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(BAS-201)

UNIT 1

QUANTUM MECHANICS

TOPICS- DAVISSON AND GERMER EXPERIMENT

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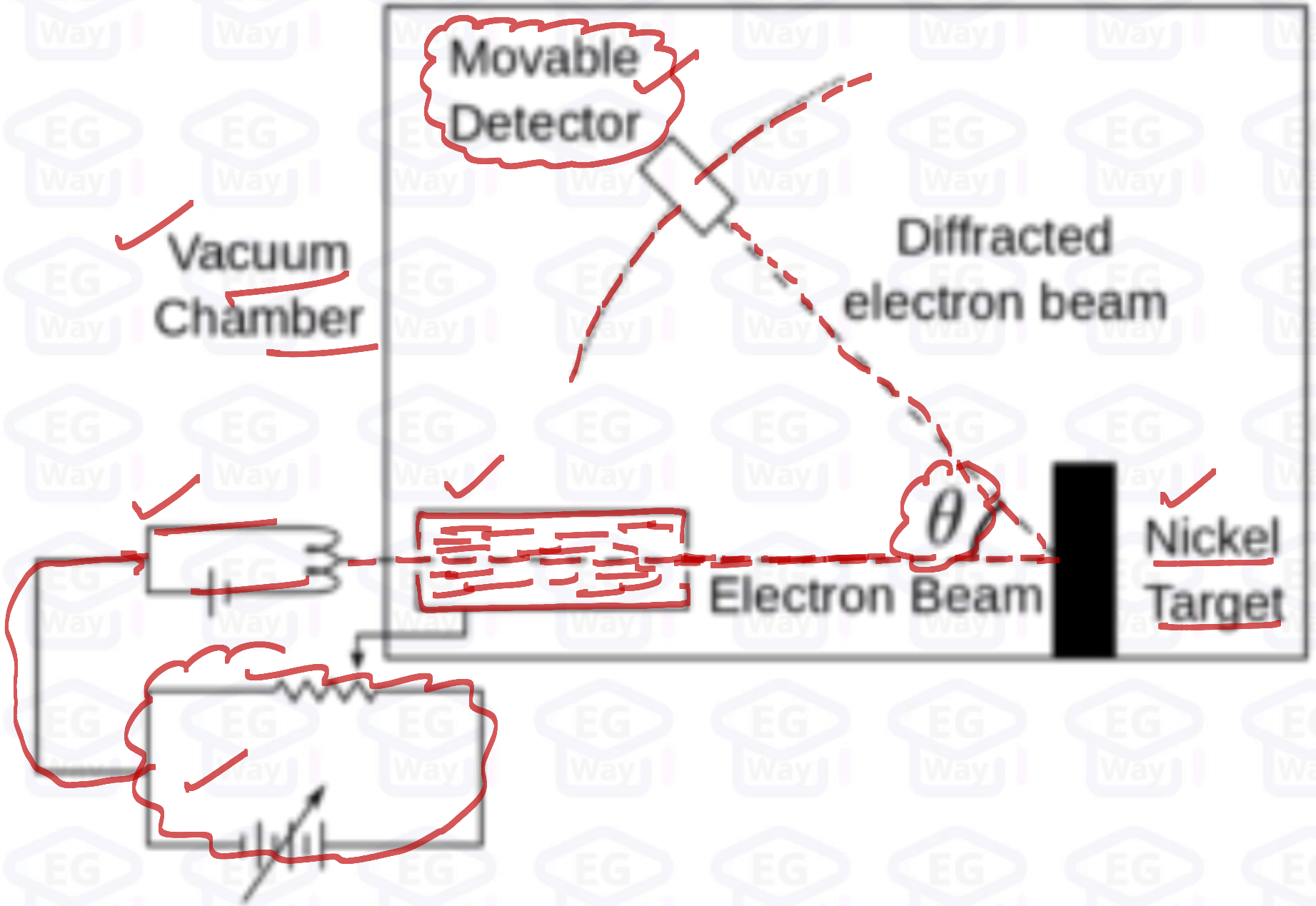
SYLLABUS

Quantum Mechanics: Inadequacy of classical mechanics, Planck's theory of black body radiation(qualitative), Compton effect, de-Broglie concept of matter waves, **Davisson and Germer Experiment**, Phase velocity and group velocity, Time-dependent and time-independent Schrodinger wave equations, Physical interpretation of wave function, Particle in a one-Dimensional box.

Davisson and Germer Experiment:

