The Open University of Sri Lanka
Faculty of Natural Sciences
B.Sc/ B. Ed Degree Programme

Department	: Physics
Level	: 5
Name of the Examination	: Final Examination
Course Code and Title	**: PHU5302 - Atmospheric Physics**
Academic Year	: 2019/2020
Date	: 31st December 2019
Time	: 9.30 a.m. -11.30 a.m.
Duration	: Two (2) hours

General Instructions

1. Read all instructions carefully before answering the questions.

2. This question paper consists of **6** questions in **4** pages.

3. Answer any **4** questions only. All questions carry equal marks.

4. Answer for each question should commence from a new page.

5. Draw fully labelled diagrams where necessary

5. Relevant log tables are provided where necessary.

6. Having any unauthorized documents/ mobile phones in your possession is a punishable offense

7. Use blue or black ink to answer the questions.

8. Circle the number of the questions you answered in the front cover of your answer script.

9. Clearly state your index number in your answer script

$C_p = 1004 \text{ Jkg}^{-1}\text{K}^{-1}$ $R_d = 287 \text{ J K}^{-1} \text{ kg}^{-1}$ $g_0 = 9.8 \text{ m/s}^2$ $P_0 = 1013.25 \text{ hPa}$

$\varepsilon = 0.622$ $1 \text{ Pa} = 1 \text{ Nm}^{-2}$ Stefan Boltzmann constant $= 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$

Answer 4 questions only.

01.

(a) Describe the role of greenhouse gases as atmospheric thermal insulators.

(b) Briefly discuss the atmospheric layer Stratosphere, explaining the layer height, temperature variation and main features. Why do planes fly in the stratosphere rather than the troposphere?

(c) The bottom layer of the troposphere that is in contact with the surface of the earth is the atmospheric boundary layer (ABL). What are the main physical processes which modify ABL characteristics? Explain the major reasons for turbulence formation at ABL.

(d) Compare the boundary layer characteristics with the free atmosphere according to temperature, turbulence, friction and vertical transport.

02.

(a) Use the diagram below to explain the distribution of atmospheric pressure over a certain area.
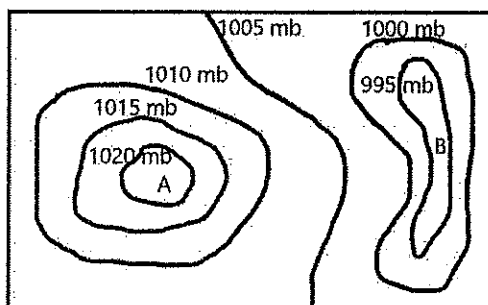
1. The figure describes the horizontal distribution of pressure over an area, and it is shown on the map using isobars. What is meant by isobars?

2. What is meant by the spacing of isobars?

3. A change in air pressure can observe according to the horizontal distribution of pressure on the map. Which term can be used to describe this change in air pressure?

4. What can you say about the pressure over areas A and B?

5. What is meant by a greater difference in air pressure between two places close to each other?

(b) What is Coriolis force and explain its effects?

(c) Where does the Coriolis Effect have the most significant impact? Which component of the Coriolis force is relevant in the atmosphere and why?

(d) Draw the airflow around low- and high-pressure regions with the effect of friction. Explain the wind flow in each case.

03.

(a) What is an ideal gas? How does a real gas differ from an ideal gas?

(b) Consider a parcel of moist air at temperature T and total pressure P.

1. Derive an expression for the total density of moist air parcel (ρ) with the use of partial densities of dry air (ρ_d) and water vapor (ρ_v). Clearly define the variables used.

2. Write an expression for the total pressure of moist air parcel with the use of partial pressure of dry air (P_d) and water vapor (e). State used gas law.

3. Derive an expression for virtual temperature (T_v) using the above relationships. Why do we introduce virtual temperature?

(c) If water vapor comprises 1% of the volume of the air parcel (i.e. if it accounts for 1% of the molecules in air), what is the virtual temperature correction for T= 290 K?

(d) Estimate the thickness of the dry air column trapped between the pressure levels 1000 to 500 mb which has an average temperature of 5° C.

04.

(a) State the first law of thermodynamics and its differential equation form defining the symbols used.

(b) Derive the first law of thermodynamics in terms of specific heat capacity at constant pressure.

(c) The gravity on Venus is 0.904 that of Earth. Compare the cooling rate with height on Earth and Venus. Assume the atmosphere of Venus is pure CO_2. The Specific heat at a constant pressure of CO_2 is 840 $Jkg^{-1}K^{-1}$.

(d) Specific humidity of an air mass is 0.0182 at 33^0C. The total pressure of the moist air mass is 1015 hPa. Determine the virtual temperature and the density of the air mass.

05.

(a) How does Earth's atmosphere affect incoming solar radiation?

(b) Classify radiant flux density depending on the orientation of the surface.

(c) Calculate the equivalent black body temperature of the Earth, assuming that the Earth is in radiative equilibrium. Consider the planetary albedo as 0.3 and the solar constant as $1367 Wm^{-2}$.

(d) What is a rainbow? How do rainbows form?

06.

(a) What is meant by cloud nuclei and briefly discuss the types of cloud nuclei

(b) Compare the differences between warm and cold clouds?

(c) What is the role of instability in thunderstorm formation?

(d) Explain how a cloud-to-ground lightning stroke develops and how return-strokes form.