



MACHAKOS UNIVERSITY

University Examinations 2019/2020 Academic year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

SPH 350: PRINCIPLES OF ENVIRONMENTAL PHYSICS

DATE: 4/12/2019

TIME: 2.00-4.00 PM

INSTRUCTIONS TO CANDIDATES

Answer question one and any other Two questions

USEFUL CONSTANTS

Take Relative biological Equivalent (RBE) for gamma and beta are 1 and 20 for alpha particles, thermal conductivity of Styrofoam, concrete, wood cap rock and glass are 0.075 W/(m.k) , 0.80 W/(m.k) , 0.10 W/(m.k) , 0.7 W/(m.k) and 0.050 W/(m.K) respectively.

QUESTION ONE. (30 MARKS)

- a) You are trying to overhear a juicy conversation, but from your distance of 5.0 m, it sounds like only an average whisper of 30.0 dB. So you decide to move closer to give the conversation a sound level of 90.0 dB instead. How close should you come? (3 marks)
- b) The intensity due to a number of independent sound sources is the sum of the individual intensities.
- When four triplets cry simultaneously, how many decibels greater is the sound intensity level than when a single one cries? (3 marks)
 - To increase the sound intensity level again by the same number of decibels as in part (a), how many more crying babies are required? (3 marks)

- c) In a nuclear accident, a lab worker receives a dose of D rads of radiation of x rays having an RBE of 2. If instead he had been exposed to the same amount of energy from alpha particles having an RBE of 19, his exposure would have been. (3 marks)
- d) A picture window has dimensions of $1.40 \text{ m} \times p \text{ m}$ and is made of glass 5.20 mm thick. On a winter day, the outside temperature is -20°C while the inside temperature is a comfortable 19.56°C . If the rate of heat loss through the window is $5.7 \times 10^{-8} \text{ J/s}$
- Find the value of p (3 marks)
 - How much heat flows through the window in one hour? (3 marks)
- e) A geophysicist in Menengai geothermal field, measures the cap rock to be $50 \text{ km} \times 100 \text{ km}$ and 500 m thick. She also measures temperature of the heat source as 300°C while that on the earth surface as 23°C (see figure 1). If the heat energy released into the atmosphere in 1 hour is $6.0 \times 10^4 \text{ joules}$, Calculate the thickness of the cap rock. (4 marks)

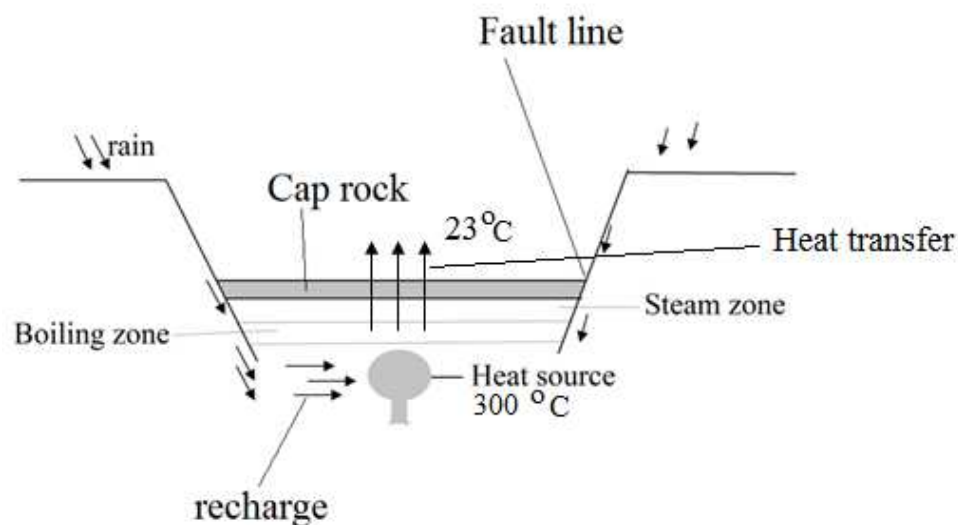


Figure 1;

Geothermal field

- f) A shower head has 20 circular openings, each with radius $R \text{ mm}$. The shower head is connected to a pipe with radius 0.80 cm . If the speed of water in the pipe is 3.0 m/s and its speed as it exits the shower-head openings is 12 m/s . Calculate the value of R ? Assume water is not compressible (4 marks)
- g) A cold region is separated from a hot region by a Styrofoam slab of a cross-sectional area of 100 cm^2 and 3.00 cm thick. If the temperature of the cold region is -11°C and the temperature of the hot region is 80°C , how much heat flows through the slab in 1 day? (4 marks)

QUESTION TWO (20 MARKS)

- a) In a geothermal field three wells are being discharged into the atmosphere. The wells produce sounds of $4.0 \times 10^7 \text{W}$, $12.0 \times 10^6 \text{W}$ and $1.6 \times 10^4 \text{W}$ respectively. Find the intensity level of sound they exert onto a nearby hospital 2 km away. (8 marks)
- b) Define the intensity of sound referred to as threshold of pain (2 marks)
- c) Explain the principle behind instruments used to detect ionization radiations like gamma rays (2 marks)
- d) Describe two ways in each case on how radiations
 - i) cause damage to human body (4 marks)
 - ii) Can be used to our advantage (4 marks)

QUESTION THREE (20 MARKS)

- a) Name some two areas of a human body which are
 - i) very sensitive and (4 marks)
 - ii) Less sensitive to ionizing radiations have (4 marks)
- b) Some three machines crushing rocks and grinding metals are running near a hospital producing 60dB, 120dB and 80dB respectively.
 - i) Calculate the combined intensity level of sound as received in the hospital. (9 marks)
 - ii) If the hospital is 1 km from the factories, calculate the sound power generated by the factory with 120 dB. (3 marks)

QUESTION FOUR (20 MARKS)

- a) A person working in a nuclear electricity power plant in Japan is exposed to 4.1 mSv of radiation type gamma ^{99}Tc .
 - i) What is the total energy deposited on the workers body in Joules and in electron volts (eV) if his mass is 70 kg? (9 marks)
 - ii) Discuss if this energy is enough to cause enough tissue damage (5 marks)
- b) Distinguish between binary and ordinary geothermal power plants using well labeled diagrams (6 marks)

QUESTION FIVE (20 MARKS)

- a) Gamma rays with energies of $3.0 \times 10^{12} \text{ eV}$ are occasionally observed from distant astrophysical sources. What are their wavelengths and frequencies (6 marks)
- b) An animal swallows a radioactive isotope which provides a dose of 0.20 Gy. Which type of radiation will give the highest dose equivalent in mSv among gamma, beta and alpha? (4 marks)
- c) Describe two factors which determine the magnitude of biological effects of radiation (5 marks)
- d) The thermal conductivity of concrete is 0.80 W/(m.k) , and the thermal conductivity of a certain wood is 0.10 W/(m.k) . How thick would a solid concrete wall have to be to have the same rate of heat flow as an 8.0-cm-thick solid wall of this wood? Both walls have the same surface area and the same interior and exterior temperatures. (5 marks)