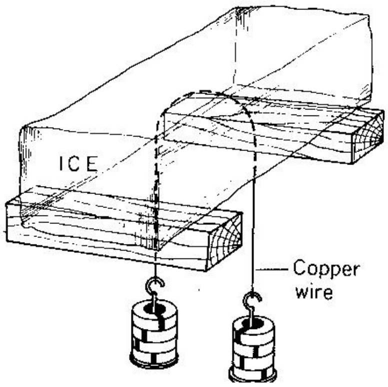


A weighted copper wire is allowed to pass through a block of ice. It sinks through, without cutting the ice block into two pieces

Explanation

When a copper wire is pulled, a very high pressure is exerted on the ice block, lowering its melting point and the ice melts.

The wire sinks through the water which is no longer under pressure and freezes above the wire because melting point returns to 0^0c

In freezing, the water gives out its latent heat of fusion and thus conducted down through the wire to enable the ice below it to melt. This effect is called regelation (freezing).

Note: If an iron wire is used in demonstration, it passes through the ice more slowly. No effect is obtained if string is used.

VAPOUR PRESSURE.

It refers to the pressure exerted on the wall of the container by the vapour.

Consider a liquid in a closed vessel when molecules escape from the liquid they form vapour the surface of the liquid

the vapour molecules move in directions and exerts a pressure called vapour pressure.

When the bounce off, the vessel strikes the liquids on surface and enter it. The dynamic equilibrium is eventually

reached ,in which the rate at which molecules live the liquid is equal to which others returns to it.

When this happens, the space above the liquid is said to be saturated with vapour.

The vapour pressure used in this state is called saturated vapour pressure but before the equilibrium the vapour

is said to be unsaturated.

Saturated vapour pressure

It is the pressure exerted on the walls of a contain by the vapour when the rate at which molecules are entering

the liquid is equal to the rate at which molecules are entering the liquid.

OR : **Saturated vapour pressure**

Is pressure exerted the vapour in a dynamic equilibrium in its own liquid.

Boiling point

Is the temperature at which at which the saturated vapour pressure is equal to the external atmospheric pressure.

At this temperature liquid molecules have enough energy to form bubbles of vapour inside the liquid. The bubbles

formed at the bottom contain saturated vapour when the reach the surface they burst.

FACTORS WHICH AFFECT THE BOILLING POINT AND FREZING/MELTING POINT OF WATER

Addition of impurities

Increase or decrease in pressure

Effects of impurities on boiling and melting points

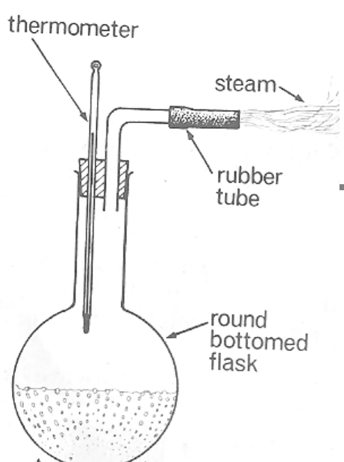
a) Melting point
   The impurities lower the melting point of a surface e.g when impurity is added to ice it melts at a lower temperature. This is because impurities weaken the cohesive forces in ice molecules making it easy for them to move freely hence the change of state from solid to liquid.
b) Boiling point

Impurities raise the boiling point of a substance e.g when salti added to water the mixture must be heated at a higher temperature before it boils. This is because impurities strengthen the cohesive forces between water molecules so more heat must be supplied to weaken them. The increase in the heat supply makes the boiling point to rise.

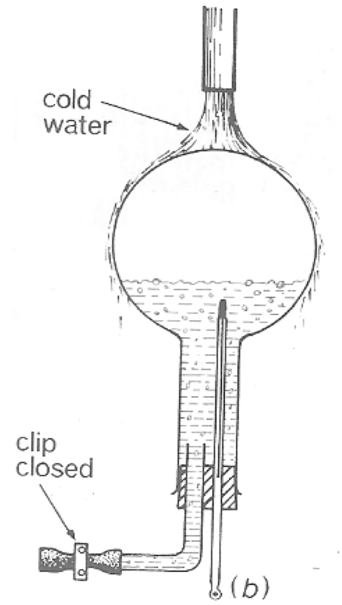
Effect of pressure on boiling and melting points

Boiling points

Increase in pressure raises the boiling point of liquid. This can be showed below resulting in decrease in gas pressure.



- Water in the flask shown above has to be heated to about 100^{0}c before it boils. If the pressure above the flask is high, the liquid starts to boil at a much lower temperature than usual.
- This can be shown by boiling water in the flask for a few minutes so that the steam sweeps out most air .Heating is stopped and the clip is closed
- Cold water is poured on the inverted flask, so condensing the steamed water this reduces pressure above water.
- The water starts to boil and if cooling in this way it continued boiling goes on until above 40^{0}c

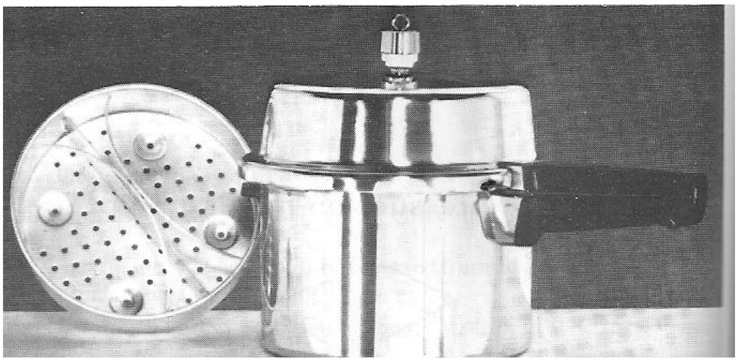


Melting point

Increase in pressure lowers the melting point of a solid e.g ice. This effect makes skating /skiing possible, the pressure of ice skate melts the ice under it, so that there is a thin layer of water between the skate and ice. The layer of water acts as a lubricant and almost completely removes friction between skate and ice.

