Name: Vidhi Shah Reg No: 21BCE1297 Batch: L3+L4
Dataset 2

EXPERIMENT: No. 3 Electron Diffraction - deBroglie Wavelength

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- **AIM:** ① To observe the diffraction of electrons on polycrystalline graphite and to confirm the wave nature of electrons.
② To calculate and compare both the deBroglie's and Bragg's wavelength of electron.

- **APPARATUS REQUIRED:** Electron diffraction tube, tube holder, high voltage power supply, analogue multimeter.

- **FORMULA USED:**

① Bragg's wavelength:

$$\boxed{\lambda = d\frac{D}{2L}}$$

d → the seperation between two adjacent planes
D → diameter of the rings
L → Distance between graphite target and fluorescent screen = 135mm

② deBroglie's Wavelength:

$$\boxed{\lambda = \frac{h}{\sqrt{2meV}}}$$

m → mass of electron
e → Charge of electron
h → Planck's constant
V → Applied Voltage, kV

• Observation Table:

S. No.	Voltage 'V' (kV)		Diameter of ring 'D' MSR (cm)	VSC	TR (cm)	$\theta = \frac{D}{L}$	$\tan(2\theta)$	d (nm)	Braggs (λ), (Å)	deBroglie (λ), (Å)
1.	4	Ring1	2.3	1	2.31	0.1711	0.3562	0.213	0.182 Å	0.194 Å
		Ring2	4.3	7	4.37	0.3237	0.7561	0.123	0.199 Å	0.194 Å
2.	4.4	Ring1	2.2	0	2.20	0.1630	0.3380	0.213	0.173 Å	0.185 Å
		Ring2	4.1	8	4.18	0.3096	0.7128	0.123	0.190 Å	0.185 Å
3.	4.8	Ring1	2.1	6	2.16	0.1600	0.3314	0.213	0.170 Å	0.177 Å
		Ring2	4.1	7	4.17	0.3089	0.7106	0.123	0.189 Å	0.177 Å
							Mean λ		0.184 Å	0.185 Å

• Calculation:

$$\text{Braggs}(\lambda) = d\frac{D}{2L}, \quad \text{deBroglie}(\lambda) = \frac{h}{\sqrt{2meV}}$$

$$L = 13.5\,\text{cm},\ m = 9.11\times10^{-31}\,\text{kg},\ e = 1.6\times10^{-19}\,\text{C},\ h = 6.626\times10^{-34}\ \text{m}^2\frac{\text{kg}}{\text{s}}$$

$$\Rightarrow me = 14.576\times10^{-50}$$

① **V = 4 kV:**

Ring1:

$$\text{Braggs}(\lambda) = 0.213\times10^{-9}\left(\frac{2.31\times10^{-2}}{2\times13.5\times10^{-2}}\right)\text{m} = 0.0182\times10^{-9}\,\text{m} = 0.182\,\text{Å}$$

$$\text{deBroglie}(\lambda) = \frac{6.626\times10^{-34}}{\sqrt{2\times14.576\times10^{-50}\times4\times10^{3}}}\,\text{m} = 0.0194\times10^{-9}\,\text{m} = 0.194\,\text{Å}$$

Ring2:

$$\text{Braggs}(\lambda) = 0.123\times10^{-9}\left(\frac{4.37\times10^{-2}}{2\times13.5\times10^{-2}}\right)\text{m} = 0.0199\times10^{-9}\,\text{m} = 0.199\,\text{Å}$$

$$\text{deBroglie}(\lambda) = \frac{6.626\times10^{-34}}{\sqrt{2\times14.576\times10^{-50}\times4\times10^{3}}}\,\text{m} = 0.194\,\text{Å}$$

② $\underline{V = 4.4\,kV}$:

<u>Ring 1</u>:

Braggs $(\lambda) = 0.213\times10^{-9}\left(\frac{2.2}{13.5\times2}\right)m = 0.01735\times10^{-9}m = 0.1735\,Å$

<u>Ring 2</u>:

Braggs $(\lambda) = 0.123\times10^{-9}\left(\frac{4.18}{13.5\times2}\right)m = 0.0190\times10^{-9}m = 0.19\,Å$

de Broglie $(\lambda) = \frac{6.626\times10^{-34}}{\sqrt{2\times14.576\times10^{-50}\times4400}}\,m = 0.0185\times10^{-9}m = 0.185\,Å$

③ $\underline{V = 4.8\,kV}$

<u>Ring 1</u>:

Braggs $(\lambda) = 0.213\times10^{-9}\left(\frac{2.16}{27}\right)m = 0.0170\times10^{-9}m = 0.170\,Å$

<u>Ring 2</u>:

Braggs $(\lambda) = 0.123\times10^{-9}\left(\frac{4.17}{27}\right)m = 0.01899\times10^{-9}m = 0.1899\,Å$

de Broglie $(\lambda) = \frac{6.626\times10^{-34}}{\sqrt{2\times14.576\times4800}}\,m = 0.01771\times10^{-9}m = 0.1771\,Å$

RESULT:

(1) deBroglie wavelength of electron = 0.185 Å
(2) Bragg's Wavelength of electron = 0.184 Å