

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Operation Fermat's Path: 12th Grade Advanced Wave Optics Quest

Evaluate non-paraxial ray behavior and thin-film interference patterns to prepare physics students for university-level electrodynamics and engineering labs.

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**1. An unpolarized light beam is incident on a series of two linear polarizers. If the transmission axis of the second polarizer is rotated to 60 degrees relative to the first, what fraction of the original unpolarized intensity ( $I_0$ ) emerges?**

- A.  $0.125 I_0$
- B.  $0.25 I_0$
- C.  $0.375 I_0$
- D.  $0.5 I_0$

**2. In a Michelson Interferometer, if one mirror is moved a distance of  $\lambda/4$ , the interference pattern will shift by exactly one full fringe.**

- A. True
- B. False

**3. A soap bubble ( $n=1.33$ ) appears green ( $\lambda=530\text{nm}$ ) at its thinnest point due to constructive interference. This occurs because of a \_\_\_\_\_ phase shift at the first boundary.**

- A. Zero-degree
- B. 90-degree
- C. 180-degree
- D. 360-degree

**4. Standard glass lenses ( $n=1.5$ ) often suffer from chromatic aberration. Which physical property primarily accounts for this phenomenon in high-precision optical systems?**

- A. Total Internal Reflection
- B. Optical Dispersion
- C. Spherical Aberration
- D. Diffraction Limits

**5. To eliminate reflection for a specific wavelength utilizing a non-reflective coating, the thickness of the coating ( $n_{\text{coat}} < n_{\text{glass}}$ ) should ideally be \_\_\_\_\_.**

- A.  $\lambda / (2n)$
- B.  $\lambda / (4n)$
- C.  $\lambda / 2$
- D.  $\lambda$

**6. According to the Rayleigh Criterion, increasing the diameter of a telescope's primary mirror decreases its angular resolution.**

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- A. True
- B. False

**7. A beam of light travels from water ( $n=1.33$ ) toward a boundary with air ( $n=1.00$ ). What is the critical angle for Total Internal Reflection?**

- A. 41.8 degrees
- B. 48.8 degrees
- C. 56.3 degrees
- D. 90.0 degrees

**8. In a double-slit experiment, if the distance between the two slits is halved while keeping all other variables constant, the fringe spacing on the screen will \_\_\_\_.**

- A. Decrease by half
- B. Remain the same
- C. Double
- D. Quadruple

**9. Which of the following conditions is required to produce a 'Gibeon' style Mirage, where distant objects appear higher than their actual position (Superior Mirage)?**

- A. A temperature inversion (cold air below warm air)
- B. Rapidly rising hot air currents
- C. Light passing from a vacuum to a medium
- D. Monochromatic light sources

**10. A paraxial approximation is valid only when the angle between the light ray and the principal axis is small enough that  $\sin(\theta) \approx \theta$ .**

- A. True
- B. False