

Title: Grating Element of diffraction grating

1. **Practical Significance:** An optical component called a diffraction grating divides polychromatic light into its many wavelengths, or colors. Each wavelength of the polychromatic light is bent at a slightly different angle by the grating. Thus, we can state that the grating disperses light. As a result, monochromators and spectrometers frequently employ diffraction gratings. Other applications for them include optical encoders for accurate motion control and wave front measuring.

2. Relevant Program Outcomes:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
3. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
4. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
5. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

3. Relevant course outcomes: -

CO3- Student will be able to: Understand the phenomenon of diffraction of light.

4. Practical Learning outcomes:

1. To know about the concept of diffraction grating.
2. To determine the grating element of diffraction grating using laser beam of known wavelength.

5. Practical Skills:

1. **MANIPULATIVE SKILLS:** - The learner develops manipulative skills in practical work if she/he is able to
 - i. comprehend the theory and objectives of the experiment
 - ii. conceive the procedure to perform the experiment
 - iii. set-up the apparatus in proper order
 - iv. check the suitability of the equipment, apparatus, tool regarding their working and functioning
 - v. know the limitations of measuring device and find its least count, error etc.
 - vi. handle the apparatus carefully and cautiously to avoid any damage to the instrument as well as any personal harm
 - vii. perform the experiment systematically
 - viii. make precise observations

The distance between two successive slits in a diffraction grating is called the **grating element** or **grating spacing**, usually denoted by d . If the grating has N lines per unit length, the grating element is given by

$$d = \frac{1}{N}$$

When monochromatic light of wavelength λ is incident normally on the grating, the condition for the formation of bright diffraction maxima is given by the **grating equation**

$$d \sin \theta = n\lambda$$

where

d = grating element (distance between adjacent slits)

θ = diffraction angle for the n^{th} order maximum

n = order of diffraction (1, 2, 3, ...)

λ = wavelength of the incident light

In this experiment, a **laser beam** is used as the light source because laser light is highly monochromatic, coherent, and intense.

8. Circuit diagram/Experimental Set-up/Work situation: -

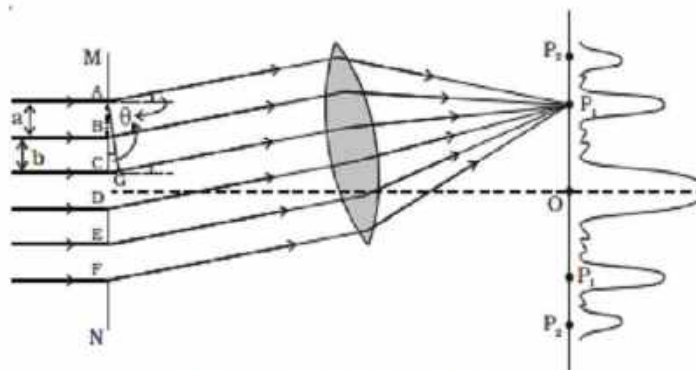


Fig Diffraction grating



9. Resources Required: -

S. No.	Name of equipments	Specifications	Quantity
1	Optical Bench		1
2	Diffraction Grating		1
3	Laser		1
4	Screen		1
5	Meter Scale		1

10. Precautions: -

1. Don't see directly the laser beam.
2. Take reading carefully.
3. Don't touch the diffracting grating with naked hand.
4. The grating element should be handled carefully.

11. Procedure: -

1. Level the optical bench.
2. Fit diffraction grating on grating stand.
3. Switch on laser device.
4. Measure the distance between grating and screen on optical bench.
5. Measure the distance between central maxima and different other maxima of available orders from both side of central maxima.
6. Repeat the experiment by changing the distance between grating and screen.
7. Now calculate the grating element using the above given formula.

