



# UNIVERSITY OF EMBU

2016/2017 ACADEMIC YEAR

SECOND SEMESTER EXAMINATION

FIRST YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE -  
AGRICULTURE

AEM 104: ENVIRONMENTAL PHYSICS

DATE: APRIL 7, 2017

TIME: 11:00AM-1:00PM

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions.

Use the following constants where necessary

$$e = 1.6 \times 10^{-19} \text{C}$$

$$k = 9.0 \times 10^9 \text{Nm}^2\text{C}^{-2}$$

$$R = 0.831 \text{KJ/Mol/K}$$

$$M_E = 5.98 \times 10^{24} \text{Kg}$$

$$R_E = 6370 \text{Km}$$

$$M_M = 7.35 \times 10^{22} \text{Kg}$$

$$R_M = 1740 \text{Km}$$

QUESTION ONE (30 MARKS)

- State the Newton laws of motion. (3 marks)
- List and briefly describe the six categories of ocean waves. (6 marks)
- List and briefly describe the five main stratus of the atmosphere. (5 marks)
- List and define the four fundamental forces in nature. (4 marks)
- Outline the electromagnetic spectrum giving the general frequency and wavelength trends (3 marks)
- Distinguish between electromagnetic and mechanical waves.. (2 marks)
- What is the green house effect and how does the use of fossil fuels contribute to it?. (3 marks)

- h) Using a flow chart diagram, highlight the main aspects of the hydrological cycle of the earth?  
(4 marks)

**QUESTION TWO (20 MARKS)**

- a) The Marianas trench has a depth of 11.0km below sea level. Compute the pressure at the bottom of the trench; (i) by treating sea water as an incompressible fluid, (ii) by taking into account the compressibility of water.[The density of water at the surface is  $1.0 \times 10^3 \text{ Kg m}^{-3}$  and its bulk modulus is  $2.1 \times 10^9 \text{ Pa}$ ] (10 marks)
- b) Waves propagating in deep water are dominated by gravity. The quantities relevant to the propagation of gravity waves should be the acceleration due to gravity,  $g$  and the density of the fluid  $\rho$ . Using dimensional considerations, derive an approximate dispersion relation  $\omega = \omega(k)$  for deep water waves. (10 marks)

**QUESTION THREE (20 MARKS)**

- a) Given the same conditions of temperature, volume and pressure, is moist air heavier or lighter than dry air? Is this reason why water vapor is only found at the bottom of the atmosphere? (8 marks)
- b) Compute the escape speed  $v_e$  at the top of the atmosphere,  $z = 110\text{km}$ ; at what temperature is the thermal speed of hydrogen molecules comparable to  $v_e$ ? Compare the result with the escape speed from the surface of the moon. (12 marks)

**QUESTION FOUR (20 MARKS)**

- a) The absorption of electromagnetic radiation by chlorophyll  $a$  and chlorophyll  $b$  present in green plants peaks at wavelengths  $\lambda_a = 6.80 \times 10^{-7} \text{ m}$  and  $\lambda_b = 6.44 \times 10^{-7} \text{ m}$ , respectively. In what region of the electromagnetic spectrum do these wavelengths fall? Is this fact related to the color of chlorophyll?

Photosynthesis of glucose ( $\text{C}_6 \text{H}_{12} \text{O}_6$ ) can be summarized in the net reaction



The total energy needed to make one  $\text{CO}_2$  molecule to react is  $E = 2.34 \times 10^{-18} \text{ J} = 14.6 \text{ eV}$ . On average, how many photons must be absorbed by a  $\text{CO}_2$  molecule in chlorophyll  $a$  to react? In chlorophyll  $b$ ? (12 marks)

- b) The Earth radiates approximately as a blackbody at 255 K. Calculate the wavelength at which the blackbody distribution peaks and compare the result with the wavelength at which the emission from the Sun peaks (the Sun can be approximated by a blackbody at 5800 K). (8 marks)

**QUESTION FIVE (20 MARKS)**

- a) In order to reduce pollution and save energy a small town uses a trolleybus running on the energy stored in a large cylinder of mass  $m = 800$  kg, radius  $R = 1$  m, spinning at the angular velocity  $\omega_0 = 5$  revolutions per second at full speed. How much kinetic energy is stored in the flywheel rotating at full speed? The power needed to run the bus is 25 HP on average. How long will the trolleybus run on the kinetic energy stored in the flywheel alone? (10 marks)
- b) Discuss the anomalous behavior of the density of water during temperature changes and during the water/ice phase transition, and the consequences for marine and freshwater life. (5 marks)
- c) Describe the principles of smoke precipitators and electrostatic air cleaning. (5 marks)

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