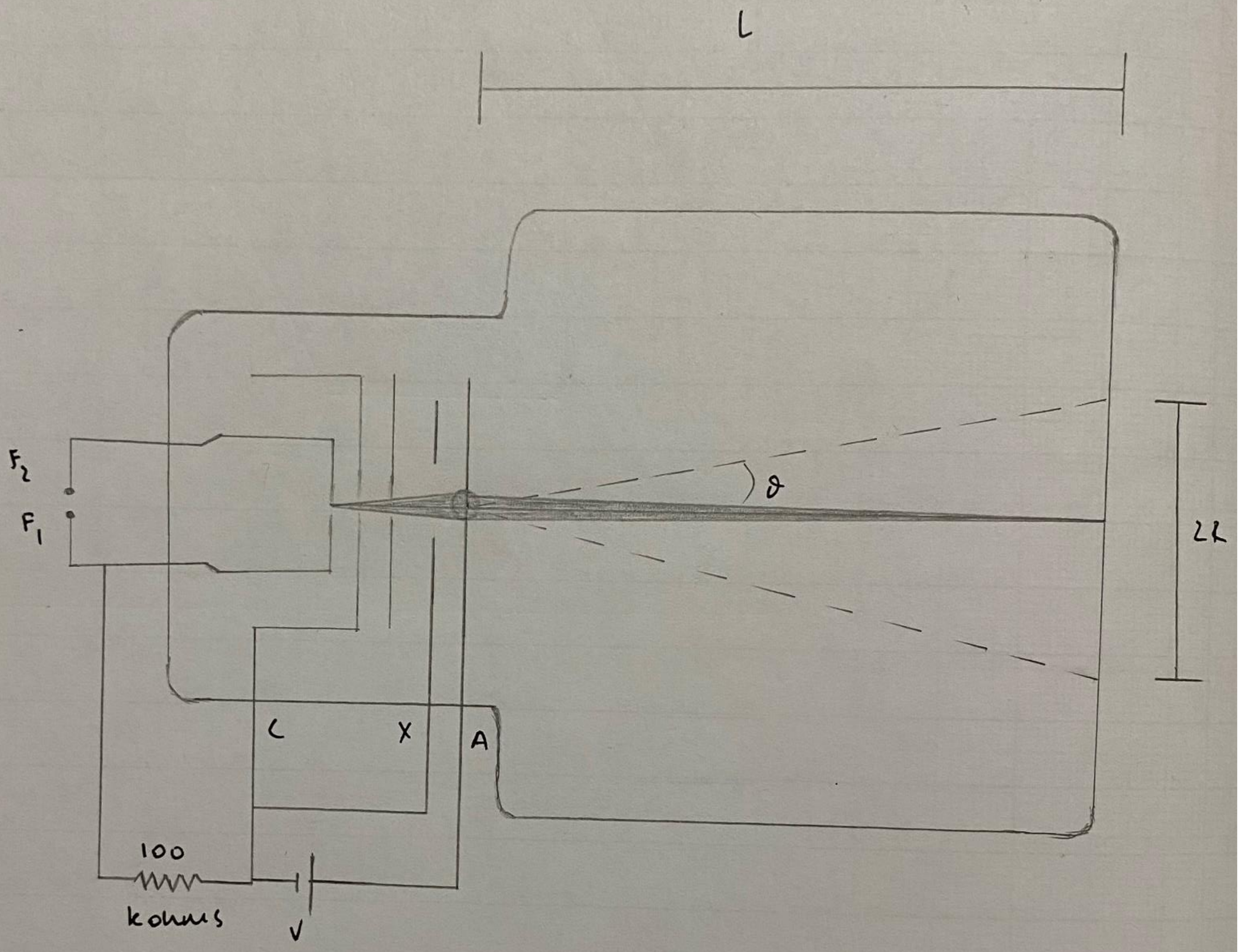


Fig 3.1. Experimental setup

Electron Diffraction

Apparatus Required:

1. Electron diffraction tube with stand
2. High voltage power supply (up to 10 kV)
3. connecting wires
4. Plastic measuring scale

Objective:

To calculate the interplanar spacing in graphite from the diffraction pattern

Basic Information:

In this experiment electrons get transmitted through a very thin polycrystalline graphite sheet. The schematic sketch is shown in Fig 3.1. Graphite has two independant lattice spacings (d_1 and d_2) and these are shown in Fig 3.2. The two diffraction rings that are seen at each voltage are due to these two planes.

