Diffraction at single and double slits

Group 12

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**Aim**: To measure the intensity distribution due to diﬀraction at single and double slits and use it to measure the slit width (d), and slit separation (a).

**Apparatus**: Optical bench, He-Ne Laser, single slit, double slit, photocell, microammeter.

**Procedure:**

**Single Slit**

1. The laser was fixed on the mount and a single slit was aligned with the laser such that a diffraction pattern was observed on the photocell.
2. The photocell was then connected with a multimeter.
3. The centre of the photocell was then aligned with the third dark fringe on one side.
4. The readings were taken by moving the photocell across the diffraction pattern in interval of 10 divisions on the micrometer.

**Double Slit**

1. The single slit was then replaced with a double slit.
2. An interference pattern was got on the photocell and the photocell was moved in intervals of 20 divisions from one end of the interference pattern to the other.
3. The intensity readings were noted.

**Observations:**

**For single slit-**

|  |  |
| --- | --- |
| distance (mm) | intensity(mA) |
| 6 | 4.1 |
| 6.1 | 3.8 |
| 6.2 | 4 |
| 6.3 | 4.2 |
| 6.4 | 5.1 |
| 6.5 | 4.6 |
| 6.6 | 4.7 |
| 6.7 | 5.3 |
| 6.8 | 5.8 |
| 6.9 | 5.4 |
| 7 | 5.5 |
| 7.1 | 6.9 |
| 7.2 | 6.6 |
| 7.3 | 7.4 |
| 7.4 | 8 |
| 7.5 | 8.6 |
| 7.6 | 8.6 |
| 7.7 | 9.2 |
| 7.8 | 9.6 |
| 7.9 | 10 |
| 8 | 10.7 |
| 8.1 | 10.5 |
| 8.2 | 10.9 |
| 8.3 | 11.4 |
| 8.4 | 12.2 |
| 8.5 | 12.3 |
| 8.6 | 12.4 |
| 8.7 | 13.4 |
| 8.8 | 13.6 |
| 8.9 | 13.7 |
| 9 | 12.8 |
| 9.1 | 12.7 |
| 9.2 | 13.9 |
| 9.3 | 14.5 |
| 9.4 | 12.6 |
| 9.5 | 12.1 |
| 9.6 | 11.7 |
| 9.7 | 11.9 |
| 9.8 | 11.8 |
| 9.9 | 11.8 |
| 10 | 11.7 |
| 10.1 | 11.3 |
| 10.2 | 10.8 |
| 10.3 | 9.3 |
| 10.4 | 8.6 |
| 10.5 | 8.2 |
| 10.6 | 7.8 |
| 10.7 | 7.4 |
| 10.8 | 6.9 |
| 10.9 | 6.8 |
| 11 | 6.6 |
| 11.1 | 6.5 |
| 11.2 | 6.4 |
| 11.3 | 5.8 |
| 11.4 | 4.9 |
| 11.5 | 4.3 |
| 11.6 | 4.2 |
| 11.7 | 4.1 |
| 11.8 | 4.2 |
| 11.9 | 4.4 |
| 12 | 4.7 |
| 12.1 | 4.7 |
| 12.2 | 4.9 |
| 12.3 | 5 |
| 12.4 | 5.3 |
| 12.5 | 6.7 |
| 12.6 | 7.8 |
| 12.7 | 8.4 |
| 12.8 | 9.4 |
| 12.9 | 9.4 |
| 13 | 9.5 |
| 13.1 | 10.1 |
| 13.2 | 12.1 |
| 13.3 | 14.1 |
| 13.4 | 16.2 |
