EAS270, "The Atmosphere"   Quiz 1   26 Sep, 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. The troposphere is the height-layer of the atmosphere that _____

    (a) extends from ground or sea-level to the 1 mb level

    (b) extends from 1000 mb - 1 mb

    (c) extends from 1mb - 0 mb (ie. from 1mb out into empty space)

    (d) extends from ground or sea-level to about 10 - 12 km altitude   ✓✓

    (e) lies above the stratosphere

2. The proportions of nitrogen and oxygen in the atmosphere _____

    (a) are constant through the troposphere and stratosphere   ✓✓

    (b) vary randomly from 78% to 21% due to mixing

    (c) increase from 21% to 78% with increasing height

    (d) decrease from 78% to 21% with increasing height

    (e) drop discontinuously across the tropopause from 78% to 21%

3. Dimethyl sulphide (DMS) given off by decay of ocean biota _____

    (a) reacts in air to produce aerosols that may absorb or scatter radiation   ✓✓

    (b) is one of the permanent atmospheric gases

    (c) is a variable greenhouse gas

    (d) reacts in the sea to produce aerosols

    (e) none of the above

4. The mass of air overlying 1 square metre of area on the 100 mb surface is _____

    (a) 100 mb

    (b) 10000 Pa

    (c) 100 N m^{-2}

    (d) 100 kg

    (e) 1000 kg   ✓✓

5. Air density _____

   (a) is inversely proportional to windspeed

   (b) decreases rapidly with increasing height   ✓✓

   (c) increases rapidly with increasing height

   (d) is constant with height in the troposphere

   (e) is constant with height in the troposphere and stratosphere

6. Suppose in Edmonton the pressure and temperature are $(p, T)=(935$ mb$, 15$ ^{o}C$)$. The air density ρ is _____

   (a) 1 kg m^{-3}

   (b) 1 mb

   (c) 1.1 kg m^{-3} ✓✓

   (d) 112 Pa

   (e) 1 Pa

7. **This question is coupled with the previous question**: Suppose in Edmonton the pressure and temperature are $(p, T)=(935$ mb$, 15$ ^{o}C$)$. The 900 mb level is about _____ overhead (Hint: use the hydrostatic equation to compute the needed Δz)

   (a) 300 m   ✓✓

   (b) 30 m

   (c) 3 m

   (d) 3000 m

   (e) 3 km

8. Solar elevation above the horizon in Edmonton (latitude 53.5 degrees N), at solar noon on the day of the December (winter) solstice, is _____ degrees

   (a) 13   ✓✓

   (b) 23.5

   (c) 45

   (d) 60

   (e) none of the above

9. The spectrum of radiation from a certain black body has a spectral peak at wavelength $\lambda_{max} = 14\,\mu$m. The temperature of the body must be about _____

   (a) 207^oC

   (b) 67^oC

   (c) -67K

   (d) 207K   ✓✓

   (e) 480K

10. Suppose two (otherwise identical) surfaces are at temperatures $T,\ 2T$ K. The hotter surface radiates energy at a rate (E) that is _____ times the rate of the cooler surface

    (a) $1/2$

    (b) 2

    (c) $1/4$

    (d) 4

    (e) 16   ✓✓

11. The numerical value of earth's "solar constant" is about _____

    (a) $9.8\ [\text{m s}^{-2}]$

    (b) $0.5\ [\mu\text{m}]$

    (c) $4\ [\mu\text{m}]$

    (d) $500\ [\text{W m}^2]$

    (e) $1370\ [\text{W m}^{-2}]$ ✓✓

    For the remaining questions, please refer to the attached surface analysis.

12. The given charts are valid at _____

    (a) 1800 MDT

    (b) 0600 MDT   ✓✓

    (c) 0600 GMT

    (d) 0600 UTC

    (e) none of the above

13. The weather system in the Northwest Territories (NWT) just north of the Alberta-Saskatchewan border can be called a ____

   (a) mid-latitude cyclone

   (b) depression

   (c) storm

   (d) low

   (e) any and all of the above   ✓✓

14. In central Saskatchewan the weather was ____

   (a) frosty

   (b) exceptionally windy

   (c) pleasant

   (d) overcast and rainy, with falling pressure   ✓✓

   (e) not reported

15. At Red Deer (the station immediately east of the labelled High in SW Alberta) the sea-level corrected pressure was ____ and ____

   (a) 922.4 mb; rising

   (b) 1022.4 mb; rising   ✓✓

   (c) 1022.4 Pa; rising

   (d) 1224 Pa; falling

   (e) 1224 mb; falling

16. The correct label for the isobar that cuts across the northern border of Alberta would be ____ mb

   (a) 1020

   (b) 1018

   (c) 1016   ✓✓

   (d) 1014

   (e) 1012

Equations and Data.

- $p = \frac{M\,g}{A}$

  The pressure (p, Pa) that results when a mass M kg of air overlies area A m^2, where $g = 10$ m s^{-2}

- $\frac{\Delta P}{\Delta z} = -\,\rho\,g$

  The hydrostatic law. ΔP [Pascals], the change in pressure as one ascends a distance Δz [m]; ρ [kg m^{-3}] the density; $g \sim 10$ [m s^{-2}] acceleration due to gravity.

- $P = \rho\,R\,T$

  The ideal gas law. P [Pascals], pressure; ρ, [kg m^{-3}] the density; T [Kelvin], the temperature; and $R = 287$ [J kg^{-1} K^{-1}], the specific gas constant for air).

- $E = \epsilon\,\sigma\,T^4$

  Stefan-Boltzmann law. $L \uparrow$ [W m^{-2}], the emitted longwave energy flux density; ϵ, the emissivity of the surface (dimensionless, $= 1$ for a black body); $\sigma = 5.67$ x 10^{-8} [W m^{-2} K^{-4}], the Stefan-Boltzmann constant; T [K], the surface temperature.

- $\lambda_{max} = \frac{2900}{T}$

  Wien's displacement law. λ_{max} [μm], the wavelength at which the peak in the emission spectrum occurs; T [K], the temperature of the emitting surface.

- $\theta = 90 - \Phi_{lat} + \phi_{sol.dec}$

  The solar elevation θ at solar noon, at a location with latitude Φ_{lat}, at the time of year when solar declination is $\phi_{sol.dec}$. Latitude is negative in the southern hemisphere; and solar declination is negative during northern hemisphere winter.

1012
1016
1024
1020
1010
1022
1101
1027
1009
1006