Applying the diffraction formula for first order, we have,

$$\lambda = d \sin\theta \qquad \dots (1)$$

where λ is the de Broglie wavelength of the electron, d is the interplanar spacing and θ is the angle of diffraction. Electrons are accelerated through a potential difference of 'V' volts and hence their de Broglie wavelength is:

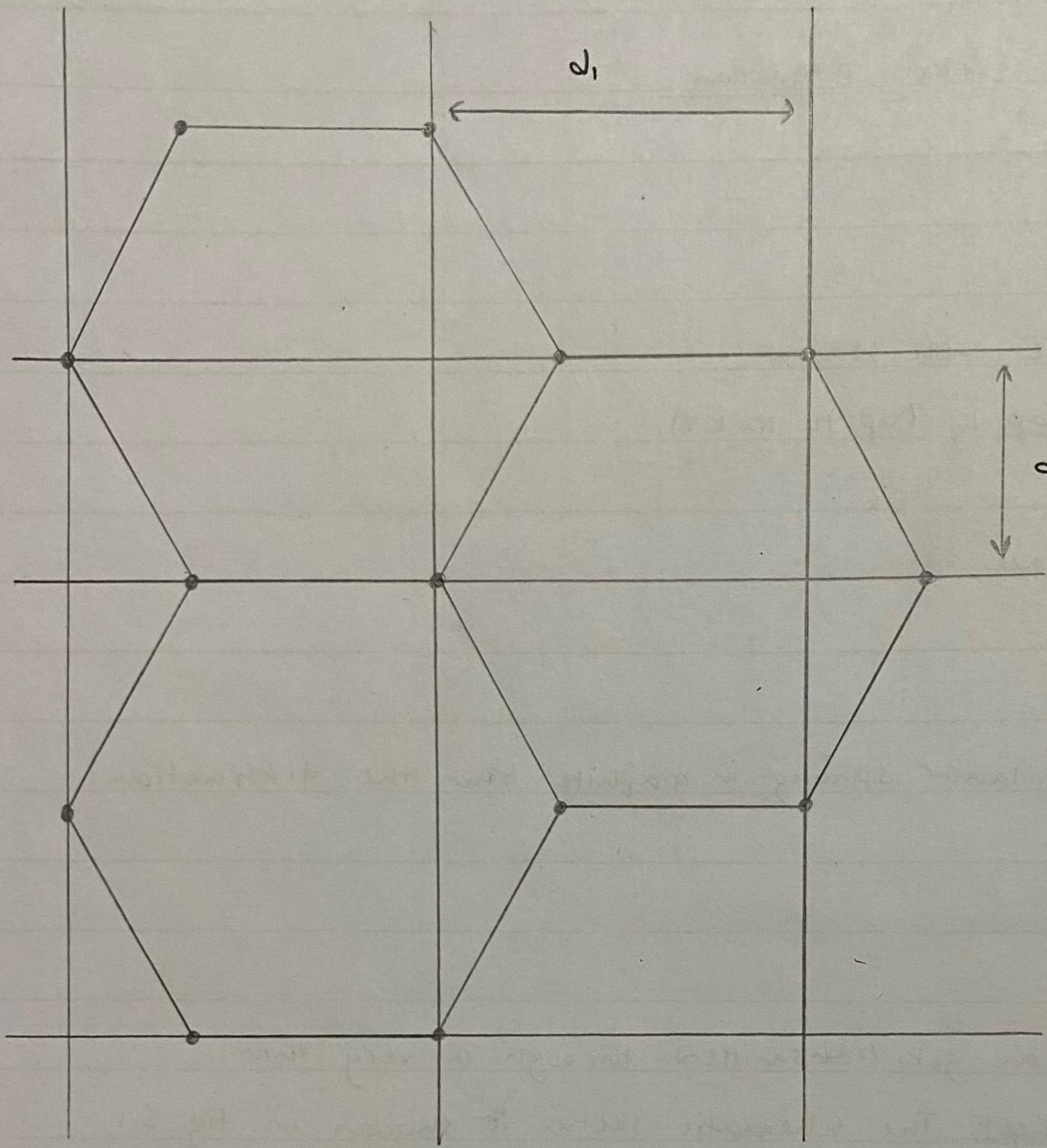
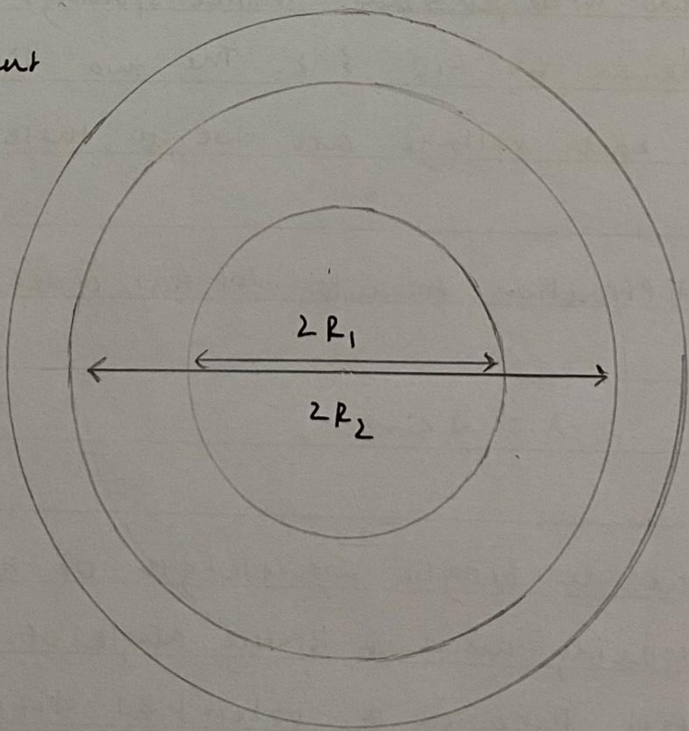


