

ATM 316 Examples for Chapter #1

Fall, 2022 – Fovell

(Example 1-1) A projectile is flying eastward at 100 m/s and northward at 50 m/s. Flight-level winds are westerly at 50 m/s and northerly at 10 m/s. What is the projectile ground speed and direction? Keep in mind that westerly = from the west, towards the east, and northerly = from the north, towards the south.

(Example 1-2) The 1000 mb geostrophic wind is westerly at 10 m/s. The 500 mb geostrophic wind is from the southwest at 20 m/s. Where is the cold air located? (This example will make more sense as the term progresses. The immediate purpose is to determine the vertical shear vector. The vertical shear vector represents higher altitude wind minus lower altitude wind, and is drawn from the HEAD of the lower altitude vector to the HEAD of the higher altitude vector.)

(Example 1-3) Helicity is a scalar quantity used in severe weather forecasting to determine the likelihood of rotating (supercell) thunderstorms and tornadoes. It is defined as the dot product of the 3D velocity vector with the 3D vorticity vector, producing a scalar with units m/s^2 . Let

$$\vec{U} = 10\hat{i} + 5\hat{j} + 2\hat{k}, \text{ and}$$

$$\vec{\zeta} = 0\hat{i} + 0.001\hat{j} + 0.02\hat{k}$$

$$\text{Solve for } H = \vec{U} \cdot \vec{\zeta}$$

(Example 1-4) Picture a situation in which the sea is to the left and land is to the right. You are on the land, enjoying a sea breeze. The wind is westerly at 10 m/s. The temperature gradient in the x-direction is $+10^\circ\text{C}/100 \text{ km}$; i.e., it's colder to the west. As parcels travel, however, they are heated by the sun at $1^\circ\text{C}/\text{h}$. What is the local rate of change of temperature at your location?

(Example 1-5) Surface pressure decreases by 3 mb over 180 km in the eastward direction. The wind pushes a sailboat past an island, eastward at 10 km/h. A barometer *on the boat* measures a pressure fall of 1 mb per 3 h. What is the rate of pressure change on the *island*?

(Example 1-6). $f(x) = 2x^2 - 5x + 1$. What is the Taylor expansion of this function about the point $x_0 = 2$?