

Experiment - 1

Object :- To study the working principle of simple microscope.

Requirements :- Prepared slides, microscope, light source etc.

Principle :- This is the oldest and most basic type of microscopy. (A simple light microscope is basically a simple magnifying glass i.e., a "convex lens" with a short focal length. It produces a magnified, upright and virtual image of the object.

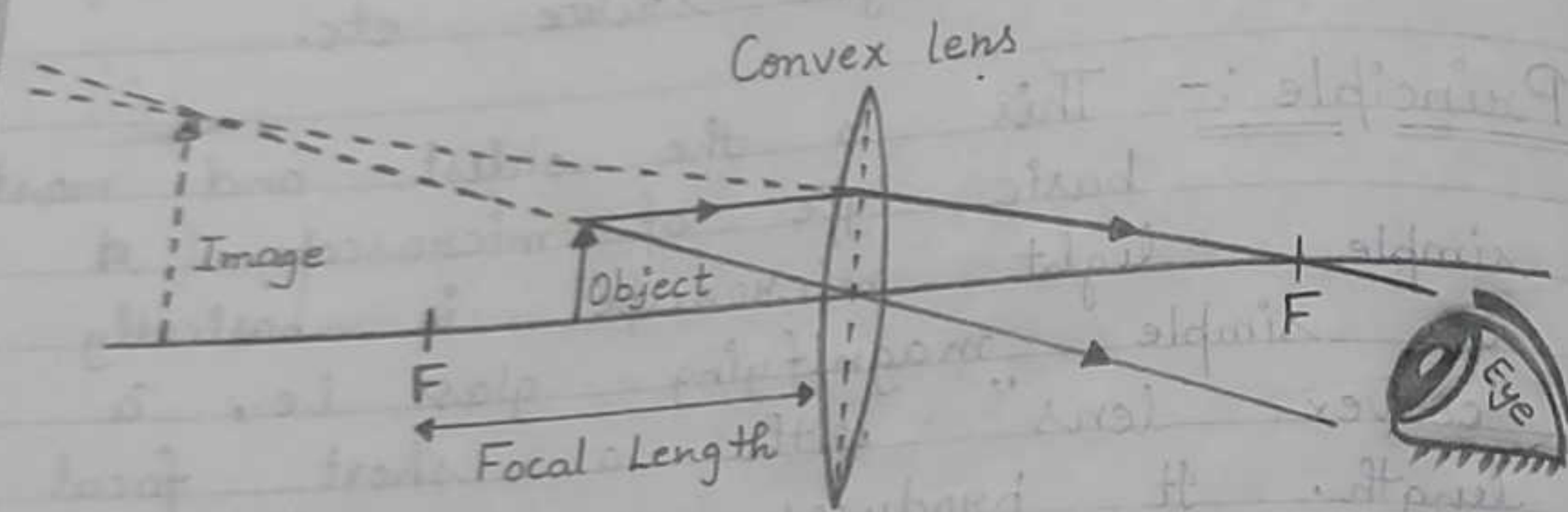
The lens of a simple light microscope is also known as a loupe. The magnification is usually limited to 10X. The magnifying power of a simple light microscope is given by the formula

$$M = 1 + (D/F)$$

where M = Magnification

D = Least distance of distinct vision (25cm)

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Ray Diagram of a Simple Microscope

$$M = 1 + \frac{D}{f}$$

$$M = \text{Magnification}$$

F = Focal length of the lens

Note that the focal length of the lens should be small because smaller the focal length, greater is the magnifying power.

Parts of a Simple Light Microscope (Dissecting Microscope) :-

It uses only one lens and has the following parts :-

1. Foot or Base
2. Stand
3. Vertical Limb
4. Folded Arm
5. Simple Convex Lens
6. Stage
7. Reflecting Mirror
8. Clip
9. Adjustment Screw

The base works as supporting stand and bears the weight of the microscope. The glass stage that carries the slide is supported by an arm

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that is attached to the stand with the help of the adjustment screw for focussing. The convex lens is carried by the annulated arm attached to the stand.

The slide or specimen is placed on the stage. Clips hold the slide in place. The reflecting mirror provides light and illuminates the slide specimen from below. A simple dissection microscope provides magnification of 4 to 40 times depending on the magnifying power of the lens. This microscope is used for observing small insects like ant, head louse (Pediculus) bed bug (Cimex), etc.

