- It is very accurate. It is because the resistance of platinum wire varies linearly with temperature.
- It has a wide range of temperature i.e. from -200 to 1200
- It is very sensitive to small unit temperatures.

**Disadvantages of the platinum resistance thermometer.**

- ✓ It cannot measure very rapidly changing temperature. This is because it has low -thermal conductivity and high heat capacity.
- ✓ It cannot measure temperature at a point due to size of silica tube.
- ✓ Its heavy and not portable.

3) -THERMO COUPLE THERMOMETER
When two wires of different materials are joined together to form two junctions and their junctions maintained at different temperatures, a small e.m.f called thermo electric e.m.f is created between the junctions.
The magnitude of the emf varies with temperature difference between the two junctions.
MODE OF OPERATION
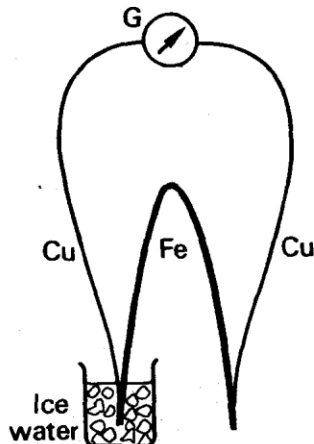
- ✓ One junction is placed on the water-ice mixture and the other junction is put in steam and the emf , E_0 set up is measured using the millivoltmeter.
- ✓ With the other junction still in the water-ice mixture, and the other junction now put in contact with a body of unknown temperature, and the Emf , E_{100} set up is measured using the millivoltmeter .
- ✓ The temperature of the body can then be calculated using

$$\theta = \frac{E_\theta}{E_{100}} \times 100°C$$

ADVANTAGES OF THERMO COUPLE

- ✓ It measures temperature at a point.
- ✓ It is used to measure rapidly changing temperatures. This is because of its small heat capacity and high thermal conductivity.
- ✓ It is robust and compact.
- ✓ It has a wide range of temperature between -250°C to 1600°C.
- ✓ They are cheap and easy to construct.

DISADVANTAGES OF THERMO COUPLE
- ✓ It cannot measure slowly changing temperatures.
- ✓ It is inaccurate because doesn't vary linearly with temperature.
- ✓ Each thermocouple requires separate calibration.

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(4)-CONSTANT- VOLUME GAS THERMOMETER

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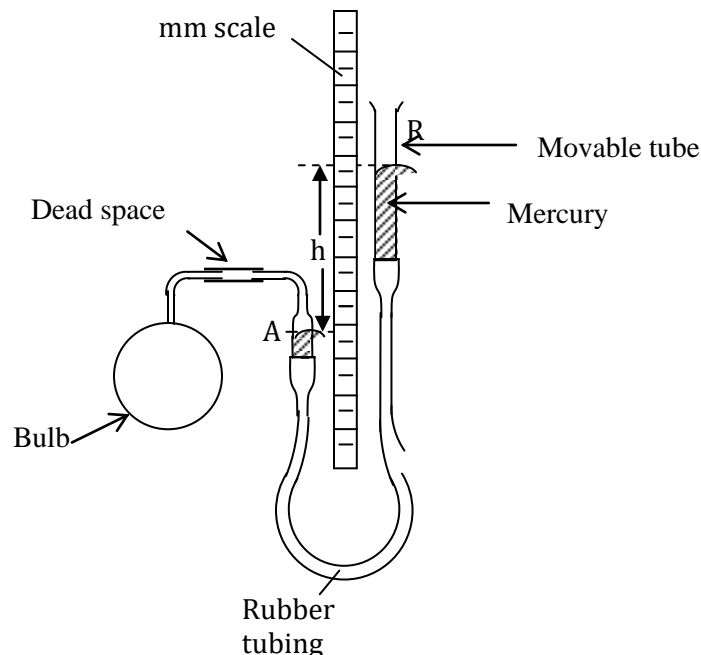
- ✓ The bulb with air is immersed in ice- water mixture. Time is allowed for the air inside the bulb to assume the temperature of the bath. The air contracts ,mercury in the left hand arm rises to a level above the constant volume mark,A.
- ✓ Tube R is moved downwards to bring the mercury level in the left hand arm to the constant volume mark,A.
- ✓ The difference,h_0 in mercury levels in the two arms is determined.
- ✓ The bulb with air is immersed in a steam bath at atmospheric pressure. Time is allowed for the air inside the bulb to attain the temperature of the bath. The air in the bulb expands pushing mercury in the left hand arm downwards.
- ✓ Tube R is moved upwards to bring the mercury level in the left hand arm to the constant volume mark,A.
- ✓ The difference,h_{100} in mercury levels in the two arms is determined.
- ✓ The bulb with air is immersed in the liquid whose temperature is required. Time is allowed for the air inside the bulb to attain the temperature of the liquid and tube ,R is adjusted to bring the mercury level in the left hand arm to the constant volume mark,A.
- ✓ The difference,h_θ in mercury levels in the two arms is determined.
- ✓ The unknown temperature can be calculated using

$$\theta = \frac{h_\theta - h_0}{h_{100} - h_0} \times 100°C$$

ADVANTAGES OF CONSTANT VOLUME GAS THERMOMETER

- ✓ It is very sensitive
- ✓ It has wide range of temperature from-270℃ to 1500 ℃ .
- ✓ It is very accurate since the pressure of fixed mass of gas at constant volume varies linearly with temperature.

