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1 CHAPTER

Basic Optics

MCQ and NAT Questions

Q.1 The refractive indices of glass and water are 1.50 and 1.33, respectively. The relative refractive index of water with respect to glass is _____.

Q.2 Light is made to travel in glass having a refractive index of 1.72. The velocity of light in vacuum is 3×10^5 km/sec. The time taken by the light to travel a distance of 750 km in this glass is _____ msec.

Q.3 A laser light with a wavelength of 633 nm is passed through 1 cm length of tissue and 2 cm length of glass. The refractive index of tissue and glass are 1.33 and 1.5 respectively. The velocities of laser light in the tissue and in the glass are in the ratio of

(a) 1.33 : 0.75 (b) 1.33 : 3.00
(c) 1.33 : 1.50 (d) 1.50 : 1.33

Q.4 A light ray incident on air-glass interface. With an angle of 30°. If glass refractive index is 1.5. Find the refracted angle.

(a) 20.30° (b) 18.70°
(c) 19.47° (d) 21.80°

Q.5 Light incident on a glass plate at an angle of 60° after reflection it gets plane polarized. The RI of glass plate is

(a) 1.33 (b) 1.7372
(c) 3.5 (d) 0.866

Q.6 A light beam incident normally at a glass air interface. Glass has refractive index of 1.53 and air has refractive index of 1 then the loss of intensity through reflection is

(a) 5.1% (b) 4.3%
(c) 2.8% (d) 20.94%

Q.7 If an unpolarized light of intensity 4 Cd is incident on a polarizer, then the intensity of light transmitted out from the polarizer is

(a) 2 Cd
(b) $\frac{4}{3}$ Cd
(c) 1 Cd
(d) can't be determined until angle of incidence is not given

Q.8 The polarized light produced when two orthogonal coherent waves having different amplitudes and a constant phase difference of 90° superposed on each other is known as

(a) circularly polarized light
(b) partially polarized light
(c) linearly polarized light
(d) elliptically polarized light

Q.9 When a light beam is made to incident on a surface which is rough as compared with the wavelength of light

(a) specular reflection take place
(b) transmittance takes place
(c) absorption takes place
(d) diffused reflection takes place

Q.10 A beam of unpolarized light is first passed through a linear polarizer and then through a quarterwave plate. The emergent beam is

(a) unpolarized
(b) linearly polarized
(c) circularly polarized
(d) elliptically polarized

Q.11 The dispersion in an X-ray diffractometer, $d\theta/d\lambda$ is given by the expression

(a) $\frac{m}{2d\cos\theta}$ (b) $\frac{m}{2d\sin\theta}$
(c) $2d\sin\theta$ (d) $2d\sin\theta$

Q.12 Light of wavelength 630 nm in vacuum, falling normally on a biological specimen of thickness 10 μm, splits into two beams that are polarized at right angles. The refractive index of the tissue for the two polarizations are 1.32 and 1.333. When the two beams emerge, they are out of phase by

(a) 0.13° (b) 74.3°
(c) 90.0° (d) 128.6°

Q.13 A grating that has 1200 lines/mm is irradiated with a narrow beam of white light at an incident angle of 25° to the grating normal. The first order peak observed at an angle of 15° belongs to the wavelength
(a) 567.9 nm (b) 587.8 nm
(c) 597.1 nm (d) 600.7 nm

Q.14 A light beam is incident normally on a glass-air interface. The glass has refractive index 1.53. Air is assumed to be of refractive index 1.0. The Fresnel, intensity reflection coefficient is
(a) 0.53 (b) 0.25
(c) 0.044 (d) 0.022

Q.15 Brewster angle is the angle of incidence of monochromatic light at the interface of two media, for which
(a) the incidence beam would be totally internally reflected
(b) a polarized beam would become unpolarised after reflected
(c) an unpolarised beam would become polarized after reflected
(d) none of the above

Q.16 For a glass of refractive index 1.732, the angle of incidence of ordinary light, for which the reflected beam is completely polarized is
(a) 30 degrees (b) 60 degrees
(c) 45 degrees (d) 75 degrees

Q.17 When light passes from a medium of refractive index n_1 into a medium of refractive index n_2, the reflection at the boundary is expressed as
(a) $(n_2 - n_1)^2$ (b) $\left(\frac{n_2 - n_1}{n_2 + n_1}\right)^2$
(c) $\frac{1}{(n_2 - n_1)^2}$ (d) $(n_2 + n_1)^2$

Q.18 Two crossed polarizer's are placed in the part of a light beam. The light output is
(a) zero
(b) plane polarized
(c) circularly polarized
(d) elliptically polarized

Q.19 The minimum number of lines that must be drawn on a grating needed to resolve the Sodium Doublet having nominal wavelengths of 589.0 nm and 589.6 nm is
(a) 600 (b) 1200
(c) 982 (d) 300