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Experiment - 2

Object :- To study the working principle of compound microscope.

Requirements :- Prepared slides, compound microscope, light source etc.

Principle :- The credit for the invention of the compound microscope is given to "Hans Janssen" and "Zacharias Janssen". It employs two lenses - an objective lens and an eye piece that together achieve greater magnification than a simple microscope. When the specimen to be magnified is placed just beyond the focus of the objective lens a virtual, inverted and highly magnified image of the object is formed at the least distance of distinct vision from the eye held close to the eye piece. The magnification (M) of the compound lens is given by the formula

$$M = (D/f_o) \times (L/f_e)$$

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where M = Magnification
 D = Least distance of distinct vision (25cm)
 f_o = Focal length of objective lens
 L = Length of microscope tube
 f_e = Focal length of eyepiece lens.)

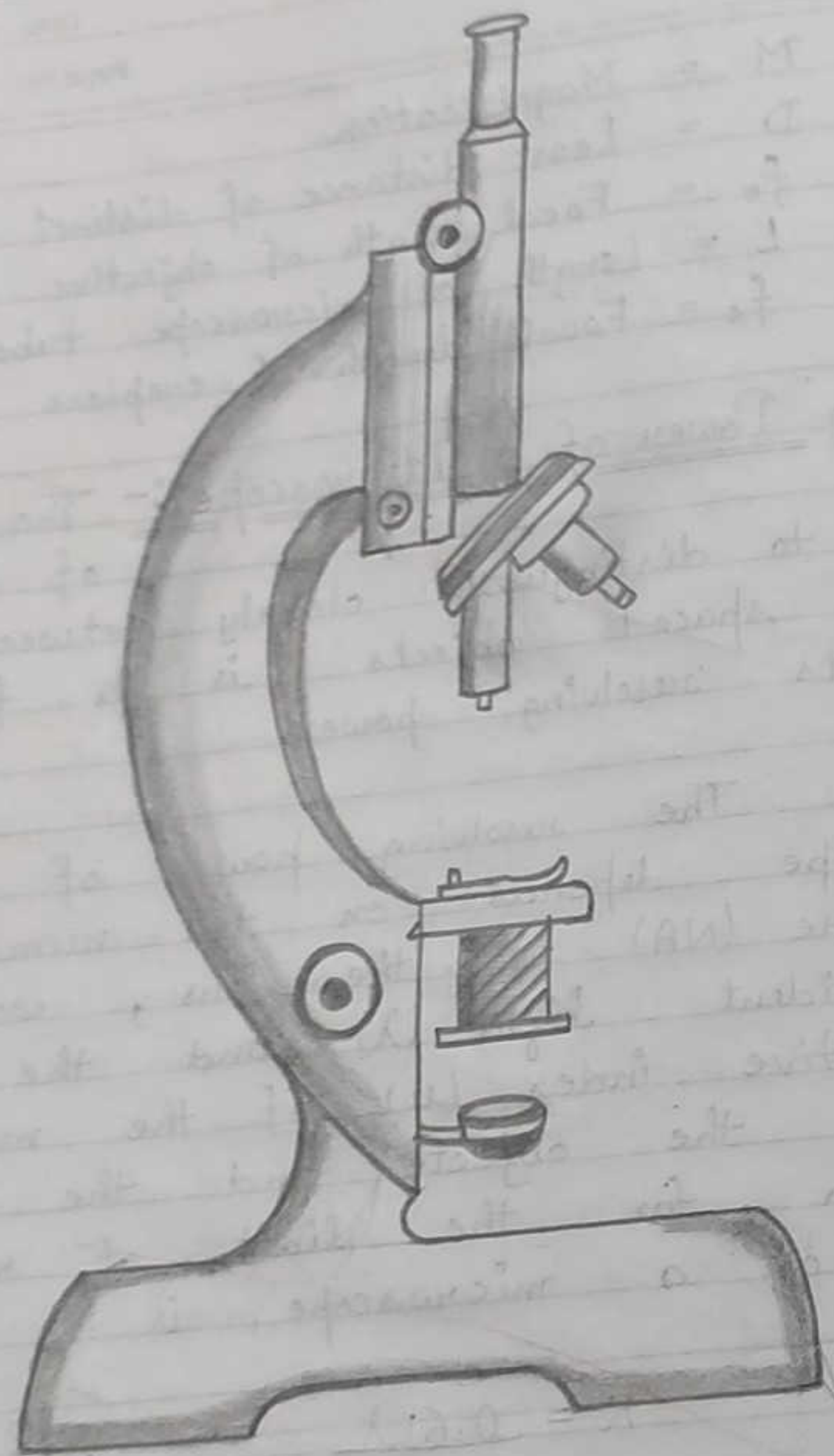
Resolving Power of a Microscope :- The ability of a microscope to distinguish clearly between two closely spaced objects is a function of its resolving power.