| 13.5 | 16.9 |
| 13.6 | 18.2 |
| 13.7 | 19.9 |
| 13.8 | 20.9 |
| 13.9 | 21.4 |
| 14 | 22.3 |
| 14.1 | 23.5 |
| 14.2 | 26.5 |
| 14.3 | 28.8 |
| 14.4 | 30.2 |
| 14.5 | 31.9 |
| 14.6 | 34 |
| 14.7 | 36.1 |
| 14.8 | 38 |
| 14.9 | 39.5 |
| 15 | 41.5 |
| 15.1 | 42.2 |
| 15.2 | 43 |
| 15.3 | 45 |
| 15.4 | 45.7 |
| 15.5 | 44.9 |
| 15.6 | 44.5 |
| 15.7 | 43.2 |
| 15.8 | 42.7 |
| 15.9 | 42.2 |
| 16 | 42.5 |
| 16.1 | 42.4 |
| 16.2 | 41.8 |
| 16.3 | 39.2 |
| 16.4 | 37.6 |
| 16.5 | 33.8 |
| 16.6 | 33.6 |
| 16.7 | 33.4 |
| 16.8 | 31.2 |
| 16.9 | 29.5 |
| 17 | 28.7 |
| 17.1 | 26.9 |
| 17.2 | 24.5 |
| 17.3 | 21.9 |
| 17.4 | 18.6 |
| 17.5 | 16.6 |
| 17.6 | 16 |
| 17.7 | 14.9 |
| 17.8 | 13.6 |
| 17.9 | 13.5 |
| 18 | 20.7 |
| 18.1 | 20.9 |
| 18.2 | 19.8 |
| 18.3 | 19 |
| 18.4 | 18.8 |
| 18.5 | 20.8 |
| 18.6 | 21.2 |
| 18.7 | 21.6 |
| 18.8 | 21.2 |
| 18.9 | 22.7 |
| 19 | 22.7 |
| 19.1 | 24.6 |
| 19.2 | 26.8 |
| 19.3 | 29.3 |
| 19.4 | 32.5 |
| 19.5 | 39.4 |
| 19.6 | 45.9 |
| 19.7 | 48.5 |
| 19.8 | 52.2 |
| 19.9 | 52.9 |
| 20 | 56.6 |
| 20.1 | 62.3 |
| 20.2 | 69.4 |
| 20.3 | 80 |
| 20.4 | 91.4 |
| 20.5 | 105.2 |
| 20.6 | 109.6 |
| 20.7 | 110.7 |
| 20.8 | 111.2 |
| 20.9 | 111.3 |
| 21 | 111.4 |
| 21.1 | 111.8 |
| 21.2 | 112.1 |
| 21.3 | 112.4 |
| 21.4 | 112.6 |
| 21.5 | 112.9 |
| 21.6 | 113 |
| 21.7 | 113.1 |
| 21.8 | 113.1 |
| 21.9 | 113.1 |
| 22 | 113.2 |
| 22.1 | 113.2 |
| 22.2 | 113.3 |
| 22.3 | 113.4 |
| 22.4 | 113.4 |
| 22.5 | 113.5 |
| 22.6 | 113.6 |
| 22.7 | 113.5 |
| 22.8 | 113.6 |
| 22.9 | 113.6 |
| 23 | 113.5 |
| 23.1 | 113.6 |
| 23.2 | 113.6 |
| 23.3 | 113.6 |
| 23.4 | 113.6 |
| 23.5 | 113.6 |
| 23.6 | 113.6 |
| 23.7 | 113.7 |
| 23.8 | 113.7 |
| 23.9 | 113.7 |
| 24 | 113.6 |
| 24.1 | 113.6 |
| 24.2 | 113.6 |
| 24.3 | 113.5 |
| 24.4 | 113.5 |
| 24.5 | 113.5 |
| 24.6 | 113.5 |
| 24.7 | 113.5 |
| 24.8 | 113.5 |
| 24.9 | 113.5 |
| 25 | 113.5 |
| 25.1 | 113.5 |
| 25.2 | 113.5 |
| 25.3 | 113.5 |
| 25.4 | 113.5 |
| 25.5 | 113.4 |
| 25.6 | 113.4 |
| 25.7 | 113.3 |
| 25.8 | 113.3 |
| 25.9 | 113.2 |
| 26 | 113.2 |
| 26.1 | 113.2 |
| 26.2 | 113.2 |
| 26.3 | 113.1 |
| 26.4 | 113.1 |
| 26.5 | 113 |
| 26.6 | 112.9 |
| 26.7 | 112.9 |
| 26.8 | 112.9 |
| 26.9 | 112.8 |
| 27 | 112.8 |
| 27.1 | 112.8 |
| 27.2 | 112.7 |
| 27.3 | 112.6 |
| 27.4 | 111.2 |
