EAS270, "The Atmosphere" $\underline{\text{Quiz 1}}$ 22 Sep, 2004

<u>Professor</u>: J.D. Wilson <u>Time available</u>: 20 mins <u>Value</u>: 7%

Instructions: For all 14 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.

- 1. The total 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) 1000 kg $\checkmark \checkmark$
 - (e) 100 Pa
- 2. Suppose in Edmonton the pressure and temperature are (p, T)=(935 mb, 15 C). From the ideal gas law the air density ρ is _____
 - (a) 1 kg m^{-3}
 - (b) 1 mb
 - (c) 1 Pa
 - (d) 1.13 kg m⁻³ $\checkmark \checkmark$
 - (e) 113 Pa
- 3. This question is coupled with the previous question: Suppose in Edmonton the pressure and temperature are (p, T)=(935 mb, 15 C). The 900 mb level is about _____ overhead
 - (a) 3 m
 - (b) 30 m
 - (c) 300 m ✓✓
 - (d) 3000 m
 - (e) 3 km
- 4. Synoptic scale horizontal winds are generated by _____
 - (a) horizontal gradients in density
 - (b) horizontal gradients in temperature
 - (c) horizontal gradients in pressure $\checkmark \checkmark$
 - (d) vertical gradients in density
 - (e) vertical gradients in pressure

- 5. In the troposphere of the 'standard atmosphere', minimum temperature occurs _
 - (a) at ground
 - (b) at the tropopause
 - (c) at the top of the troposphere
 - (d) in the middle of the troposphere
 - (e) both (b) and (c) are correct $\checkmark \checkmark$
- 6. Nitrogen constitutes about _____ % (by volume) of the atmosphere in the form of _____
 - (a) 21; atomic gas N
 - (b) 21; molecular gas N_2
 - (c) 78; atomic gas N
 - (d) 78; molecular gas $N_2 \checkmark \checkmark$
 - (e) 1; molecular gas N_2
- 7. The concentration of water vapour in the atmosphere normally _____ with increasing distance from the earth's surface because _____
 - (a) increases; of the colder temperatures aloft
 - (b) decreases; evaporation at the earth's surface is its source $\checkmark \checkmark$
 - (c) is unchanged; water vapour is not one of the variable gases
 - (d) increases; strong sunlight higher in the atmosphere evaporates cloud liquid water
 - (e) decreases; water vapour is a light gas and so is able to escape earth's gravity
- 8. A diurnal (daily) cycle in CO₂ concentration above a mature crop is attributable to _____
 - (a) reflected solar radiation
 - (b) aerosols interacting with the ozone layer
 - (c) the greenhouse effect
 - (d) daytime photosynthesis and night me respiration $\checkmark \checkmark$
 - (e) nighttime photosynthesis and daytime respiration
- 9. Important sources of atmospheric methane include
 - (a) cattle and other domesticated animals
 - (b) rice cultivation
 - (c) coal mines, and gas and oil fields and pipelines
 - (d) photosynthesis
 - (e) all of (a,b,c) are factors $\checkmark \checkmark$

- 10. The radius of the earth is about R = 6500 km, and more than 99% of the atmospheric mass is found below a height h = 100 km above sea level. The ratio of the volume V_a of atmosphere to the volume V_e of the solid earth is $V_a/V_e =$ _____ (Hint: formulae given; to calculate V_a , multiply the surface area of the earth by the depth h).
 - (a) $\frac{4}{3}\pi R^3$
 - (b) $4\pi R^2$
 - (c) $\frac{4}{3}\pi h$
 - (d) $4\pi R$
 - (e) $3 h/R \checkmark \checkmark$

For the remaining questions, please refer to the attached 12Z surface and 850 mb weather analyses for 21 Sept, 2004.

- 11. The isobar indicated by the label **A** on the western flank of the NE Canada storm should be assigned a pressure of _____
 - (a) 996 mb
 - (b) 998 mb
 - (c) 1000 mb ✓✓
 - (d) 1004 mb
 - (e) 1000 dam
- 12. Dewpoint and pressure at the station immediately north of the label **A** were
 - (a) -5 C; 987 mb
 - (b) -3 C; 987 mb
 - (c) -5 C; 998.7 mb
 - (d) -3 C; 998.7 mb $\checkmark \checkmark$
 - (e) -3 C; 1098.7 mb
- 13. According to the isotherm patterns at 850 mb, a strong temperature gradient is found in the region of _____
 - (a) northern Alberta
 - (b) central Alberta
 - (c) northern Saskatchewan
 - (d) northern Manitoba
 - (e) the Manitoba-Ontario border $\checkmark \checkmark$

- 14. Judging by the height contours, at 850 mb in central Saskatchewan one would expect a _____ wind
 - (a) east
 - (b) north-east
 - (c) north
 - (d) north-west
 - (e) west $\checkmark \checkmark$

Equations and Data.

• $p = \frac{M g}{A}$

The pressure (p, [Pa]) that results when mass M [kg] overlies area A [m²], where $g \sim 10 \text{ [m s}^{-2}$]

• $V = \frac{4}{3}\pi R^3, A = 4\pi R^2$

Volume (V) and surface area (A) of a sphere of radius R

• $T^{res} = \frac{M}{Q}$

The "mean residence time" of an atmospheric gas is the ratio of its total mass M to its surface exchange rate Q

• $P = \rho R T$

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).

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

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.

