



# MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR DEGREE IN  
BACHELOR OF EDUCATION (SCIENCE)

SPH 450: ATMOSPHERIC PHYSICS

DATE: 2/6/2017

TIME: 2:00 – 4:00 PM

---

## INSTRUCTIONS

Answer Question One and Any Other Two Questions

The following constant may be useful  $g = 1.67 \times 10^{-19} \text{ J}$

## SECTION A (COMPULSORY)

### QUESTION ONE (30 MARKS)

- Explain what is meant by the phrase “The Earth’s Energy balance” (3 marks)
- Explain why atmospheric pressure above an altitude of 40 km reduces to zero. (1 mark)
- In the troposphere temperature decreases with height and then increases, decreases again before it finally increases as shown in Figure 1,

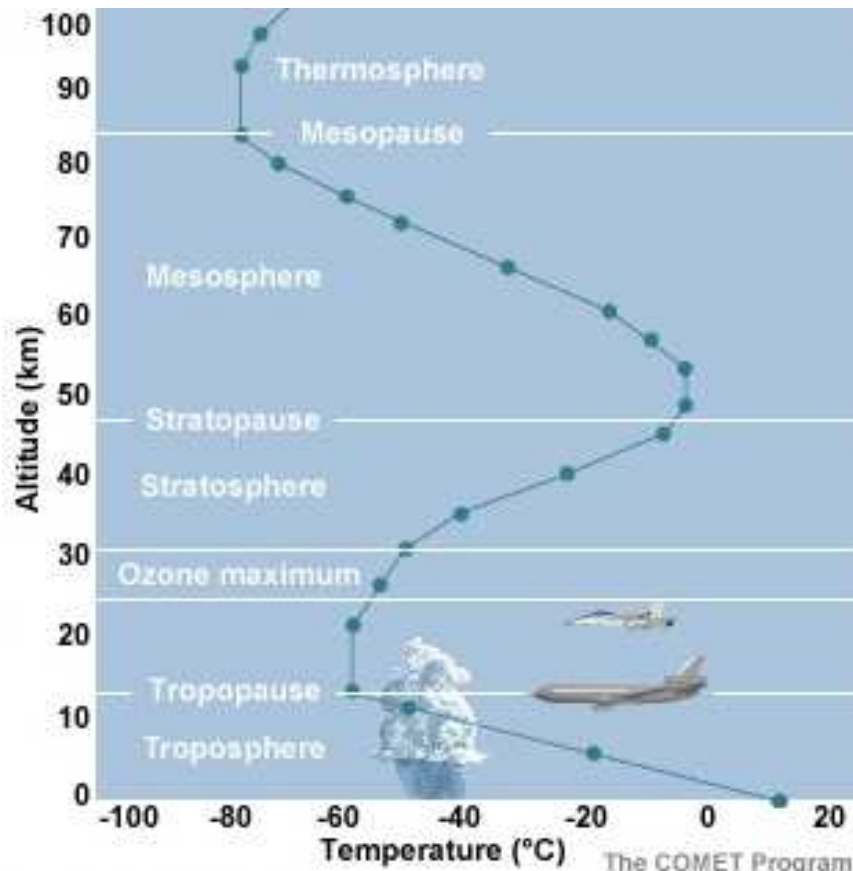


Figure 1

- i) Explain why it happens this way (4 marks)
- ii) Sketch variation of temperature and speed of sound with altitude in a common graph. (1 mark)
- d) Explain how the first law of thermodynamics can be used to explain the greenhouse effect (2 marks)
- e) Define the term “albedo” (2 marks)
- f) Explain the role of thunderstorm cloud in the atmospheric electricity (2 marks)
- g) Describe global electric circuit (5 marks)
- h) Besides a thunder cloud give two other natural elements capable of generating lightning (2 marks)
- i) Explain the two meanings of the term “Energy conservation” (2 marks)
- j) Explain the difference between heat flux  $q'' = -k \frac{dT}{dx}$  and rate of heat transfer  $q = \frac{dQ}{dt} = -kA \frac{dT}{dx}$  (3 marks)
- k) Explain what is meant by the term Plasma (3 marks)

**SECTION B: ANSWER ANY OTHER TWO QUESTIONS**

**QUESTION TWO (20 MARKS)**

- a) Explain how supersonic airplanes flying above the rain clouds can affect the environment (6 marks)
- b) Describe how global warming is enhanced by human activities (4 marks)
- c) i) Write down an equation that governs variation of atmospheric density  $\delta(Z)$  with height and explain the parameters used. (3 marks)
- ii) Given that decay constant  $\lambda_d = 7.0 \times 10^3 \text{ m}$  and density of air at ground level is  $1.208 \text{ kg/m}^3$ . Draw a graph showing how atmospheric density varies from a height of 0 to 45 km. (7 marks)

**QUESTION THREE (20 MARKS)**

- a) i) Define electrical conductivity of the atmosphere (3 marks)
- ii) Write down the relationship between current density (current passing through a unit area in the atmosphere) and electric field. (2 marks)
- b) Give three processes that cause ionisation of the atmosphere (3 marks)
- c) i) Show that heat exchange between a surface and its surroundings is given by  $q = h A(T_s - T_\infty) + \epsilon A \sigma (T_s^4 - T_{sur}^4)$  (6 marks)
- ii) A laboratory air and walls are at a temperature  $12^\circ \text{C}$ . A heating pipe of radius 40 mm, emissivity  $\epsilon = 0.85$  and surface temperature  $300^\circ \text{C}$  is used to warm the laboratory. The coefficient of free heat transfer convection is  $15 \text{ W/m}^2 \cdot \text{K}$ . Find the rate of heat loss from the surface per unit length of the pipe? (6 marks)

**QUESTION FOUR (20 MARKS)**

- a) An unidentified heavenly body UFO from outside our solar system enters the earth's atmosphere and deposits particles that soon increases earth's albedo. Fortunately this particles are washed slowly to zero, during precipitation according to the following data. (Take decay constant equal to 0.2)

Time (sec)	2010	2011	2012	2013	2014	2016	2017	
No of particles $\times 10^{18} \text{kg}$	9.0	7.4	6.0	4.8	4	3.3	2.7	2.2

- i) Write an equation that can model the data. (3 marks)
- ii) Represent the information graphically up to the year when the number of particles in the atmosphere is zero. (6 marks)
- b) State three electrical characteristics of the atmosphere that are important for one to understand lightning flashes (3 marks)
- c) Illustrate the electron density profile of the atmosphere showing the effect of if the point is in the light or dark side of the earth and also how it is related to the activity of the sun R. (5 marks)
- d) Define the term fair weather (3 marks)

**QUESTION FIVE (20 MARKS)**

- a) Show that conduction in a hollow sphere is given by 6 marks

$$q_r = 4 \pi k \frac{T_{S1} - T_{S2}}{\frac{1}{r_1} - \frac{1}{r_2}}$$

- b) By a drawing show the variation of temperature in atmosphere with height. 4 marks

- c) Variation of atmospheric pressure with height can be modelled by the equation

$$P(Z) = P(0)e^{-z/\lambda_p} \text{ Where } \lambda_p = 8 \times 10^3 \text{ m and } P(0) = 101.325 \text{ Kpa}$$

- i) complete the table below 5 marks

Z (m) x 10 <sup>3</sup>	0	5	10	15	20	25	30	35	40
P(Z) pa									

- ii) Draw a graph of Height Z versus pressure P(z) (4 marks)

- iii) Find the pressure at an altitude of 3.2 x 10<sup>4</sup> m. (1 mark)