Q.20 To a swimmer viewing a Sodium lamp beside the pool. The colour of the lamp seen from underneath the water appears:
(a) Yellow
(b) Yellow with a reddish
(c) Yellow with a greenish tinge
(d) White

Q.21 The refractive indices of glass and water are 1.50 and 1.33, respectively. If the glass is immersed in water, its relative refractive index is
(a) 0.89 (b) 1.13
(c) 1.33 (d) 2.83

Q.22 Light is incident on a glass plate of refractive index 1.732. It is plane polarized on reflection when the incidence angle is
(a) 30° (b) 45°
(c) 60° (d) 75°

Multiple Select Questions (MSQs)

Q.23 Which is/are the role of fiber optics technology?
(a) In voice and video communication
(b) In data transfer
(c) In military defence
(d) In transportation

Q.24 A light ray is incident in a fiber optic cable from medium-1 to medium-2. The refractive indices of medium-1 and medium-2 are 1.45 and 1.3 respectively. So,
(a) Medium-1 is core and medium-2 is cladding.
(b) Medium-1 is cladding and medium-2 is core.
(c) Acceptance angle of fiber is 41.26°.
(d) Critical angle of fiber is 63.70°.

Q.25 Choose the correct statement(s) regarding optical detector.
(a) Optical detectors works on the principle of optical absorption.
(b) For fiber optic communication purpose most suited photodetector is PN diode as compared to PIN diode.
(c) PIN detectors can be operated in photovoltaic and photoconductive mode.
(d) Avalanche photodiode is a type of optical detector.

■■■■

Answers Basic Optics

1.	(0.89)	2.	(4.31)	3.	(d)	4.	(c)	5.	(b)	6.	(b)	7.	(a)
8.	(d)	9.	(d)	10.	(c)	11.	(a)	12.	(a)	13.	(a)	14.	(c)
15.	(c)	16.	(b)	17.	(b)	18.	(a)	19.	(c)	20.	(a)	21.	(b)
22.	(c)	23.	(a, b, c, d)	24.	(a, c, d)	25.	(a, c, d)						

Explanations Basic Optics

1. (0.89)

$$\mu_g = 1.50$$
$$\mu_w = 1.33$$
$${}_g\mu_w = \frac{\mu_w}{\mu_g} = \frac{1.33}{1.50} = 0.89$$

2. (4.31)

Velocity of light in vacuum
$$= 3 \times 10^5 \text{ km/sec}$$
$$= 3 \times 10^8 \text{ m/sec}$$
Velocity of light in this glass
$$= \frac{3\times10^8}{1.72} = 1.74 \times 10^8 \text{ m/sec}$$
$$\text{Time taken} = \frac{750\times10^3}{1.74\times10^8}$$
$$= 4.31 \times 10^{-3} \text{ sec}$$
$$= 4.31 \text{ msec}$$

3. (d)

$$\mu_T = 1.33$$
$$\mu_g = 1.5$$
$$\because \quad \mu \propto \frac{1}{v}$$
$$\frac{v_T}{v_g} = \frac{\mu_g}{\mu_T} = \frac{1.50}{1.33}$$

4. (c)

By Snell's law,
$$n_1 \sin\theta_i = n_2 \sin\theta_r$$
$$\sin\theta_r = \frac{n_1}{n_2}\sin\theta_i$$
$$\sin\theta_r = \frac{1}{1.5}\times\frac{1}{2}$$
$$\theta_r = 19.47°$$

5. (b)

By Brewster's law
$$\mu = \tan(i)$$
$$\mu = \tan 60 = 1.732$$

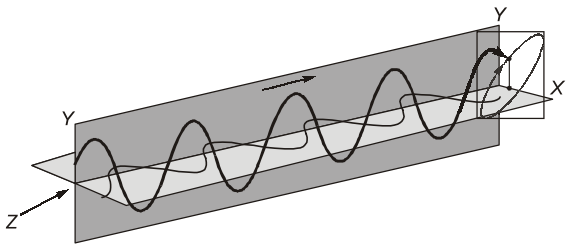
6. (b)

Total % reflection loss
$$= \left[\frac{\mu_2 - \mu_1}{\mu_2 + \mu_1}\right]^2 \times 100\%$$
Reflection loss (RL)
$$= \left[\frac{1.53-1}{1.53+1}\right]^2 = \left[\frac{0.53}{2.53}\right]^2 = 0.043$$
$$RL = 0.043 \times 100$$
$$= 4.3\%$$

7. (a)

Intensity of light transmitted out from the polarizer is given by
$$I = \frac{I_0}{2} = \frac{4}{2} = 2 \text{ Cd}$$

8. (d)



Elliptically polarized light is the resultant of two coherent waves having different amplitudes and a constant phase difference of 90° as shown in above figure.

11. (a)

$$2d\sin\theta = m\lambda \qquad \text{(Bragg's law)}$$
differentiating with respect to λ