| 27.5 | 111 |
| 27.6 | 110.7 |
| 27.7 | 110.6 |
| 27.8 | 110.3 |
| 27.9 | 110.2 |
| 28 | 110.2 |
| 28.1 | 109.6 |
| 28.2 | 108.9 |
| 28.3 | 104.5 |
| 28.4 | 99.8 |
| 28.5 | 90.4 |
| 28.6 | 80.6 |
| 28.7 | 77.5 |
| 28.8 | 73.4 |
| 28.9 | 70.5 |
| 29 | 67.5 |
| 29.1 | 59.6 |
| 29.2 | 55.5 |
| 29.3 | 48.9 |
| 29.4 | 40.2 |
| 29.5 | 36.8 |
| 29.6 | 30.8 |
| 29.7 | 28.9 |
| 29.8 | 25.8 |
| 29.9 | 24 |
| 30 | 23.5 |
| 30.1 | 18.6 |
| 30.2 | 17 |
| 30.3 | 14.5 |
| 30.4 | 11.1 |
| 30.5 | 9.5 |
| 30.6 | 7.2 |
| 30.7 | 7.5 |
| 30.8 | 5.9 |
| 30.9 | 5.6 |
| 31 | 5.3 |
| 31.1 | 4.7 |
| 31.2 | 4.3 |
| 31.3 | 3.9 |
| 31.4 | 3.7 |
| 31.5 | 3.8 |
| 31.6 | 4.1 |
| 31.7 | 4.2 |
| 31.8 | 4.4 |
| 31.9 | 4.9 |
| 32 | 5 |
| 32.1 | 5.6 |
| 32.2 | 5.8 |
| 32.3 | 6.4 |
| 32.4 | 6.9 |
| 32.5 | 8.1 |
| 32.6 | 8.7 |
| 32.7 | 8.9 |
| 32.8 | 9.4 |
| 32.9 | 9.5 |
| 33 | 9.7 |
| 33.1 | 10 |
| 33.2 | 10.2 |
| 33.3 | 10.6 |
| 33.4 | 11.1 |
| 33.5 | 11.2 |
| 33.6 | 11.3 |
| 33.7 | 11.4 |
| 33.8 | 11.3 |
| 33.9 | 11.2 |
| 34 | 11.1 |
| 34.1 | 10.9 |
| 34.2 | 10.8 |
| 34.3 | 10.5 |
| 34.4 | 10.2 |
| 34.5 | 9.6 |
| 34.6 | 9.3 |
| 34.7 | 9 |
| 34.8 | 8.9 |
| 34.9 | 8.5 |
| 35 | 8.2 |
| 35.1 | 7.9 |
| 35.2 | 7.5 |
| 35.3 | 6.9 |
| 35.4 | 6.4 |
| 35.5 | 5.4 |
| 35.6 | 4.9 |
| 35.7 | 4.4 |
| 35.8 | 4.3 |
| 35.9 | 3.9 |
| 36 | 3.8 |
| 36.1 | 3.5 |
| 36.2 | 3.2 |
| 36.3 | 2.9 |
| 36.4 | 2.2 |
| 36.5 | 1.9 |
| 36.6 | 1.4 |
| 36.7 | 1.2 |
| 36.8 | 1.1 |
| 36.9 | 0.9 |
| 37 | 0.8 |
| 37.1 | 0.7 |
| 37.2 | 0.6 |
| 37.3 | 0.5 |
| 37.4 | 0.5 |
| 37.5 | 0.6 |
| 37.6 | 0.7 |
| 37.7 | 0.7 |
| 37.8 | 0.8 |
| 37.9 | 0.8 |
| 38 | 0.9 |
| 38.1 | 1.1 |
| 38.2 | 1.2 |
| 38.3 | 1.3 |
| 38.4 | 1.6 |
| 38.5 | 1.9 |
| 38.6 | 2.1 |
| 38.7 | 2.2 |
| 38.8 | 2.3 |
| 38.9 | 2.4 |
| 39 | 2.5 |
| 39.1 | 2.6 |
| 39.2 | 2.9 |
| 39.3 | 3.1 |
| 39.4 | 3.2 |
| 39.5 | 3.3 |
| 39.6 | 3.3 |
| 39.7 | 3.5 |
| 39.8 | 3.9 |
| 39.9 | 3.6 |
| 40 | 3.4 |
| 40.1 | 3.5 |
| 40.2 | 3.5 |
| 40.3 | 3.4 |
| 40.4 | 3.3 |
| 40.5 | 3.2 |
| 40.6 | 3 |
| 40.7 | 2.9 |
| 40.8 | 2.8 |
| 40.9 | 2.8 |
| 41 | 2.7 |
| 41.1 | 2.6 |
| 41.2 | 2.5 |
| 41.3 | 2.4 |
| 41.4 | 2.3 |
| 41.5 | 2.2 |
| 41.6 | 1.9 |
| 41.7 | 1.8 |
| 41.8 | 1.7 |
| 41.9 | 1.6 |
| 42 | 1.5 |
| 42.1 | 1.3 |
| 42.2 | 1.1 |
| 42.3 | 0.9 |
| 42.4 | 0.8 |
| 42.5 | 0.7 |