DISADVANTAGES OF CONSTANT VOLUME GAS TERMOMETER

- ✓ It is bulky i.e. is not portable.
- ✓ It has no direct readings; therefore it requires skills to be read it.
- ✓ It cannot measure rapidly changing temperatures as the bulb needs time to reach steady states.

Sources of errors in a constant volume gas thermometer include;

✓ The temperature of the gas in the dead space is different from that of the gas in the bulb .
✓ Thermal expansion of the bulb.
✓ The capillary effects at the mercury surfaces.

Corrections to the errors in a constant volume gas thermometer include;

✓ The diameter of dead space is made small so that it contains only a small fraction of the gas.
✓ The expansion of the bulb can be estimated from its coefficient of cubical expansion by using the temperature shown by the gas thermometer.

NOTE.
Gas thermometers are used to calibrate other thermometers because;
✓ Gases can be obtained in the highest state of purity .
✓ Gases expand much for a small change in temperature.

(5)-PYROMETERS

They are used to measure very high temperatures e.g. temperature of furnace
They are divided into two;

✓ Total radiation pyrometer which responds to total radiation i.e. heat and light produced.
✓ Optical radiation pyrometer which responds to only light produced.

OPTICAL RADIATION PYROMETER (a radiation pyrometer is an instrument used to measure the temperature of a body by the radiation it emits.)
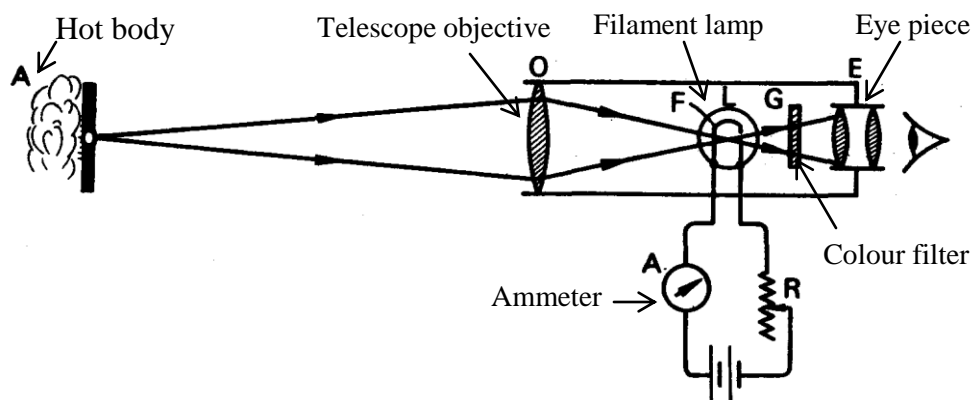
MODE OF OPERATION

✓ A hot body whose temperature is to be measured is focused by objective lens so that its image lies in the plane of the filament, F.

✓ The light radiation from both the filament and the hot body is passed through red filter to the eye.

✓ If the image of the hot body is brighter than the filament, the filament appears dark on bright background.

✓ If the filament appears bright on a dark back ground, the hot body is less bright than the filament.

✓ Using the rheostatR, the current through filament disappears.

✓ At that point, the temperature of hot body is then equals that of the filament.

✓ And this temperature can then be read from the ammeter (previously calibrated in kelvin) .

EXERCISE

1. (i) State four desirable properties a material; must have to be used as a thermometric substance .

(ii) State why scales of temperature based on different thermometric property may not agree

(iii) A platinum resistance thermometer has a resistance of 5.42Ω at triple point of water. Calculate its resistance at a temperature of $50.0℃$

2. (a) (i)Define the term thermometric property and give four examples.

(ii) State two qualities of a good thermometer property .

(b) (i)With reference to the a liquid in glass thermometer, describe the steps involved in setting up a Kelvin scale of temperature .

(ii) State one advantage and disadvantage of the resistance thermometer.

(c) (i) With reference to a constant-volume gas thermometer define temperature on the Celsius scale .

(ii) State two advantages and two disadvantages of constant-volume gas thermometer.

(d) (i) Define the triple point of water .

(ii) Describe how you would measure the temperature of a body on thermodynamic scale using a thermo couple.

3,(a) (i)What is meant by the term fixed points in thermometry. Give two examples of such points

(ii) How is temperature on a Celsius scale defined on a platinum resistance thermometer?

(b) Explain the extent to which thermometer based on different properties but calibrate using the same fixed points are likely to agree when used to measure a temperature

(i) Near one of the fixed points (02marks)

(ii) Midway between the two fixed points (02marks)

(c) What are the advantages of a thermocouple over a constant volume gas thermometer in measuring temperature?

(d) (i)Describe with the aid of a diagram, how a constant volume gas thermometer may be used to measure temperature (06marks)

(ii) State three corrections that need to be made when using the thermometer in c(i) above.
(iii)State and explain the sources of in accuracies in using mercury-in-glass thermometer.

(e) The resistance of the element of a platinum resistance thermometer is 4Ω at the point and 5.46Ω at the steam point. What temperature on the platinum resistance scale would correspond to a resistance of a 9.84Ω.