(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS - 2019/2020 ACADEMIC YEAR

FIRST YEAR FIRST SEMESTER
SPECIAL/SUPP EXAMINATIONS

FOR THE DEGREE OF B.ED (SCIENCE) BSC (PHYSICS), BSC (CHEMISTRY) & BSC (RENEWABLE ENERGY).

COURSE CODE: SPC 111

COURSE TITLE: MECHANICS, HEAT AND PROPERTIES OF MATTER

EXAM DURATION: 2 HOURS

DATE: 01/2/2021 **TIME:** 11:00-1:00Pm

INSTRUCTIONS TO CANDIDATES

- Answer question one and any other two questions two (2) questions. Question one is compulsory and carries 30 marks, the other questions carry 20 marks each.
- The following physical quantities may be useful.
  - *Density of water = 1000kg/m^3*
  - *Acceleration due to gravity, g = 9.8m/s^2*
  - *Emissivity of the sun, e = 0.93*
  - *Stefan- Boltzmann constant, $\sigma = 5.67\text{x}10^{-8}$ W/m^{2}K^4*
  - *Linear expansivity of steel, $\alpha = 1.1 \text{ x } 10^{-5}$ /°C*
  - *Speed of sound in air = 340m/s*
  - *Young's modulus of steel = $2.0 \text{ x } 10^{11}$ N/m^2*
  - *Thermal conductivity of brick = 0.13W/m°C*
  - *$I_o = 1 \text{ x } 10^{12}$ W/m^2*
  - *Radius of earth = $6.96 \text{ x } 10^8$m*
  - *Specific heat capacity of water = 4.2KJkg^{-1}K^{-1}*
  - *Specific heat capacity of ice = 2.1 KJkg^{-1}K^{-1}*
  - *Specific latent heat of fusion of ice = 334 KJkg^{-1}*
  - *Specific latent heat of vaporization of steam = 2260 KJkg^{-1}*
  - *Specific heat capacity of steam = 2.01 KJkg^{-1}K^{-1}*
  - *Density of mercury = 13600 kg/m^3*

Question ONE (30 marks)

a) (i) Differentiate between scalar and vector quantities. (1 mark)

(ii) Given that $\boldsymbol{P}=\boldsymbol{i}+\boldsymbol{j}+\boldsymbol{k}$ show that $\mathbf{P} \times \boldsymbol{P}=0$ (2 marks)

(iii) Vector **Y** is perpendicular to vector **X**. The magnitude of vector **Y** is twice that of **X**. Find **X.Y**. (2 marks)

b) A body of mass $2.00kg$ undergoes acceleration given by $(3\boldsymbol{i}+4\boldsymbol{j})\ m/s^2$. Find the resultant force acting on in terms of $\boldsymbol{i}$ and $\boldsymbol{j}$ hence find the magnitude of the resultant force on the body. (2 marks)

c) Prove if the following dimensions are correct, $E=mc^2$(E is the energy, m is the mass and C is the speed of light) (3mks).

d) The rectangular components of the vectors which lie in $x - y$ plane have their magnitudes and directions given below. Find the x and y components of the vectors. $r = 12$ and $\theta = 70^0$ (b) $r = 3$ and $\theta = 50^0$ (5mks)

e) A wave is described by $y = A\ Sin(kx - \omega t)$, where A = 4 cm, k =2.65 rad/m and ω=4.78 rad/s where x is in metres and t in seconds. Determine the amplitude, wavelength, frequency and speed of the wave. (4 marks)

f) Water flows through a 3 cm diameter hose pipe at 0.65 m/s. the diameter of the nozzle is 0.30 cm. at what speed does the water pass through the nozzle? (3 marks)

g) (i) Define coefficient of restitution, e and identify the type of collision when $e < 1$.

(ii) A bullet of mass $m_b$moving with an initial velocity of u_b collides with a stationary wooden block of wood of mass m_w hanging freely on an inextensible massless fixed string. If the bullet is imbedded inside the block and the two move with a velocity of $v_{bw}$and both of them swing to a maximum height of h then

show that: $v_{bw} = \sqrt{2hg}$ (2 marks).

h) The room temperature of a place is estimated to be 20°C. Convert this temperature to Fahrenheit and Kelvins. (2 marks).

j) Briefly explain the Kinetic Theory of Gases and state any two assumptions involved. (2 marks)

Question TWO (20 marks)

a) State two laws of friction. (2 marks)

b) Derive the expressions for acceleration a and tension T for two masses hanging freely on a frictionless pulley joined by a common massless and inextensible cord.

