Dynamics of the Atmosphere (11:670:324)
Spring 2012
Homework #1

1. The aviation weather observation (METAR) from Mount Washington in New Hampshire reads:

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KMWN 171254Z 26036KT 0SM -SNSG BLSN FZFG VV000 M07/M07
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The wind direction in is indicated by the third group of characters; in this case it indicates that the wind is blowing from 260° at 36 knots. (Knots are used internationally for aviation; 1 knot = 0.514 m s^{-1}.)

If this wind vector is written as $\vec{V} = u\hat{i} + v\hat{j}$, what are the values of *u* and *v*? Please give your answer in units of m s^{-1}.

(6 points)

2. (a) Please calculate the Coriolis acceleration in vector form for a parcel of air at 40° N latitude moving northward at 20 m s^{-1}. *Hint: Use the Coriolis acceleration term in the vector momentum equation in rotating coordinates*. (b) In contrast to Earth, Venus rotates clockwise when viewed from above, with one Venusian day equal to 243 terrestrial days. Please calculate the Coriolis acceleration in vector form for a parcel of air at 40° N latitude moving northward at 20 m s^{-1} on Venus.

(8 points)

3. Given the vectors, $\vec{A} = A_x\hat{i} + A_y\hat{j}$ and $\vec{V} = u\hat{i} + v\hat{j} + w\hat{k}$, please show that

a) $\nabla \cdot \left(\nabla \times \vec{V}\right) = 0$

b) $\hat{k} \times \left(\hat{k} \times \vec{A}\right) = -\vec{A}$.

(10 points)

4. A thermometer on a balloon moving with the wind measures a temperature increase of 1 K/hour. The balloon is flying at a constant altitude. The isotherms (i.e., lines of equal temperature) on the latest weather map for that altitude are oriented north-south and spaced 100 km apart with a contour interval of 5 K and higher temperature toward the east. The wind is blowing from the west at 40 km/hour, and the airflow is perfectly horizontal. Please use Euler's relation for the expansion of the total derivative to compute the rate of temperature change measured at a stationary meteorological tower at the same level as the balloon is flying.

(8 points)