

Professor: J.D. WilsonTime available: 20 minsValue: 10%

Instructions: Choose the best (or most logical) option, and use a pencil to mark that choice on the scantron form. **Eqns/data given at back.** You may keep this quiz.

1. If vapour pressure $e = 1.1$ kPa and the temperature $T = 23^\circ\text{C}$, what is the absolute humidity ρ_v ?
 - (a) $8 \times 10^{-3} \text{ kg m}^{-3}$
 - (b) $8 \times 10^{-6} \text{ kg m}^{-3}$
 - (c) 0.1 kg m^{-3}
 - (d) $1 \times 10^{-4} \text{ kg m}^{-3}$
 - (e) 8 g kg^{-1}
2. What is the relative humidity of air having temperature $T = 6^\circ\text{C}$ and vapour pressure $e = 0.7$ kPa?
 - (a) 95%
 - (b) 75%
 - (c) 65%
 - (d) 55%
 - (e) 45%
3. What option is closest to the dewpoint T_d of air whose temperature and relative humidity are $T = 19^\circ\text{C}$ and 65%?
 - (a) 28°C
 - (b) 23°C
 - (c) 19°C
 - (d) 12°C
 - (e) 4°C
4. Referring to Figure (1), which option best describes the buoyancy force F_B that will act on a parcel of air that rises from the surface into the mixed layer?
 - (a) $F_B = 0$, no buoyancy force
 - (b) $F_B > 0$, downward buoyancy force
 - (c) $F_B > 0$, upward buoyancy force
 - (d) $F_B < 0$, downward buoyancy force
 - (e) $F_B < 0$, upward buoyancy force
5. Referring to Figure (2), which statement is **false** or **without justification**?
 - (a) the LFC lies at the level marked “z”
 - (b) this is an idealized summer daytime scenario
 - (c) the middle layer is well mixed
 - (d) the surface layer is absolutely unstable
 - (e) the upper layer is an inversion

6. Referring to Figure (3), which answer best approximates the total number density of CCN (cm^{-3})? Hint: area under the “curve.”
- (a) 10
 - (b) 50
 - (c) 100
 - (d) 200
 - (e) 1200
7. Referring to the sounding (Fig. 4), what pressure and temperature correspond to the point of intersection of isotherms and isobars within the heavy circle **O**?
- (a) 300 Pa, 18°C
 - (b) 300 hPa, 18°C
 - (c) 300 kPa, 18°C
 - (d) 300 hPa, -10°C
 - (e) 300 hPa, -25°C
8. Referring to the sounding (Fig. 4), what is the correct static stability category for the layer whose upper and lower boundaries are those of the drawn box?
- (a) absolutely unstable
 - (b) absolutely stable
 - (c) conditionally unstable
 - (d) neutral with respect to unsaturated adiabatic motion
 - (e) neutral with respect to saturated adiabatic motion
9. Again referring to the sounding (Fig. 4), what is the correct static stability category for the layer below 700 hPa?
- (a) absolutely unstable
 - (b) absolutely stable
 - (c) conditionally unstable
 - (d) neutral with respect to unsaturated adiabatic motion
 - (e) neutral with respect to saturated adiabatic motion
10. Again referring to the sounding (Fig. 4), which level is closest to the LCL for lifted surface parcels?
- (a) 925 hPa
 - (b) 850 hPa
 - (c) 700 hPa
 - (d) 500 hPa
 - (e) 250 hPa

Equations & Data.

- 1 kPa = 10 hPa = 1000 Pa, T [K] = T [°C] + 273.15
- $e = \rho_v R_v T$, The ideal gas law for water vapor. e [Pascals], pressure; ρ_v , [kg m⁻³] the absolute humidity (ie. vapor density); T [Kelvin], the temperature; and $R_v = 462$ [J kg⁻¹ K⁻¹], the specific gas constant for water vapor.
- $F_B = g (T_p - T)/T$ or $F_B = g (\theta_p - \theta)/\theta$. Alternative expressions for the buoyancy force on a parcel whose temperature and potential temperature are (T_p, θ_p) at a level where the environmental temperature and potential temperature are (T, θ) . The denominator must be expressed in Kelvin.

Table 1: Equilibrium vapour pressure $e_s(T)$ [hPa] versus temperature T [°C]. Figure cited applies to equilibrium over a plane surface of water where $T \geq 0^\circ\text{C}$, or of ice where $T < 0^\circ\text{C}$.

