Information for the following questions: You are in the NH midlatitudes \((f > 0)\). Let \(\Delta p = 10\) mb over 1000 km, \(\rho = 1 \text{ kg/m}^3\), and \(f = 10^{-4}/\text{s}\). The geostrophic equation in natural coordinates is

\[
V_g = -\frac{1}{f \rho} \frac{\partial p}{\partial n},
\]

and the gradient wind equation is

\[
V = -\frac{f R}{2} \pm \sqrt{\frac{f^2 R^2}{4} - \frac{R^2}{\rho} \frac{\partial p}{\partial n}}.
\]

By convention, \(R > 0\) is CCW. Show your work. Of the values you obtain, the smallest real wind speed value will be that associated with the regular cyclonic (CCW) low. Since we associate synoptic-scale cyclones with potentially large wind speeds, this result may not be intuitively obvious.

1. Compute the geostrophic wind speed, expressed in meters per second.

2. Let \(|R| = 1000\) km (in absolute magnitude). Compute the gradient wind speed corresponding to the regular low (regular CCW cyclone). You should obtain a value that is smaller than the geostrophic wind speed, right?
3. Let $|R| = 1000$ km (in absolute magnitude). Compute the gradient wind speed corresponding to the **anomalous low** (CW). You should obtain a value that is much larger than the geostrophic wind speed, right?

4. Let $|R| = 1000$ km (in absolute magnitude). Compute the gradient wind speeds corresponding to the **regular and anomalous highs** (both are CW). Those are the two roots in the lower right quadrant of the chart I used in class.
5. The cyclostrophic equation is \( V = \sqrt{-\frac{R \partial\rho}{\rho \partial n}} \). Let \(|R| = 1000 \text{ km}\) (in absolute magnitude). Solve for real values of the \textbf{cyclostrophic low} considering positive and negative values for \( R \). You should get two identical values of \( V \).

6. The inertial flow equation is \( V = -Rf \). Let \(|R| = 1000 \text{ km}\) (in absolute magnitude). Solve for a real value of the \textbf{inertial flow} \( V \). Your result should suggest to you that since slow motions would be expected from this balance, \( R \) cannot be this large in magnitude.