TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE OF:

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING (BSME)

SPH 2173: PHYSICS FOR ENGINEERS I

END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2014
TIME ALLOWED: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FIVE** questions
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **FOUR** printed pages

Question One (Compulsory)

a) Use dimensional analysis to check if the following equation is dimensionally correct.

$$v^2 = 2ax,$$

where v is the velocity, a is the acceleration and x is the displacement. **(3 marks)**

b) State Newton's Law of universal gravitation; hence derive the dimensions of the gravitational constant. **(5 marks)**

c) Derive the relationship between the linear velocity v and angular velocity ω of a particle moving in a circular path of radius r **(5 marks)**

d) A vacuum propelled capsule for a high speed tube transportation system of the future is being designed for operation between two stations A and B which are 10km apart. if the acceleration and deceleration are to have a limiting value of $6ms^{-2}$ and if the velocities are limited to $400kmh^{-1}$, determine the minimum time for the capsule to make the 10km trip. **(5 marks)**

e) (i) Define heat capacity. **(2 marks)**

(ii) Calculate the quantity of heat required to raise the temperature of a metal block with heat capacity of $23.1 J^oC^{-1}$ by 30^oC **(3 marks)**

f) Explain the meaning of the following terms:

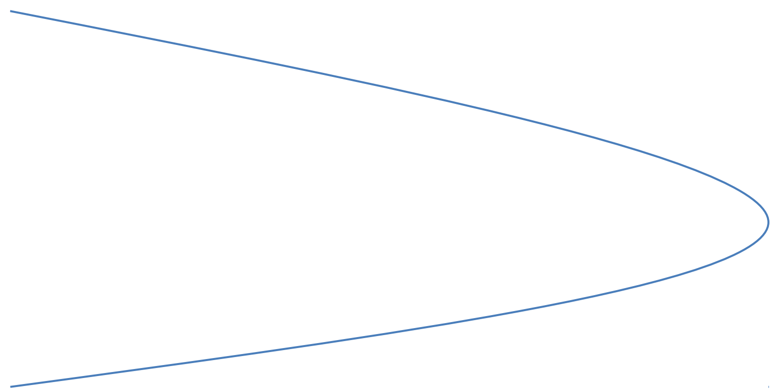
(i) Surface tension

(ii) Viscosity

(iii) Stress

(iv) Strain **(4 marks)**

g) A weight of 300N is suspended by two strings, A and B making angles of 20^o and 50^o to the horizontal respectively. Find the tension on the strings. **(6 marks)**



Question Two

a) State the laws of reflection of light. **(2 marks)**

b) An object is placed on the axis of a converging mirror of focal length 200mm, the image produced is inverted and has a magnification of 1.5. By calculation, determine the position of the object. **(4 marks)**

c) A microscope has an objective lens with a 4mm focal length and an eye piece (ocular) with a 30mm focal length. The two lenses are separated by 0.16m and a final image is formed 0.25m from the ocular. Find:

(i) The position of the image formed by the objective **(2 marks)**

(ii) The position of the object relative to the objective lens **(2 marks)**

(iii) The magnification of the microscope **(2 marks)**

d) A projectile is fired from a level ground at an angle $\theta = 50^o$ above the horizontal. If the initial velocity is $45ms^{-1}$, find the:

(i) Maximum height reached **(2 marks)**

(ii) Range **(2 marks)**

(iii) Velocity after 3.0 seconds **(4 marks)**

Question Three

a) Define temperature and state its SI unit **(2 marks)**

b) (i) Distinguish between specific latent heat of fusion and molar heat capacity **(2 marks)**
(ii) How much energy is required to heat 10kg of ice at -10ºC to steam at 120ºC **(6 marks)**

c) At 30ºC, an iron rod has a diameter of 6cm and is 0.01mm too large to pass through a hole in a brass plate. At what temperature of both the ball and the plate, will the ball just pass through the hole? Take:
Coefficient of linear expansion of iron $1.2 \times 10^{-5}K^{-1}$
Of iron = $1.2 \times 10^{-5}k^{-1}$
Coefficient of linear expansion of brass = $1.9 \times 10^{-5}k^{-1}$
Specific heat capacity of water $4.2 \times 10^{3}Jkg^{-1}$
Specific heat capacity of ice = 1.2 x 10J $Jkgk^{-1}$
Specific heat capacity of stem = $2 \times 10^{3}Jkg^{-1}k^{-1}$
Latent heat of fusion of water = $2.1 \times 10^{3}Jkg^{-1}$
Latent heat of vaporization of water = $2.2 \times 10^{6}Jkg^{-1}$ **(10 marks)**

Question Four

In a compact disc, audio information is stored on the areas on the surface of the disc. This information is read by the compact disc player. Given that the CD player moves with a constant speed of $1.3ms^{-1}$ and using the figure below.

Figure 1

Determine:

(i) Angular speed of the disc in revolution per minute when information is being read from the innermost first track (r=23mm) and the outermost final track (y = 58mm) **(8 marks)**

(ii) Maximum playing time of a standard music CD is 74 minutes and 33 seconds. How many revolutions does this disc make during the time? **(6 marks)**

(iii) What total length of the track moves past the objective lens during this time? **(2 marks)**

(iv) What is the angular acceleration of the CD over the 4473 seconds time interval? Assume that α is constant . **(4 marks)**

Question Five

a) A projectile is fired from the ground level at 35° above the horizontal. At a later time its horizontal displacement is 40m and its height is 20m. Determine:
   (i) Initial speed **(5 marks)**
   (ii) Velocity at the given point **(5 marks)**

b) A driver of a truck moving at $30ms^{-1}$ suddenly notices a goat 70m straight ahead. If the driver's reaction time is 0.5s and the maximum deceleration is $0.8s^{-2}$, can he avoid hitting the goat without steering to one side? **(5 marks)**

c) A particle is thrown vertically upwards at $28ms^{-1}$ from the ground. Determine its velocity at a height of 20m and the time the particle will be at 12m **(5 marks)**