[6th July 2021]

Long Answer

(Q1.) Explain the working. What is resolution? How is it related to numerical Aperture? Draw a typical setup of a light and electron microscope.

Resolution

Resolution or resolution power of microscope is its ability to distinguish between two particles situated very close.

→ It depends on :-
(i) Wavelength of light
(ii) numerical aperture (NA) of lens system used.

→ Resolution of a microscope can be calculated by [Abbe Equation], after the name of German Physicist "Ernst Abbe in 1876".

$$\text{Resolution Power} = \frac{\text{Wavelength of light used for illumination} \times 0.61}{2 \times \text{Numerical Aperture}}$$

$$r = \frac{0.61\,\lambda}{NA}$$

0.61 → trigonometric constant

where, r = resolution
λ = wavelength of illuminating light
NA = Numerical aperture

⇒ Numerical Aperture is defined as the property of a lens that determines the quality of light that can enter into it, for a fixed object distance.

* $NA = \eta \times \sin\theta$

where, NA = numerical aperture

η = refractive index of medium (like air, water, oil, glycerol, DPX)

η (Refractive Index)
H_2O = 1.33
Glycerol = 1.47

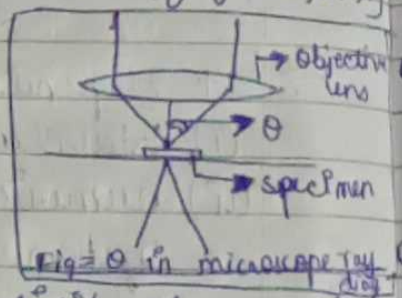


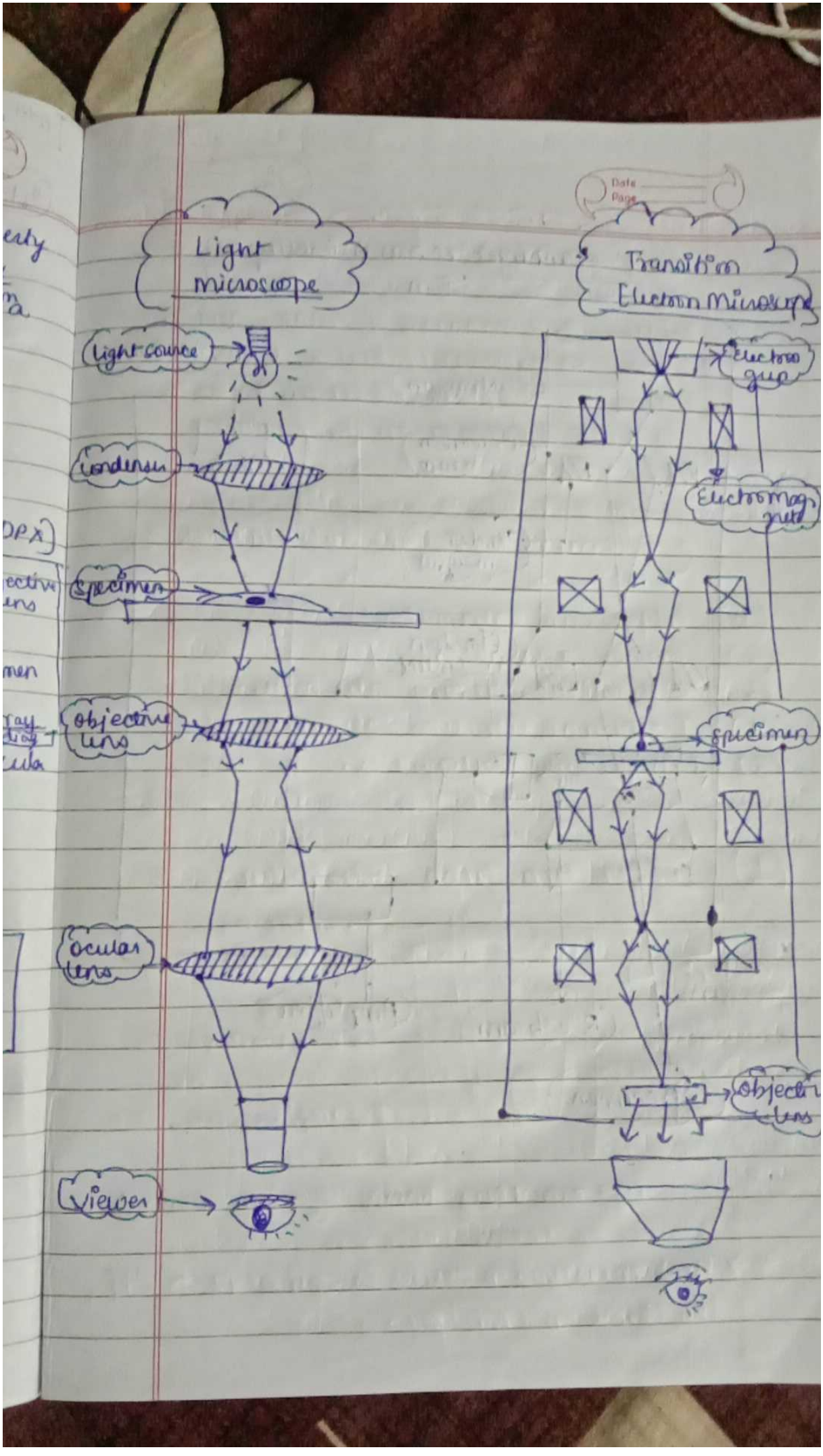
Fig: θ in microscope (ray diagram)

