

Name \_\_\_\_\_

### ATMS 301 Homework # 3, Autumn 2016

Due: Monday, November 14, 2016 at the **beginning** of class Please show all your work.

1. A parcel of air at sea level in western Washington has a temperature of  $10^{\circ}\text{C}$  and is saturated.

(For this problem, you may assume the moist adiabatic lapse rate  $\Gamma_s$  is  $6.2^{\circ}\text{C} \cdot \text{km}^{-1}$  and that the dry adiabatic lapse rate  $\Gamma_d$  is  $9.8^{\circ}\text{C} \cdot \text{km}^{-1}$ .)

(a) The parcel is forced to rise to an elevation of 2 kilometers at the crest of the Cascade Mountains. What is its new temperature?

(b) After passing the Cascade crest, the parcel descends dry adiabatically down the east side of the mountains to an elevation of 500 meters. What is its new temperature?

2. The environmental lapse rate is  $8^{\circ}\text{C} \cdot \text{km}^{-1}$ . (You may assume the same values of  $\Gamma_s$  and  $\Gamma_d$  as in #1.)

(a) If an unsaturated air parcel is displaced upwards, will it continue to rise? Why?

(b) If a saturated air parcel is displaced upwards, will it continue to rise? Why?

3. An air parcel is at sea level with a pressure of 1000 hPa and a temperature of  $15^{\circ}\text{C}$ . (You may assume the same values of  $\Gamma_s$  and  $\Gamma_d$  as in #1.)

(a) The parcel rises dry adiabatically to a height of 1.5 kilometers. What is its new temperature?

(b) At this point, the parcel becomes saturated. It continues to rise another 1.5 kilometers. What is its new temperature?

(c) After rising a total of 3 kilometers, the parcel is now at a pressure of 700 hPa. What is the density of the parcel? (You may assume the value of the gas constant  $R$  is  $287 \text{ J} \cdot \text{kg}^{-1} \text{ K}^{-1} = 287 \text{ N} \cdot \text{m} \cdot \text{kg}^{-1} \text{ K}^{-1}$ .)

4. The mixing ratio  $w$  of a parcel is  $3.5 \text{ g} \cdot \text{kg}^{-1}$ . The temperature of the parcel is  $0^\circ\text{C}$  so the saturation mixing ratio  $w_s$  is  $3.8 \text{ g} \cdot \text{kg}^{-1}$ . What is the relative humidity of the parcel?

5. Does moisture (water vapor) in the atmosphere make vertical instability more or less likely? Explain.