The resolving power of a microscope depends on the numerical aperture (NA) of the lens, wavelength of incident light (λ) and the refractive index (μ) of the medium between the object and the lens. The formula for the limit of resolution (R) of a microscope is :-

$$R = \frac{0.61\lambda}{NA}$$

where NA (Numerical aperture) = Natural sine of semi angle of aperture $\times \mu$

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Compound Microscope

By using waves of shorter wavelength (electron beams or blue portion of visible light spectrum) the limit of resolution of a microscope can be reduced resulting in an increase in the resolving power of the microscope. Resolving power of light microscope can be further improved by using oil with a high refractive index between the slide and the objective lens. Improvements in microscopes allow objects as small as $1 \text{ \AA}$ (Angstrom) to be observed.

Parts of a Compound Microscope :-

A compound microscope has the following parts :-

1. Base or Foot :- Forms the base of the compound microscope and bears its weight.
2. Mirror :- The mirror has two faces, one of which is concave and the other is plain. The concave mirror provides a cone of light rays focussed on the slide) while the plain mirror is

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used if a beam of parallel light rays is needed.

3. Stage:- The stage has an aperture with a glass in it. Light rays from the mirror reach the slide through this aperture.

4. Body Tube:- Most compound microscopes have a 160 cm long body tube with an objective lens on its lower side and an eyepiece or ocular lens on the upper side.

5. Nose Piece:- Different objective lenses with different focal lengths are attached to a movable nose piece.

6. Arm:- It supports the body tube and coarse adjustment.

7. Condensor:- It is a biconvex lens positioned between the reflecting mirror and stage and focuses the light rays on the slide.

8. Coarse Adjustment :- Coarse adjustment has a broad head which can be moved clockwise to move the body tube downwards or anticlockwise to move it upwards.
9. Fine Adjustment :- It moves the body tube upwards and downwards but at much slower rates than the coarse adjustment. It is used to focus the object sharply after the coarse adjustment has brought the object into focus.
10. Eye piece or Ocular Lens :- It is located at the head of the body tube. Eyepieces of different focal lengths and magnifying power may be used as per need. (5X and 15X)
11. Objective Lens :- These are attached to the nose piece and have magnifying powers of 2X, 3X, 5X, 10X, 40X and 100X. These can be changed according to need. Objective lens of 100X is used only with oil for immersion. Without oil the image obtained is grainy and of poor quality.

Principle of Binocular Microscope:- Both simple

and compound microscopes may be monocular or binocular. A monocular microscope has a single eyepiece. A binocular microscope has two eyepieces (bi = two) that permit the user to observe the specimen with both eyes instead of one eye. Binocular microscopes are heavier and more expensive but are less tiring and more comfortable to use. Binocular microscopes also permit the user to have a perception of depth in the specimen and may help in appreciating some details better.

Experiment - 3

Object :- To study the working principle of pH meter.

Requirements :- pH meter, unknown sample, Buffer solution, beaker etc.

pH Meter :- A pH meter is an electronic device used to measure the pH of a liquid. The "p" in pH stands for the German word potenz meaning power or potential and "H" stands for hydrogen ions. Therefore, pH refers to the number of hydrogen ions in a solution and is calculated by the formula :-

$$\text{pH} = -\log_{10} [\text{H}^+]$$

where $[\text{H}^+]$ is the concentration of hydrogen ions in a solution.)