Refer graph 1.0

**For double slit-**

|  |  |
| --- | --- |
| distance(mm) | Intensity(mA) |
| 0.8 | 1.5 |
| 1 | 2.4 |
| 1.2 | 2.8 |
| 1.4 | 2.1 |
| 1.6 | 1.9 |
| 1.8 | 1.9 |
| 2 | 2 |
| 2.2 | 2.3 |
| 2.4 | 3.2 |
| 2.6 | 6.6 |
| 2.8 | 7.1 |
| 3 | 8 |
| 3.2 | 6.3 |
| 3.4 | 10.8 |
| 3.6 | 13.2 |
| 3.8 | 10.2 |
| 4 | 10.8 |
| 4.2 | 15.8 |
| 4.4 | 14.5 |
| 4.6 | 12.8 |
| 4.8 | 15.2 |
| 5 | 13.1 |
| 5.2 | 10.9 |
| 5.4 | 9.3 |
| 5.6 | 7.7 |
| 5.8 | 7 |
| 6 | 6.9 |
| 6.2 | 6.2 |
| 6.4 | 5.5 |
| 6.6 | 6.3 |
| 6.8 | 6.6 |
| 7 | 6.2 |
| 7.2 | 5.2 |
| 7.4 | 4.5 |
| 7.6 | 7.7 |
| 7.8 | 7.3 |
| 8 | 6 |
| 8.2 | 10 |
| 8.4 | 11.5 |
| 8.6 | 13.3 |
| 8.8 | 11.6 |
| 9 | 14.2 |
| 9.2 | 16.6 |
| 9.4 | 13.2 |
| 9.6 | 15.2 |
| 9.8 | 11.8 |
| 10 | 15.2 |
| 10.2 | 10.3 |
| 10.4 | 9.1 |
| 10.6 | 11.1 |
| 10.8 | 8.6 |
| 11 | 8.3 |
| 11.2 | 6 |
| 11.4 | 5.6 |
| 11.6 | 3.2 |
| 11.8 | 3.8 |
| 12 | 2.7 |
| 12.2 | 3.5 |
| 12.4 | 2.9 |
| 12.6 | 2.2 |
| 12.8 | 2.4 |
| 13 | 2.5 |
| 13.2 | 3.5 |
| 13.4 | 4.7 |
| 13.6 | 6.6 |
| 13.8 | 9.6 |
| 14 | 8 |
| 14.2 | 8.6 |
| 14.4 | 8.9 |
| 14.6 | 9.4 |
| 14.8 | 9.6 |
| 15 | 14 |
| 15.2 | 10.4 |
| 15.4 | 9.2 |
| 15.6 | 8.5 |
| 15.8 | 10.2 |
| 16 | 7.6 |
| 16.2 | 6.8 |
| 16.4 | 6.6 |
| 16.6 | 5.5 |
| 16.8 | 6.6 |
| 17 | 7.6 |
| 17.2 | 9 |
| 17.4 | 20.4 |
| 17.6 | 25.6 |
| 17.8 | 28 |
| 18 | 28.7 |
| 18.2 | 37.9 |
| 18.4 | 45.6 |
| 18.6 | 53.4 |
| 18.8 | 63.3 |
| 19 | 66.3 |
| 19.2 | 75.5 |
| 19.4 | 79 |
| 19.6 | 81 |
| 19.8 | 75.9 |
| 20 | 77.1 |
| 20.2 | 68.7 |
| 20.4 | 63.1 |
| 20.6 | 57.8 |
| 20.8 | 52.9 |
| 21 | 51.2 |
| 21.2 | 46.8 |
| 21.4 | 43.8 |
| 21.6 | 42.3 |
| 21.8 | 51.6 |
| 22 | 50.6 |
| 22.2 | 63.2 |
| 22.4 | 81.6 |
| 22.6 | 105.1 |
| 22.8 | 110.4 |
| 23 | 110.8 |
| 23.2 | 111.7 |
| 23.4 | 112.2 |
| 23.6 | 112.3 |
| 23.8 | 112.5 |
| 24 | 112.4 |
| 24.2 | 112.5 |
| 24.4 | 112.3 |
| 24.6 | 112.2 |
| 24.8 | 112.1 |
| 25 | 112 |
| 25.2 | 111.5 |
| 25.4 | 110.8 |
| 25.6 | 110.2 |
| 25.8 | 108.9 |
| 26 | 102.4 |
| 26.2 | 101.4 |
| 26.4 | 100.2 |
| 26.6 | 103.8 |
| 26.8 | 107.5 |
| 27 | 110 |
| 27.2 | 110.8 |
| 27.4 | 111.5 |
| 27.6 | 112 |
| 27.8 | 112.2 |
| 28 | 112.3 |
| 28.2 | 112.4 |
| 28.4 | 112.6 |
| 28.6 | 112.5 |
| 28.8 | 112.6 |
| 29 | 112.6 |
| 29.2 | 112.4 |
| 29.4 | 112.3 |
| 29.6 | 112.1 |
| 29.8 | 112 |
| 30 | 111.7 |
| 30.2 | 111.4 |
| 30.4 | 110.7 |
| 30.6 | 109.8 |
| 30.8 | 107.7 |
| 31 | 108.3 |
| 31.2 | 101.4 |
| 31.4 | 105.4 |
| 31.6 | 108.6 |
| 31.8 | 109.8 |
| 32 | 110.3 |
| 32.2 | 110.7 |
| 32.4 | 111.2 |
| 32.6 | 111.6 |
| 32.8 | 111.7 |
| 33 | 111.8 |
| 33.2 | 111.7 |
| 33.4 | 111.8 |
| 33.6 | 111.7 |
| 33.8 | 111.7 |
| 34 | 111.6 |
| 34.2 | 111.4 |
| 34.4 | 111 |
| 34.6 | 110.4 |
| 34.8 | 109.7 |
| 35 | 108.9 |
| 35.2 | 104.7 |
| 35.4 | 81.2 |
| 35.6 | 68.6 |
| 35.8 | 64 |
| 36 | 60.7 |
| 36.2 | 58.2 |
| 36.4 | 59.2 |
| 36.6 | 64.1 |
| 36.8 | 66.1 |
| 37 | 68 |
| 37.2 | 72.6 |
| 37.4 | 78.4 |
| 37.6 | 80.6 |
| 37.8 | 81.5 |
| 38 | 81 |
| 38.2 | 79.1 |
| 38.4 | 74.1 |
| 38.6 | 66.5 |
| 38.8 | 63.3 |
| 39 | 59.3 |
| 39.2 | 51.8 |
| 39.4 | 41.2 |
| 39.6 | 32.3 |
| 39.8 | 28.7 |
| 40 | 26.4 |
| 40.2 | 20.6 |
| 40.4 | 16.8 |
| 40.6 | 13.8 |
| 40.8 | 12.8 |
| 41 | 11.9 |
| 41.2 | 10.8 |
| 41.4 | 10.2 |
| 41.6 | 9.8 |
| 41.8 | 9.8 |
| 42 | 9.4 |
| 42.2 | 8.8 |
| 42.4 | 8.1 |
| 42.6 | 7.3 |
| 42.8 | 6.9 |
| 43 | 6.7 |
| 43.2 | 5.5 |
| 43.4 | 4.5 |
| 43.6 | 3.2 |
| 43.8 | 3.5 |
| 44 | 3.2 |
| 44.2 | 2.6 |
| 44.4 | 2.2 |
| 44.6 | 1.9 |
| 44.8 | 1.8 |
| 45 | 1.7 |

