EAS270, "The Atmosphere" <u>Quiz 3</u> 7 Nov, 2005

<u>Professor</u>: J.D. Wilson <u>Time available</u>: 25 mins <u>Potential Value</u>: 10%

Instructions: For all 16 questions, choose what you consider to be the best (or most logical) option, and use a pencil to mark that choice on the answer form. **Eqns/data given at back**. You may keep this quiz.

1. A parcel of air has pressure P, temperature T, vapor pressure e, and dewpoint temperature T_d. You could determine its relative humidity RH $= e/e_*(T)$ given which two factors?

   (a) T, e

   (b) T, P

   (c) T, T_d

   (d) T_d, e

   (e) Both option (a) and option (c) are correct ✓✓

2. A parcel of air with temperature $T = 15^o$ C and dewpoint $T_d = 10^o$ C has absolute humidity ρ_v [kg m^{-3}] $=$ ____

   (a) 9.2 x 10^{-5}

   (b) 1.8 x 10^{-3}

   (c) 9.2 x 10^{-3} ✓✓

   (d) 0.18

   (e) 1

3. On a skew T - log p diagram, the two families of curves that are parallel to each other *high in the atmosphere* are ____

   (a) dry adiabats & moist adiabats ✓✓

   (b) isotherms & isobars

   (c) isobars & dry adiabats

   (d) isobars & moist adiabats

   (e) isotherms & dry adiabats

4. Wind machines are liable to be useful in preventing damaging low temperatures from occurring next to ground on ____

   (a) clear, windy nights

   (b) cloudy, windy nights

   (c) cloudy, snowy nights

   (d) clear, calm nights ✓✓

   (e) rainy nights

5. When air temperature (T) is in the range $-4^o \leq T \leq 0^o$ C, raising the relative humidity to 100% or greater tends to result in formation of ____ due to the ____ of ice nuclei.
   (a) snow; influence
   (b) ice crystals; presence
   (c) supercooled droplets; scarcity ✓✓
   (d) supercooled droplets; abundance
   (e) supercooled ice crystals; abundance

6. Due to the ____ effect, the environmental vapour pressure required to assure the equilibrium of a droplet of pure water of temperature T and radius $R << 1\mu$m ____ the benchmark $e_*(T)$.
   (a) curvature; is less than
   (b) curvature; exceeds ✓✓
   (c) solute; is less than
   (d) solute; exceeds
   (e) Bergeron; equals

7. If air temperature in a certain layer decreases with increasing height by 0.9°C per 100 m, the layer is ____ (Note: take 0.5°C per 100 m for the SALR)
   (a) hydrostatic
   (b) absolutely unstable
   (c) absolutely stable
   (d) conditionally unstable ✓✓
   (e) adiabatic

8. Which association is false?
   (a) Cirrus - wispy
   (b) Cumulus - heapy
   (c) Stratus - layered
   (d) Nimbus - producing rain, hail or snow
   (e) Orographic - produced by airflow over very warm ocean ✓✓

9. The aim when seeding cold clouds with ice nuclei to reduce hail damage is ____
   (a) to oppose or even reverse the Bergeron process
   (b) to cause the warm cloud process to work in parallel with the Bergeron process
   (c) to increase competition between ice nuclei for cloud liquid water ✓✓
   (d) to ensure that ice nuclei have a smaller terminal velocity
   (e) to ensure that ice nuclei have a larger terminal velocity

10. If the environmental temperature at height z is $T_e(z)$, the buoyancy force (per unit mass) on a parcel at that level that has a different temperature T_p is ____

    (a) g (gravitational acceleration, ie. gravity force per unit mass)
    (b) $g\,(T_p - T_e)/T_e$ ✓✓
    (c) $g\,T_p$
    (d) $g\,T_p/T_e$
    (e) $g\,T_e/T_p$

11. The occurrence of hail is more probable beneath ____

    (a) cirrocumulus in the tropics
    (b) altostratus at mid- or polar- latitudes
    (c) fairweather cumulus at any latitude
    (d) shallow mid-latitude nimbostratus
    (e) cumulus clouds with deep vertical development ✓✓

12. Neglecting entrainment, saturated parcels subjected to a small but abrupt (and adiabatic) vertical displacement in the atmosphere would subsequently oscillate in height if ____

    (a) the environmental lapse rate (ELR) equalled the dry adiabatic lapse rate (DALR)
    (b) the environmental lapse rate equalled the saturated adiabatic lapse rate (SALR)
    (c) the DALR and the SALR were equal
    (d) the atmospheric layer in question were unconditionally stable ✓✓
    (e) cloud condensation nuclei were present in adequate number

For the remaining questions, please refer to the attached Stony Plain sounding (00Z 23 July 2005, ie. 18:00 MDT 22 July).

13. Consider the stratification of the layer beneath 850 mb. This layer is almost "well-mixed" relative to the dry adiabats, but not quite: rather, it should be classified as ____

    (a) unconditionally unstable ✓✓
    (b) unconditionally stable
    (c) conditionally unstable
    (d) conditionally stable
    (e) an inversion

14. The above diagnosed stratification (ie. stability classification) is ____ in the near-ground layer during summer afternoon, but ____ above 850 mb

    (a) rare; much more common
    (b) rare; impossible
    (c) common; rare ✓✓
    (d) invariably present; common
    (e) infrequent; usual

15. The ELR feature based at about 840 mb could be called ____

    (a) an elevated inversion ✓✓
    (b) a dry adiabat
    (c) a saturated adiabat
    (d) an isotherm
    (e) an isobar

16. From information given with the sounding we can reasonably guess that height contours at 500 mb should ____ height contours at 850 mb. (Hint: ignore any possible friction; assume 6 dam spacing at both levels).

