1. (a) Calculate the energy of green light having wavelength of 577 nm. Planck’s constant is 6.63×10-34 Js. Also calculate its (b) wave number and (c) angular frequency. Speed of light = 3×108 m/s.

Solution. (a) E = h ν = h c / λ = 6.63× 10-34 × 3×108 / 577×10-9 = 3.43×10-19 J

(b) Wave number (k) = 2π/λ = 1.1×107 m-1.

(c) Angular frequency (ω) = 2πν = 2πc / λ = 3.25×1015 rad/s



1. A distance between pinhole and screen in a pinhole camera is 25 cm. Calculate height of the image produced by a 5-mm object having a distance of 20 cm in front of the pinhole.

Solution. Given that l’ = 25 cm; h = 5 mm; l = 20 cm

h’/h = l’/l => h’ = 6.3 mm

Q. For a given diagram having MN equal to 2 m and NP equal to 30 cm, calculate the area of umbra and penumbra.

Solution. MN = 2m => Area of Umbra = π (MN/2)2 = 3.14 m2

LM = NP = 0.3 m; LP = LM + MN + NP = 2.6 m

Total area of Umbra and Peumbra = π (LP/2)2 = 5.3 m2

Area of Peumbra = (5.31 – 3.14) = 2.17 m2

Q. A narrow beam of sodium yellow light, with wavelength of 589 nm in vacuum, is incident from air onto a smooth water surface at an angle of 35°. (a) Determine the angle of refraction and (b) the wavelength of the light in water. Refractive index of water is 1.333.

Solution. (a) Use Snell’s law: nsin i = n'sin i'; Given that n = 1, i = 35°, n' = 1.333

(b) Use the relation: λ/ λ’ = n’/ n = sin i/ sin i’ ; Given that λ ~589 nm, n = 1, n' = 1.333

Q. The wavelength of red helium–neon laser light in air is 632.8 nm. (a) What is its frequency (ν)? (b) What is its wavelength (λ’) in glass that has an index of refraction of 1.50? (c) What is its speed in the glass?

Solution. (a) Use relation: ν = c / λ; Given that λ = 632.8 nm, c = 3×108 m/s

(b) Use the relation: λ/ λ’ = n’/ n; Given that λ = 632.8 nm, n' = 1.5, n = 1

(c) Use the relation: c/λ = v’/λ’= υ = constant; Given that c = 3×108 m/s, λ = 632.8 nm, λ’= From (b).

Q. An object is situated at a distance of 50 cm in front of a plane mirror of 1 m height. The mirror forms a virtual image at a distance of 2 m. Calculate the field of view (FV) of the plane mirror.

Solution. Use the relation: FV = DE×OB’/OA

Given that DE = 1 m, OA = 0.5 m, OB' = OA + AB' = 0.5 + 2 = 2.5 m => FV = (1×2.5)/0.5 = 5 m

Q. Calculate critical angle for glass/ air interface. Refractive index of glass is 1.5 and refractive index of glass is 1.

Solution. Use sin ic = *n'* /*n* or ic = sin-1(n'/ n), where n = 1.5 (glass) and n' = 1 (air).

ic = sin-1(1/ 1.5) ⇒ ic = sin-1(0.67) = 41.8o

Q. For 589-nm light, calculate the critical angle for the following materials surrounded by air: (a) diamond, (b) flint glass, and (c) ice. Refractive index, n, of material is, 2.419 (diamond), 1.66 (flint glass), 1.309 (ice). Refractive index, n', of air is 1.

Solution. Critical angle, ic = sin-1(n'/ n).

(a) ic = 24.4o.

(b) ic = 37o.

(c) ic = 49.8o.

Q4. For 589-nm light, calculate the critical angle for the following materials surrounded by water: (a) diamond, (b) flint glass, and (c) ice. Refractive index, n, of material is, 2.419 (diamond), 1.66 (flint glass), 1.309 (ice). Refractive index, n', of water is, 1.333.

Solution. Critical angle, ic = sin-1(n'/ n).

(a) ic = 33.4o.

(b) ic = 53.4o.

(c) Sin ic = 1.02 > 1. There will be no internal reflection.

Q. A man is at the bank of a swimming pool. The height of water level in the swimming pool is 2 m. What will be the apparent depth of the water level? Refractive index of water is 1.333. Refractive index of air is 1.

Solution. Apparent depth, l’ = l (n’/n)

Given that l = 2 m, n = 1.33, n' = 1.

l’ = 2×1/1.333 = 1.50 m

Q. A prism that has an apex angle φ = 50° is made of cubic zirconia, with n = 2.2. What is its angle of minimum deviation (δmin)?

Solution. Use the expression

 with apex angle φ = 50o and n = 2.2.

Answer. Angle of minimum deviation (δmin) = 86.8o

Q. Calculate index of refraction of a triangular glass prism with an apex angle of 60° and angle of minimum deviation of 37.2o.

Solution. Use the expression

, which gives n = 1.5.