EGEE 470
Quiz #4

Read the following statements carefully and indicate whether they are true or false. For partial credit (if your answers turn out to be wrong), summarize how exactly you arrived at your conclusions.

F (30%) An atmosphere whose temperature gradient is 10 °C/km is less stable than when the gradient is 10 °F/1000 ft.

See p. 624, textbook:

\[
\frac{10 \text{ °F}}{1000 \text{ ft}} \frac{\frac{5}{9} \text{ °C}}{1 \text{ °F}} \frac{1 \text{ ft}}{12 \text{ in.}} \frac{1 \text{ in.}}{2.54 \text{ cm}} \frac{1 \text{ m}}{100 \text{ cm}} \frac{1000 \text{ m}}{1 \text{ km}} = 18.2 \frac{\text{ °C}}{\text{km}}
\]

less stable (more unstable)

T (30%) If the sea-level temperature and pressure are 20 °C and 1 atm and the atmosphere is isothermal, the pressure at 2000 m above sea level exceeds 0.75 atm.

See Handout #23 of 3/4/16:

\[
\frac{P(z)}{P_0} = \exp \left( -\frac{9.81 \text{ m/s}^2}{R_T} \left( \frac{2000 \text{ m}}{0.029 \text{ atm}} \right) \right) \approx 0.792 \text{ atm}
\]

ok!

F (40%) The Gaussian plume model predicts that the downwind (u=5 m/s) centerline ground-level concentration of SO₂ emitted at 40 g/s and an effective stack height of 180 m, whose cross-wind and vertical dispersion coefficients are 287 and 89 m, will exceed the primary NAAQS level.

\[
C_{\text{gal}} = \frac{m}{\nu \Pi \sigma_y \sigma_z} \exp \left( -\frac{1}{2} \left( \frac{H}{\sigma_z} \right)^2 \right)
\]

\[
= (\text{not absorbed (worst case scenario)}).
\]

\[
= \left( 40 \times 10^6 \frac{\text{g}}{\text{s}} \right) \frac{1}{(5 \text{ m/s})(287 \text{ m})(89 \text{ m})} \exp \left( -0.5 \left( \frac{80 \text{ m}}{89 \text{ m}} \right)^2 \right) = 12.9 \frac{\text{g}}{\text{m}^3}
\]

\[
\text{at stack height}
\]

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= 4.9 ppb