MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

Department of Physics

I Semester B.Tech. - Test 1 Engineering Physics [PHY1051]
Scheme of evaluation

Date 09-09-2019 TIME: 4:15-5:15 PM MAXIMUM MARKS: 15

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1. Choose the most appropriate answer for the following out of the options given. [½x10]

1. The reason there are two slits, rather than one, in a Young's experiment is:
   a) to increase the intensity
   b) one slit is for frequency, the other for wavelength
   c) to create a path length difference
   d) two slits in parallel offer less resistance

2. Suppose Young's double-slit experiment is performed in air using red light and then the apparatus is immersed in water. What happens to the interference pattern on the screen?

   a) The bright and dark fringes stay in the same locations, but the contrast is reduced.
   b) The bright fringes are closer together.
   c) The bright fringes are farther apart.
   d) No change happens in the interference pattern.

3. A diffraction pattern is produced on a viewing screen by illuminating a long narrow slit with light of wavelength λ. If λ is increased and no other changes are made:
   a) the intensity at the center of the pattern decreases and the pattern expands away from the bright center
   b) the intensity at the center of the pattern increases and the pattern contracts toward the bright center
   c) the intensity at the center of the pattern does not change and the pattern expands away from the bright center
   d) the intensity at the center of the pattern does not change and the pattern contracts toward the bright center

4. Consider a thin film (thickness "*t*") of certain refractive index is coated on glass. If both rays reflecting from the two surfaces of the film undergo a phase change of π radians, the condition for destructive interference is

a) $\boldsymbol{2t = \left(m + \frac{1}{2}\right)\lambda_n}$ b) $2t = m\lambda_n$

c) $t = \left(m + \frac{1}{2}\right)\lambda_n$ d) $t = m\lambda_n$

5. You could determine the index of refraction for visible light of a dark but reflective medium such as black glass by measuring the

   a) angles of incidence and refraction.
   b) angle of reflection for an arbitrary angle of incidence.
   c) **angle at which reflected light is completely polarized.**
   d) smallest angle at which diffraction occurs for visible light when a diffraction pattern is scratched onto the surface.

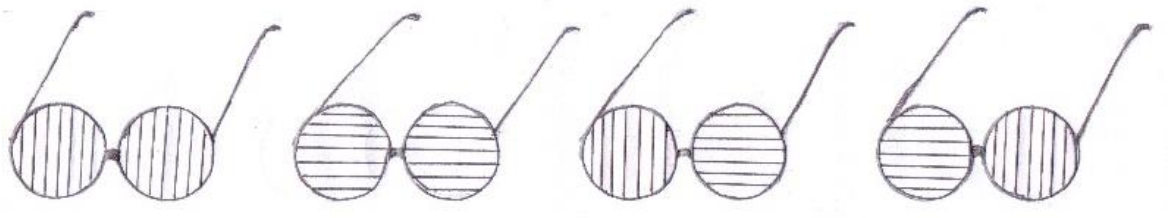
6. A point source of monochromatic light is placed in front of a bowling ball and a screen is placed behind the ball. The light intensity pattern on the screen is best described as:
   a) a dark disk
   b) a dark disk with bright rings outside
   c) a dark disk with a bright spot at its center
   d) a dark disk with a bright spot at its center and bright rings outside

7. In a double-slit diffraction experiment the number of interference fringes within the central diffraction maximum can be increased by:
   a) increasing the wavelength
   b) increasing the slit separation
   c) decreasing the slit separation
   d) increasing the slit width

8. If an unpolarized light passes through a polarizing sheet,

   a) gets linearly polarized with its intensity reduced to half its original intensity
   b) gets linearly polarized with the same intensity as the original intensity
   c) remains unpolarized
   d) remains unpolarized with its intensity reduced to half the original intensity

9. Consider the four pair of sunglasses below. Identify the pair of glasses that is capable of eliminating the glare resulting from sunlight reflecting off the calm waters of a lake? (The polarization axes are shown by the straight lines.)



a) b) c) d)

10. The following radiation is suitable for crystal diffraction:
    a) visible light
    b) x-rays
    c) infrared rays
    d) microwaves