Every aqueous solution can be measured to determine its pH. This

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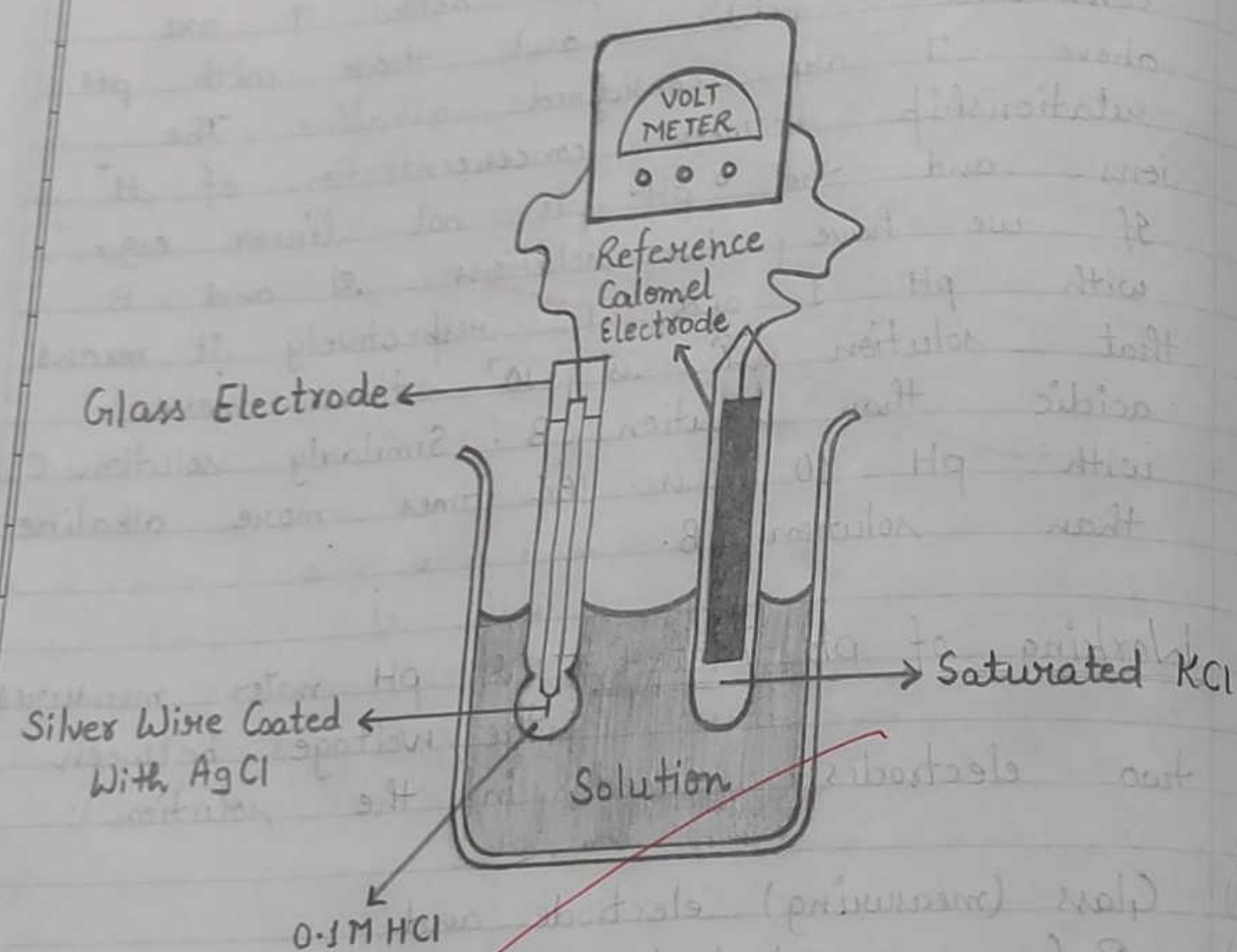
tells us how acidic or basic the solution is. pH is measured on a scale of 0 - 14. Solutions with pH below 7 are considered acidic and those with pH above 7 are considered alkaline. The relationship between concentration of H^+ ions and the pH is not linear e.g., if we have two solutions A and B with pH 1 and 7 respectively it means that solution A is 10^6 times more acidic than solution B. Similarly solution C with pH 10 is 10^3 times more alkaline than solution B.

