

Atmospheric Sciences 5130
Start-of-course Quiz

1. Given T and p of a gas, what is the formula to calculate its density, ρ ?
2. Given ρ and the volume, V , what is the formula to calculate the mass, M , of a sample of a gas?
3. What is the formula to calculate the mass per unit area of a column of the atmosphere extending from the surface, where $p = p_s$, to the top of the atmosphere where $p = 0$?
4. What is the formula used to calculate the thickness of a layer of the atmosphere given the pressures at the bottom and top of the layer, p_1 and p_2 , and the average virtual temperature of the layer, \overline{T}_v ?
5. What formula is used to calculate the temperature change, ΔT , of a volume V of dry air at p , T , if heated by a light bulb of with energy output of H watts (joules per second) for one hour?
6. (a) During a cold air outbreak from Siberia over the Sea of Japan, the temperature of the lowest 300 hPa of the atmosphere warms by 20°C , due to heating by the upper 30 m of the ocean. How much does this ocean layer cool as a result? (The density of water is 1000 kg m^{-3} , and the specific heat capacity of water is $4186\text{ joules kg}^{-1}\text{ K}^{-1}$.)
(b) If the energy transfer from ocean to atmosphere occurs over a 1-day period, what is the average rate of energy transfer (in units of W m^{-2})?
7. A parcel of dry air rises and expands adiabatically from $p = p_1$ where $T = T_1$ to $p = p_2$. What is the formula for $T_2 = T(p_2)$?
8. How much is a kilogram of air cooled (in $^\circ\text{C}$) by evaporating 5 g of water into it?
9. Define the LCL (lifting condensation level). How do you find it using a skew- T log p chart?
10. What is the definition of the dry adiabatic lapse rate, Γ_d ? What is its theoretical value, in terms of physical constants? What is its numerical value?

11. What is the definition of the saturated adiabatic lapse rate, Γ_s ? Does it have a fixed value? Is $\Gamma_s > \Gamma_d$?
12. What are the conditions, in terms of the actual lapse rate $\gamma \equiv -dT/dz$, Γ_d , and Γ_s , for absolute instability, absolute stability, and conditional instability?
13. Define the saturation mixing ratio, w , in words or with a mathematical expression.
14. Define relative humidity, RH.
15. Define the dewpoint temperature, T_d , in words or with a mathematical expression.
16. A radiosonde measures T , p , and RH. How can you obtain T_d from these quantities (either mathematically or using a skew- T log p chart)?
17. What is CAPE (Convective Available Potential Energy)? Define it mathematically or using a skew- T log p chart.
18. What three processes lead to an air parcel having its actual temperature be equal to (1) θ , potential temperature, (2) θ_e , equivalent potential temperature, and (3) T_w , wet-bulb temperature?
19. How do mixing ratio and θ_e change as near-surface air flows into a hurricane isothermally (above an ocean with a constant sea surface temperature) but with pressure decreasing, if the relative humidity remains constant?
20. Why are evaporative coolers effective in Utah but not in Florida?