Refer graph 2.0

**Graphs:**

Graph 1.0

Graph 2.0

**Calculations:**

For single slit

Distance between slide and screen(D)= 100cm

Length of central maxima(x)= 13.7mm

Wavelength= 633nm

a = λ√x2 + D2/x

a=633\*[(13.7)^2+(100)^2]/13.7

a=4663.59nm or 4.66359micrometer

For double slit

Distance between slide and screen(D)= 100cm

Length of central envelope(x)= 27.8mm

Fringe width of the pattern inside the envelope= 4.2mm

Wavelength= 633nm

a = λ√(x2 + D2)/x

a=633\*[(27.8)^2+(100)^2]/27.8

a=2363.32nm or 2.36332micrometer

d = λ√ [y2/4 + D2]/y

d=633√[(4.6)^2/4+(100)^2]/4.6

d=13764.5nm or 13.76450micrometer

**Precautions:**

1. Never look at the laser beam directly as this may damage the eyes permanently.
2. The photocell should be as away from the slit as possible.
3. The measurements should be made moving the micrometer screw in the same direction.
4. The laser should be operated at a constant voltage 220V obtainable from a stabilizer. This

prevents the flickering of the laser beam.

1. The interval between two consecutive positions of the photocell should be small enough to resolve the interference pattern.

**Results:**

The slit width for single slit is 4.6 microns and double slit is 2.3microns.

The distance between slits in double slit experiment is 13.7microns.