The pressure cooker

This is a strong aluminium pan, whose lid is sealed with a rubber sealing ring to prevent steam from escaping from inside the pan.
As the substance e.g water is heated to boil,the steam pressure inside builds up causing the boiling point to rise to about 120^{0}c
The high temperature makes the substance get cooked quickly.



GAS LAWS

Gases when heated will show a significant change in pressure volume and temperature. Unlike solids and liquids which show on insignificant change in volume. There are 3 gas laws -:

1. Boyle's law
2. Charles's law
3. Pressure law

BOYLE'S LAW.

It states that the pressure of a fixed mass of gas is inversely proportional to its volume provided temperature remains constant.

Mathematically

P $\propto \frac{1}{v}$ at constant temperature.

PV = k (constant)

So, in calculation we use ;

$P_1V_1 = P_2V_2$

Example 1

The pressure of a fixed mass of gas is 5artmospheres when its volume is 200cm^3. Find its pressure when the volume

(i) Is halved
(ii) Is doubled

(iii) Is increased by $1\frac{1}{2}$ times provided temperature remains constant.

Solution

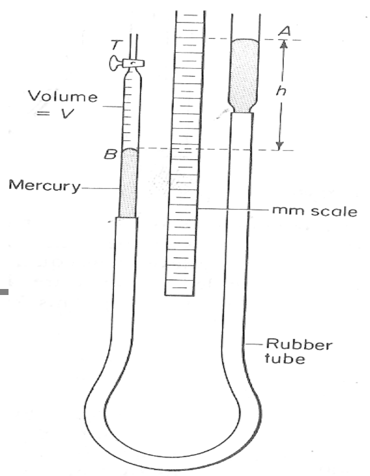
(i) $P_1 V_1 = P_2V_2$
$5 \times 200 = P_2 \times 100$
$P_2 = 10$ atmospheres.

(ii) $P_1V_1 = P_2 V_2$
$5 \times 200 = P_2 \times 400$
$P_2 = 2.5$ atmospheres

(iii) $P_1 V_1 = P_2 V_2$
$5 \times 200 = p_2 \times 300$
$= 3^1/_3$ atmospheres.

When pressure is doubled the volume is halved or vice versa

EXPERIMENT TO VERIFY BOYLE'S LAW

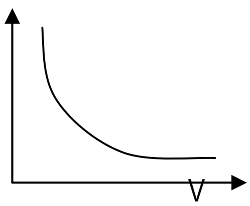


- Trap dry air in a bulb by pouring mercury through the reservoir
- For each volume (v) of trapped air , determine the height differences (h) between mercury levels y and x
- Find the pressure (p) = H + h where H is the atmospheric pressure.
- Record results including $\frac{1}{v}$ as in the table below.

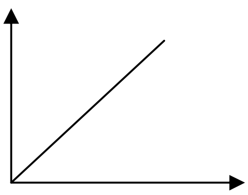
$V(cm^3)$	h(cmHg)	P =(H + h)/cmHg	$\frac{1}{V}(cm^{-3})$

Graphs of Boyle's law.

P



P



$\frac{1}{v}$ gas

CHARLES'S LAW.

It states that volume of affixed mass of gas at constant pressure is directly proportional to its absolute temperature**.**

Mathematically.

Volume v ∝ T where T is absolute temperature

V = kT = $\frac{v}{T} = k(constant)$

In calculation we use

$\frac{v1}{T1} = \frac{v2}{T2}$

Example 1

i) Affixed mass of gas occupies $500cm^3$ at 27°C. At what temperature will the volume of the gas double if pressure remains constant?

ii) Find the volume of gas at -123°C if pressure remains constant.

$T_1 = 27°C + 273 = 300K$ $T_2 = ?$

i) $\frac{V1}{T1} = \frac{V2}{T2} = \frac{500}{3o0} = \frac{1000}{T2}$

$T_2 = 600K$

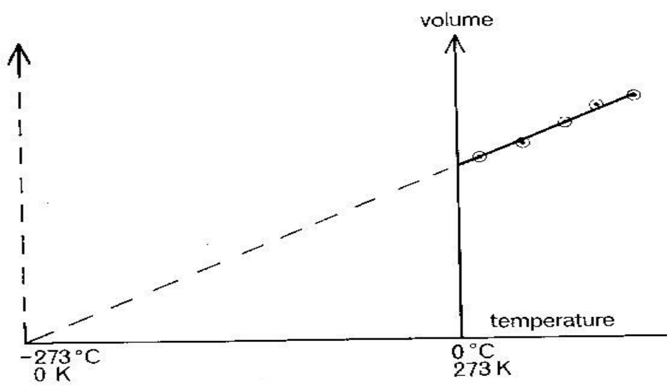
ii) $T_1 = 27 + 273$ $T_2 = -123 + 273$

$= 300K$ $= 150K$

$\frac{V1}{T1} = \frac{V2}{T2} \frac{500}{300} = \frac{V2}{150}$

$V_2 = 250cm^3$.

Graphs of Charles's law.



The graph is a straight line; it crosses the temperature axis at -273°C

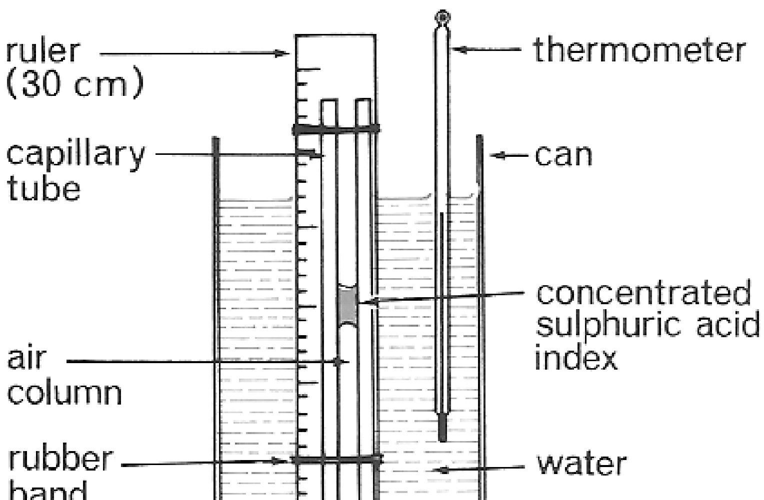
Absolute zero temperature (ok)

This is the lowest temperature possible where all molecules of gases have zero kinetic energy.

