1. I wish to compute and compare wind speeds at two locations on two different isobaric charts. Do I need to know...
   (a) the height gradients at the two locations
   (b) the latitudes of the two locations
   (c) the air densities at the two locations
   (d) both (a) and (b)
   (e) all of the above

State your answer and provide a brief justification.

2. Someone claims that northern hemispheric tornadoes cannot be anticyclonic, owing to Earth’s rotation. Is this statement true or false? Justify your answer.
3. Bizarro World is identical to Earth except it rotates in the opposite direction (clockwise, as viewed from above the north pole). It also has a jet stream located at the tropopause in its midlatitudes, but what is the direction of jet, and why?

4. The figure below depicts the zonal geostrophic wind ($u_g > 0$ for westerly) as a function of height for a Northern Hemisphere location. Vectors point towards where the wind is going (away from the source). Heights are given alphabetic labels. Designate the height(s) at which the north-south $\nabla T$ clearly and unambiguously vanishes by providing the letter representing the level, along with a brief justification.
5. The 1000 mb geostrophic wind is from the north. 1000-500 mb layer mean temperature is decreasing towards the north. Use your knowledge of the thermal wind relationship to answer these questions qualitatively:

(a) What is the direction of the geostrophic wind at 500 mb?

(b) What is the temperature advection? Answer: cold advection, warm advection, no advection.

(c) Is the temperature advection stronger, weaker, or the same at 500 mb compared to at 1000 mb?

(d) Suppose the wind observed at 500 mb is subgeostrophic. What could account for the wind speed being slower than the geostrophic value?

6. A “barotropic” atmosphere is one in which density is a function only of pressure. Consider a 1000-500 mb layer in a barotropic atmosphere. If the 1000 mb geostrophic wind is 10 m/s from the south, what is the geostrophic wind at 500 mb? You should be able to provide a quantitative answer and a short but persuasive justification. Hint: Think about the ideal gas law.
7. The 1000 mb geostrophic wind is from the north at 10 m/s. Temperature decreases to the north. On the figure below, sketch slopes of the 1000 and 500 mb isobaric surfaces in the N-S and W-E directions on the upper row’s plots, and sketch wind vectors qualitatively representing $u_g$ and $v_g$ at 1000 and 500 mb levels on the lower row’s plots. Identify a calm wind with a circle. There should be a total of 4 isobaric surfaces drawn, and a total of 4 vectors or circles.