



MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

SPH 450: ATMOSPHERIC PHYSICS

DATE: 7/12/2021

TIME: 2:00 – 4:00 PM

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

The following constants may be useful

Density of water 1000 kg/m^3

SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

- Explain how rocket launches and aeroplanes flying above the rain clouds can affect the environment (4 marks)
- Sunlight in the tropics is intense and hot while the Polar Regions are cold. What are the consequence of this (4 marks)
- Nature always attempt to maintain temperature of the earth constant. How does it achieve this? (4 marks)
- Explain how the earth's energy balance drives winds and weather patterns (4 marks)
- State three electrical characteristics of the atmosphere that are important for one to understand lightning flashes (4 marks)
- Explain why pressure increases with decrease in altitude on the earth surface. (2 marks)
- Mountain climbers use oxygen tanks when they climb a mountain, give a reason. (2 marks)
- With an aid of a diagram, show how speed of sound varies with altitude. (3 marks)
- Define the term fair weather. (3 marks)

SECTION B: ANSWER ANY TWO QUESTIONS

QUESTION TWO (20 MARKS)

- a) Give three processes that cause ionisation of the atmosphere (3 marks)
- b) Illustrate the electron density profile of the atmosphere showing the effect 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)
- c) A sample of a gas in atmosphere occupies a volume $3.6 \times 10^{10} m^3$ and its density is $1.13 \text{ kg}/m^3$. It contains dry gas 0.59 kg, liquid water $2.0 \times 10^{-4} \text{ kg}$ and ice $3.0 \times 10^{-6} \text{ kg}$. Find the
- i). amount of water vapour in the gas. (4 marks)
 - ii). Hence find its specific humidity and (4 marks)
 - iii). TPW. (4 marks)

QUESTION THREE (20 MARKS)

- a) Define the earth's energy balance and state its implications if balance is not maintained. (4 marks)
- b) Define electrical conductivity of the atmosphere (3 marks)
- c) A waste water in a nuclear power plant of surface area $5.0 \times 10^6 m^2$ and depth 2.5 m is made of Steel of mass $6.0 \times 10^{12} \text{ kg}$, The sun heats the water from 24°C to 28°C . if the sun delivers $1370 \text{ W}/m^2$. Note some of the heat goes to heat the steel material that makes the pond through same temperature range. (*take specific heat capacity of steel as $1280 \text{ J}/g^\circ\text{C}$*). Calculate
- i) Energy input (3 marks)
 - ii) Change in internal energy of water (3 marks)
 - iii) Change in internal energy of the material that makes the pool (3 marks)
 - iv) Time it take the sun to heat water filled in the fish pond (4 marks)

QUESTION FOUR (20 MARKS)

- a) In the mesosphere weather does not occur. Explain. (2 marks)
- b) Given that density of air is $0.8 \text{ kg}/m^3$, find pressure exerted by a column of air at a height 5 km that extends 8 km high. Hence determine its mass per unit area. (5 marks)

- c) A water reservoir of capacity $3.5 \times 10^{18} m^3$ is fed by two streams. The flow rate of first stream is $24.6 \text{ } m^3/s$ and the flow rate of the second stream is $18.7 \text{ } m^3/s$. Sewage concentration in the first stream and second stream is 40 mg/L and 30 mg/L , respectively. The reaction rate coefficient of the sewage is 0.930 /day . Assuming the pollution is completely mixed in the reservoir and no evaporations or other water losses or gains, calculate
- i) Input rate (3 marks)
 - ii) Output rate (3 marks)
 - iii) Decay rate (3 marks)
 - iv) the steady state concentration (4 marks)

QUESTION FIVE (20 MARKS)

- a) Explain how rocket launches and aeroplanes flying above the rain clouds can affect the environment (4 marks)
- b) A city $40 \text{ km} \times 80 \text{ km}$ has 2000 cars each discharging 2 kg of a pollutant gas daily. The pollutant rises as high as 30 km and also changes to other substance with a reaction rate of $0.07/\text{hr}$. Wind blows into the city at $2.5 \times 10^7 m^3/\text{hr}$ and blows the polluted air at same rate.
 - i) State whether this is a steady state or a steady state with non-conservative pollutant system (3 marks)
 - ii) Calculate the rate at which the pollutant enters the city (3 marks)
 - iii) Calculate the rate at which pollutant leaves the city (3 marks)
 - iv) Calculate the decay rate of pollutant (3 marks)
 - v) Estimate the steady state concentration of the pollutant in the air, assuming complete mixing. (3 marks)