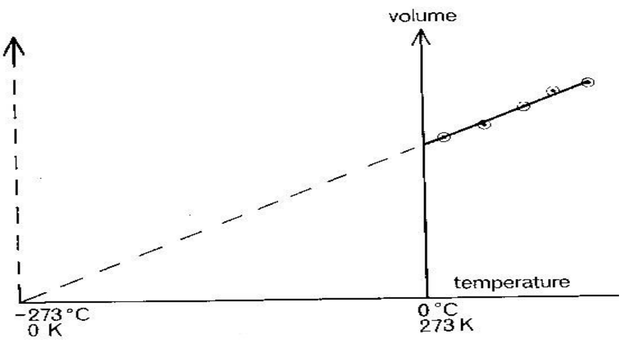
All gases liquefy before this temperature and don't obey gas laws at this temperature because they have turned into liquid.

Experiment to verify Charles's law.

- Trap air in a capillary tube using a sulphuric acid index
- Set the apparatus as in the diagram above.
- Vary the volume of trapped air by gently warming water in the beaker.



- For every temperature θ of water in the beaker record corresponding volume of trapped air using the scaleon the meter ruler.
- Record the results as in a suitable table
- Then a graph of volume against temperature is plotted as shown.



- The graph is very straight line and crosses temperature Axis at -273^{0}c. This verifies Charles' law.

NOTE
- Trapped air acts as gas
- Constant pressure will equal to the atmospheric pressure of the trapped air.
- Pressure due to the weight of the index is equal to zero.
- Concentrated sulphuric acid is used for trapping air in capillary tube
- Drying the trapped air.

PRESSURE LAW.

The pressure of a fixed mass of gas at constant volume is directly proportional to its absolute temperature.

Mathematically

$P \propto T$

$P = KT = \frac{P}{T} = K$ (Constant)

In calculation we use

$= \frac{p1}{t1} = \frac{p2}{t2}$

Example

The pressure of gas in a cylinder is 15atm at 27°C what will It be at 177°C at what temperature will the pressure be 10 atmospheres.

$T_1 = 27 + 273 = 300K$ $T_2 = (177 + 273)K = 450K$

$\frac{P1}{T1} = \frac{P2}{T2} = \frac{15}{300} = \frac{P2}{450}$

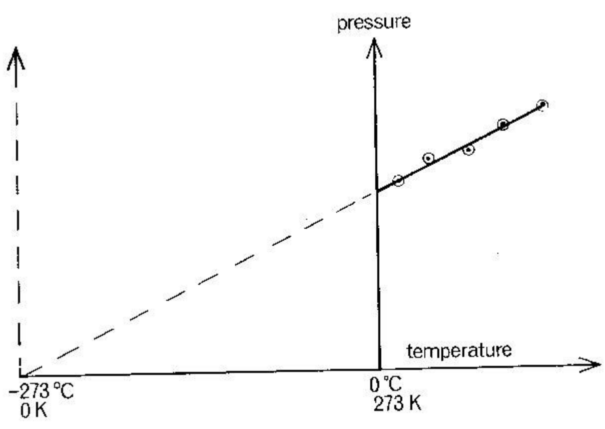
$P_2 = 22.5$atm.

(i) $P_1 = 15$atm $P_2 = 10$atm
$T_1 = 300K$ $T_2 = ?$

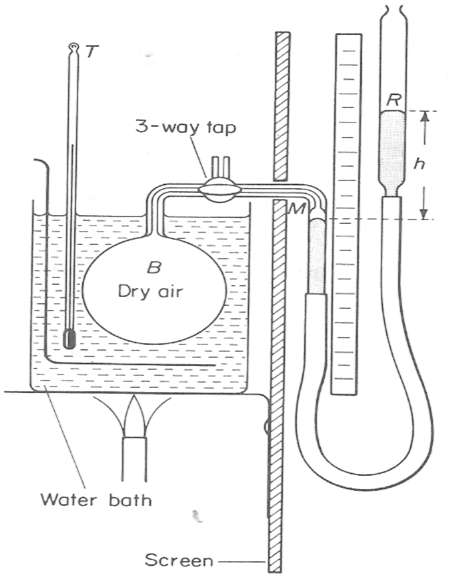
$\frac{P1}{T1} = \frac{P2}{T2} = \frac{15}{300} = \frac{10}{T2}$

$T_2 = 200K$.

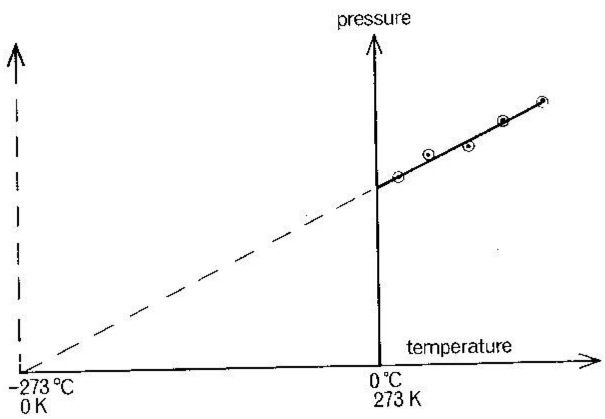
Graphical form of pressure law.



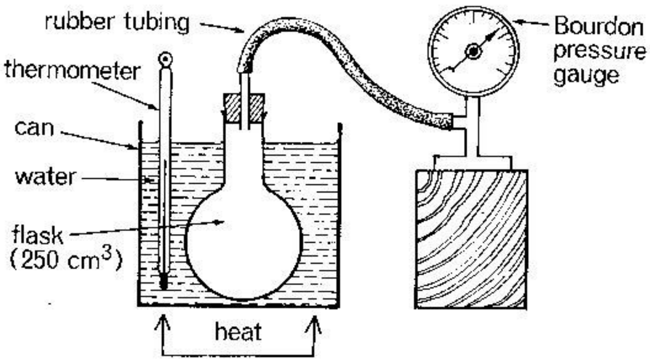
Experiment to verify pressure law.



