

1) The Speed of the light in a medium is $v = 2.5 \times 10^8 \text{ m/s}$.

Calculate the refractive index of the medium.

Soln.

Given, $v = 2.5 \times 10^8 \text{ m/s}$

$$n = ?$$

$$n = \frac{c}{v} = \frac{3 \times 10^8}{2.5 \times 10^8}$$

$$\boxed{n = 1.2}$$

2) A light ray is travelling ^{from} water to air. Calculate the Critical angle for the light ray at the air-water interface

Soln. To find $\theta_c = ?$

$$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$

$$n_2 = n_{\text{air}} = 1$$

$$n_1 = n_{\text{water}} = 1.33$$

$$n_{\text{glass}} = 1.5$$

$$\theta_c = \sin^{-1} \left(\frac{1}{1.33} \right)$$

$$\theta_c = 48.753^\circ$$

3) A light ray travelling in air strikes the surface of a block of glass at an angle of incidence of 45° . Calculate the critical angle.

Soln. To find $\theta_c = ?$

$$\theta_c = \sin^{-1} \left(\frac{n_2}{n_1} \right)$$

$$n_2 = 1.5$$

$$n_1 = 1$$

$$\theta_c = \sin^{-1} \left(\frac{1.5}{1} \right)$$

$$\theta_c = 41.81^\circ$$

4) An OFC system uses an optic fiber with a core refractive index of 1.5 and a cladding refractive index of 1.48. Calculate the acceptance angle for this fiber.

Soln:

Given. $n_1 = 1.5$
 $n_2 = 1.48$

$\theta_a = ?$

$$\theta_a = \sin^{-1}(\sqrt{n_1^2 - n_2^2})$$

W.K.T.

$$NA = \sqrt{n_1^2 - n_2^2} = n \sin \theta_a$$

$$\theta_a = \sin^{-1}(\sqrt{(1.5)^2 - (1.48)^2})$$
$$= \sin^{-1}(0.0596)$$

$$\theta_a = 14.13^\circ$$



5) A laser emits light of wavelength of 650 nanometer.

Calculate the frequency of the emitted light.

Soln $\lambda = 650 \times 10^{-9} \text{ m.}$

$$f = \frac{c}{\lambda} = \frac{3 \times 10^8}{650 \times 10^{-9}}$$

$$f = \underline{4.6 \times 10^{14} \text{ Hz}}$$

6) An optic fiber has a NA of 0.48 and refractive index of Cladding is 1.45. Calculate.

n_1 .

Soln:

$$NA = 0.48$$

$$n_2 = 1.45$$

$$NA = \sqrt{n_1^2 - n_2^2}$$

$$0.48 = \sqrt{n_1^2 - 1.45^2}$$

Squaring

$$(0.48)^2 = n_1^2 - (1.45)^2$$

$$(0.48)^2 + (1.45)^2 = n_1^2$$

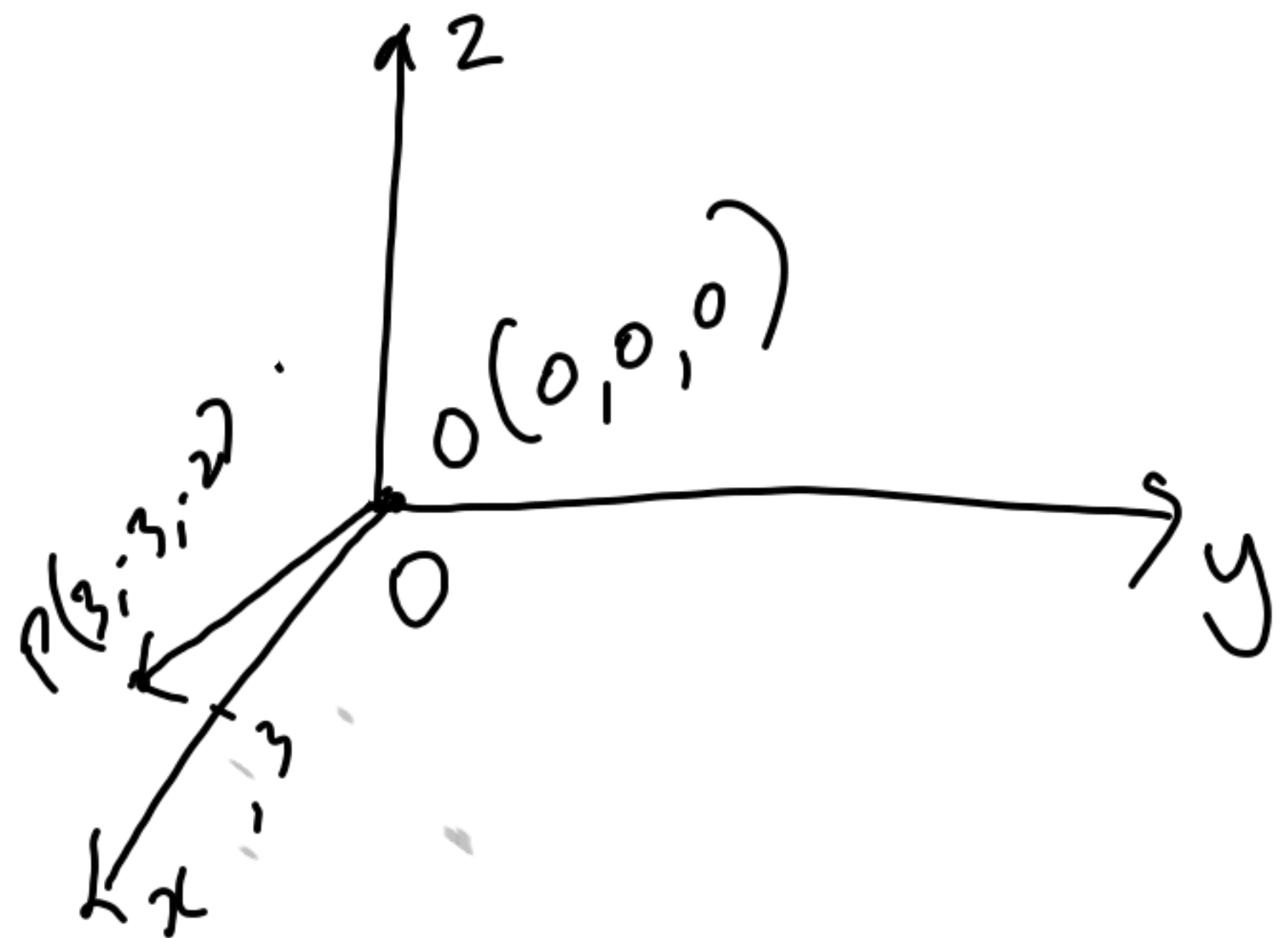
$$n_1 = 1.52$$

⑦ Obtain the unit vector in the direction from the origin towards the point $P(3, -3, -2)$

Soln

To find the unit vector.

Given, $P(3, -3, -2)$



$$\vec{OP} = (x_2 - x_1)\vec{a}_x + (y_2 - y_1)\vec{a}_y + (z_2 - z_1)\vec{a}_z$$

$$O(0, 0, 0) \quad P(3, -3, -2)$$

$x_1 \quad y_1 \quad z_1 \qquad x_2 \quad y_2 \quad z_2$

$$\vec{OP} = (3 - 0)\vec{a}_x + (-3 - 0)\vec{a}_y + (-2 - 0)\vec{a}_z$$

$$\vec{OP} = 3\vec{a}_x - 3\vec{a}_y - 2\vec{a}_z$$

$$|\vec{OP}| = \sqrt{3^2 + (-3)^2 + (-2)^2}$$

$$|\vec{OP}| = \sqrt{22} = 4.69$$

unit vector.

