THE OPEN UNIVERSITY OF SRI LANKA

B.Sc. DEGREE PROGRAMME 2006/2007

FINAL EXAMINIATION 2007

PHU 3146 / PHE 5146 ATMOSPHERIC DYNAMICS

DURATION : TWO & HALF HOURS (2 1/2 HR)

Date : 28 – 06 – 2007 **Time : 2.00 pm– 4.30 pm**

Answer **FOUR** Questions only.

1. Using a box of air, derive the continuity equation.
If the mass divergence in the first kilometer above ground is $-3 \times 10^{-5}\ s^{-1}$ calculate the magnitude and direction (upward, downward) of the vertical velocity at the one kilometer level.

2. Show that the relationship for the vertical shear of the geostrophic wind is given by $\frac{\partial \vec{V}_g}{\partial \ln p} = -\frac{R}{f}\hat{k} \times \left(\vec{\nabla} T\right)_p$, where symbols have their usual meanings.
The mean temperature in the layer between 75 and 50 kPa decreases eastward by 3° C per 100 km. If the geographic wind at the 75 kPa level is from the southeast at 20 ms^{-1} what is the geostropic wind speed and direction at 50 kPa? Assume, $f = 10^{-4}\ s^{-1}$.

3. Considering the conservation of the absolute angular momentum of a particle moving in the atmosphere which has both horizontal and vertical velocity components v and w, respectively obtain an expression for Coriolis acceleration.
A train of 2×10^5 kg mass travels at 50 ms^{-1} along a straight horizontal track at 45° N. What is the lateral force exerted on the rails? What is the difference in the upward reaction forces exerted by the rails when the trains traveling eastward and westward?

4. Derive the hydrostatic equation showing all assumptions made.
Show that a homogeneous atmosphere has a finite height, which depends only on the temperature at the lower boundary. Compute the height of a homogeneous atmosphere with surface temperature $T_0 = 273$ K and surface pressure 100 kPa.

5. Show that the conservation of potential vorticity can be written as $\frac{d}{dt}\left(\frac{b+f}{h}\right) = 0$,
where b represents relative vorticity, f is the coriolis parameter and h denotes the height of the air column. If the large scale uniform westerly air flow reaches a mountain barrier, discuss the changes in flow when crossing over the mountain barrier.

6. What is meant by prognostic equation and diagnostic equation? Give one example each for the two types and state under what conditions that they are useful in obtaining solutions for real atmospheric problems.