Working of pH Meter :- A pH meter measures the voltage between two electrodes placed in the solution :-

- (A) Glass (measuring) electrode and
- (B) Reference electrode

The glass electrode is made of borosilicate glass that is permeable to H^+ ions but not to other cations and anions. When a thin layer of borosilicate glass is interposed between two solutions of different H^+ ions

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pH Meter

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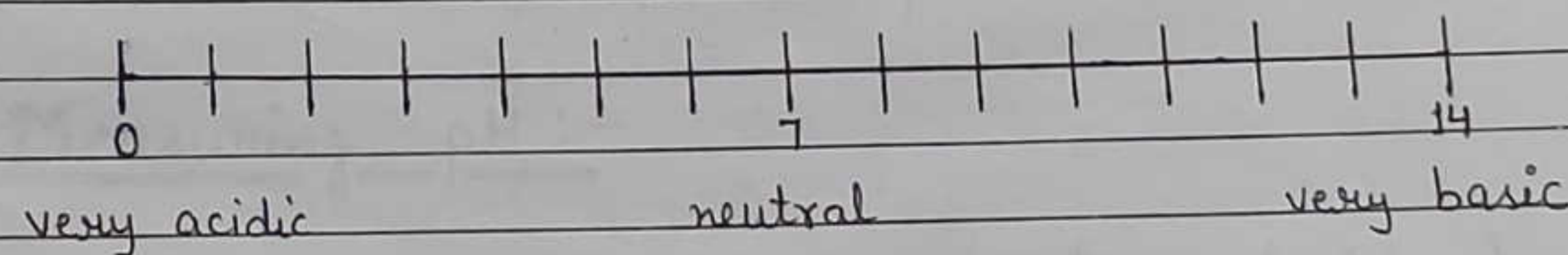
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concentration, H^+ ions move from higher concentration to lower concentration. This generates a potential difference proportional to the difference in pH of the two solutions and can be measured by a voltmeter.

Design of a pH Meter:- A digital pH meter has the following components:-

1. Glass electrode:- The pH dependent unit is a glass electrode that has a silver wire coated with silver chloride immersed in 0.1 M HCl. The HCl is in contact with H^+ permeable glass.



2. Voltmeter:- The silver wire connects the glass electrode to a voltmeter. It measures the potential in mV.

3. Reference electrode:- It is pH independent and simply helps to

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complete the circuit. It contains KCl.

4. Digital display :- The potential difference (in mV) is converted to values on the pH scale and displayed.)

A pH meter may have a single probe, the glass and reference electrodes being put into one unit for convenience or may have two probes with separate glass and reference electrodes.

Using a pH Meter :- A small amount of the solution whose pH is to be measured is taken. This is called a sample.

Measuring pH :-

1. In the laboratory the pH meter should always remain switched on and in stand by position when not in use. The glass probe should always remain immersed in a storage solution or distilled water to prevent it from drying.

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2. Before measuring pH of the sample the instrument is calibrated with standardized solutions. For alkaline solutions standard buffers with pH 7 and 10 should be used. For acidic solutions standard buffers with pH 4 and 7 should be used.
3. Once calibrated, the electrode is dipped in the sample solution and the pH is measured when the reading stabilizes.
4. Before each measurement, the probe is rinsed with distilled water and wiped carefully.
5. After measurement, the pH meter is returned to its stand by position.

Results:-

Acidic Solutions	
S.No	pH
1. Saliva	6.8
2. Urine	6.0
3. Lemon juice	2.5
4. Milk	6.5
5. Cold drink	3.2
6. 0.1 N Acetic acid	2.9
7. 0.1 N HCl	1.1

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Alkaline Solutions

S.No	Test Solution	pH
1.	Blood	7.4
2.	0.1 N NH_4OH	11.1
3.	Saturated $(\text{CaOH})_2$	12.4
4.	0.1 N KOH	13.0
5.	0.1 N NaOH	13.0
6.	Bleach	12.2
7.	Detergent solution	10.0
8.	Baking soda	8.5

Precautions :-

1. The pH meter should always be left in stand by position.
2. The probe should not be allowed to dry.
3. Temperature and voltage fluctuations should be avoided while measuring pH.