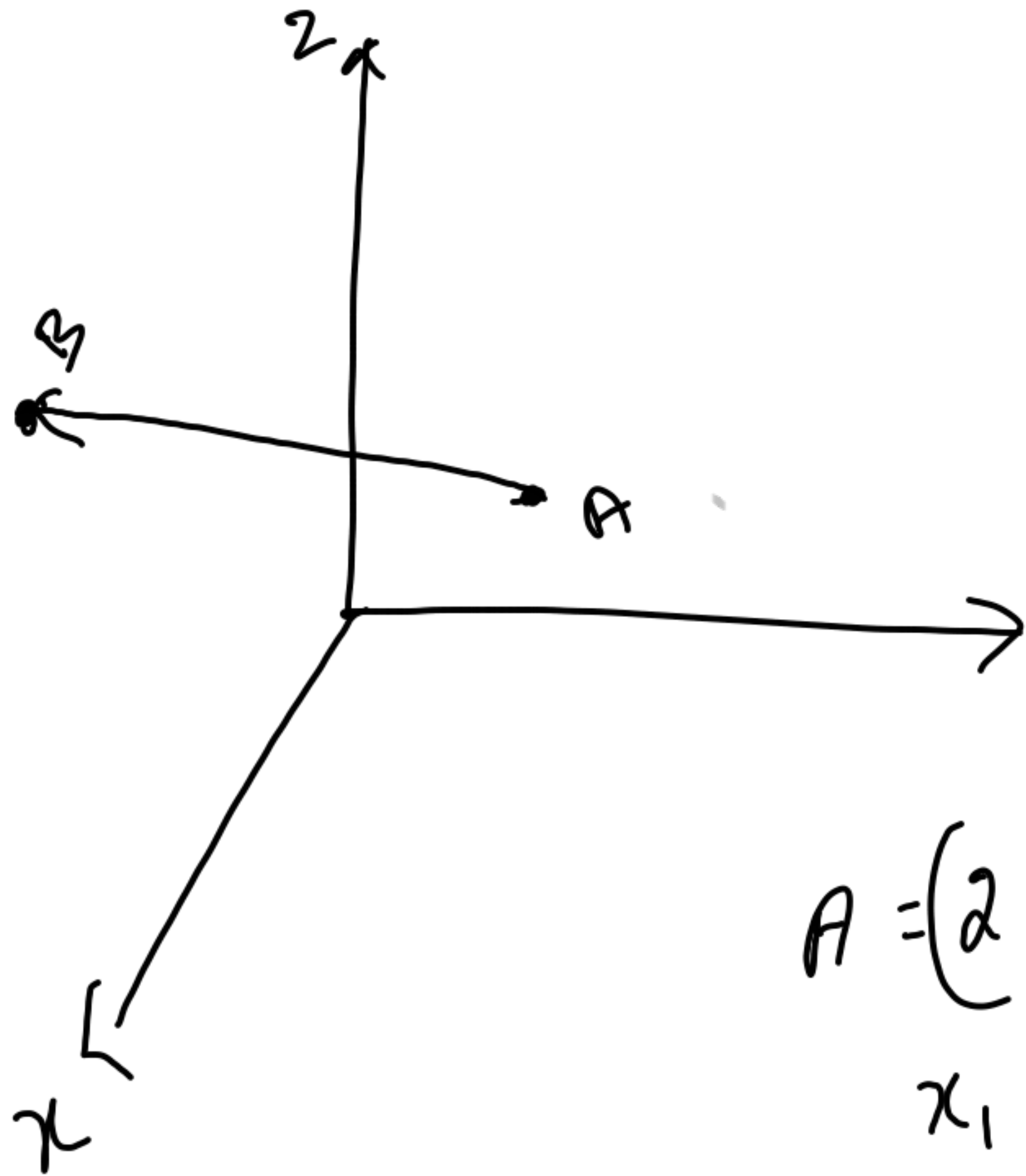
$$\vec{a}_{op} = \frac{\vec{OP}}{|\vec{OP}|} = \frac{3\vec{a}_x - 3\vec{a}_y - 2\vec{a}_z}{4.69}$$

$$\vec{a}_{op} = 0.6396\vec{a}_x - 0.6396\vec{a}_y - 0.4264\vec{a}_z$$

$$|\vec{a}_{op}| = \sqrt{(0.6396)^2 + (-0.6396)^2 + (-0.4264)^2}$$

$$|\vec{a}_{op}| = 1$$

8) Two point A(2,2,1) and B(3,-4,2) are given in the Cartesian System. Obtain the vector from A to B and a unit vector from A to B



$$A = \begin{pmatrix} 2 & 2 & 1 \end{pmatrix}$$

$x_1 \quad y_1 \quad z_1$

$$B = \begin{pmatrix} 3 & -4 & 2 \end{pmatrix}$$

$x_2 \quad y_2 \quad z_2$

$$\vec{AB} = (x_2 - x_1)\vec{a}_x + (y_2 - y_1)\vec{a}_y + (z_2 - z_1)\vec{a}_z$$

$$\vec{AB} = (3 - 2)\vec{a}_x + (-4 - 2)\vec{a}_y + (2 - 1)\vec{a}_z$$

$$\vec{AB} = \vec{a}_x - 6\vec{a}_y + \vec{a}_z$$

$$|\vec{AB}| = \sqrt{(1)^2 + (-6)^2 + (1)^2}$$

$$= \sqrt{1 + 36 + 1}$$

$$|\vec{AB}| = \sqrt{38} = 6.164$$

$$\vec{a}_{AB} = \frac{\vec{AB}}{|\vec{AB}|} = \frac{\vec{a}_x - 6\vec{a}_y + \vec{a}_z}{6.164}$$

$$\vec{a}_{AB} = 0.162\vec{a}_x - 0.97\vec{a}_y + 0.162\vec{a}_z$$

$$|\vec{a}_{AB}| = \sqrt{(0.162)^2 + (-0.97)^2 + (0.162)^2}$$

$$|\vec{a}_{AB}| = 1$$