Fig 3.2. (Top) Two independent types of lattice planes in polycrystalline graphite and (bottom) the diffraction rings produced by these lattice planes.



$$\lambda = \frac{12.3}{\sqrt{V}} \text{ Å} \qquad \ldots (2)$$

From the geometry of Fig 3.1, we have

$$\sin\theta = \frac{R}{\sqrt{R^2 + L^2}} \qquad \ldots (3)$$

upon simplifying and using the fixed value of L = 13.5 cm and R expressed in cm,

$$\sin\theta = \frac{1}{\left(1 + \left(\frac{13.5}{R}\right)^2\right)^{0.5}} \qquad \ldots (4)$$

Interplanar spacing can be calculated from equation (1) by substituting (2) and (4) into it.

Safety Guidelines and Precautions:

1. Never accelerate beyond 5 kV
2. Never touch any controls on the power supply other than the 'On - Off' switch and the voltage varying knob.
3. Never use any force to measure the ring diameters. Keep a plastic ~~st~~ scale very gently over the tube to measure the diameters. Metal scales are not allowed.

Procedure:

1. Set the accelerating voltage to 4 kV
2. For the inner ring, measure the diameter ($2R_1$)
3. Fill up the radius (R_1) in the tabular column.
4. For the outer ring, measure the diameter ($2R_2$)
5. Fill up the radius (R_2) in the tabular column.
6. Calculate λ, $\sin\theta$ and d from the equations (2), (4) and (1)

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Ring	V (kV)	$2R_1$ (or) $2R_2$ (cm)	R_1 or R_2 (cm)	λ (Å)	$\sin\theta$	d (Å)
Inner	4	2.6	1.3	0.194	0.099	1.96
	4.5	2.4	1.2	0.183	0.089	2.06
	5	2.0	1.0	0.174	0.074	2.35
Outer	4	4.5	2.25	0.194	0.164	1.18
	4.5	4.2	2.1	0.183	0.154	1.18
	5	4.0	2.0	0.174	0.147	1.18

Table 3.1. Readings from experiment

respectively and fill up the corresponding cells in the tabular column.

7. Repeat steps 2 to 6 for accelerating voltages 4.5 and 5 kV

8. Calculate the average d for both inner and outer rings.

Observations:

Readings noted in table 3.1.

Calculations:

$$\text{Average inner } d = \frac{1.96 + 2.06 + 2.35}{3}$$

$$= 2.123 \text{ Å}$$

$$\text{Average outer } d = \frac{1.18 \times 3}{3}$$

$$= 1.18 \text{ Å}$$

Result:

The interplanar spacings in graphite were measured as $d_1 = 0.212$ nm and $d_2 = 0.118$ nm

Teacher's Signature ______________