Sample Numeric Questions EAS270 The Atmosphere

Comment: These are sample numerical questions based on equations given in the textbook and/or Lecture Powerpoint files (which can be found on the course web page). I leave it to you to look up the relevant equations and data, but please note that in any quiz or exam you would be given the equations and all needed constants. Familiarity with proper MKS units for the quantity of interest will, even without calculations, often help you identify the correct answer, or at least refine the possibilities. And of course proper units must be used in all calculations, or wrong answers will result. Choose the best answers - note that exact numerical values will vary according to whether you take $g = 10$ m s^{-2} or $g = 9.81$ m s^{-2} (etc.) but your choice of the "right" answer does not hinge on those minor details.

1. The mass of the atmosphere is $M_a = 5.14$ x 10^{15} kg, of which water vapour constitutes 0.25%. If the residence time of water vapour is 10 days, what is the global average surface exchange rate $\overline{Q}$ [kg m^{-2} s^{-1}]? (The surface area of the earth is $A = 4\pi R^2$ where earth's radius $R =$ 6500 kilometers).

2. Suppose in Edmonton the temperature and pressure are (p, T)=$(935\ mb, 15^oC)$. The air density ρ is ____

   (a) 1 kg m^{-3}
   (b) 1 mb
   (c) 1 Pa
   (d) 1.13 kg m^{-3}
   (e) 113 Pa

3. If the density and pressure at some point in the atmosphere were $\rho =$ 0.94 kg m^{-3}, $p = 70$ kPa then the temperature at that point must have been ____

   (a) -14 K
   (b) -14^oC
   (c) 0.0094^oC
   (d) 0.0094 K

(e) none of the above

4. If temperature and pressure at ground were $T = 0^o$C, $p = 933$mb, then according to the hydrostatic law, near the ground the rate of decrease of pressure with height is about ____

   (a) 11.7 mb m^{-1}
   (b) 11.7 kPa m^{-1}
   (c) 11.7 Pa m^{-1}
   (d) 11.7 Pa
   (e) none of the above

5. If a calculation determined that at a point **P** of the atmosphere the rate of lapse of pressure with height was 9 Pa m^{-1} then if the pressure at **P** is 700 mb, the pressure ten metres above **P** is ____

   (a) 790 mb
   (b) 610 mb
   (c) 790 mb
   (d) 610 Pa
   (e) 699.1 mb

6. If the emissivity of a particular dark wet soil is $\epsilon = 0.9$ then if the soil surface temperature is $T = 20^o$C the rate of emission of longwave radiative energy by this surface is about ____

   (a) 9.07 10^{-3} J s m^{-2}
   (b) 419 W m^2
   (c) 377 W m^{-2}
   (d) 377 J s m^2
   (e) 1.44 10^5 J s^{-1}

7. A wet snowpack with emissivity $\epsilon = 0.85$ emits longwave radiative energy at a rate of about ____

(a) 0 W m^2
(b) 0 W m^{-2}
(c) 100 W m^{-2}
(d) 316 W m^{-2}
(e) 268 W m^{-2}

8. Assuming Wien's law applies, the spectral peak in the longwave emission spectrum of a wet snowpack with emissivity $\epsilon = 0.85$ lies at about ____

   (a) 0 W m^2
   (b) 3000 μm
   (c) 11 μm
   (d) 1.1 μm
   (e) ∞ μm

9. If the dewpoint is $T_d = +5^oC$, the vapor pressure is ____ (here you will need to use the Table of equilibrium vapor pressure versus temperature, given on the course web site)

   (a) 8.7 mb
   (b) 8.7 Pa
   (c) 8.7 N m^{-2}
   (d) 870 mb
   (e) none of the above

10. If the vapor pressure is $e = 23.37$ mb, the dewpoint temperature T_d is ____ (here again, you will need to use use the Table of equilibrium vapor pressure versus temperature):

    (a) 20^oC
    (b) 20 mb
    (c) 10^oC

(d) $0^o C$

(e) none of the above

11. If the temperature and dewpoint are $(20^o C, 5^o C)$ the relative humidity must be ____

    (a) 100%

    (b) 25%

    (c) 20%

    (d) 27%

    (e) 37%

12. If the temperature and vapor pressure are $(20^o C, 8.7\,\text{mb})$ the relative humidity must be ____:

    (a) 100%

    (b) 25%

    (c) 20%

    (d) 27%

    (e) 37%

13. If the temperature and vapor pressure are $(0^o C, 10\,\text{mb})$ the absolute humidity ρ_v must be ____

    (a) insufficient information given to answer question

    (b) 7.9x10^{-3} kg/kg

    (c) 7.9x10^{-3} kg m^{-3}

    (d) 7.9x10^{-5} kg m^{-3}

    (e) 7.9x10^{-1} kg m^{-3}

14. : If air density $\rho = 1.05$ kg m^{-3} and absolute humidity $\rho_v = 7.9$x10^{-3} kg m^{-3} then the specific humidity q is ____

    (a) 133

(b) 13.3
(c) 1.33
(d) 7.5 g/kg
(e) 7.5 kg m^{-3}

15. Calculate the Geostrophic windspeed at a point at latitude 75^oN, if the height-contours (drawn at intervals $\Delta h = 6$ [dam]) are spaced at separations $\Delta x = 300$ [kilometers].

    (a) 0.14 $\mathrm{m\,s^{-1}}$
    (b) 1.4 $\mathrm{m\,s^{-1}}$
    (c) 14 $\mathrm{m\,s^{-1}}$
    (d) 1.4 kph
    (e) 14 kph