

# ATM 316 Some final exam practice questions

Fall, 2020 – Fovell

**This is NOT a homework assignment. Solutions will NOT be posted. These are example, supplementary questions and do not necessarily cover all topics that may be on the final exam.**

1. The observed wind at the surface is from the south at 10 m/s. At the 2 km level, the wind is from the west at 20 m/s.

(a) Compute the surface–2km vertical shear vector. Express the result as a vector.

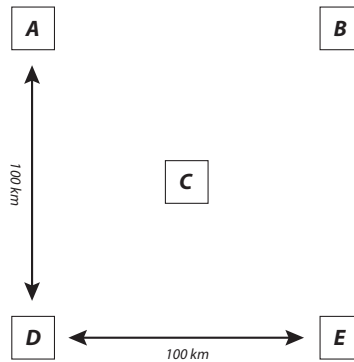
(b) Does this represent warm, cold, or no advection? Is there any reason to be unsure?

2. A horizontal flow field is described by  $\vec{V} = y\hat{i} + x\hat{j}$ . Compute its horizontal divergence and vertical vorticity. Show your work.

3. Temperature is decreasing to the north at 10°C per 100 km. The wind is northerly at 10 km/h. The local temperature at our location is not changing. There is no vertical motion. What is the heating rate, in K/hr, a parcel must be experiencing as it travels in our direction?



8. The horizontal temperature gradient is  $\nabla T = -2 \text{ (K/100km)} \hat{i} + 4 \text{ (K/100km)} \hat{j}$ . The temperature at point D is  $20^\circ\text{C}$ . What is the second derivative of temperature with respect to  $x$  (i.e.,  $\frac{\partial^2 T}{\partial x^2}$ ) at location C? Show your work.



9. The 1000 mb geostrophic wind is from the west at 10 m/s. The 1000-500 mb temperature decreases eastward at 1 K per 100 km. Do you have enough information to estimate the westerly component of the geostrophic wind magnitude and direction at 500 mb? Yes or no, and why?

10. Interpret the “tool” and give an example of its application.

$$\frac{d_a \vec{A}}{dt} = \frac{d\vec{A}}{dt} + \vec{\Omega} \times \vec{A}.$$

11. A rocket is fired directly eastward in the Northern Hemisphere, traveling at high velocity, but we observe it turn to the right following its motion. Fully explain why.

12. Do a scale analysis on the (inviscid, i.e., frictionless) vertical equation of motion. You will have to make assumptions and select characteristic values. Make it clear what you have selected and why.

$$\frac{dw}{dt} - 2\Omega u \cos \phi - \frac{u^2 + v^2}{a} = -\frac{1}{\rho} \frac{\partial p}{\partial z} - g$$

13. Name the single most important reason why the mesospheric jet changes direction between summer and winter. Briefly justify your answer.

14. For a given situation, the geostrophic wind speed is 10 m/s, but the actual wind speed is only 8 m/s. Fully explain what can be causing the actual wind to be slower.