- Set the apparatus as
- Gently heat the water in the beaker to vary temperature.
- For every temperature θ set adjust the mercury level in the manometer until it touches the I mark.
- Record the height difference p of trapped air given by p = H + h, where H is atmosphere pressure.
- Plot a graph of p against θ as shown.



Method 2



- *The apparatus is set up as shown above*
- *The rubber tubing from the flask to the pressure gauge should be as short as possible The flask must be in water almost to the top of its neck.*
- *The can is heated from the bottom; the pressure is then recorded over a wide range of temperature. The heating is stopped to allow steady gauge reading for each reading taken.*
- *The results are tabulated and a graph of pressure against temperature plotted. A straight line graph touching the temperature axis at -273°C verifies pressure law*

Equation of state (ideal gas equation)

This is an equation which relates pressure, volume and absolute temperature of a fixed mass of a gas in different states. It is written as $\frac{pv}{T}$ = constant where T is the absolute temperature.

But in calculation we use

$$\frac{p1v1}{T1} = \frac{P2V2}{T2}$$

EXAMPLE

The pressure and volume of a fixed mass of gas at 27⁰C is 5atm and 300°C respectively. Find the temperature of a gas in °C, occupying the volume of 4500°C at pressure of 4 atmospheres.

$T_1 = 27 + 273 = 300$ T_2=?

$$\frac{p1v1}{T1} = \frac{P2V2}{T2}$$

$$\frac{T2\ X\ 5\ X\ 3000}{300} = \frac{4\ X\ 4500\ X\ 300}{T2}$$

$T_2 = 360K$

In Celsius scale $T_2 = 360 - 273 = 87^0C$

Question

1. A cycle pump contains 50cm³ of air at 17°C at 1 atmosphere. Find

i) The pressure when the air is compressed to 10cm3 and its temperature rises to 27°C
ii) Volume of air at pressure of 4 atmospheres and temperature of 77°C.

Standard temperature and pressure (S.T.P)

This is the physical condition of temperature equal to 0°C and pressure is equal to 76cmhg at S.T.P,1 mole of any gas occupies 22.4l

GAS LAW AND KINETIC THEORY.

Kinetic theory can be used to explain

i) Cause of gas pressure
ii) Boyle's law
iii) Charles's law
iv) Pressure law.

CAUSES OF PRESSUERE.

1. Gas molecules are in constant random motion colliding with each other and bombarding the walls of the container. As they bombard the walls of the container, they exert a force on the walls. These forces cause gas pressure.

2. **BOYLE'S LAW**

At constant temperature, the average speed of gas molecules is constant. When the volume of the container decreases, the rate of collision and bombardment increases resulting in increase of force exerted on the walls and increase in pressure. Likewise increase in volume at constant temperature result in decrease in pressure.

3. **CHARLES 'S LAW.**

When temperature of gas molecules increases, they move faster. To maintain the pressure constant, the volume of gas must increase simply because when temperature decreases, the volume has to in decrease to maintain the pressure constant.

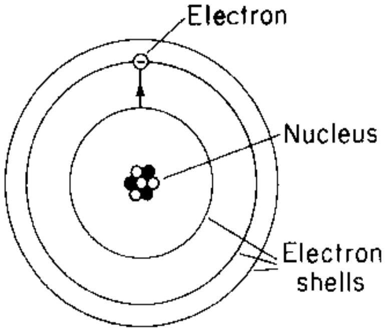
4. **PRESSURE LAW.**

When the temperature of gas increases, molecules move faster. When the volume is less, this decreases the rate of bombardment resulting in decrease in gas pressure.

ELECTROSTATICS

This refers to the study of charge at rest. To understand the nature of charge, it is necessary to know the structure of an atom.

Structure of an atom



The electrons are negatively charged while protons are positively charged. The two types of charges however are of the same magnitude in a neutral atom.

In a neutral atom, the number of negative charges is equal to the number of positive charges and the atom is said to be electrically neutral. Therefore, electrostatics is the study of static electricity because the charges which constitute it are stationary.

ELECTRIFICATION

This is the process of producing electric charges which are either positive or negative.

Methods of producing Electric charges

- By friction or rubbing (good for insulators and non conductors).
- By conduction/contact (good for conductors).
- By induction (conductors).

Electrification by friction

Two uncharged bodies (insulators) are rubbed together. Electrons are transferred from the body to the other. The body which looses electrons becomes positively charged and that which gains electrons becomes negatively charged.

Acquire positive charge	**Acquire negative charge**
Glass	silk
Fur	Ebonite (hard rubber)
Cellulose Ace tale	Polythene

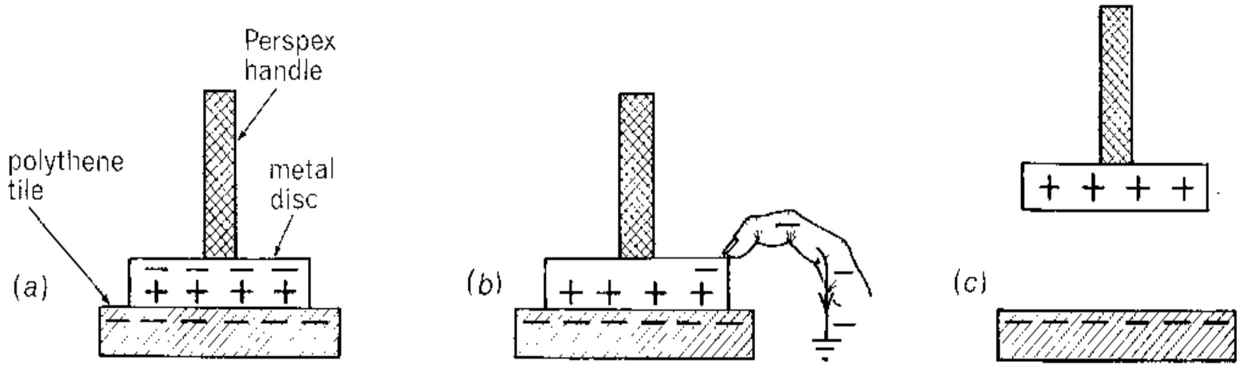
Explanation of charging by friction

When two bodies are rubbed together, work is done, transferred electrons from one body to another. This results into two bodies acquiring opposite charges.