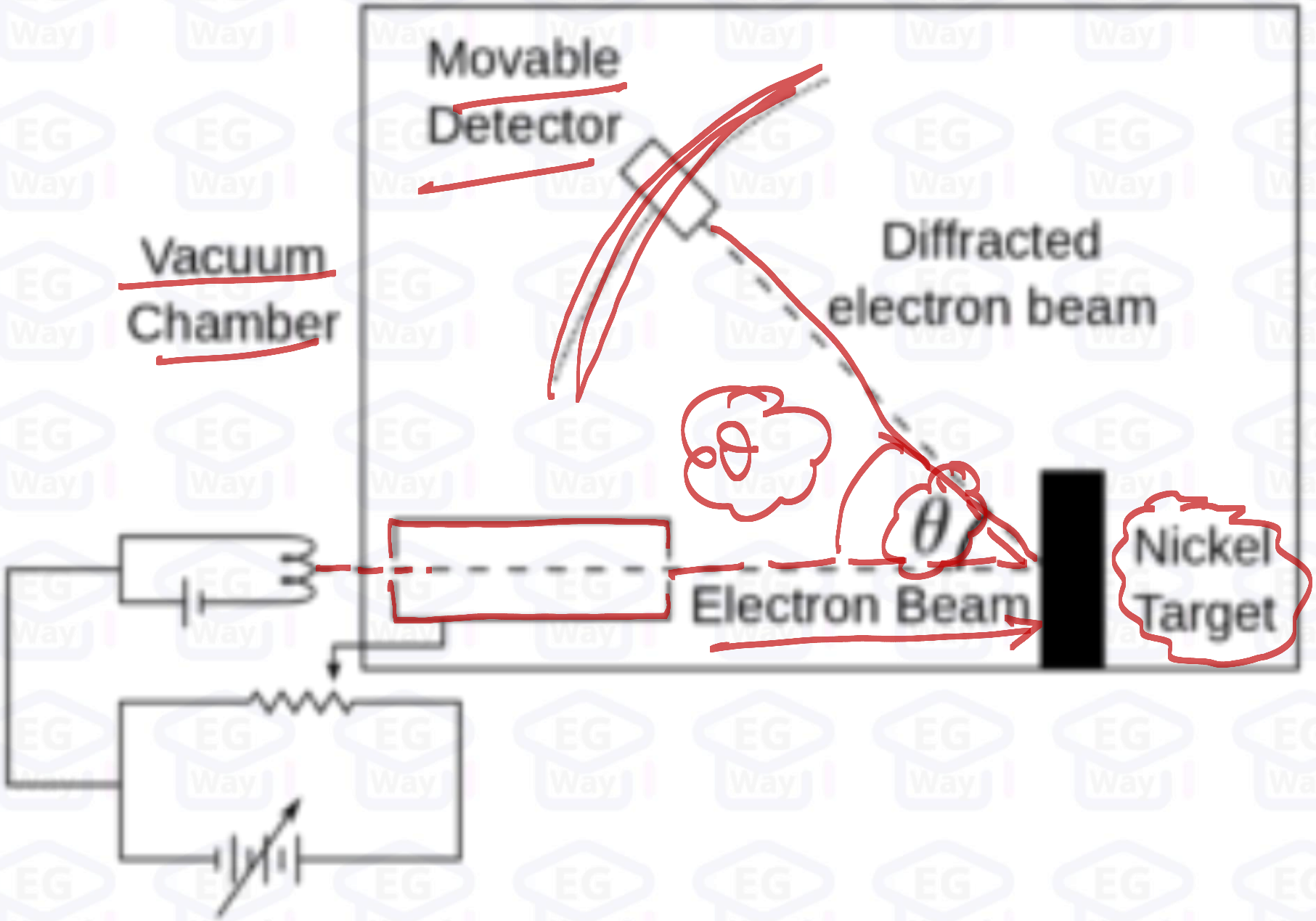
The Davisson–Germer experiment was a 1923-27 experiment by Clinton Davisson and Lester Germer in which electrons, scattered by the surface of a crystal of nickel metal, displayed a diffraction pattern. This confirmed the hypothesis, advanced by Louis de Broglie in 1924, of wave-particle duality, and was an experimental milestone in the creation of quantum mechanics.


Movable
Detector
Vacuum
Chamber
Diffracted
electron beam
θ
Nickel
Target
Electron Beam

The experimental setup for the Davisson and Germer experiment is enclosed within a vacuum chamber. Thus the deflection and scattering of electrons by the medium are prevented. The main parts of the experimental setup are as follows:

- **Electron gun:** An electron gun is a Tungsten filament that emits electrons via thermionic emission i.e. it emits electrons when heated to a particular temperature.
- **Electrostatic particle accelerator:** Two opposite charged plates (positive and negative plate) are used to accelerate the electrons at a known potential

- **Collimator:** The accelerator is enclosed within a cylinder that has a narrow passage for the electrons along its axis. Its function is to render a narrow and straight (collimated) beam of electrons ready for acceleration.
- **Target:** The target is a Nickel crystal. The electron beam is fired normally on the Nickel crystal. The crystal is placed such that it can be rotated about a fixed axis.
- **Detector:** A detector is used to capture the scattered electrons from the Ni crystal. The detector can be moved in a semicircular arc as shown in the diagram above.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Working of Davisson Germer experiment

- A low voltage power supply was used to heat an electron cannon with a tungsten filament F coated with barium oxide.
- When an appropriate potential difference is applied from a high voltage power source, the electron cannon produces electrons that are then accelerated to a certain velocity.
- These released electrons were forced to travel through a cylinder perforated with small holes along its axis, resulting in a finely collimated beam.
- The cylinder's beam is once more directed toward the surface of a nickel crystal. As a result, electrons disperse in numerous

- The intensity of the electron beam created is recorded by the electron detector, and it is then moved on a circular scale after being linked to a sensitive galvanometer (to record the current).
- The intensity of the scattered electron beam is measured for different values of angle of scattering by moving the detector on the circular scale at different places that change the θ (angle between the incident and scattered

Observations of Davisson Germer experiment:

- Only the existence of an electron in the form of a particle may be detected by the detector.
- The intensity (strength) of the electronic current received by the detector, as well as the scattering angle, are being investigated. This current is referred to as the electron intensity.
- The dispersed electrons intensity is not constant. It displays a maximum and the lowest value that correspond to the maxima and minima of an X-ray diffraction pattern.
- By varying the angle of scattering (θ), we were able to get a change in the intensity (I) of the scattered electrons.

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