Chapter One Exercises

Directions: Solve the assigned exercises on a separate sheet of paper. Be sure to show intermediate steps. You may work cooperatively, but each student must turn in her or his own work.

1. An air parcel has a temperature of 90° F. Determine its temperature in (a) Celsius, (b) Kelvin.
2. The temperature of an air parcel is -10° C. Determine its temperature in (a) Kelvin, (b) Fahrenheit.
3. If the temperature of an air parcel is 298K, what is the parcel's temperature in (a) Celsius, (b) Fahrenheit.
4. Determine the average velocity of the molecules within a parcel of air that has a temperature of 0° C.
5. The average speed of the molecules in a parcel of air is 600 m/sec. Calculate the temperature of the parcel in degrees C.
6. Determine the density of an air parcel given it has a temperature of 70° F and a pressure of 1000 mb.
7. An air parcel has a density of 1.2 $\text{kg}\cdot\text{m}^{-3}$ and a temperature of 10° C. Determine the air pressure of the parcel.
8. Determine the density in g/L of the standard atmosphere (assume a surface density of 1.22 g/L) at an elevation of (a) 1000 m, (b) two miles.
9. A parcel at 700 mb has a temperature of -5° C. Calculate the potential temperature of the parcel.
10. A parcel has a temperature of 2° C and a potential temperature of 283K. Calculate the approximate elevation of the parcel. Assume a surface pressure of 1000 mb.
11. The potential temperature of a parcel at 500 mb is 288K. Determine the parcel's temperature in degrees Celsius.
12. At what elevation (in meters), does the standard atmosphere have the following densities? Assume a surface density of 1.22 g/L. (a) 1.0 g/L, (b) 0.5 kg/m^3, (c) 0.1 g/L
13. For a standard atmosphere (use surface pressure of 1000 mb), determine the elevation z, in meters, at which (a) 10% of the atmosphere is below z, (b) 50% of the atmosphere is below z, (c) 90% of the atmosphere is below z.
14. A classroom in Olin Hall has dimensions 10 m by 12 m by 3 m. Determine (a) the total mass, in kg, of the air in the room, (b) the mass, in kg, of oxygen in the room.
15. On a summer day the surface temperature is 72° F. What temperature, in degrees F, would you expect to find at the top of a one-mile high mountain? Assume a standard temperature lapse rate.
16. The temperature at an elevation of 8000m is -25° C, while the temperature at an elevation of 2000m is 5° C. Calculate the average lapse rate for this interval in ° C / 1000 m.
17. Given the temperature at the surface is 72° F and the temperature at the 700 mb pressure level is 10° C, calculate the average lapse rate for this segment of the atmosphere in ° C / 1000 m. Assume a surface pressure of 1000 mb.

18. The table of data given below gives the measured lapse rates for the atmosphere broken into six intervals. The surface temperature is 75° F. Use these data to determine the atmospheric temperature (in degrees C) at (a) 3000m, (b) 5000m, (c) 6000m, and (d) 7500m

Interval (meters agl*)	Lapse Rate (° C/ 1000 m)
7000 - 8000	6
5000 - 7000	8
3500 - 5000	7
2000 - 3500	3
1500 - 2000	1
0000 - 1500	4

* - agl means above ground level

19. The surface temperature at Decorah is 0° C and the surface density is 1.30 g/L. The surface temperature at Tallahassee, Fl is 20° C and the surface density is 1.22 g/L. Assuming a standard lapse rate for temperature over both cities (which means a standard exponential decrease of pressure with elevation), calculate the elevation of the 500 mb pressure surface over each city.

20. You are able to determine the atmospheric pressure outside your airplane is 600 mb. If the surface temperature is 20° C, what is the elevation (in meters) of the airplane? Assume a standard atmospheric temperature lapse rate (so pressure decreases exponentially with elevation) and $\rho_s =$ 1.22 g/L.

21. Consider a column of air that is above a horizontal area of 1 square meter with a surface pressure of 1000 mb. Calculate the mass, in kg, of the air (a) between the pressure levels of 1000 mb and 850 mb, (b) within the first kilometer closest to the earth's surface, and (c) between the elevations of 1 km and 2 km.

22. Use the tabular data given below to estimate the precipitable water (depth of water in cm) in a column of air that has a base of one square meter and extends from the surface of the earth to the 500 mb pressure elevation.

Pressure (mb)	Mixing Ratio (g/kg)
1000	20
850	15
700	10
500	5

23. An Olin classroom has dimensions 20m by 15m by 3m. If the mixing ratio of the air in the classroom is 30g/kg, determine (a) the mass of the water vapor in the air, (b) the depth of the water if all of the vapor precipitates out of the air.

24. A summer thunderstorm over Decorah results in a rainfall depth of 1.5 inches. Estimate the average mixing ratio of the thunderstorm atmosphere assuming 50% of the water vapor in the atmosphere precipitated and the precipitation column extended to an elevation of 6000 m.

25. Thunderstorms act like a vacuum in that they suck up a great volume of moisture-laden air and "wring" out the water vapor. Suppose a thunderstorm precipitates a depth of 750 mm of water (approximately 3 inches) over a 1 km^2 region. Assume the average mixing ratio in any column of air between the surface and 400 mb (available to the storm) is 20 g/kg. Additionally, assume the storm's "precipitation efficiency" (what percentage of the precipitable moisture actually precipitates) is 60% for the each column. Estimate the area, in km^2, that the storm must draw from to provide enough precipitable water for the storm.