∴ NA determines the ability of a particular lens to gather light and resolve fine details of the specimen at a fixed object distance.

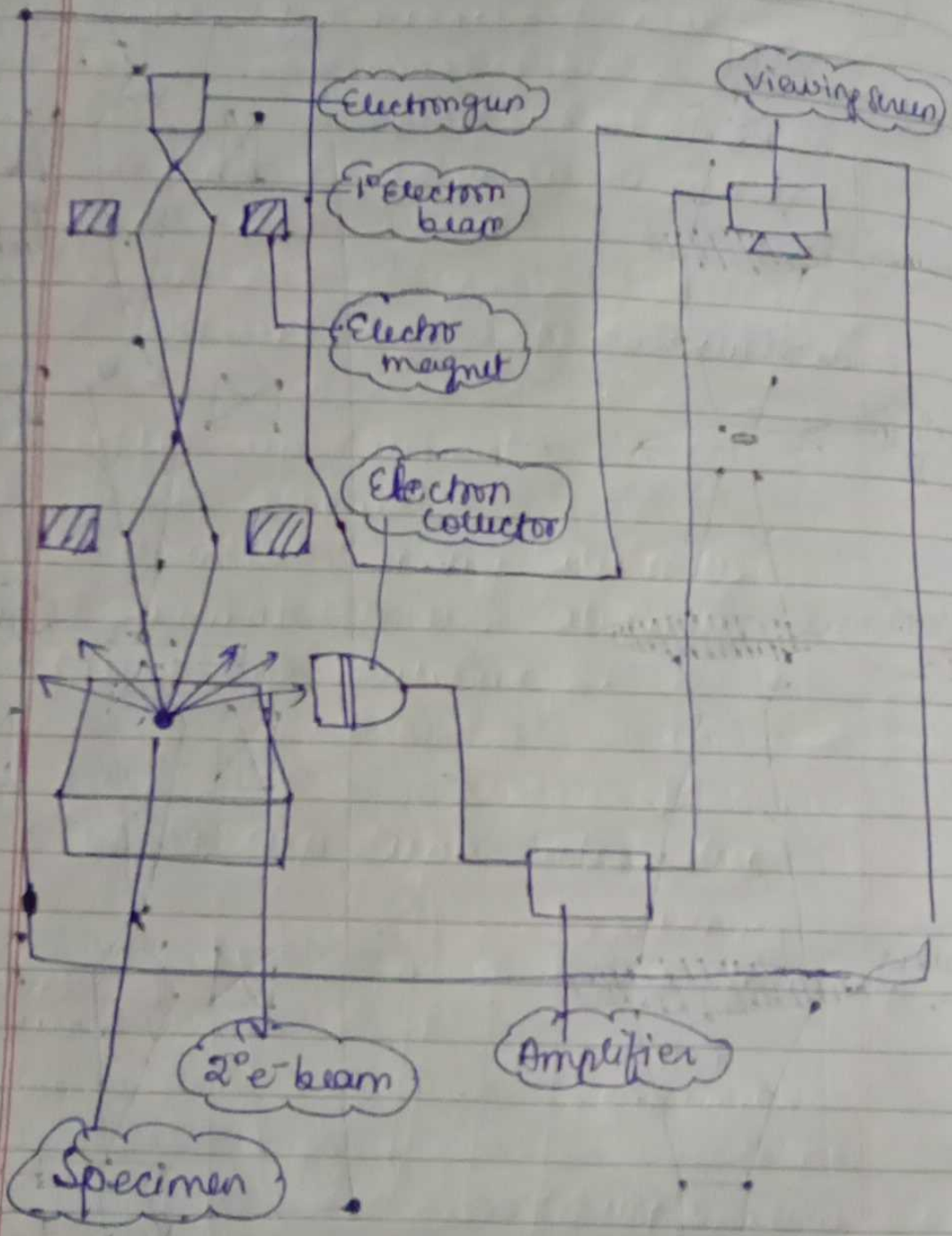
Refractive Index ↑	Numerical Aperture ↑	Resolution ↓

