EXPERIMENTAL SKILLS

1. Measuring Instruments for length:

(A) Instruments with linear scale:

(i) Metre scale and

(ii) Vernier callipers

(iii) Trowelling microscope

(B) Instruments with circular scales:

(i) Screw gauge (ii) Spherometer

Each measuring instrument has what is known as vernier constant also known as least count.

In case of linear scale, the vernier constant is given by

Vernier constant = 1 M.S.D. – 1 V.S.D.

In case of circular scales: The vernier constant is given by

$$\text{Vernier calliper} = \frac{\text{pitch}}{\text{number of divisions on the circular scale}}$$

Where, pitch the linear distance moved on the main scale in one rotation.

2. **Simple pendulum:** In absence of loss of energy the amplitude of oscillations remains constant and the total energy of the bob (or the system) is given by

$$T.E. = \frac{1}{2} m w^2 A^2$$

and the time period is given by $T = 2\pi\sqrt{\frac{l}{g}}$. However, when energy losses are present, the amplitude of oscillations keeps on decreasing and in case of weak damping forces, the amplitude decreases experimentally.

3. **Young's modulus:** To measure the Young's modulus of the material of wire, we use searle's apparatus. It consists of Auxiliary wire and experimental wire. Auxiliary wire is used for comparison of the length. The wires (both experimental and auxiliary) should be initially of same length and same material.

4. **Surface tension and viscosity:** Surface tension of liquid is determined by capillary rise method. The relevant formula is

$$\sigma = \frac{hr\rho g}{2\cos\theta}$$

where symbols have their usual meanings. To measure the viscosity of liquid (with relatively higher viscosity), a long liquid column is used in which a small metallic spherical object (lead shots) is allowed to fall. After some time it attains terminal velocity. Measuring this terminal velocity its viscosity can be calculated

$$\eta = \frac{2r^2(\rho - \sigma)g}{9v_t}$$

where $r \rightarrow$ radius of spherical body

$\rho \rightarrow$ density of solid

$\sigma \rightarrow$ density of liquid

$v_t \rightarrow$ terminal velocity.

5. **Specific heat:** Specific heat of liquid is generally measured using cooling curve method. It is based on Newton's law of cooling according to which

$$\frac{d\theta}{dt} \propto (\theta - \theta_0)$$

Method of mixtures cannot also be used to measure the specific heats of solids and liquids. It is based on principle of calorimetry.

6. **Resonance tube:** To determine the speed of sound in air at room temperature, resonance tube is used. Let l_1 and l_2 be the lengths of air column for the first and second resonance respectively with a tuning fork *v*.

Then

$$C = v \times 2(l_2 - l_1)$$

7. **Resistance measurement:** Resistance of a wire is measured using Ohm's law, Post office box, Metre Bridge. Post Office Box and Metre Bridge are based on Wheatstone Bridge principle. In case of electrical experiments, the voltmeter is always used in parallel and Ammeter is used in series. In case

of Metre Bridge, the resistances in the gaps are interchanged to eliminate the end corrections.

8. **Potentiometer:** It works on the principle that when a current flows through a wire of uniform thickness and material, the potential difference between its two points is directly proportional to the length of the wire between the two points. It is used

   (i) to compare the E.M.F of two cells

   (ii) to compare the two resistances

   (iii) to measure the internal resistance of the cell.

   In case of potentiometer experiments the e.m.f. of the driving cell (cell in the main circuit) should be greater than that of the cells in the auxiliary circuits.

9. **Focal lengths:** To measure the focal lengths of concave mirror, convex mirror and convex lens, we use what is known as optical bench. In case of concave mirror and convex lens, there is real image formation and hence one can use parallax method. Focal lengths of these two can also be calculated graphically after finding the image positions corresponding various object positions.

   In case of convex mirror, convex lens is also used because convex mirror always forms a virtual image.

10. **Refractive index:** In case of glass slab, the refractive index can be measured using the concept of real depth and apparent depth.

In case of prism, we use deviation method. The deviation produced in the ray of light while passing through the prism, depends on the angle of incidence. For a certain angle of incidence, deviation produced is minimum, then refractive index is given by

$$\mu = \frac{\sin\left(\frac{A + D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

where $A \rightarrow$ angle of prism

$D_m \rightarrow$ minimum deviation

11. **Diodes and Transistors:** For the diode to conduct the anode should be +ve w.r.t. cathode. The Zener diode is always used in reverse biased condition. Zener diode is generally used as voltage regulators.

For the proper working of transistors, the $(b-e)$ pair should be forward biased and $(b-c)$ pair should be reverse biased. Here we have three types of study (i) input characteristics (ii) output characteristics (iii) mutual or transfer characteristics.

12. **Multimeter:** Multimeters can be used to identify diode, LED, NPN transistor and PNP transistor.

In case of diodes, the resistance indicated in multimeter will be very low if multimeter leads are connected is one way

(+ve lead to anode and –ve lead to cathode) and very high resistance when connected opposite way. Whereas in case of resistors it same for both the ways. The identification of transistor (it is three terminal device) is also possible. If a multimeter is connected between emitter and base and then between base and collector, conduction takes place in both the cases then the terminal which is common in both cases is the base.