12. Observations and Calculations: -

S. No.	Distance between grating and screen (d) cm	Order of spectrum	Distance between central maxima and other order maxima's			tanθ=L/d	θ rad
			Along one side (S) cm	Along other side (S') cm	Mean (L)= (S+S')/2 cm		
1		1					
		2					
2		1					
		2					
3		1					
		2					

13. Calculations: - Formula used is: - $d \sin\theta = n\lambda$

14. Results: -

Grating element of given diffraction grating is = cm

15. Interpretation of results: -

$$\% \text{ error} = \frac{\text{observed value} - \text{standard value}}{\text{standard value}} \times 100$$

16. Conclusions and recommendations: -

Conclusion:

In this experiment, the **grating element of the given diffraction grating** was determined using a laser beam. When the laser light passed through the diffraction grating, a series of bright diffraction spots corresponding to different orders were observed on the screen. By measuring the distance of these spots from the central maximum and applying the grating equation, the value of the grating element was calculated. The result obtained is consistent with the expected value within the limits of experimental accuracy. This experiment clearly demonstrates the principles of diffraction and interference of light.

Recommendations:

1. The diffraction grating should be handled carefully and kept clean to obtain clear diffraction patterns.
2. The laser beam should fall normally on the grating to reduce measurement errors.
3. Distances between diffraction spots should be measured accurately using a properly aligned scale.
4. Multiple readings should be taken for different diffraction orders and averaged to improve the accuracy of the result.

17. Practical related Questions: -

1. What is wavelength of laser beam?
2. What is least count of optical bench scale?
3. What is a diffraction grating?
4. What is meant by the grating element of a diffraction grating?
5. Why is a laser beam used in this experiment instead of ordinary light?
6. What do you mean by the order of diffraction?
7. State the grating equation used in this experiment.
8. What happens to the diffraction pattern if the wavelength of light is increased?
9. What are the possible sources of error in this experiment?
10. How does the number of lines per unit length affect the diffraction pattern?
11. What will happen to the separation between diffraction spots if the distance between the grating and the screen is increased?

18. References/Suggestions for further readings

<https://www.youtube.com/watch?v=OWLjrKdw79U>

19. Assessment Scheme/Rubrics – to assess ‘process’ and ‘product’

S.N.	Criteria	Scale ⇒			
		Poor	Satisfactory	Good	Excellent
1	Understanding of Experiment	Shows little understanding of the aim and theory of the experiment.	Basic understanding of the aim but explanation is incomplete.	Good understanding of the aim and theory with minor gaps.	Demonstrates clear and thorough understanding of the aim and underlying theory.
2	Experimental Procedure & Handling of Apparatus	Unable to follow procedure properly; improper handling of apparatus.	Follows procedure with guidance; handling of apparatus needs improvement.	Performs experiment correctly with minimal guidance.	Performs experiment independently with proper handling of apparatus.
3	Observation & Data Recording	Observations are incomplete or incorrect; data not properly recorded.	Records basic observations but with some errors or missing details.	Observations recorded correctly with minor mistakes.	Observations are complete, accurate, and systematically recorded.
4	Graph / Calculations / Analysis	Graphs or calculations missing or incorrect.	Graphs or calculations attempted but contain noticeable errors.	Graphs and calculations mostly correct with minor errors.	Graphs, calculations, and analysis are accurate and clearly presented.
5	Neat and Clean Reporting of Practical Record	Record is untidy with overwriting and missing diagrams or sections.	Record is somewhat neat but contains formatting or labeling issues.	Record is neat with properly drawn diagrams and organized content.	Record is very neat, well organized, and professionally presented.
6	Viva / Conceptual Questions	Unable to answer basic questions related to the experiment.	Answers some questions but lacks clarity in concepts.	Answers most questions correctly with reasonable explanation.	Answers confidently with clear conceptual understanding.
7	Precautions	Not known	Known but not understand	Known and understand	Known, understand and also know the importance
8	Safety measures	Doesn't follow	Follow but reason is not known	Follow and reason is known	Follow known and understand
9	Team work ability	Doesn't participate and perform the experiment	Perform but not interact with group	Perform and participate	Perform, participate, lead actively