* Resolution $\propto \frac{1}{\text{Numerical Aperture}}$

⇒ more resolution requires less numerical aperture and less refractive index


Light microscope
Light source
condensin
Specimen
objective lens
Ocular lens
Viewer
Transition Electron Microscope
Electron gun
Electromag net
Specimen
Objecti lens

Scanning Electron Microscope SEM



(Q.) Explain working of calorimeter. Briefly mention the different types

→ Calorimeter is an instrument used for heat measurements.

→ It mainly consist of a metallic vessel made of materials which are good conductors of electricity such as copper & aluminium etc.

→ It measures the amount of heat generated or absorbed in physical or chemical reactions

(A) Principle

→ If two bodies are kept in physical contact with each other and they have different temperature then the heat is transferred from body with higher temperature to body with lower temp.

→ Body at higher temp releases heat while body at lower temp absorbs heat.

→ Principle of calorimetry indicates, the "law of conservation energy", i.e total heat lost by hot body is equal to total heat gained by cold body.

Heat lost = Heat gained

* Heat transfer in a system is calculated using formula :-

$$q = mc\Delta t$$ 1

Where, q = measure of heat transfer.
m = mass of body
c = specific heat of the body
Δt = change in temperature.

Different types of Calorimeter

(1.) Coffee cup Calorimeter
(2.) Bomb Calorimeter
(3.) Differential Scanning Calorimeter.
(4.) Isothermal titration Calorimeter.
(5.) Calvet type Calorimeter.

(1.) Coffee cup type Calorimeter:

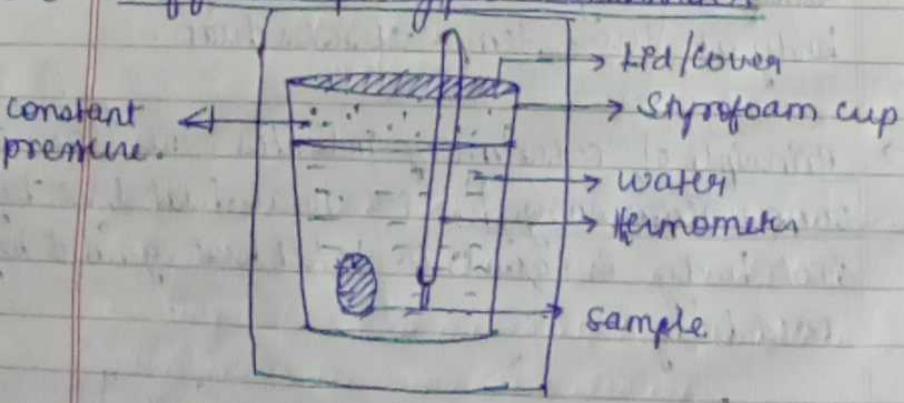
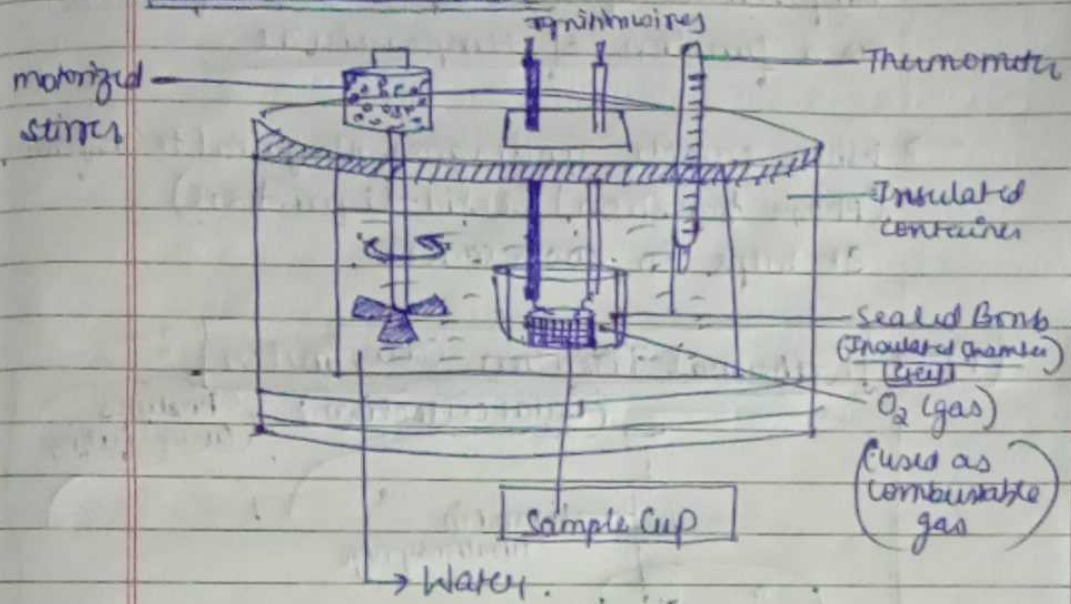


Fig = Typical Diag showing Coffee Cup Calorimeter.

→ Heat measured in device is equivalent to ΔH, the change in enthalpy.
→ volume change