Law of Electro statics

- Like charges repel each other.
- Unlike charges attract each other.

Electrification by conduction

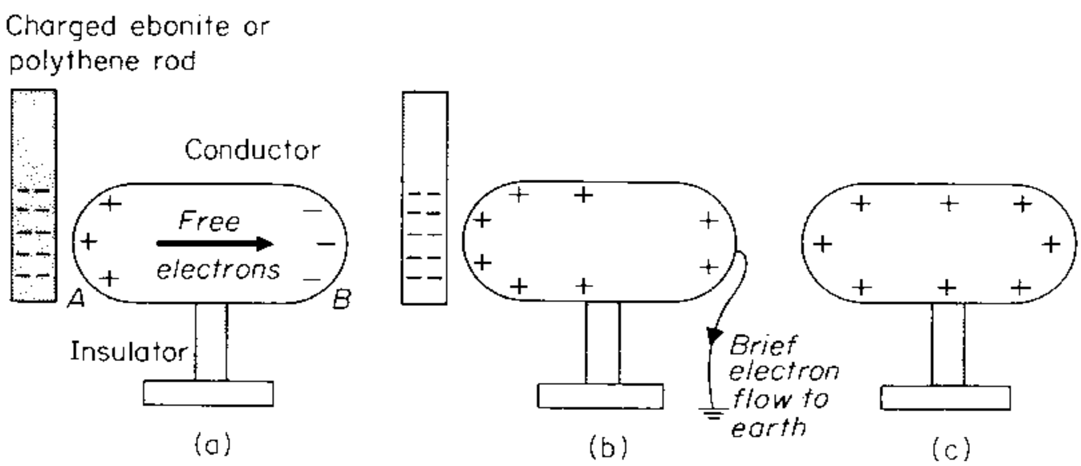


- Support the uncharged conductor on an insulated stand.
- Put a positively charged rod in contact with the conductor.
- Because of mutual repulsion between the positive charges in the rod, some of them are converted or transferred to the conductor.
- When the conductor is removed from the rod, it is found to be positively charged.

NB: The insulated stand prevents flow of charge away from the conductor. To charge the conductor negatively, a negative rod is produced.

Electrification by induction

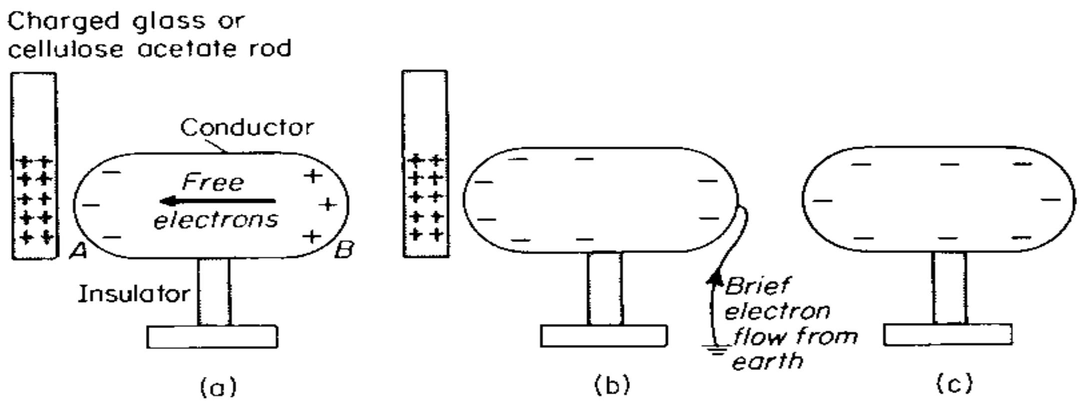
(a) Charging the body positively.



Procedure

- Put the conductor on an insulated stand as in (i)
- Bring a negatively charged rod near the conductor.
- The positive and negative charges separate as shown in (ii)
- Earth the conductor by momentarily touching it with a finger and electrons flow from it to the earth as in (iii) in presence of the charged rod.
- Remove the charged rod, the conductor is found to be positively charged.

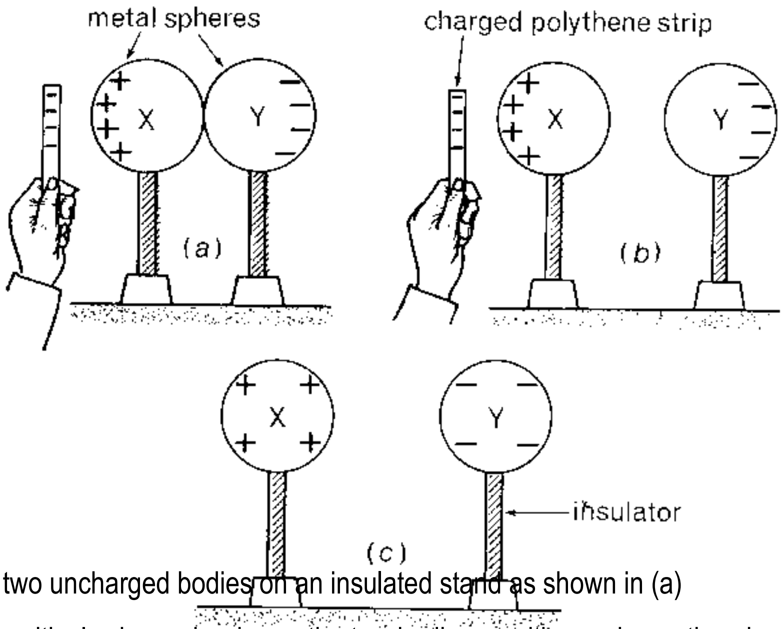
(b) Charging the body by induction negatively,



Procedure

- Put the conductor on an insulated stand as in (i)
- Bring a positively charged rod near the conductor.
- The positive and negative charges separate as shown in (ii)
- Earth the conductor by momentarily touching it with a finger and electrons flow from it to the earth as in (iii) in presence of the charged rod.
- Remove the charged rod, the conductor is found to be negatively charged.