T	$e_s(T)$	T	$e_s(T)$	T	$e_s(T)$	T	$e_s(T)$	T	$e_s(T)$	T	$e_s(T)$	T	$e_s(T)$
-10	2.60	-5	4.02	0	6.11	5	8.72	10	12.27	15	17.04	20	23.37
-9	2.84	-4	4.37	1	6.57	6	9.35	11	13.12	16	18.17	21	24.86
-8	3.10	-3	4.76	2	7.05	7	10.01	12	14.02	17	19.37	22	26.43
-7	3.38	-2	5.17	3	7.58	8	10.72	13	14.97	18	20.63	23	28.09
-6	3.69	-1	5.62	4	8.13	9	11.47	14	15.98	19	21.96	24	29.83
												25	31.67
												26	33.61
												27	35.65
												28	37.80
												29	40.06

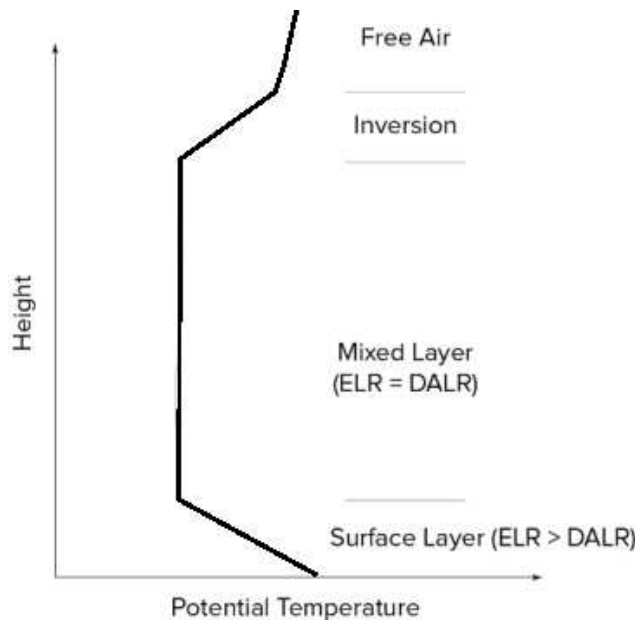


Figure 1: Idealized summer daytime profile of potential temperature θ . (Ross's Figure 8.29).

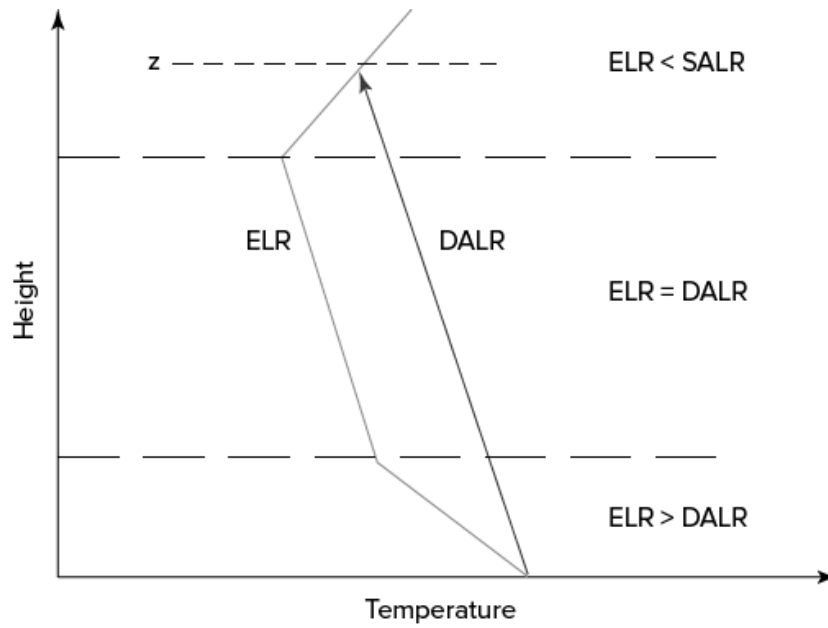


Figure 2: Idealized three-layer temperature profile. Assume the line with the arrow gives the temperature of a parcel as it rises from the surface. (Ross's Figure 8.21).

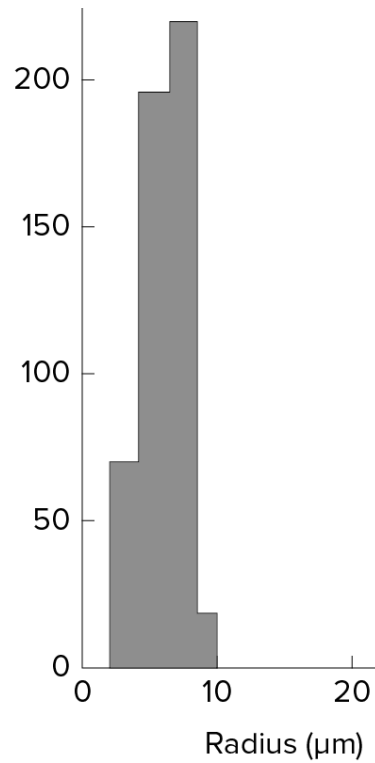


Figure 3: Idealized size distribution of CCN particles in continental air. The unit on the y -axis is $\text{cm}^{-3} \mu\text{m}^{-1}$, i.e. number of CCN per cubic centimetre per μm interval of radius. (Ross's Figure 9.5).

