



RAJARATA UNIVERSITY OF SRI LANKA  
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences  
Third Year – Semester I - Examination – September / October 2019

PHY 3301 – ATMOSPHERIC PHYSICS

Time: Three (03) hours

Answer **all** the questions.

A non-programmable calculator is permitted.

1. a) The atmosphere is divided vertically into four layers on the basis of temperature.
  - i. Show how temperature varies with altitude in atmosphere. (02 marks)
  - ii. Briefly describe the four layers in the atmosphere (04 marks)
  - iii. Why does temperature decrease with altitude in troposphere? Explain. (03 marks)
  - iv. Why is the troposphere warmer than the stratosphere? How does this happen? (03 marks)
- b) On a spring day a middle-latitude city (about 40°N latitude) has a surface (sea level) temperature of 10°C. If vertical soundings reveal a nearly constant environmental lapse rate of 6.5 °C per kilometer and the temperature at the tropopause is -55°C, what is the height of the tropopause? (02 marks)
- c) Explain why mountaineers suffer from nose bleeding at higher altitude. (01 mark)
2. a) What is meant by dry adiabatic lapse rate? (02 marks)
- b) Derive an expression for the dry adiabatic lapse rate of the atmosphere. Hence calculate an approximate value for dry adiabatic lapse rate in the troposphere. (Specific heat at constant pressure  $\sim 10^3 \text{ J Kg}^{-1}\text{K}^{-1}$ ) (05 marks)
- c) What can you say about the dry adiabatic lapse rate of a planet whose gravitational acceleration is equal to that of the Earth, but the atmospheric composition is entirely different? (03 marks)
- d) Derive an expression for the saturated lapse rate and compare it with the dry adiabatic lapse rate. (05 marks)

Contd.

3. a) Derive the Clausius Clapyron equation,

$$\ln \frac{P_2}{P_1} = - \frac{\Delta H_{vap}}{R} \left( \frac{1}{T_2} - \frac{1}{T_1} \right)$$

Every notation has their usual meaning.

(04 marks)

- b) An air parcel at sea level has a temperature of 28°C and a dew point temperature of 15°C. Calculate,

i. the vapor pressure of water.

(03 marks)

ii. the relative humidity.

(01 mark)

iii. the water vapor mixing ratio. (both volume and mass).

(02 marks)

[latent heat of vaporization =  $2.5 \times 10^6 \text{ J kg}^{-1}$ , gas constant for water vapor =  $461 \text{ J/kg K}$ , triple point temperature =  $0^\circ\text{C}$ , triple point pressure =  $6.11 \text{ hPa}$ , the average pressure at mean sea level =  $1013 \text{ hPa}$ , molecular weight of air  $29 \text{ gmol}^{-1}$ ]

- c) A sample of 100 g of dry air has initial temperature  $T$  of 270 K and pressure of 900 mb. During an isobaric process, once the heat is added the volume expands by 20% of the initial volume. Estimate,

i. final temperature

(02 marks)

ii. added amount of heat

(02 marks)

iii. work done against the environment

(01 mark)

[universal gas constant  $8.314 \text{ J mol}^{-1}\text{K}^{-1}$ , heat capacity at constant volume  $717 \text{ J kg}^{-1}\text{K}^{-1}$ ]

4. a) Explain the process of lightning and thundering with their charge separation in cloud

(03 marks)

- b) Briefly explain six (6) different types of lightning according to their appearance.

(03 marks)

- c) Describe how weather forecasting is done. Explain the techniques which are used for weather predictions.

(05 marks)

- d) Discuss the importance of weather forecasting.

(04 marks)

5. a). Precipitation is any product of the condensation of atmospheric water vapor that falls under gravity. Write down five (5) types of precipitation and describe three (3) of them.

(03 marks)

- b) Briefly explain four (4) different types of fog.

(02 marks)

- c) Describe the methods of cloud seeding.

(03 marks)

- d) Discuss advantages and disadvantages of cloud seeding.

(02 marks)

- e) Cloud types can be categorized into two parts. They are based on appearance and height. Write down ten (10) types of clouds and their features.

(05 marks)

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