Charging two bodies simultaneously of opposite charges



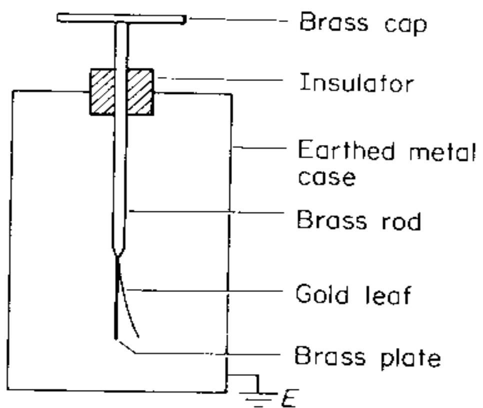
- Support two uncharged bodies on an insulated stand as shown in (a)
- Bring a positively charged rod near the two bodies, positive and negative charges separate as in (b).
- Separate (A) from (B) in presence of the inducing charge.
- Remove the inducing charge, (A) will be negatively charged and (B) will be positively charged.

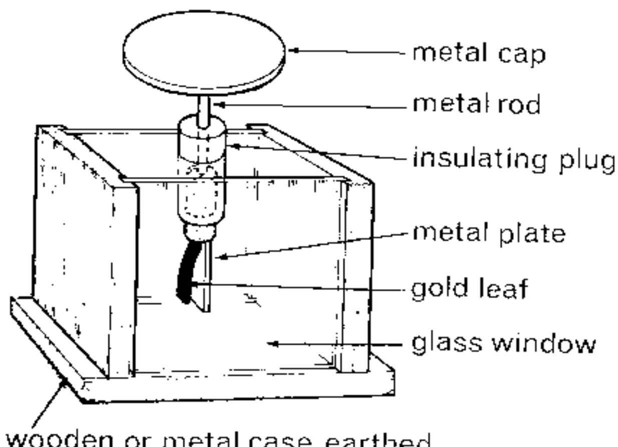
CONDUCTORS AND INSULATORS

A conductor is a material which allows charge to flow through it. It has loosely bound electrons known as conduction electrons. The flow of these electrons constitutes current flow e.g. all metals, graphite, acids, bases and salt solutions are conductors.

An insulator is a material which does not allow flow of charge through it. It has no conduction electrons because its electrons are strongly bound by the nuclear attractive forces e.g. rubber, dry wood, glass, plastic, sugar solutions etc.

The gold leaf electroscope

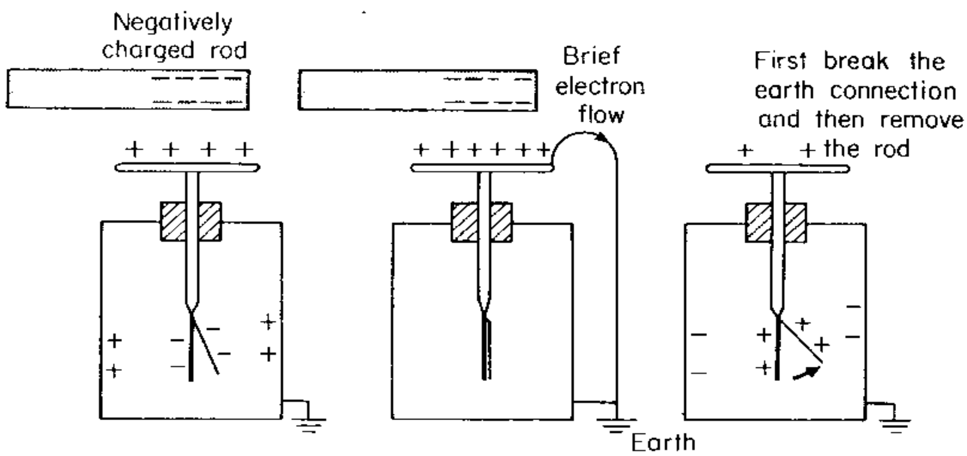




- It consists of a brass cap and brass plate connected by a brass rod.
- A gold leaf is fixed together with a brass plate with a brass.
- The brass plate, gold leaf and part of brass rod are put inside a metallic box which is enclosed with glass windows.

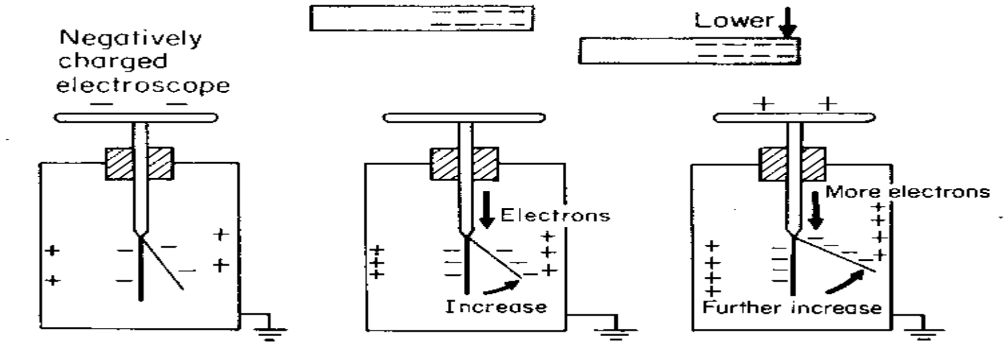
CHARGING A GOLD LEAF ELECTROSCOPE BY INDUCTION.

