Physics 161

Lecture 27 Summary

Wave optics

December 7, 2017

Lecture 27: learning objectives

You will be able to explain coherent and incoherent light.

You will be able to apply the conditions for constructive and destructive interference to Young's double-slit experiment.

You will be able to explain interference in thin films.

You will be able to describe the physical origins of diffraction and analyse single-slit diffraction and diffraction gratings.

Properties of electromagnetic waves

Interference is hard to observe in light, because it has such a small wavelength. It helps if:

- The sources are coherent.
- The waves have identical wavelengths.

Coherent waves:
Waves which have the same wavelength and maintain a constant phase difference with respect to each other.

Here we are no longer applying the ray approximation!

Young's double slit experiment

Path difference, δ :
Difference in distance travelled by light waves passing through each slit.

$$\delta = r_2 - r_1 = d\sin\theta$$

Constructive interference = bright

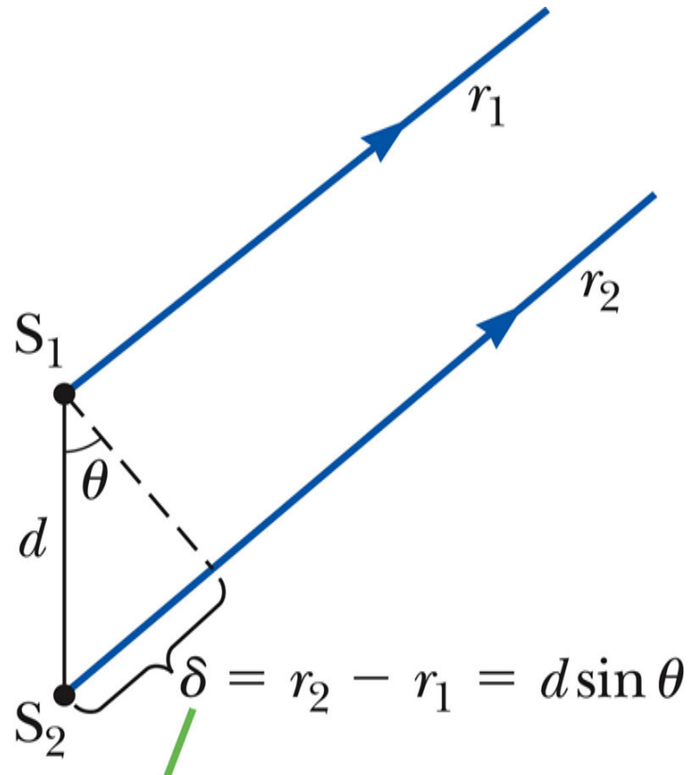
$$\delta = d\sin\theta_{\text{bright}} = m\lambda$$

$$y_{\text{bright}} = m\frac{\lambda L}{d}$$

Destructive interference = dark

$$d\sin\theta_{\text{dark}} = \left(m + \frac{1}{2}\right)\lambda$$

$$y_{\text{dark}} = \left(m + \frac{1}{2}\right)\frac{\lambda L}{d}$$



The path difference between the two rays is $r_2 - r_1 = d\sin\theta$.

b

Thin film reflection

For single layer thin films additional phase change of reflected wave 1 but not 2.

