JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY
SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES
UNIVERSITY EXAMINATION FOR DEGREE OF BACHELOR OF ENVIRONMENTAL HEALTH
1^{ST} YEAR 1^{ST} SEMESTER 2022/2023 ACADEMIC YEAR
MAIN
REGULAR

COURSE CODE: HCB 1111

COURSE TITLE: PHYSICS FOR ENVIRONMENTAL HEALTH

EXAM VENUE: **STREAM: EDUCATION**

DATE: **EXAM SESSION:**

TIME: 2:00 HRS

Instructions:

1. **Answer question 1 (Compulsory) and ANY other 2 questions.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

The following constants may be used where necessary

4. Density of water = 1.0 x 10^3kg/m^3, Density of blood = 1.06 x 10^3kg/m^3, Acceleration due to gravity g=9.8 m/s^2, Universal gravitational constant G=6.67 x10^{-11}Nm^{2}kg^{-2} , permittivity of free space $\epsilon_o = 8.85 \times 10^{-12} Fm^{-1}$, charge on an electron=1.6X10^{-19} C, K=1/(4πε$_o$) = 9*10^9, Mass of an electron, M_e=9.11×10^{-31}Kg, 1eV= 1.6×10^{-19}J, permeability of free space, μ_o=4π×10^{-7}Tm/A

SECTION A

Question One (30 Marks)

(a) (i) Distinguish between vector and scalar quantities citing an example of each. (4 marks)

(ii) A particle undergoes three consecutive displacements, d_1=15i+30j+12k cm, d_2=23i-14j-5k cm, and d_3=-13i+15jcm. Find the components of the resultant displacement and its magnitude. (2 marks)

(b) An *E. coli* bacterium travels a total distance of 100 μm along a straight line from one position of rest to another. For a brief time during this trip it accelerates from rest at a constant acceleration to a speed of 20 μm/s and for another brief time near the end, it decelerates (with the same magnitude of acceleration, but oppositely directed) coming to rest after the total distance traveled. If the total time for the trip is 5.4 s, find the time during which the bacterium accelerates, the time during which it decelerates, its acceleration, and the fraction of the distance traveled at constant velocity. (4 marks)

(c) (i) Describe the various modes of heat transfer. (3 marks)

(ii) Some animals have hair which is *hollow-filled tubes* and others have *solid tubular strands*. Explain with reasons what kind of hair is suitable for surviving in very cold climates (2 marks)

(iii) State the Zeroth law of thermodynamics (1 mark)

(iv) An ideal gas occupies a volume of 100 cm^3 at 20°C and 100 Pa. Find the number of moles of gas in the container. (2 marks)

(d) Compressive strength of bone is such that a bone can only take about 1% change in length before fracturing. Given that Young's modulus for bone is, $1 \times 10^{10}\ Pa$, what is the maximum force that can be applied to a bone whose minimum cross-section is 3.0 cm? (This is approximately the cross section of the human shinbone.) (2 marks)

(e) On a day when the temperature reaches 50°F, what is the temperature in degrees Celsius and in kelvins? (3 marks)

(f) (i) What is a thermometric property? (2 marks)

(ii) An electrical resistance thermometer is made from platinum wire where its resistance changes from $0.40\,\Omega$ when the wire is at $0.0\,^{\circ}C$ to a value of $0.68\,\Omega$ when the wire is heated to $100.0\,^{\circ}C$. Assuming that the resistance varies linearly with temperature, find the resistance when the temperature is $25.0\,^{\circ}C$ (3 marks)

(g) Briefly describe water potential.