(i) Charging it positively



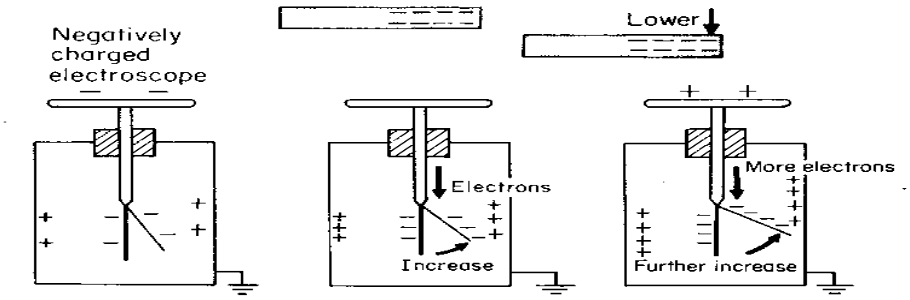
- Bring a negatively charged rod near the cap of the gold leaf electroscope.
- Positive charges are attracted to the cap and negative charges are repelled to the plate and gold leaf.
- The leaf diverges due to repulsion of the same number of charges on the plates.
- Earth the gold leaf electroscope in presence of a negatively charged rod.
- Electrons on the plate and leaf flow to the earth.
- The leaf collapses.
- Remove the negatively charged rod, positive charges on the ca spread out to the rod and leaf therefore the leaf diverges hence the gold leaf is positively charged.

(ii) Charging it negatively**.**



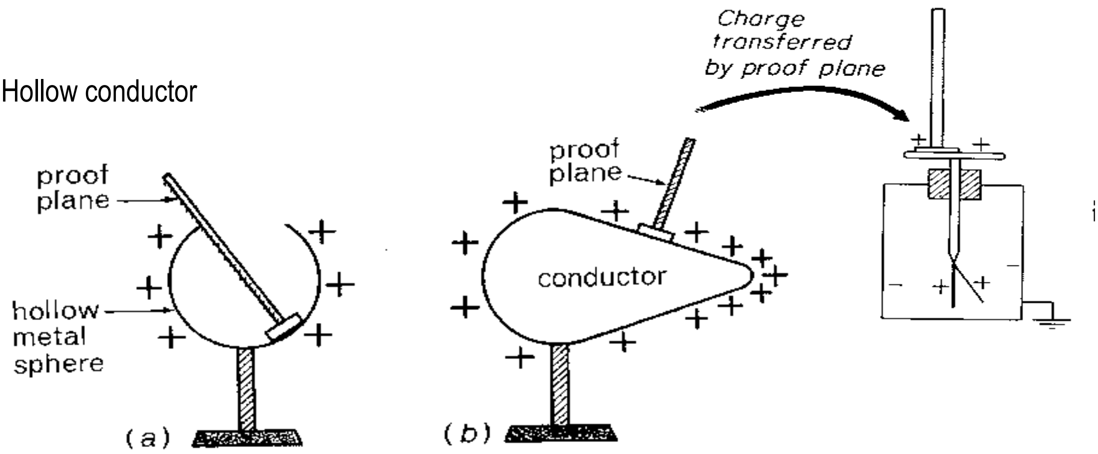
- Get an uncharged gold leaf of electroscope.
- Bring the positively charged rod near the gold leaf cap.
- Negative charges are attracted to the cap and positive charges are repelled to leaf and glass plate.
- Earth the gold leaf electroscope in presence of a positively charged rod.
- Negative charges flow from the earth to neutralize positive charges on plate and leaf.
- The leaf collapses.
- Remove the positively charged rod, negative charges on the cap spread out on the leaf plate, therefore, the leaf diverges and a gold leaf therefore becomes negatively charged.

Testing for presence of charge



Distribution of charge on a conductor.

(a) Hollow conductor



When the proof plane is placed on the outside surface of a charged hollow conductor, charge is transferred to the uncharged G.L.E, the leaf diverges as shown in (a). This proves that charge was present on the outside of the surface.

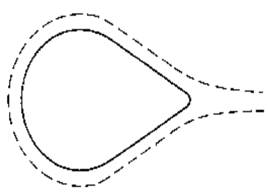
When the proof plane is placed on the inside of a charged conductor is transferred to the uncharged G.L.E, the leaf does not diverge as in (b) therefore, charge resides on the outside surface of the hollow charged conductor.

(b) Curved bodies

(c)

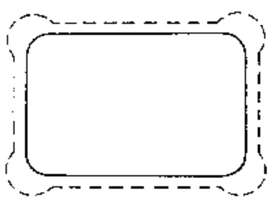
A curve with a big curvature has a small radius and a curve with small curvature has big radius therefore, curvature is inversely proportional to radius. A straight line has no curvature.

Surface charged density is directly proportional to the curvature. Therefore a small curvature has small charge density. Surface charge density is the ratio of charge to the surface area.



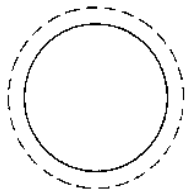
Pear shaped

(ii)Rectangular conductor



Cylindrical

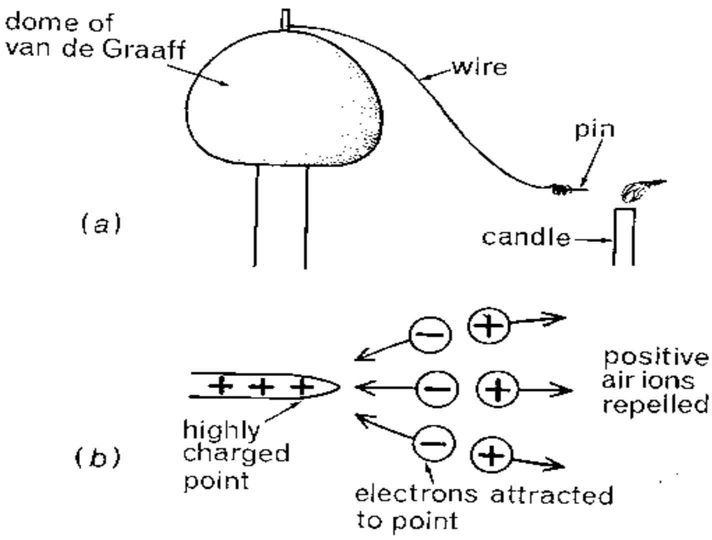
(iii) Spherical conductor



Action of points

Charge concentrates at sharp points. This creates a very strong electrostatic field at charged points which ionizes the surrounding air molecules producing positive and negative ions. Ions which are of the same charge as that on the sharp points are repelled away forming an electric wind which may blow a candle flame as shown in the diagram below and ions of opposite charge are collected to the points

.