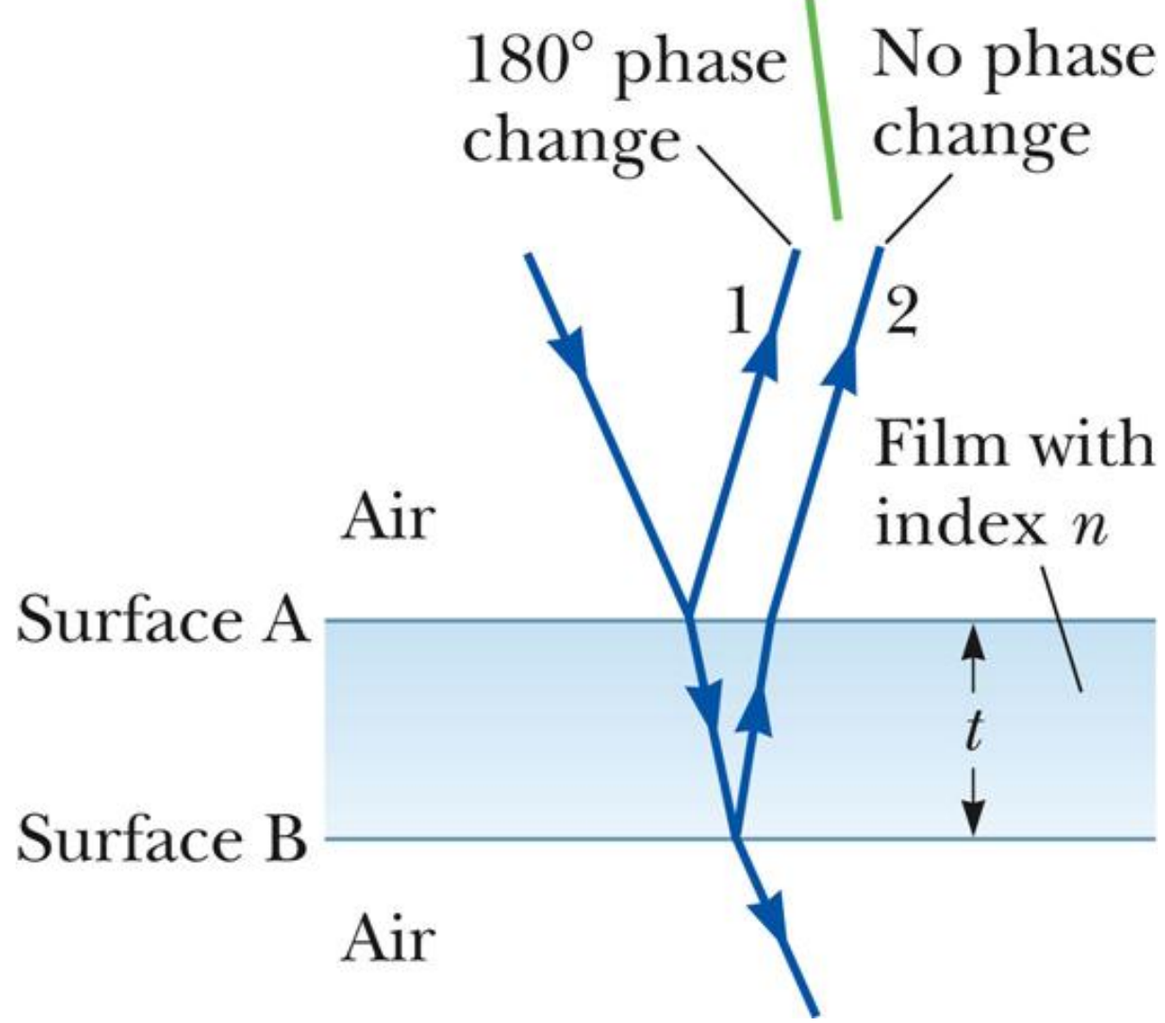
Constructive interference

$$2nt = \left(m + \frac{1}{2}\right)\lambda$$

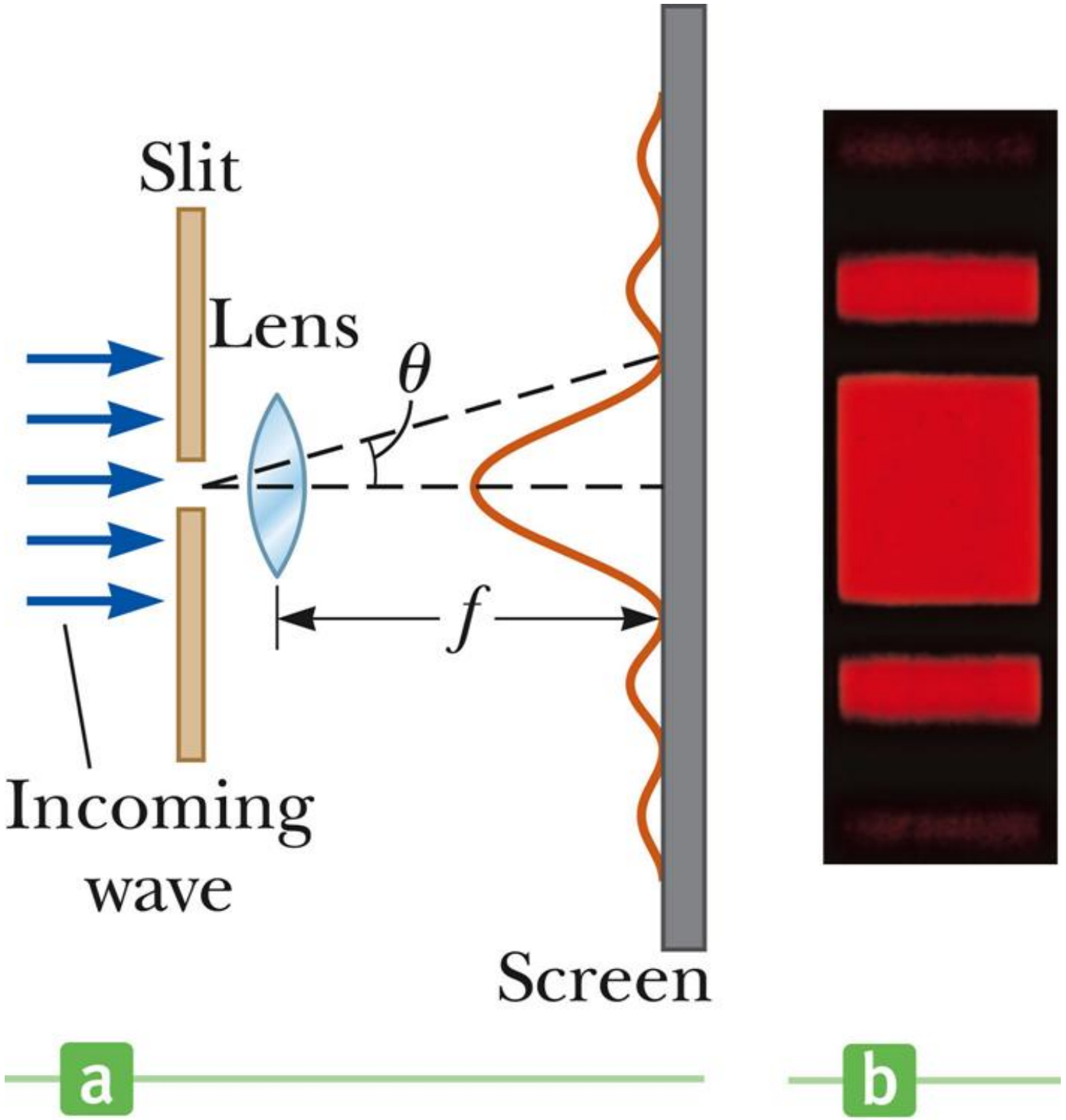
Destructive interference

$$2nt = m\lambda$$

Interference in light reflected from a thin film is due to a combination of rays 1 and 2 reflected from the upper and lower surfaces of the film.



