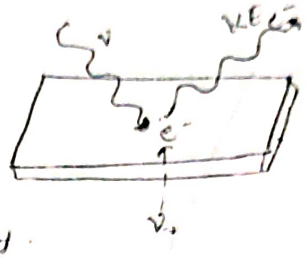
Photoelectric effect → phenomenon in which electrons are emitted from the surface of a metal when light strikes it.

⇒ There is a specific threshold freq., ν_0, to emit an electron from a metal surface



⇒ Below threshold freq, no e^-'s are emitted regardless of the intensity of the light

⇒ for light ≥ freq., ν greater than threshold freq., the no of e^-'s emitted ∝'s with the intensity of the light

⇒ The K.E of the emitted electrons ∝'s linearly ≥ the freq of the light used.

⇒ Threshold freq. is the minimum energy rqd to remove e^- from the metal surface $E_0 = h\nu_0$

If $\nu < \nu_0$ no e^- emitted
If $\nu > \nu_0$ e^- will emit

$KE_{electron} = h\nu - h\nu_0$
$= E - E_0$

↓ KE of emitted electron

Energy of incident photon

Energy rqd to remove an electron from metal's surface

Photon electron spectroscopy :

is a technique in which a radⁿ ≥ enough energy can remove an e^- from an atom/molecule

when radⁿ is X-ray, then it is X-ray photoelectron spectroscopy

X-ray Photoelectron spectroscopy.

XPS also generates photoelectron spectrum of atoms / molecules

XPS also known as ESCA (electron spectroscopy for chemical analysis) is the surface technique

→ provides both elemental & chemical state info of the material which can be analysed.

→ sample is illuminated with x-rays and photoelectrons are emitted from the surface.

↓

K.E of emitted e⁻'s is characteristic of the element from which the photoelectron is originated.

The K.E of emitted photoelectron is equal to the diff. b/w the photon energy & binding energy of the electron

ϕ = work function of spectrometer

$$KE = h\nu - B.E - \phi$$

This technique is inherently surface sensitive because the X-ray energy is low. The signal detected originates from the outer 1–10nm of a sample.

↓

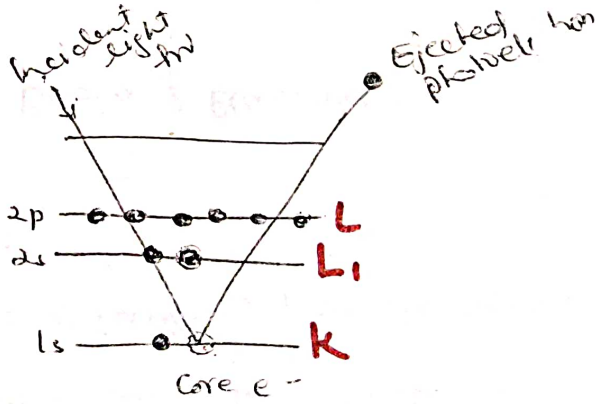
K.E is measured by cylindrical mirror analyzer

↓

The spectrum plotted by the computer from the analyzer signal

↓

B.E can be determined from the peak positions & the elements present in the sample identified.



X ray will emit core electron

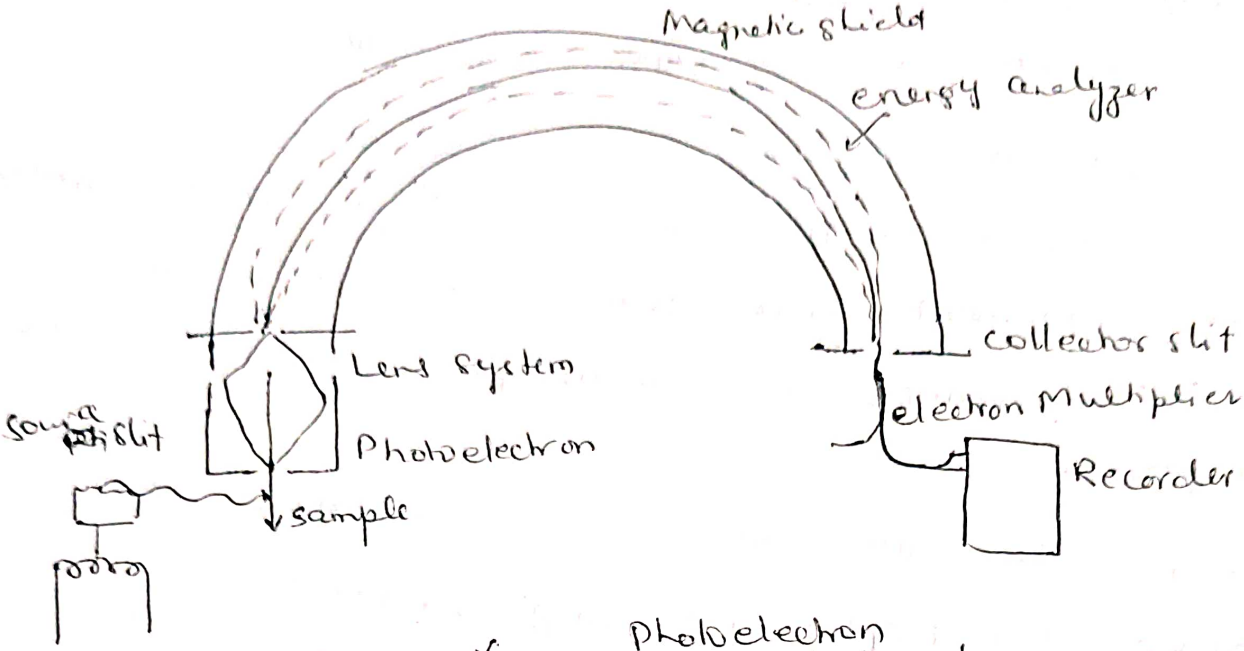
Components of XPS

1. Source of X-rays → emits photoelectron from the surface of sample
2. An ultra high Vaccum (UHV) → to eliminate excessive surface contamination
3. An electron energy analyser → to measure K.E. of emitted e⁻s
4. Magnetic field shielding
5. An electron detector system
6. A set of stage manipulators

Advantages → measures composition of the surface
→ measures chemical/electronic state of each element in the surface
→ Uniformity of across the top surface

Applications in Industry : Polymer surface
Corrosion
Adhesion
Thin film coating
Semiconductors

Disad :- Expensive
ultra vaccum req.
Slow



Photoelectron
X-ray spectrophotometer