Therefore, a charged sharp point acts as;

(i) Spray off' of its own charge in form of electric wind.

(ii) Collector of unlike charges. The spray off and collecting of charges by the points is known as **corona discharge** (action of points.)

Application of action of points (corona discharge)

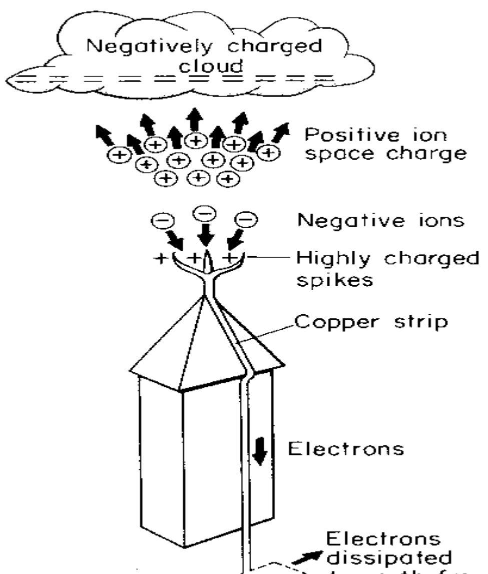
Used in a lightening conductor.

- Used in electrostatics generators.
- Electrostatic photocopying machines.
- Air crafts are discharged after landing before passengers are allowed. Air crafts get electrified but charge remains on the outer surface.

Lightening conductor

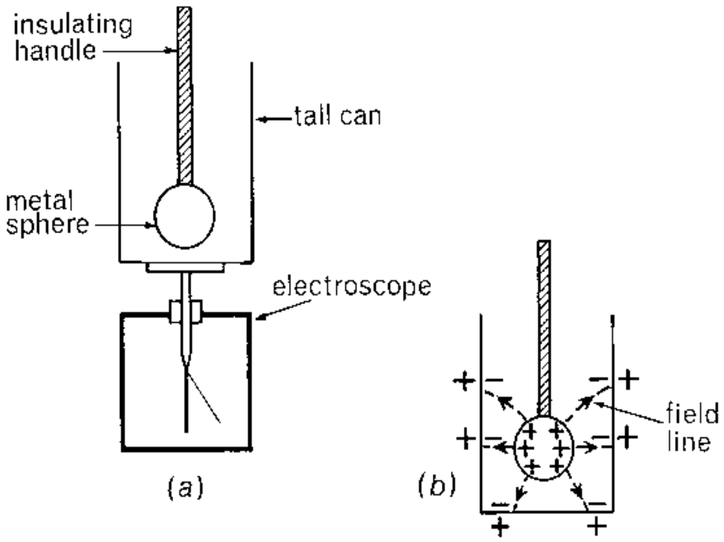
A lightening conductor is made up of a thick copper strip which is fixed to the ground and on the walls of the tall building ending with several shaped spikes. It is used to protect structures from damage once struck by highlightening.

How it works



- A moving cloud becomes negatively charged by friction.
- Once it approaches the lightening conductor, it induces opposite charge on the conductor.
- A high charge density on a conductor ionizes the air molecules and sends a stream of positively charged ions which neutralize some of the negative charges of the cloud.
- The excess negatively charged ions are safely conducted to the earth through a copper strip.

Ice pail experiment



Electric fields

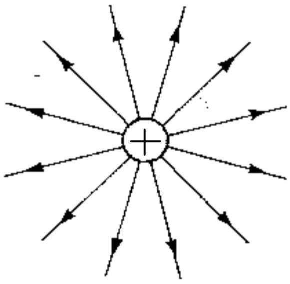
This is a region a round the charged body where electric forces are experienced. Electric fields may be represented by field lines. Field lines are lines drawn in an electric field such that their directions at any point give a direction of electric field at that point. The direction of any field at any given point is the direction of the forces on a small positive charge placed at that point.

Properties of electric field lines

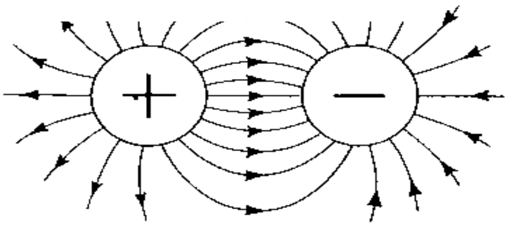
- They begin and end on equal quantities of charge.
- They are in a state of tension which causes them to shorten.
- They repel one another side ways.

Field patterns

(a) Isolated charge

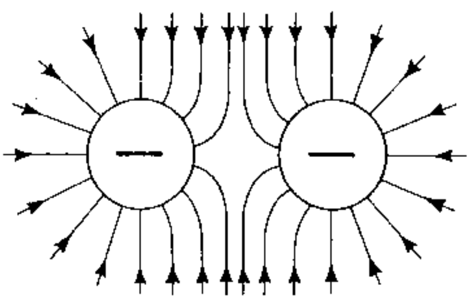


(b) Unlike



Longitudinal tension in the field lines

(c) Like charges close together

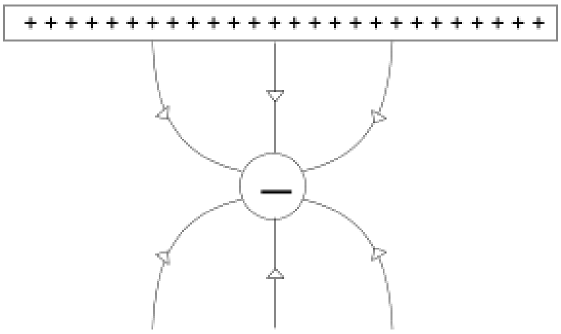


Lateral repulsion between the field lines

A neutral point is a region where the resultant electric field is zero i.e. field lines cancel each other and therefore no resultant electrostatic forces exist.

(d) Field between charged points and plates

(i) **Negative charge close to a positively charged plate**



(ii) Positive charge on a negatively charged plate