THE OPEN UNIVERSITY OF SRI LANKA
B. Sc. DEGREE PROGRAMME 2008/2009
FINAL EXAMINATION 2008
PHU 3145 /PHE5145 ATMOSPHERIC PHYSICS
DURATION: TWO & HALF HOURS (2 ½ HR)

DATE:30.12-2008 **TIME:09.30 AM-12.00NOON**

ANSWER **FOUR** QUESTIONS AND NO MORE.

Q1.Potential density D is defined as the density that dry air would attain if it were transformed reversibly and adiabatically from its existing conditions to a standard pressure p_o.

(a)If the density and pressure of a parcel of the air are ρ and p respectively, show that

$$D = \rho\left(\frac{p_o}{p}\right)^{c_v/c_p}$$

Where c_p and c_v are the specific heats of air at constant pressure and constant volume, respectively.

(b) Calculate the potential density of a quantity of air at a pressure of 600 hPa and a temperature of -15°C.

(c) Variation of potential density with height is given by,

$$\frac{1}{D}\frac{dD}{dz} = -\frac{1}{T}(\tau_d - \tau)$$

Where τ_d is the dry adiabatic lapse rate, τ the actual lapse rate of the atmosphere, and T the temperature at height z. Use the above expression to show that the criteria for stable, neutral and unstable conditions in the atmosphere and that the potential density decreases with increasing height, is constant with height, and increases with increasing height respectively.

Q2. What is meant by virtual temperature?
Explain why it is necessary to define such a temperature in atmospheric physics.
Establish a relationship for virtual temperature in terms of temperature, pressure and vapour pressure.

If water vapour accounts for 2% of the molecules of the air, what is the virtual temperature correction.

Q3. Write short notes about the followings. Draw diagrams whenever possible.

i. The mixing ratio (w)
ii. Relative humidity (RH)
iii. Wet- bulb temperature(T_w)
iv. Potential temperature (θ)
v. Wet-bulb potential temperature (θ_w)

An air parcel of an initial temperature 15°C and a dew point 4°C is at pressure level 1000 mb. Find the w, RH, T_w, θ and θ_w

Q4. Explain each of the following statements.
(a) Auroral displays are largely confined to high latitudes and can usually be Forecast a few days in advance.
(b) A parcel of air cools when it is lifted. Dry parcels cool more rapidly than moist parcels.
(c) The gas constant for moist air is greater than that for dry air.
(d) Pressure in the atmosphere increases approximately exponentially with depth, whereas the pressure in the ocean increases approximately linearly with depth.
(e) Describe a procedure for converting station pressure to sea level pressure.

Q5. (a) Starting from the first principals derive an expression relating the pressure , temperature and height in the atmosphere.
Define the following atmospheres.
(i) Isothermal atmosphere
(ii) Constant lapse rate atmosphere
Obtain the above relationship for each of the above atmospheres.

(b) Assuming an isothermal atmosphere with a temperature of -33°C and a surface Pressure of 1000 mb , estimate the levels at which pressure equals 500 , 50, and 5 mb .

Q6. Define or explain the terms.
a. Black Body
b. Gray Body
c. Irradiance
d. Albedo
e. Radiance

Calculate the equivalent black body temperature of the earth, assuming a planetary albedo of 0.03.The irradiance of solar radiation incident upon the earth is 1380 Wm^{-2} and ^{radius} of the earth is $6.4x10^6$ m.
State all the assumptions you have made.