c) (i) Define the terms viscosity and suface tension(2 marks)

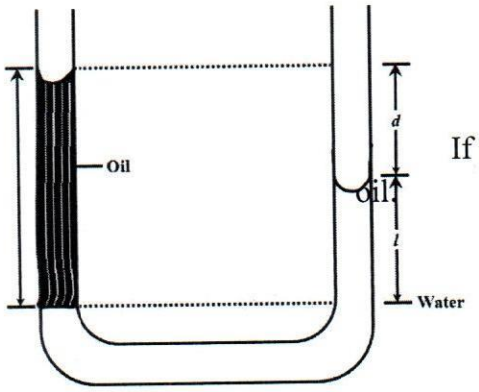
(ii) The surface tension of soap solution is $2x10^{-2}N/m$. How much work will be done in making a bubble of diameter $2x10^{-2}m$? (2 marks)

d) (i) Differentiate between tensile stress and tensile strain. (2 marks).

(ii) A uniform steel wire of length 400cm and cross-sectional area of $3.0\ x\ 10^{-6}m^2$ is extended by $1.0x\ 10^{-3}m$. Calculate the energy stored in the wire if the elastic limit is not exceeded (2 marks).

e) State Newton's Second Law of Motion, hence show that $F = ma$ (3 marks).

f) The U-tube below shows two liquids in static equilibrium.



If l=0.14 m and d=0.12m. Find the density of oil?

(2 marks)

Question THREE (20 marks)

a) Define the term *simple harmonic motion.* (1 mark).

b) An object with simple harmonic motion has an amplitude of 0.02 m and frequency of 20 Hz. Calculate its period and acceleration at the middle. (3 marks)

c) For a helical spring of spring constant k stretched through length x by a force F and released to oscillate in SHM, then show that its periodic time is given by $T = 2\pi\sqrt{\frac{m}{k}}$.

(6 marks).

d) Differentiate between angular displacement and angular velocity. The mass of a bicycle and its rider is 100 kg and he wants to take a turn of radius 80 m with a speed of 20 m/s. calculate the angle he must lean in inorder to negotiate the turn safely. (3 marks)

e) State any two Kepler's laws (2 marks)

f) Differentiate between transverse and longitudinal waves. (2 marks)

g) Briefly explain the concept of weightlessness. (3 marks)

Question FOUR (20 marks)

a) State *Zeroth law* of thermodynamics (1 mark)

b) Define the following terms:

(i) Heat capacity (1 mark)

(ii) Specific heat capacity (1 mark)

(iii) Latent heat (1 mark)

c) Find the amount of heat required to convert 0.15 kg of ice at - 10°C to steam at 120°C (6 marks)

e) A 100 m long bridge is built of steel. If it is a continuous structure, how much will its length change from the coldest winter days (−30°C) to the hottest summer days (40°C)? (2 marks)

f) The length of the column of a mercury thermometer is 4.0 cm when the thermometer is immersed in ice water and 24.0 cm when the thermometer is immersed in boiling water. The mercury column is 25.4 cm long when the thermometer is placed in a boiling chemical. What is the boiling point of the chemical? (3 marks).

g) Calculate the quantity of heat conducted through 2 m^2 of a brick wall 12 cm thick in one hour if the temperature on one side is 8°C and on the other side is 28 °C. (3 marks).

h) Find the rate at which the sun radiates heat at 6000K. (2 marks)

Question FIVE (20 marks)

a) Differentiate between infrasonic and ultrasonic sound. (1 mark)

b) Define the terms Doppler Effect, beats and intensity of sound. ($1\frac{1}{2}$ marks)

c) Give one application of Doppler Effect. (1 marks)

d) Define the terms: ($1\frac{1}{2}$ marks)

(i) Overtone

(ii) Fundamental

(iii) Harmonics

e) A normal speech gives a sound intensity level of about 65 Decibels at 1 m. estimate the power in human speech assume sound travels in a hemispherical area. (3 marks).

f) The speed sound in mercury is 1410 m/s. what is the bulk modulus of mercury? (3 marks)

g) When a violin is played together with a tuning fork of frequency 440 Hz beats are heard at the rate of three beats per second. What are the possible frequencies of the violin? (3 marks).

h) A horn of stationary car has a frequency of 400 Hz what frequency is observed by an observer moving towards the car at 30 m/s? (3 marks)

i) Calculate the fundamental frequency for 10 m organ pipe that is open at both ends. (3 marks)