28. A double-slit interference experiment is performed using blue light from a hydrogen discharge tube ($\lambda = 486$ nm). The fifth-order bright fringe in the interference pattern is 0.578° from the central maximum. How far apart are the two slits separated?

29. A beam containing light of wavelengths λ_1 and λ_2 passes through a set of parallel slits. In the interference pattern, the fourth bright line of the λ_1 light occurs at the same position as the fifth bright line of the λ_2 light. If λ_1 is known to be 540.0 nm, what is the value of λ_2?

30. Visible light from an incandescent light bulb ranges from 400.0 nm to 700.0 nm. When this light is focused on a diffraction grating, the entire first-order spectrum is seen, but none of the second-order spectrum is seen. What is the maximum spacing between lines on this grating?

31. In an arrangement to demonstrate double-slit interference, $\lambda = 643$ nm, $\theta = 0.737°$, and $d = 0.150$ mm. For light from the two slits interfering at this angle, what is the path difference both in millimeters and in terms of the number of wavelengths? Will the interference correspond to a maximum, a minimum, or an intermediate condition?

Alternative Assessment

1. Design simulations of interference patterns. Use a computer to draw many concentric circles at regular distances to represent waves traveling from a point source. Photocopy the page onto two transparencies, and lay them on an overhead projector. Vary the distances between "source points," and observe how these variations affect interference patterns. Design transparencies with thicker lines with larger separations to explore the effect of wavelength on interference.

2. Investigate the effect of slit separation on interference patterns. Wrap a flashlight or a pen light tightly with tin foil and make pinholes in the foil. First, record the pattern you see on a screen a few inches away with one hole; then, do the same with two holes. How does the distance between the holes affect the distance between the bright parts of the pattern? Draw schematic diagrams of your observations, and compare them with the results of double-slit interference. How would you improve your equipment?

3. Soap bubbles exhibit different colors because light that is reflected from the outer layer of the soap film interferes with light that is refracted and then reflected from the inner layer of the soap film. Given a refractive index of $n = 1.35$ and thicknesses ranging from 600 nm to 1000 nm for a soap film, can you predict the colors of a bubble? Test your answer by making soap bubbles and observing the order in which the different colors appear. Can you tell the thickness of a soap bubble from its colors? Organize your findings into a chart, or create a computer program to predict the thicknesses of a bubble based on the wavelengths of light it appears to reflect.

4. Thomas Young's 1803 experiment provided crucial evidence for the wave nature of light, but it was met with strong opposition in England until Augustin Fresnel presented his wave theory of light to the French Academy of Sciences in 1819. Research the lives and careers of these two scientists. Create a presentation about one of them. The presentation can be in the form of a report, poster, short video, or computer presentation.

5. Research waves that surround you, including those used in commercial, medicinal, and industrial applications. Interpret how the waves' characteristics and behaviors make them useful. For example, investigate what kinds of waves are used in medical procedures such as MRI and ultrasound. What are their wavelengths? Research how lasers are used in medicine. How are they used in industry? Prepare a poster or chart describing your findings, and present it to the class.