TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE OF:

BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING
BACHELOR OF SCIENCE IN CIVIL ENGINEERING
BACHELOR OF SCIENCE IN FOOD & QUALITY ASSURANCE
BACHELOR OF SCIENCE IN COMPUTER & STATISTICS
BACHELOR OF MATHEMATICS & COMPUTER SCIENCE
(BSEE, BSCE, BSFQ, BSCS, BMCS)

SPH 2170/SPH2102/APS 4104: PHYSICS 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

Use the following information where necessary

- Acceleration due to gravity g = $9.8ms^{-2}$
- Election rest mass Me = 9.11×10^{-31} kg
- Boltzmann constant h = 1.38×10^{-23} $Jmo^{-1}k^{-1}$
- Tripple point of water = 273.16k
- Speed of light in a vacuum = 3.0×10^{8} ms^{-1}
- Universal gas constant R = $8.314Jmol^{-1}$ ms^{-1}
- Universal gravitation constant G = 6.673×10^{11} Nm^2kg^{-2}
- Specific heat capacity of copper = 420Jkg-$1k^{-1}$
- Specific heat capacity of water = 420Jkg-$1k^{-1}$
- Specific heat capacity of aluminum = $900Jkg^{-1}k^{-1}$

- Latent heat of fusion of water = 2.1 x 10^3Jkg^{-1}
- Latent heat of vaporization of water = 2.2 x 10^6 Jkg^{-1}

Question One (Compulsory)

a) Use dimensional analysis to check the validity of the equation:
$V^2 = Vo^2 + 2ax$
where V and Vo are the final and initial velocities of a particle respectively, a is linear acceleration and x is the distance covered by the particle. **(2 marks)**

b) (i) For a vertically upward projection, what is the velocity at the top of the path. **(1 mark)**

(ii) If the velocity of a body changes by the same amount for each similar time interval, what can you say about the acceleration. **(1 mark)**

c) (i) Explain the term "simple harmonic motion" **(1 mark)**

(ii) Given that an object executing simple harmonic motion on a spring, show that the period of the

$$T = 2\pi\sqrt{\frac{m}{K}}$$

motion is **(6 marks)**

d) State Newton's law of universal gravitation hence derive the dimensions of the gravitational constant. **(2 marks)**

e) A body of mass 5kg is pulled up a smooth plane inclined at 30^o to the horizontal by a force at 40N acting parallel to the plane. Determine the acceleration of the body and the force exerted on it by the plane. **(5 marks)**

f) A force at 3N acts at 90^o to a force of 4N. Find the magnitude and direction of the resultant R. **(4 marks)**

g) Explain clearly the difference between a transverse and a longitudinal wave. **(2 marks)**

h) Two similar spheres of equal mass with initial velocities $\vec{u}_1$ and $\vec{u}_2$ respectively undergo an elastic collision. If $\vec{u}_1 = 2\vec{u}_2 = 20m/s^2$, determine their velocities after collision. **(3 marks)**

i) Calculate the work done against surface tension in blowing a soap bubble 4mm in diameter given that the surface tension of soap solution is 2.5 x 10^{-2}Nm^{-1} **(3 marks)**

Question Two

a) Define the following terms:
(i) Specific heat capacity
(ii) Latent heat **(2 marks)**

b) How many 20g ice cubes whose initial temperature is -10^{o}C must be added to 1.0L of hot water whose initial temperature is 90^{o}C, for the final mixture to have a temperature of 10^{o}C. Take specific heat

capacity of ice as 2100Jkg^{-1}k^{-1} and latent heat of fusion of ice as 3.36 x 10^{5}Jkg^{-1} **(4 marks)**

c) (I) State Hooke's law **(2 marks)**

(II) Explain the following terms:

(i) Mechanical strength **(1 mark)**

(ii) Ductility **(1 mark)**

(iii) Brittleness **(1 mark)**

(iv) Elasticity **(1 mark)**

(III) A rod with a radius of 0.05m and length of 2m stretches 0.002m when subjected to a tension force of 10,000N. What is Young's modulus for this rod? **(4 marks)**

(IV) A piece of copper originally 305mm long is pulled with stress of 276Mpa. If the deformation is entirely elastic, what would be the resultant elongation (E of copper = 110Gpa) **(4 marks)**

Question Three

a) (i) State Kepler's Laws of planetary motion. **(3 marks)**

(ii) Show that Kepler's third law of motion is consistent with Newton's law of universal gravitation. **(5 marks)**

b) Express the angular momentum of a satellite of mass m in a circular orbit of radius r in terms of its:

(i) Kinetic energy **(3 marks)**

(ii) Potential energy **(2 marks)**

(iii) Total energy **(2 marks)**

c) Show that the period T of a body attached to a conical pendulum given a slight angular displacement θ is given by:

$$T = 2\pi\sqrt{\frac{L\cos\theta}{g}}$$

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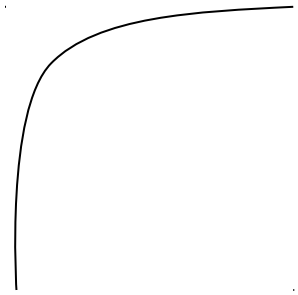
where L is the length of the pendulum and g, the gravitational acceleration **(5 marks)**

Question Four

a) The system of forces shown in figure 1 is in equilibrium. Determine P and Q **(5 marks)**



b) State and explain laws of reflection **(4 marks)**

c) A pump rises water through a height of 3m at a rate of 300 kg per minute and delivers it with a velocity of $8ms^{-1}$. Determine the power output at the pump (Assume g = $10ms^{-2}$) **(5 marks)**

d) A small baed of mass m is threaded on a smooth circular wire of radius r and centre 0_1 and which is fixed in a vertical plane. The bead is projected with speed u from the highest point, A of the wire. Find the reaction on the bead due to the wire when the bead is at P1 in terms of m, g, r, u and θ where $\theta = A\hat{0}P$

(6 marks)

Question Five

a) A particle is moving with simple harmonic motion of period 8 seconds and amplitude 5.0m. Determine:
   (i) Speed of the particle when it is 3m from the centre and its motion
   (ii) The maximum speed
   (iii) The maximum acceleration **(3 marks)**

b) With the aid of a neat sketch, show that the T at a pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$ where L is the length at the string. **(5 marks)**

c) (i) Define linear momentum **(2 marks)**
   (ii) State the law of conservation as linear momentum **(2 marks)**
   (iii) Explain how force is related to linear momentum **(4 marks)**