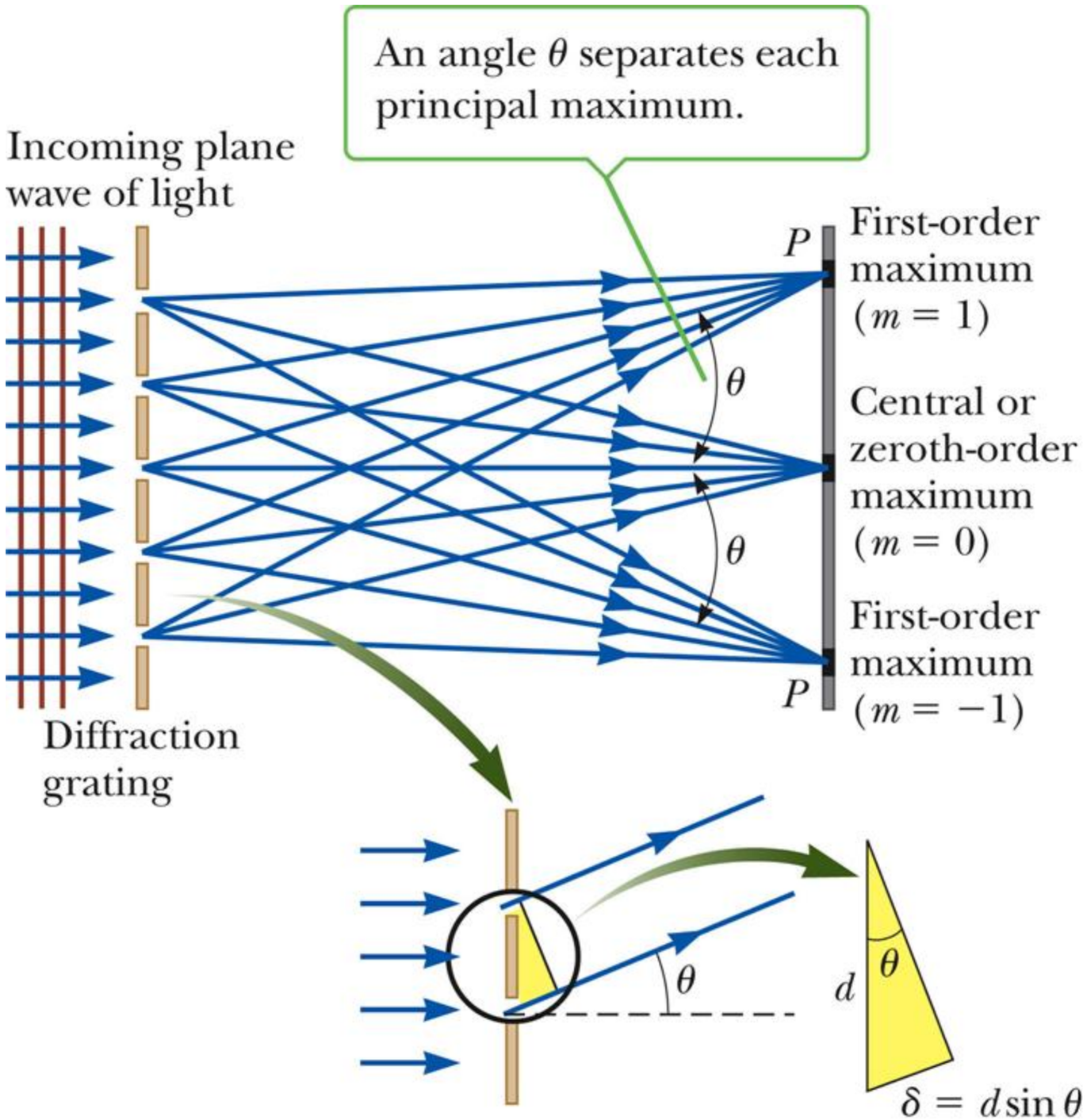
Single-slit diffraction



Destructive interference

$$\sin\theta_{\text{dark}} = m\frac{\lambda}{a}$$

Diffraction grating



Constructive interference

$$d \sin \theta_{\text{bright}} = m\lambda$$