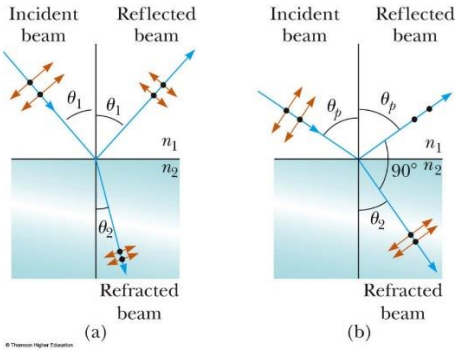
2 MARK QUESTIONS:

11. In a Michelson Interferometer experiment, Mirror M_1 is moved through a displacement ΔL. During this displacement, 250 fringe reversals (bright to dark or dark to bright) are counted. The light being used has a wavelength of 632.8 nm. Calculate the displacement ΔL. (2)

$$2\Delta L = \frac{m\lambda}{2}$$ **- 1 MARK**

$$\Delta L = \frac{m\lambda}{4} = \frac{250x\ 632.3x10^{-9}}{4} = 39.6\ \mu m$$ **- 1 MARK**

12. Explain a method to produce linearly polarized light by reflection. (2)



-1 MARK

For one particular angle of incidence (θ_p), the reflected light is completely polarized with its electric field vector parallel to the surface.

Using Snell's law of refraction **½ MARK**

$$\frac{n_2}{n_1} = \frac{\sin\theta_p}{\sin\theta_2}$$

But, $\theta_2 = 90 - \theta_p$. So, we can write,

$$\tan\theta_p = \frac{n_2}{n_1}$$

This expression is called Brewster's law, and the polarizing angle θ_p is sometimes called Brewster's angle **½ MARK**

13. A Young's interference experiment is performed with monochromatic light. The separation between the slits is 0.500 mm, and the interference pattern on a screen 3.30 m away shows the first side maximum 3.40 mm from the center of the pattern. What is the

wavelength? Calculate the separation between the first and the third side maximum. (2)

d=0.500 mm; L=3.30 m; y_1=3.4 mm
The location of the mth maximum in YDSE is given by $y = \frac{m\lambda L}{d}$

$\lambda = \frac{y.d}{L} = \frac{3.4x10^{-3}.0.5x10^{-3}}{3.3} = 515$ nm **- 1 MARK**

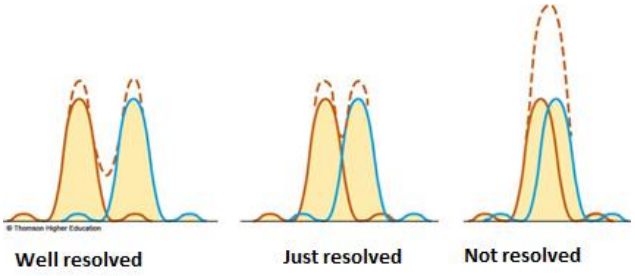
$y_3 - y_1 = \frac{3\lambda L}{d} - \frac{\lambda L}{d} = \frac{2\lambda L}{d} = \frac{2x515x10^{-9}x3.30}{0.5x10^{-3}} = 6.79$ mm **- 1 MARK**

14. State and explain Rayleigh's criterion for optical resolution. Can visible light resolve the objects of nano meter dimensions? Explain (2)

When the central maximum of one image falls on the first minimum of another image, the images are said to be just resolved. This limiting condition of resolution is known as **Rayleigh's criterion.** Analysis shows that the limiting angle of resolution of the circular aperture is **- 1 MARK**

$$\theta_{min} = 1.22\,\frac{\lambda}{D}$$

where *D* is the diameter of the aperture.



Visible light cannot be used for resolving the objects of nano meter dimensions. This is because the wavelength of visible light (400-700 nm) is much larger compared to the object dimensions (nm).

- 1 MARK

15. A beam of bright red light of wavelength 654 nm passes through a diffraction grating. Enclosing the space beyond the grating is a large semi-cylindrical screen centered on the grating, with its axis parallel to the slits in the grating. Fifteen bright spots appear on the screen. Assuming that there are 2183 grooves/cm, calculate the angular position of the highest order. (2)

W= Nd ➔ d=W/N = 4580 nm **- ½ MARK**

$d\sin\theta = m\lambda$; $\sin\theta_{max}=1$; $m \leq d/\lambda = 7$ **- ½ MARK**

$\theta = \sin^{-1}\left(\frac{7\lambda}{d}\right) = 88.3^o$ **- 1 MARK**

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