(2 marks)

SECTION B:

Question Two (20 Marks)

(a) An electrical heater with resistance 12 Ω is connected to the 240 V circuit. Find the rate of heat production. (4 marks)

(b) A piece of wood from the ruins of an ancient dwelling was found to have a $^{14}_{6}C$ activity of 13 disintegrations per minute per gram. The activity of the living wood is 16 disintegrations per minute per gram. How long ago did the tree from which the wood sample came died? Half life is 5670 years. (5 marks)

(c) Discuss the three postulates used to explain the Bohr's atomic model. (3 marks)

(d) Two lenses of compound microscope have their focal lengths as $f_o = 10$ cm and $f_e = 10$ mm. Which of the two lenses is more powerful and why? (3 mark)

(e) Explain surface tension and state its S.I units

(2 marks)

(f) Describe atmospheric pressure

(3 marks

Question Three (20 Marks)

(a) Differentiate between the following, (2 marks)

(i) Heat and temperature (4 marks)

(ii) Heat capacity and specific heat capacity? (4 marks)

(b) A chemist wishes to determine the specific heat of a new alloy. A 0.15kg sample of the alloy is heated to 540°C. It is then quickly placed in 400g of water at 10.0°C, which is contained in a 200g aluminum calorimeter cup. The final temperature of the mixture is 30.5°C. Calculate the specific heat capacity of the alloy. (The specific heats of water and aluminum are 4186J/kg °C and 900J/kg°C) (5marks)

(c) The wall of an industrial furnace is constructed from 0.15m thick fireclay brick having a thermal conductivity of $1.7 W/m.K$. Measurements made during steady state operation reveal temperatures of 1400K and 1150K at the inner and outer surfaces respectively. What is the rate of heat loss through a wall that is 0.5m by 1.2m on a side? (5 marks)

Question Four (20 Marks)

(a) Define the terms tensile stress and tensile strain

(2 marks)

(b) In a test of the mechanical properties of animal tendon, a sample of tendon is subjected to stretching. The sample is cylindrical in shape, with a diameter of 3.00 mm and an initial length of 50.0 mm. It is found that the sample obeys Hooke's law up to a tensile force of 250 N, at which point the sample has increased in length to 53.0 mm. At larger tensile forces the sample shows plastic deformation, and then breaks when the tensile force is 580 N and the length is 59.0 mm. Calculate both the stress and strain values at,

(i) The elastic limit. (2 marks)

(ii) The breaking point. (2 marks)

(c) (i) What is a blackbody radiation? (2marks)

(ii)The surface of the sun has a temperature of approximately 5800 K. To a good approximation, we may treat it as a blackbody. What is the wavelength of the peak intensity of the radiation produced by the sun? (3marks)

(d) Briefly explain the *Greenhouse Effect* (2marks)

(e) (i) Distinguish between displacement and acceleration giving S.I units (4 marks)

(f) A stone ne is dropped rest from the top of a tall building and after 3.00 s of free fall, calculate the vertical displacement of the stone. (3 marks)

Question Five (20 Marks)

(a) With the aid of a schematic set-up of a cathode ray oscilloscope, discuss its working principle. (5 marks)

(b) State any two uses of cathode ray oscilloscope. (2 marks)

(c) State two safety features of a socket (2 marks)

(d) Magnetic materials are classified into three broad classes Ferromagnetic, Diamagnetic and Paramagnetic. Differentiate the three categories (3marks)

(e) Distinguish between steady flow and turbulent flow

(2marks)

(f) State the equation of continuity for fluid flow

(1mrks)

(g) The aorta is the principal blood vessel through which blood leaves the heart in order to circulate around the body. After the aorta, the blood flow is split up and finally circulates through smaller blood vessels known as capillaries.

(i) Calculate the average speed of the blood in the aorta if the flow rate is 5.0L/min. Assume that the aorta has a radius of $1.0 \times 10^{-2} m$ ($1L = 10^{-3} m^3$). (2marks)

(ii) When the rate of blood flow in the aorta is 5.0L/min, the speed of the blood in the capillaries is $3.3 \times 10^{-4} m/s$. If the average radius of a capillary is $4.0 \times 10^{-6} m$, calculate the number of capillaries in the blood circulation system. (3 marks)

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