Vector Functions and Curves
Applications

Question

What are the tangential and normal components of the Coriolis force on an object moving with (horizontal) velocity $\underline{v}$ in the following situations

(a) At the north pole.

(b) At the south pole.

(c) At the equator.

Answer

The Earth has angular velocity $\underline{\Omega}$ which points due north. If a particle is moving with horizontal velocity v,then the tangential and normal components of the Coriolis force ($\underline{C}$) are related by:

$$\begin{aligned} \underline{C}_T &= -2\underline{\Omega}_N \times \underline{v} \\ \underline{C}_N &= -2\underline{\Omega}_T \times \underline{v} \end{aligned}$$

(a) At the north pole, $\underline{\Omega}_T = 0$ and $\underline{\Omega}_N = \underline{\Omega}$.

$$\begin{aligned} \Rightarrow \underline{C}_N &= \underline{0} \\ \underline{C}_T &= -2\underline{\Omega} \times \underline{v} \end{aligned}$$

And so the Coriolis force is 90° east of $\underline{v}$.

(b) At the south pole, $\underline{\Omega}_T = 0$ and $\underline{\Omega}_N = \underline{\Omega}$.

$$\begin{aligned} \Rightarrow \underline{C}_N &= \underline{0} \\ \underline{C}_T &= -2\underline{\Omega} \times \underline{v} \end{aligned}$$

And so the Coriolis force is 90° west of $\underline{v}$.

(c) At the equator, $\underline{\Omega}_N = \underline{0}$ and $\underline{\Omega}_T = \underline{\Omega}$.

$$\begin{aligned} \underline{C}_T &= \underline{0} \\ \underline{C}_N &= -2\underline{\Omega} \times \underline{v} \end{aligned}$$

And so the Coriolis force is vertical.