

# Saitechinfo NEET-JEE Academy



## Key Answer Sheet

Saitechinfo Centum Cyclic Unit Test

Dual Nature of Electrons | Physics | STD 12 TN State Board

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### Section A (1 Mark Each)

1. Einstein
  2. Minimum
  3.  $\lambda = h/p$
  4. Photoelectric
  5. Joule-second (Js)
  6. Frequency
  7. Momentum
  8. Wave
  9.  $h\nu = \Phi + \text{K.E.}$
  10. Field
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### Section B (3 Marks Each)

1. Expression for de Broglie Wavelength:

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

where  $\lambda$  is the wavelength,  $h$  is Planck's constant,  $p$  is momentum,  $m$  is mass, and  $v$  is velocity.

2. Factors Affecting Photoelectric Effect:

- Intensity of light: Increases the number of emitted electrons.
- Frequency of light: Must be greater than the threshold frequency.
- Potential difference: Affects the energy of emitted electrons.

3. Davisson-Germer Experiment:

- Confirmed the wave nature of electrons through diffraction on a nickel crystal.
- Demonstrated the validity of de Broglie wavelength.

4. Calculation of de Broglie Wavelength:

$$\lambda = \frac{h}{mv}$$

Substituting:

$$\lambda = \frac{6.63 \times 10^{-34}}{9.1 \times 10^{-31} \times 5.4 \times 10^6}$$
$$\lambda = 1.35 \times 10^{-10} \text{ m}$$

### 5. Threshold Frequency:

- Minimum frequency of light required for photoemission.
- Dependent on the work function of the material:  $\nu_{\text{threshold}} = \frac{\Phi}{h}$ .

### 6. Laws of Photoelectric Effect:

- Emission occurs only above the threshold frequency.
  - Kinetic energy of emitted electrons depends on light frequency.
  - Number of electrons depends on light intensity.
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## Section C (5 Marks Each)

### 1. Einstein's Photoelectric Equation:

$$h\nu = \Phi + K.E.$$

Derivation includes energy conservation where incident photon energy ( $h\nu$ ) equals the work function ( $\Phi$ ) plus the kinetic energy of the electron ( $K.E.$ ).

### 2. Energy and Wavelength Calculation:

$$E_n = -\frac{13.6}{n^2} \text{ eV}$$

For  $n = 1$ :  $E_1 = -13.6 \text{ eV}$ .

For  $n = 3$ :  $E_3 = -1.51 \text{ eV}$ .

Transition energy:

$$\Delta E = E_3 - E_1 = -1.51 - (-13.6) = 12.09 \text{ eV}$$

Wavelength:

$$\lambda = \frac{hc}{E} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{12.09 \times 1.6 \times 10^{-19}}$$

$$\lambda = 102.6 \text{ nm}$$

### 3. Kinetic Energy Calculation:

Photon energy:

$$E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{400 \times 10^{-9}}$$

$$E = 4.97 \text{ eV}$$

Kinetic energy:

$$K.E. = E - \Phi = 4.97 - 2.2 = 2.77 \text{ eV}$$

### 4. Davisson-Germer Experiment:

- Experimental setup includes an electron gun, nickel crystal, and a detector.
- Observed diffraction pattern confirmed wave nature of electrons.
- Validated de Broglie wavelength experimentally.

### 5. De Broglie Wavelength of Proton:

$$\lambda = \frac{h}{mv}$$

Substituting:

$$\lambda = \frac{6.63 \times 10^{-34}}{1.67 \times 10^{-27} \times 2.85 \times 10^8}$$

$$\lambda = 1.38 \times 10^{-15} \text{ m}$$

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