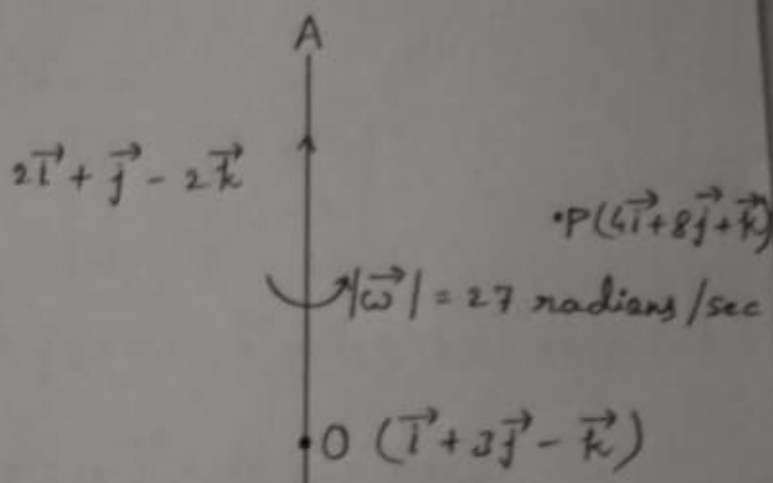


Q. (7) A rigid body is spinning with angular velocity 27 radians per second about an axis parallel to $2\vec{i} + \vec{j} - 2\vec{k}$ passing through the point $\vec{i} + 3\vec{j} - \vec{k}$. Find the velocity of the point of the body whose position vector is $4\vec{i} + 8\vec{j} + \vec{k}$.



unit vector along the given axis OA

$$\begin{aligned}
 &= \frac{2\vec{i} + \vec{j} - 2\vec{k}}{|2\vec{i} + \vec{j} - 2\vec{k}|} = \frac{2\vec{i} + \vec{j} - 2\vec{k}}{\sqrt{4+1+4}} \\
 &= \frac{1}{3} (2\vec{i} + \vec{j} - 2\vec{k})
 \end{aligned}$$

\therefore Angular velocity of the body about the axis is

$$\begin{aligned}
 \vec{\omega} &= 27 \left(\frac{2\vec{i} + \vec{j} - 2\vec{k}}{3} \right) \\
 &= 9 (2\vec{i} + \vec{j} - 2\vec{k})
 \end{aligned}$$

(2)

Let the point $\vec{i} + 3\vec{j} - \vec{k}$ on the axis be O and the given point $4\vec{i} + 8\vec{j} + \vec{k}$ be P .

$$\begin{aligned}\text{Then } \vec{r} = \overrightarrow{OP} &= (4\vec{i} + 8\vec{j} + \vec{k}) - (\vec{i} + 3\vec{j} - \vec{k}) \\ &= 3\vec{i} + 5\vec{j} + 2\vec{k}\end{aligned}$$

Now the required velocity of P

$$= \vec{\omega} \times \vec{r}$$

$$= 9 \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 2 & 1 & -2 \\ 3 & 5 & 2 \end{vmatrix}$$

$$= 9 \{ (2+10)\vec{i} + (-6-4)\vec{j} + (10-3)\vec{k} \}$$

$$= 9 (12\vec{i} - 10\vec{j} + 7\vec{k})$$