

37.4 The Diffraction Grating

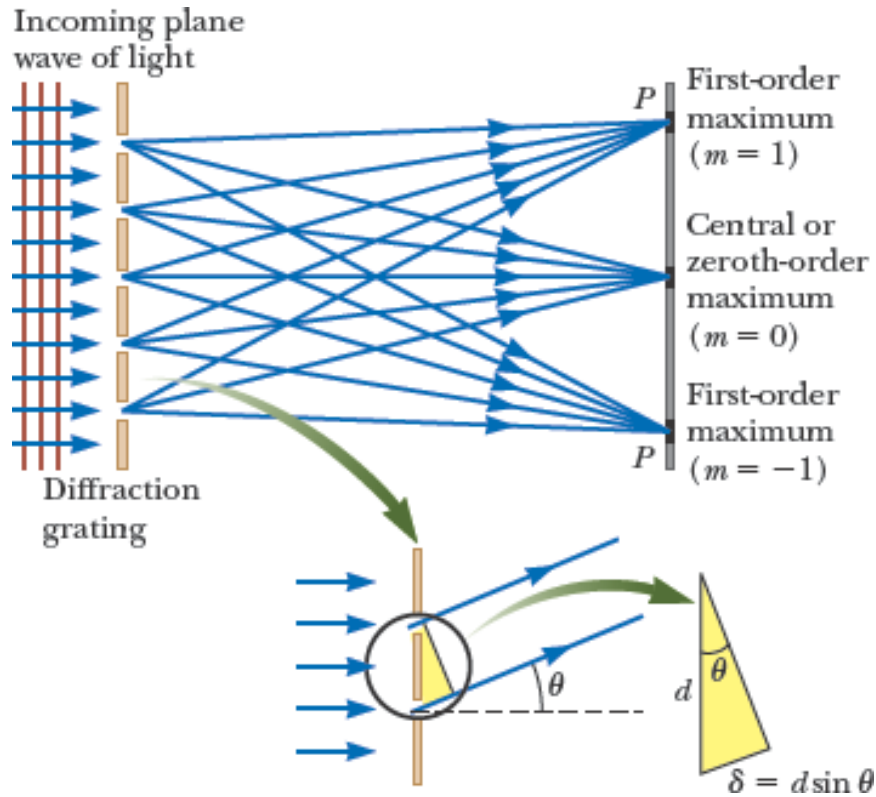
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•	The diffraction grating , a useful device for analyzing light sources, consists of a large number of equally spaced parallel slits.	
•	A <i>transmission grating</i> can be made by cutting parallel grooves on a glass plate with a precision ruling machine. The spaces between the grooves are transparent to the light and hence act as separate slits.	
•	A <i>reflection grating</i> can be made by cutting parallel grooves on the surface of a reflective material.	
	– The reflection of light from the spaces between the grooves is specular	
	– The reflection of light from the grooves cut into the material is diffuse	

1 How Diffraction Grating Works



- The waves from all slits are in phase as they leave the slits
- For an arbitrary direction θ measured from the horizontal the waves must travel different path lengths before reaching the screen (as indicated by the right triangle in the visual)
- Using trig identities, that path difference can be expressed as $\delta = d \sin \theta$.
 - If the path difference is an integral multiple of a wavelength, waves from all slits are in phase and a **bright fringe** is observed.
 - So we end up with the same equation we've been getting for the past chapter

1.1 *Maxima* in the interference pattern

$$d \sin \theta_{\text{bright}} = m\lambda$$
$$m = 0, \pm 1, \pm 2, \pm 3, \dots$$

1.2 Conceptual Example 37.4 A DVD is a Diffraction Grating

- Light reflected from the surface of a video disc is multicolored as shown in the figure below. The colors and their intensities depend on the orientation of the DVD relative to the eye and relative to the light source. Explain how that works.



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1.2.1 Solution

- The surface of a DVD has a spiraled groove track (with adjacent grooves having a separation on the order of $1\text{ }\mu\text{m}$).
- Therefore, the surface acts as a reflection grating.
- The light reflecting from the regions between these closely spaced grooves interferes constructively only in certain directions that depend on the wavelength and the direction of the incident light.

- The colors you see change when you either change the position of the light source, the DVD, or yourself.
- Change in position changes the angle of incidence or angle of the diffracted light