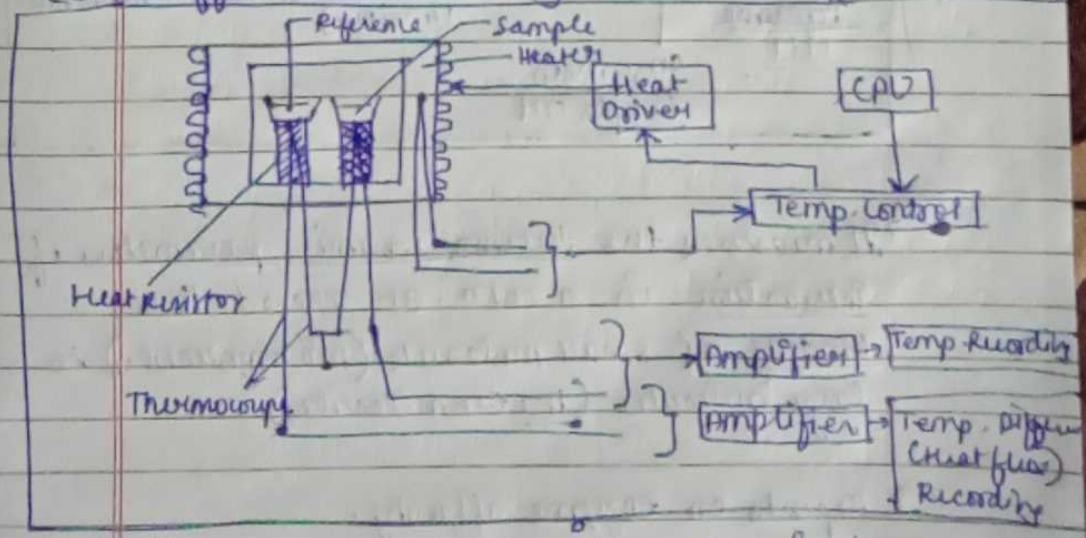
(2.) **Bomb Calorimeter :**



→ constant volume.

→ measures [Energy of Combustion]

(3.) **Differential scanning Calorimeter :**

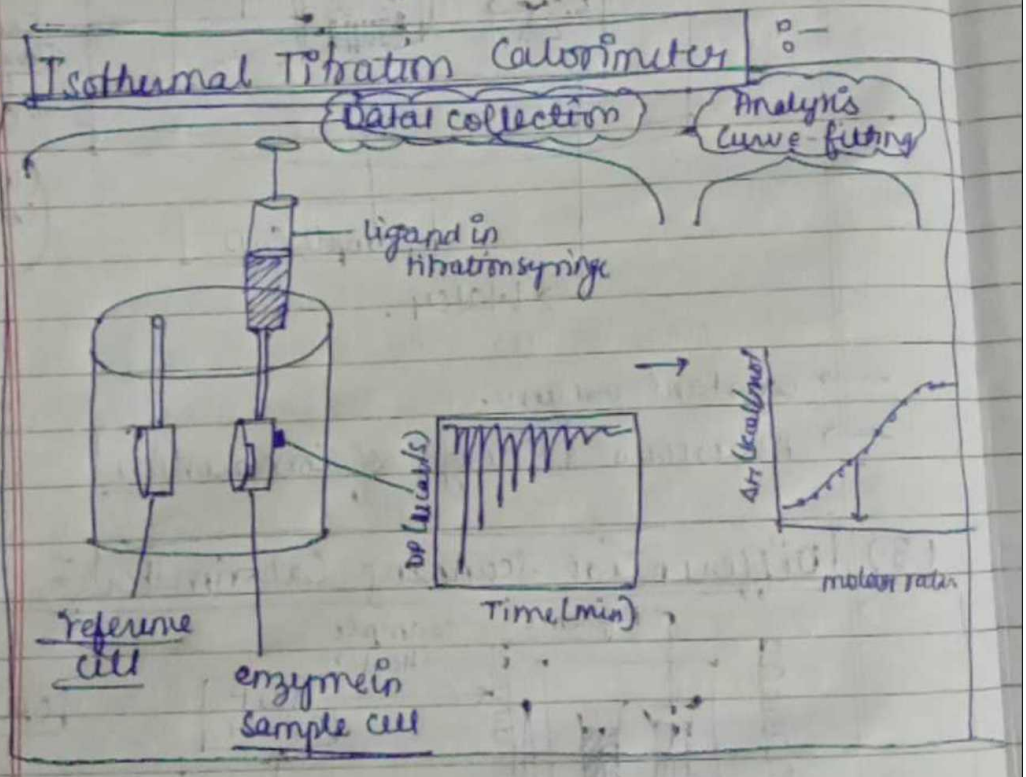


→ It measures the difference in the amount of heat required to (↑) increase temperature

temperature of a sample and reference as a function of temperature

→ When sample undergoes physical transformation (Phase transition) (solid-liquid etc) it helps in such cases.

(4.) → Isothermal Titration Calorimeter :-



→ It measures the thermodynamic parameters of interaction in a soln. It records the binding of small molecule (micromolecules) to large molecules (macromolecules)

→ Depends on enzyme affinity.