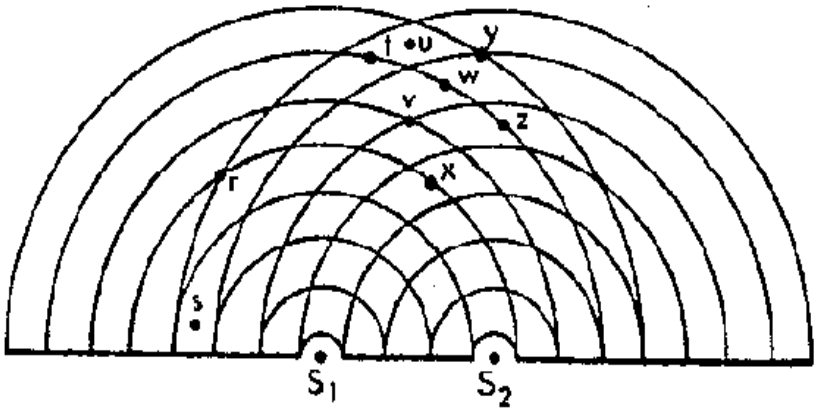
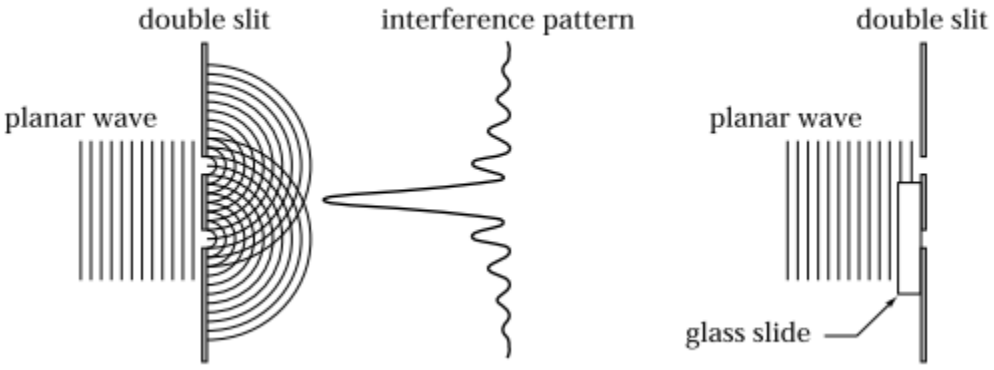
Conceptual Questions

1. Which pair of lettered points lie on the central maximum?
   a) v and t b) x and z
   c) x and w d) u and y
   e) v and u [1]



2. Which pair of lettered points lie on the same nodal line?
   a) v and t b) x and r
   c) x and w d) u and y
   e) v and u [2]

3. An interference pattern is formed on a screen by shining a planar wave on a double-slit arrangement (left). If we cover one slit with a glass plate (right), the phases of the two emerging waves will be different because the wavelength is shorter in glass than in air. If the phase difference is 180°, how is the interference pattern, shown left, altered?
   a) The pattern vanishes.
   b) The bright spots lie closer together.
   c) The bright spots are farther apart.
   d) There are no changes.
   e) Bright and dark spots are interchanged. [3]



[1] Physics 12, Nelson Education, Chapter 9 Question Bank
[2] Physics 12, Nelson Education, Chapter 9 Question Bank
[3] Peer Instruction – A User's Guide, Mazur, Optics CT 24

4. If Young's double-slit experiment were submerged in water, how would the fringe pattern be changed? [4]

5. Monochromatic red light is incident on a double slit, and the interference pattern is viewed on a screen some distance away. Explain how the fringe pattern would change if the red light source is replaced by a blue light source. [5]

6. Why doesn't the light from the two headlights of a distant car produce an interference pattern? Explain. [6]

7. A diffraction grating is illuminated with yellow light at normal incidence. The pattern seen on a screen behind the grating consists of three yellow spots, one at zero degrees (straight through) and one each at ±45°.You now add red light of equal intensity, coming in the same direction as the yellow light. The new pattern consists of
   a) red spots at 0° and ±45°.
   b) yellow spots at 0° and ±45°.
   c) orange spots at 0° and ±45°.
   d) an orange spot at 0°, yellow spots at ±45°, and red spots slightly farther out.
   e) an orange spot at 0°, yellow spots at ±45°, and red spots slightly closer in. [7]

8. For a diffraction grating, what is the advantage of (*a*) many slits, (*b*) closely spaced slits? [8]

9. White light strikes (a) a diffraction grating and (b) a prism. A rainbow appears on a wall just below the direction of the horizontal incident beam in each case. What is the colour of the top of the rainbow in each case? Explain. [9]