141025/0000 71119 WSE SHOW: 0 LIFT: 0 SWET: 223 VTOT: 34
 CAPE: 53 EQLV: 496 SELV: 766 CINS: -11
 LCLT: 264 LCLP: 723

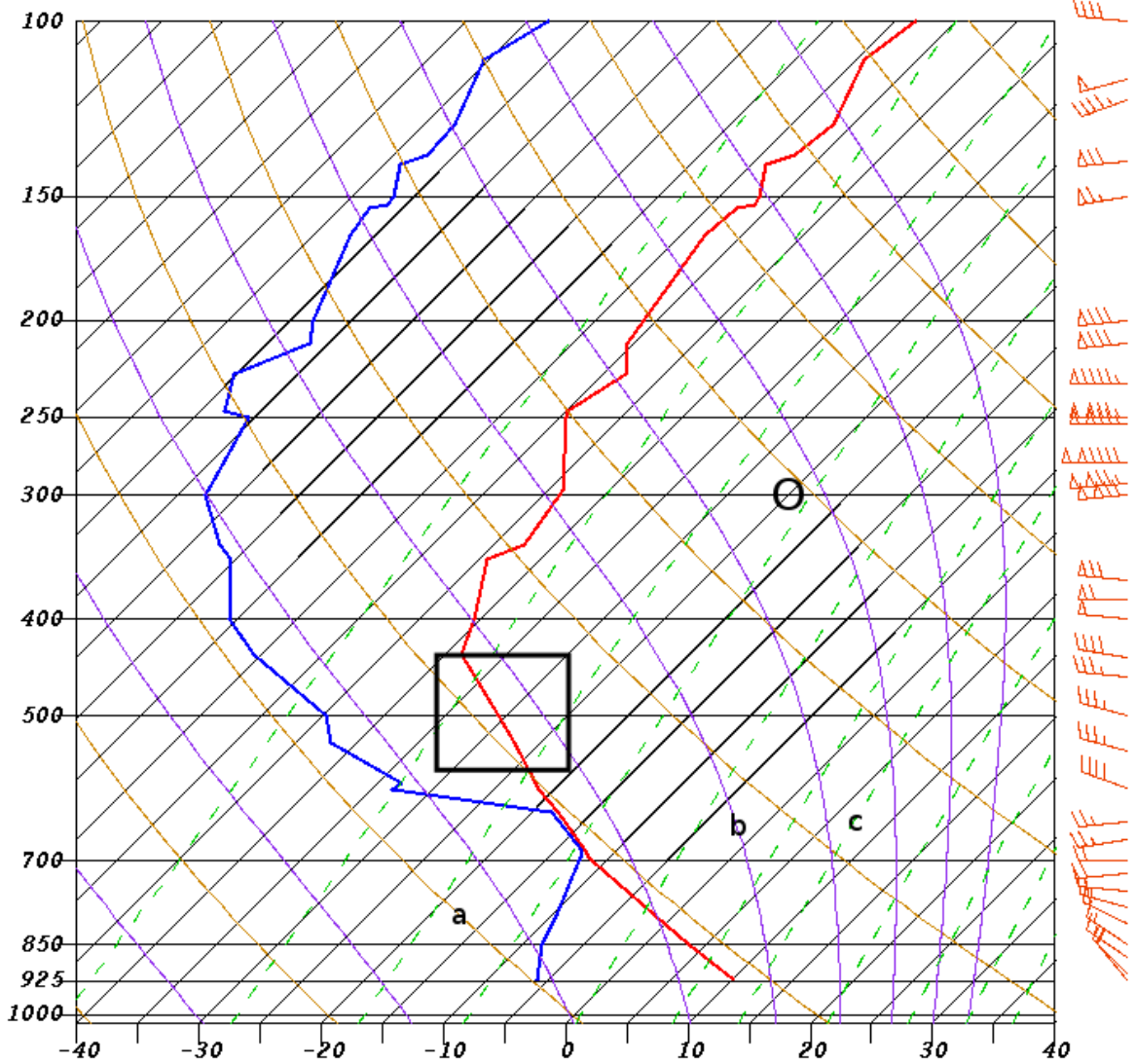


Figure 4: Stony Plain sounding, 00 UTC 25 October 2014, plotted on the skew-T diagram. Unsaturated adiabats (e.g. **a**), saturated adiabats (e.g. **b**) and isotherms are all solid lines; isohumes (e.g. **c**) are dashed lines.