Take home EXAM 2 Physics 645

Handed out 11/30/01 **due Friday 12/7/01 by class time**

Name_____

Relax…..take a deep breath…maybe even pretend to **HAVE** fun ☺ and remember, do not spend all you time on one problem, work on all of them!!

Show all your work **neatly** and in an **organized**, **clear** fashion (I can't give partial credit for what I can't see). Label each problem. A correct answer without work is not worth full credit (show more work then you would on the homework)! Don't get stuck on one problem, make sure you try them all. Draw sketches to help you visualize the problem. Ask if you do not understand a problem or have a question. You may use reference books but **please do not work together** on the exam. Please circle your answers to each problem. Finally, attach this sheet to the front of the exam.

Problem	Score	Max
1		25
2		25
3		20
4		10
5		10
6		30
Total		120

Name_____

1) **(25pts)** Using laminar Ekman theory in the case of a semi-infinite expanse of fluid with a boundary moving in its own plane at a constant velocity U with respect to a frame of reference rotating with angular velocity Ω about an axis perpendicular to the boundary. The fluid far from the boundary is at rest in this frame. a) How does the flow vary with distance from the boundary? b) What is the smallest distance at which the flow velocity is in the exactly opposite direction to that of the boundary? c) Describe and explain the differences one might expect in the distance calculated in b between an atmosphere bounded from below and an ocean bounded from above. d) Show that the net transport from these flows is perpendicular to U. e) If the region in question is the earths atmosphere at 45 North, and the boundary velocity is 10 m/sec with a eddy viscosity of 10 m^2/sec, what is the Ekman transport rate?

2) **(25pts)** Imagine that a single ocean were covering the entire globe as the atmosphere does. With no western wall to support a boundary current returning the equatorward Sverdrup flow, what would the circulation pattern be? Justify and sketch your answer. Relate your results to the Antarctic circumpolar current.

3) **(20pts)** On Nov.30 2001, the atmospheric pressure in Fairbanks was 29.75 inches of mercury with an inversion in which the temperature went from –17 F to +15 F in 20 meters. a) Find the Brunt-Vaisala frequency (use C_p=1005 m^2/s^2K). A smoke plume rises into the inversion in which there is a wind blowing eastward. b) If an observer (you) see a wavelength of 200 meters in the, now horizontal, plume trailing to the east what is the wind speed in km/hr and knots? c) Why do we normally only see one or 2 wavelengths?

4) **(10pts)** What is the stratification (the gradient) if we see a purely horizontal Lee wave (the atmospheric wave on the lee side of a mountain) with a wavelength of 20 Km from a wind speed of 20 m/sec?

5) **(10pts)** Problem 10-1 in Cushman-Roisin

6) **(30pts)** Derive the dispersion relation of internal gravity waves in the presence of rotation, assuming f < N. Show that the frequency of these waves must be higher than f but lower than N. Compare the vertical phase speed to the vertical group speed.