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Grade 12 University Physics Celebration #5

Knowledge		Application		Communication	
	out of 10		out of 14		out of 5

Select one:

Please mark this test ☐

Please DO NOT mark this test ☑

This test was optional

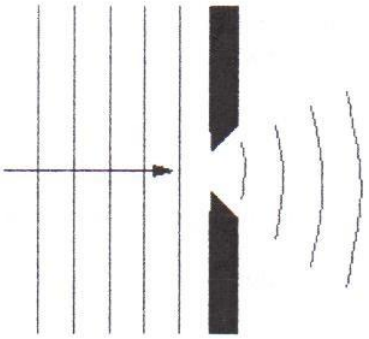
Part A: Knowledge

Multiple Choice

Identify the choice that best completes the statement or answers the question.

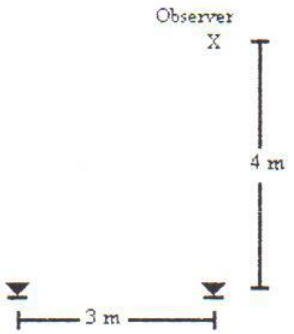
1. A narrow beam of monochromatic light enters diamond from air at an incident angle of 65°. If the speed of light in air is 3.00×10^8 m/s and the speed of light in diamond is 1.24×10^8 m/s, the angle of refraction is
   a. 65°
   b. 25°
   c. 22°
   d. indeterminable but larger than 65°
   e. nonexistent since total internal reflection occurs

2. The critical angle for diamond is 25°. Total internal reflection occurs when light is incident on
   a. the air to diamond boundary at an angle of incidence of 25°
   b. the air to diamond boundary at an angle of incidence greater than 25°
   c. the air to diamond boundary at an angle of incidence less than 25°
   d. the diamond to air boundary at an angle of incidence less than 25°
   e. the diamond to air boundary at an angle of incidence greater than 25°



3. A series of wave fronts in a wave tank travelling toward an opening are shown above. You wish to decrease the amount of visible diffraction by considering the following changes:
   I. increase the depth of the water
   II. increase the size of the opening
   III. increase the frequency of the source
   Which of the above changes, or combination of changes, would decrease the diffraction most?
   a. I only
   b. II only
   c. III only
   d. I and II only
   e. II and III only

4. In a two-point source interference pattern in a ripple tank, a point is one wavelength farther from one source than the other. If the two sources are in phase, then there is
   a. destructive interference at this point
   b. constructive interference at this point
   c. both constructive and destructive interference simultaneously
   d. neither constructive nor destructive interference at this point
   e. no interaction between the two waves at this point



5. The diagram above shows two identical speakers arranged at ear level. They are emitting the same frequency in phase. The speakers are 3.0 m apart and an observer stands 4.0 m directly in front of one speaker at point X. The sound intensity will be least for the observer at X when the wavelength of the sound is
   a. 5.0 m
   b. 4.0 m
   c. 3.0 m
   d. 2.0 m
   e. 1.0 m

6. A student counts a total of eight nodal lines on each side of a two-point source interference pattern and measures the sources to be 15 cm apart. What is the approximate wavelength of the waves?
   a. 0.50 cm
   b. 2.0 cm
   c. 7.5 cm
   d. 15 cm
   e. none of the above

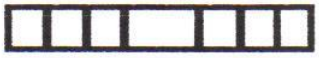
7. The assumption that light particles have an extremely small mass and travel at very high speeds was needed by Newton to explain
   a. rectilinear propagation
   b. diffraction
   c. refraction
   d. partial reflection–partial refraction
   e. reflection

8. A student performs a double-slit experiment using a monochromatic light source, two slits spaced 0.10 mm apart, and a screen located 150 cm away. The bright fringes are located 0.30 cm apart. If the distance between the slits was changed to 0.20 mm and the screen was moved to a distance of 3.0 m, what would the average distance between bright fringes become?
   a. 0.15 cm
   b. 0.30 cm
   c. 0.50 cm
   d. 0.60 cm
   e. 1.5 m

9. Which of the following combinations would produce an interference pattern with the largest average distance between bright fringes?
   a. red light on a double slit with a large distance between the slits
   b. blue light on a double slit with a large distance between the slits
   c. red light on a double slit with a small distance between the slits
   d. green light on a double slit with a small distance between the slits
   e. blue light on a double slit with a small distance between the slits

10. Light from a monochromatic source passes through a single slit and illuminates a screen. Which of the following patterns would best illustrate the interference pattern seen on the screen?

a. 

b. 

c. 

d. 

e. 

Part B: Application

1. A piece of diffraction grating has 1500 slits per cm. A sample of hydrogen gas has electricity running through it in order for it to emit its spectral colours. Two of the spectral colours have wavelengths of 656.3 nm and 410.2 nm. What is the angular separation between the two second order maxima for these colours (on the same side of the central maximum)?

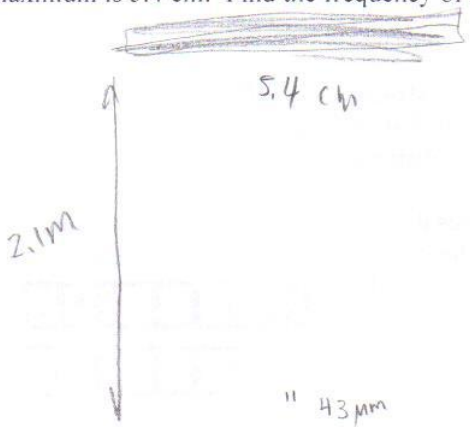
[7]

1500

1 cm

2. Light is sent through a single slit that has a width of 43 μm. A screen is placed 2.1 m away from the slit. The width of the central maximum is 5.4 cm. Find the frequency of the light.

[7]



$$\frac{x_n}{L} = \frac{n\lambda}{w}$$

$$\frac{0.054m}{2.1m} = \frac{n\lambda}{43\times10^{-6}m}$$

$$\lambda = 1.105714... \times 10^{-6}$$
$$= 1.11 \times 10^{-6}\ \mu m$$

therefore, the frequency is $1.11 \times 10^{-6}\ \mu m$

Part C: Communication

1. The diagram shown below illustrates the possible paths followed by a light ray as it enters a lens ($n = 1.56$) covered with a thin coating ($n = 1.25$). If the thin coating has a thickness of $\frac{\lambda}{4}$, what type of interference occurs with rays 3 and 4? Explain your answer. You may use diagrams to aid your explanation.

[5]