    (a) run parallel with
    (b) are more tightly packed together than
    (c) run roughly perpendicular to
    (d) coincide with
    (e) both (b) and (c) ✓✓

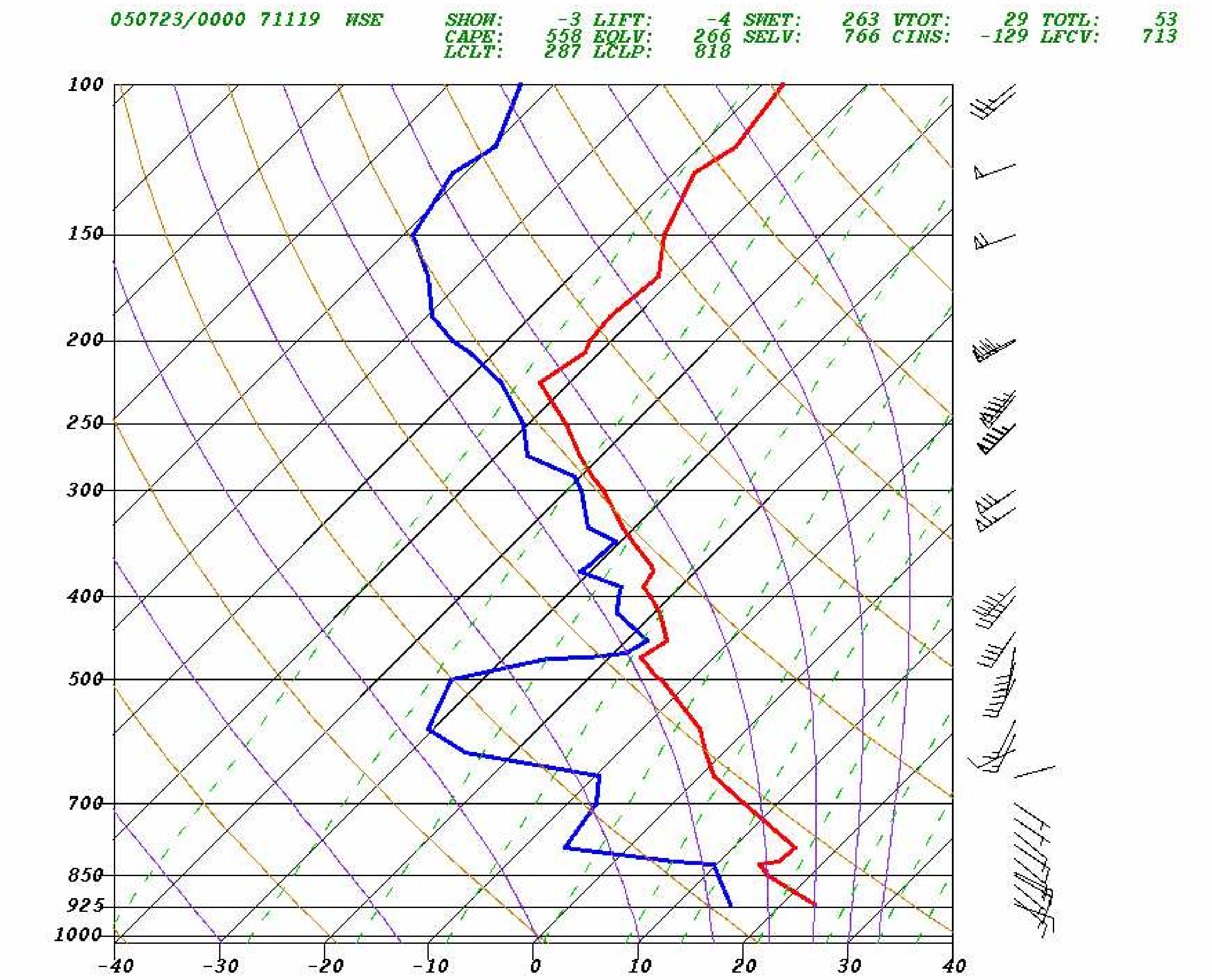
Equations and Data.

- $e = \rho_v \, R_v \, T$

  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).

Table 1: Equilibrium vapour pressure $e_*(T)$ [mb] versus temperature T [C].

T	$e_*(T)$	T	$e_*(T)$	T	$e_*(T)$	T	$e_*(T)$	T	$e_*(T)$	T	$e_*(T)$
0	6.11	5	8.72	10	12.27	15	17.04	20	23.37	25	31.67
1	6.57	6	9.35	11	13.12	16	18.17	21	24.86	26	33.61
2	7.05	7	10.01	12	14.02	17	19.37	22	26.43	27	35.65
3	7.58	8	10.72	13	14.97	18	20.63	23	28.09	28	37.80
4	8.13	9	11.47	14	15.98	19	21.96	24	29.83	29	40.06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LCLT: 287 LCLP: 818
100
150
200
250
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400
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700
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925
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-40 -30 -20 -10 0 10 20 30 40