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RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree

Third Year – Semester I – Examination - February/March 2013

PHY 3301 – ATMOSPHERIC PHYSICS

Answer SIX questions **TIME: 3 Hours**

Stefan's constant = $5.7 \times 10^{-8}\ W\,m^{-2}\,K^{-4}$.
Wien's constant = $2.898 \times 10^{-3}\ m\,K$.
Universal gas constant, R = $8.31\ Jj\,mol^{-1}\,K^{-1}$.

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1. (a) The atmospheric constituents of the earth some 4.5 billion years ago (just after the origin) was quite different from those of today.
For example the volume percentage

At the beginning		Today
N_2	= 1.5 %	78%
O_2	= traces	21%
CO_2	= 98%	0.093%

Explain the reasons for this change.

(b) Explain briefly how atmospheric temperature vary with height in a standard atmosphere, giving reasons for change of temperature with height.
How does the ozone layer depletion will influence this variation?

(c) What is a temperature inversion found in atmosphere? Explain a possible way of forming it, in no more than five sentences.

2. (a) What is it meant by Virtual Temperature and explain why it is necessary to define it in atmospheric physics?

(b) Starting with the hydrostatic equation and the ideal gas law, show that for isothermal atmosphere, the pressure depends on height exponentially as $P = P_0\, e^{-Z/H}$

Where Z is the height and H= RT/g for an isothermal atmosphere. P and P_0 are pressures at height Z and at the sea level respectively.

(c) Assuming an exponential pressure and density dependence with H= 8 km , estimate the heights in the atmosphere at which,

(i) The pressure is equal to 500 hPa.

(ii) The air density is equal to 1 kg m^{-3}

(Assume that the density at sea level is equal to 1.25 kg m^{-3} and pressure is equal to 1000 hPa)

3. (a) Define the terms

(i) Geo potential and

(ii) Geo potential height, in atmospheric physics

(b)Write down an equation for the geopotential thickness of a layer between two pressure levels comprising with scale height H, for an isothermal atmosphere. Define the symbols used.

(c) A meteorological station is located 50 m above the sea level. The surface pressure and the virtual temperature at this station are 1050 hPa and 27 °C respectively. The mean virtual temperature for the 1000 hPa to 500 hPa layer is 0 °C.

Compute the height of the 500 hPa pressure level from this station.

4. (a) Define these processes briefly

(i) Adiabatic process

(ii) Isochoric Process

(iii) Isothermal Process

(b) State briefly the 1st law of thermodynamics with its differential form.

(c) Five mole of an ideal monatomic gas, initially at a volume of 0.05 $m^3$and a pressure of 1.0×10^5 Pa, is taken through a reversible cycle that consists of three processes:

a-->*b*: An isobaric compression that decreases the volume from 0.05 m^3 to 0.1 m^3

b-->*c*: An isochoric process where the pressure goes from 1.0×10^5 Pa to 5.0×10^4 Pa

c-->*a*: An isothermal expansion that returns the system to its original state.

(i). Show the cycle on a *PV* diagram, labeling all three processes. Be sure to label the axes with appropriate scales, units, etc.

(ii). Find the net work done by the gas per cycle ?

5 (a) Define or explain the following terms used in radiation.

(i) Black body radiation

(ii) Stefan-Boltzmann Law

(iii) Wien's Displacement Law

(b) A black body initially at 27 °C is heated to 627 °C . How many times is the total radiation emitted at the higher temperature than the radiation emitted at the lower temperature.

(c) What is the wavelength of the maximum energy radiation at the higher temperature

6. (a) Define solar constant and albedo of a planet.

(b) In another $5x10^9$ years or so , our sun will probably become a red giant with its photospheric temperature dropping to 4000 K and radius swelling to 3.5×10^6 km.

Derive expressions for

(i) Radiant Flux from the sun having its temperature T_{sun} and radius R_{sun}

(ii) Solar constant (S) for a planet in an arbitrary distance R_{planet} from the sun.

(c) Calculate the solar constant and effective temperature for Venus under these conditions. Venus is 1.08×10^6 km from the sun and has an albedo A= 0.71.

7. (a) What is a thermodynamic diagram used in atmospheric science and how they are prepared?

(b) What are the desirable characteristics of a thermodynamic diagram?

(c) Where they are being used and for what purposes?

(d) Name two most popular thermodynamic diagrams and state their similarities and differences.

8. Answer or explain the followings scientifically.

(a) Why is moist air less dense than dry air at same temperature?

(b) What happens when wind pushes moist air mass against a mountain?

(c) Hot weather causes more human discomfort when the air is humid than when it is dry.

(d) Ozone (O_3) in the troposphere, where we live , is considered to be "bad" , but ozone in the stratosphere is "good" , Why?

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