MACHAKOS UNIVERSITY

University Examinations 2018/2019

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: 29/4/2019 **TIME: 8.30-10.30 AM**

INSTRUCTIONS TO CANDIDATES

The following constants may be useful

Density of water 1000 kg/m^3

QUESTION ONE (30 MARKS)

a) Nature always attempt to maintain temperature of the earth constant. How does it achieve this? (3 marks)

b) Why does the earth never get charged despite massive charges incident the earth surface during lightning bolts (2 marks)

c) With a diagram illustrate the earth's energy balance (2 marks)

d) Give three processes that cause ionisation of the atmosphere (3 marks)

e) Explain how the first law of thermodynamics can be used to explain the greenhouse effect (2 marks)

f) Define the term "albedo" (2 marks)

g) Explain the role of thunderstorm cloud in the atmospheric electricity (2 marks)

h) The thermosphere is the uppermost layer of the atmosphere where temperature increases with height. Give a reason why this happens. (1 mark)

i) Explain what cause the ionic nature of the ionosphere, in other words factors that ionise the ionosphere (2 marks)

j) Explain why pressure decreases as one nears the ionosphere (2 marks)

k) Define the electric conductivity of the atmosphere (3 marks)

l) Given that density of air is 0.8 kg/m^3, find pressure exerted by a column of air at a height 6 km that extends 12 km high. Hence determine its mass per unit area. (4 marks)

m) Explain what is meant by the earth's energy balance and its implications if balance is not maintained (3 marks)

QUESTION TWO (20 MARKS)

a) A sample of a gas in atmosphere occupies a volume 12.0 x 10^{12} m^3 and its density is 1.043 kg/m^3. It contains dry gas 0.049 kg, liquid water 3.0 x10^{-4} kg and ice 5.0 x10^{-6} kg. Find the amount of water vapour in the gas. Hence find its specific humidity and TPW. (3 marks)

b) Draw a well labelled diagram illustrating the Global electric circuit (4 marks)

c) Sunlight in the tropics is intense and hot while the polar regions are cold, what are the consequence of this (3 marks)

d) A river has two tributaries feeding into it with a flow of 5.0 m^3/s and 2.0 m^3/s respectivery. The stream's concentration of lead upstream of the junction is 18 mg/L while tributaries lead concentrations are 35 mg/L and 45 mg/L respectively. Treating lead as a conservative substance and assuming complete mixing of the three streams, lead downstream concentration is found to be 60 mg/L. Find the flow rate of the river (6 marks)

e) Explain how supersonic airplanes flying above the rain clouds can affect the environment (4 marks)

QUESTION THREE (20 MARKS)

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

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

i) Complete the table below (4 marks)

Z (m) x 10^3	5	10	15	20	25	30	35	40	45
P(Z) pa									

ii) Draw a graph of Height Z versus pressure P(z) (3 marks)

iii) Find the pressure at an altitude of 45.2 x 10^4 m. (3 marks)

b) On a common diagram illustrate how in the atmosphere

i) Temperature and

ii) Speed of sound varies with altitude (4 marks)

c) A fish pond of volume 2.0 x 10^4 m^3 and depth 2.5 m is made of Steel of mass 2.0 x 10^4 kg, how long will it take the sun to heat water filled in the pond, from 7 ℃ to 18 ℃ if the sun delivers 1670 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 1280J/g*℃*).* Calculate

i) Energy input

ii) Change in internal energy of water (2 marks)

iii) Change in internal energy of the material that makes the pool (2 marks)

iv) Time it take the sun to heat water filled in the fish pond (2 marks)

QUESTION FOUR (20 MARKS)

a) Explain how the earth's energy balance drives winds and weather patterns (3 marks)

b) 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)

c) Explain how the earth emits radiation as a long wave with an aid of an example (4 marks)

d) A dam with a volume of 120 x 10^8 m^3 is fed by a stream with a flow rate 9.0 m^3/s sewage concentration of 30 mg/L. There is also a sewage outfall that discharges 10 mg/L of the same pollutant at 2.0 m^3/s. The reaction rate coefficient of the sewage is 0.830 /day. Assuming the pollution is completely mixed in the lake and no evaporations or other water losses or gains, Calculate

i) Input rate (2 marks)

ii) Output rate (2 marks)

iii) Decay rate (2 marks)

iv) the steady state concentration (2 marks)

QUESTION FIVE (20 MARKS)

a) A geothermal site of area 1600 m^2 has 50 wells each discharging 200 mg of poisonous hydrogen sulphide gas (H_2S) spreading to the whole area and rising to a height of 8 km. Hydrogen sulphide changes to other substance with a reaction rate of 0.6/ hr. Wind blows into the site at 2.3 x 10^7 m^3/hr and blows the polluted air at same rate. Estimate the steady state concentration of H_2S in the air, assuming complete mixing.

i) State whether this is a steady state or a steady state with non conservative pollutant system (2 marks)

ii) Find the rate at which H_2S enters the site (2 marks)

iii) The rate at which H_2S leaves the site (2 marks)

iv) Find the decay rate of H_2S (2 marks)

v) Estimate the steady state concentration of H_2S in the air, assuming complete mixing. (3 marks)

b) A North Korean hydrogen bomb test deposits 9.0 x 10^{18} kg of pollutants above the Korean Peninsula. These particles are washed slowly to zero, during precipitation according to the following data. (Take decay constant equal to 0.2)

Time (days)	30	60	90	120	150	180	210	240
Mass of particles x10^{18}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 28th year hence determine number of particles in the atmosphere then. (6 marks)