[4] Physics 6th Edition, Giancoli, Chapter 24 Questions, #5
[5] Physics 6th Edition, Giancoli, Chapter 24 Questions, #6
[6] Physics 6th Edition, Giancoli, Chapter 24 Questions, #10
[7] Peer Instruction – A User's Guide, Mazur, Optics CT 22
[8] Physics 6th Edition, Giancoli, Chapter 24 Questions, #19
[9] Physics 6th Edition, Giancoli, Chapter 24 Questions, #20

Problems

10. The transmitting antenna for a radio station is 7.00 km from your house. The frequency of the electromagnetic wave broad cast by this station is 536 kHz. The station builds a second transmitting antenna that broadcasts an identical electromagnetic wave in phase with the original one. The new antenna is 8.12 km from your house. Does constructive or destructive interference occur at the receiving antenna of your radio? Show your calculations. [10]

11. A Young's double-slit experiment is performed using light that has a wavelength of 6.3×10^{2} nm. The separation between the slits is 3.3×10^{-5} m. Find the angles, with respect to the slits, that locate the first-, second-, and third-order bright (not dark) fringes on the screen. [11]

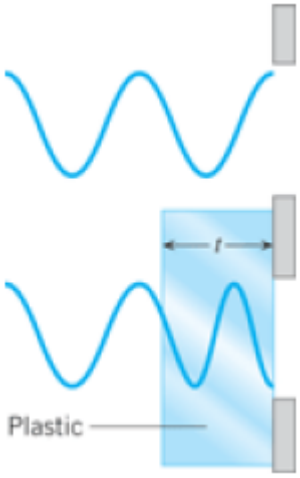
12. A student performing Young's experiment with a single-colour source finds the distance between the first and the seventh nodal lines to be 6.0 cm. The screen is located 3.0 m from the two slits. The slit separation is 2.2×10^{2} μm. Calculate the wavelength of the light. [12]

13. What is the maximum number of bright spots possible for red light (360 nm) illuminating a double slit with separation 3.0×10^{-5} m? [13]

14. In a double-slit experiment, the thrid-order maximum for light of wavelength 500 nm is located 12 mm from the central bright spot on a screen 1.6 m from the slits. Light of wavelength 650 nm is then projected through the same slits. How far from the central bright spot will the second-order maximum of this light be located? [14]

[10] Physics, 7th Edition, Cutnell & Johnson, Chapter 27 Problems, #47
[11] Physics 12, Nelson Education, Section 9.5 Questions, #9
[12] Physics 12, Nelson Education, Section 9.5 Practice, #1
[13] Physics Book Two, Irwin Publishing, Chapter 11 Problems, #33 (modified)
[14] Physics 6th Edition, Giancoli, Chapter 24 Problems, #10

15. A sheet that is made of plastic (n = 1.60) covers one slit of a double slit (see the drawing). When the double slit is illuminated by monochromatic light ($\lambda_{vacuum} = 586\ nm$), the center of the screen appears dark rather than bright. What is the minimum thickness of the plastic? [15]



16. What is the distance to the second-order maximum for a diffraction grating with 2.3×10^4 slits/mm if the screen is 0.95 m away and orange light of wavelength 610 nm is used? [16]

17. A diffraction grating produces a fourth-order maximum, at an angle of 22º, for red light (694.3 nm). Determine the spacing of the lines in centimetres. [17]

18. Two (and only two) full spectral orders can be seen on either side of the central maximum when white light is sent through a diffraction grating. What is the maximum number of lines per cm for the grating? [18]

19. A diffraction grating has 6.0×10^5 lines/m. Find the angular spread in the second-order spectrum between red light of wavelength 7.0×10^{-7} m and blue light of wavelength 4.5×10^{-7} m. [19]

20. The same diffraction grating is used with two different wavelengths of light, $\boldsymbol{\lambda_A}$ and $\boldsymbol{\lambda_B}$. The fourth-order principal maximum of light A exactly overlaps the third-order principal maximum of light B. Find the ratio $\boldsymbol{\lambda_A / \lambda_B}$. [20]

---

[15] Physics, 7th Edition, Cutnell & Johnson, Chapter 27 Problems, #9
[16] Physics Book Two, Irwin Publishing, Chapter 11 Problems, #57
[17] Physics 12, Nelson Education, Section 10.3 Practice, #3
[18] Physics 6th Edition, Giancoli, Chapter 24 Problems, #35
[19] Physics 6th Edition, Giancoli, Chapter 24 Problems, #32
[20] Physics, 7th Edition, Cutnell & Johnson, Chapter 27 Problems, #55