Question 1

A ship travels with velocity given by $\begin{bmatrix}1\\2\end{bmatrix}$, with current flowing in the direction given by $\begin{bmatrix}1\\1\end{bmatrix}$ with respect to some co-ordinate axes.

What is the velocity of the ship in the direction of the current?

Answer

vector projection $= r\frac{r\cdot s}{|r|^2} = 2$

vector projection $= \begin{bmatrix}1\\1\end{bmatrix} * \frac{3}{2}$

$$\boxed{\text{vector projection} = \begin{bmatrix}3/2\\3/2\end{bmatrix}}$$

Question 2

A ball travels with velocity given by $\begin{bmatrix}2\\1\end{bmatrix}$, with wind blowing in the direction given by $\begin{bmatrix}3\\-4\end{bmatrix}$ with respect to some co-ordinate axes.

What is the size of the velocity of the ball in the direction of the wind?

Answer

This is a scalar projection problem because we are looking for size.

scalar projection $= \frac{r\cdot s}{|r|}$

$$\boxed{\text{scalar projection} = \frac{2}{5}}$$

Question 5

At 12:00 pm, a spaceship is at position $\begin{bmatrix} 3 \\ 2 \\ 4 \end{bmatrix}$ km away from the origin with respect to some 3 dimensional co ordinate system. The ship is travelling with velocity $\begin{bmatrix} -1 \\ 2 \\ -3 \end{bmatrix}$ km/h. What is the location of the spaceship after 2 hours have passed?

Answer

This problem is a simple vector addition problem. We know the speed of the spaceship. First, what we will do is multiply the speed in km/h by 2 to figure out the distance it will travel in 2 hours.

$$2\begin{bmatrix} -1 \\ 2 \\ -3 \end{bmatrix} = \begin{bmatrix} -2 \\ 4 \\ -6 \end{bmatrix} km/2h$$

Now we can simply add the starting position + the distance in 2 hours the ship will travel.

$$\begin{bmatrix} 3 \\ 2 \\ 4 \end{bmatrix} + \begin{bmatrix} -2 \\ 4 \\ -6 \end{bmatrix} = \boxed{\begin{bmatrix} 1 \\ 6 \\ -2 \end{bmatrix} km}$$