Dynamics of the Atmosphere (11:670:324)
Spring 2013
Homework #1

1. The aviation weather observation (METAR) from Providence, Rhode Island, reads:

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KPVD 031251Z 03011KT 10SM FEW035 BKN047 OVC130 02/M05 A2981 RMK AO2
SNE21 SLP094 P0000 T00171050
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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 030° at 11 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. The gravitational acceleration at Earth's surface has a value of 9.8 m s^{-2}. When dealing with fluid motions in the atmosphere and ocean, we often treat this value as constant, because its variations with height are small as long as we are relatively close to Earth's surface. (a) Commercial jet aircraft fly at an altitude of approximately 11 km. By what percentage is the gravitational acceleration decreased at this altitude? (b) At what altitude would the gravitational acceleration decrease to 25% of its surface value?
(8 points)

3. A thermometer on a balloon moving with the wind measures a temperature increase of 2 K/hour. The balloon is flying at a constant altitude. The latest weather map indicates that the temperature increases toward the west at a rate of 3 K/100 km at the level the balloon is flying. The wind is blowing from the west at 50 km/hour, and the airflow is perfectly horizontal. Please compute the rate of temperature change measured at a stationary meteorological tower at the same level as the balloon is flying.
(8 points)

4. Suppose you are given a 2D pressure field as depicted schematically below. Here, p_1, p_2, and p_3 represent isobars (lines of equal pressure). Please derive an expression for the 2D slope of a generalized isobar (relative to horizontal) in terms of the partial derivatives of $p(x,z)$.
(6 points)