TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN CIVIL ENGINEERING/ BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING/ BACHELOR OF SCIENCE IN FOOD TECHNOLOGY & QUALITY ASSURANCE (BSEE/BSCE/BSFQ)

SPH 2170/SPH 2102/APS 4101: PHYSICS I

END OF SEMESTER EXAMINATION

SERIES: DECEMBER 2013

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

You may use the following information where necessary:

Acceleration due to gravity g	$= 9.8ms^{-2}$
Electron rest mass m	$= 9.11 \times 10^{-31}$ kg
Bolts man constant K	$= 1.38 \times 10^{-23}$ $Jmol^{-1}$ k^{-1}
Triple point of water	=273.16K
Speed of light in vacuo	$= 3.0 \times 10^{8}$m/s
Universal gas constant R	$= 8.314Jmol^{-1}$ k^{-1}
Universal gravitation constant G	$= 6.673 \times 10^{-11}$
Nm^2	$= kg^{-2}$
Specific heat capacity of copper	$=400Jkg\text{-}1k^{-1}$
Specific heat capacity of water	$=4200Jkg\text{-}1k^{-1}$
Specific heat capacity of aluminium	$=900$ Jkg-1 k^{-1}

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

Question One (Compulsory)

a) Use dimensional analysis to check that the equation below is correct:

$V^2 = 2ax$

where V is the velocity, a is the acceleration and x is the displacement **(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 marks)**

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

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

(ii) Given that an object executing simple harmonic motion on a spring has its displacement $X = A\cos(wt + \phi)$, show that w, the angular frequency is given as:

$$w^2 = \frac{k}{m}$$

where k is the spring constant and m mass of object **(3 marks)**

e) (i) What is surface tension? **(1 mark)**

(ii) Two bubbles are formed from an equal volume of water and soap which bubble would be larger? **(1 marks)**

(iii) What would happen to the bubbles in (ii) above if the temperature were increased? Explain. **(2 marks)**

(iv) 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)**

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

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

h) Write an expression for instantaneous linear expansivity α **(1 mark)**

i) (i) State Charle's Law **(1 mark)**

(iii) A constant volume thermometer has a pressure of 1.5 x 10^4 Pa at the triple point of water and a pressure of 2.05 x 10^4 Pa at the normal boiling point. Find the temperature T_B at the normal boiling point **(3 marks)**

j) Find the total random Kinetic energy of the materials in 1 mole of a gas at a temperature of 300k

Question Two

a) (i) For a projection of 45°, how may the range be increased? **(1 mark)**

$$V^2 = u^2 + 2as$$

(ii) Show that the third equation is given by: **(2 marks)**

(iii) A coin is thrown vertically upwards from the ground with a speed of $10ms^{-1}$.

- How long does it take to reach the highest point? **(2 marks)**
- What is the maximum height reached by the coin? **(2 marks)**

b) Three blocks of masses 6kg, 10 kg and 9kg are connected as shown in the figure below. Determine the acceleration and hence the tensions in the strings **(4 marks)**

T_2

c) The position of a per hile is given by:

$$x = \left(7 - 2t + 3t^2\right)$$

metres:

Determine:

(i) The average velocity between 2 seconds and 3 seconds **(2 marks)**

(ii) The average acceleration between 2 seconds and 3 seconds **(2 marks)**

d) A car travels at $12ms^{-1}$ around a flat curve of radius 40m. What is the minimum coefficient of friction required? **(3 marks)**

Question Three

a) State TWO characteristics of an ideal gas **(2 marks)**

b) A flask contains a mixture of hydrogen, neon and mercury vapour.:

(i) Compare the average kinetic energies of the three gases **(3 marks)**

(ii) Compare the root mean square speed. Give reasons **(3 marks)**

c) Five gas molecules chosen at random are found to have speeds $500ms^{-1}$, $600ms^{-1}$, $800ms^{-1}$, $700ms^{-1}$ and $900ms^{-1}$. Find the root mean square speed. It is the same as the average speed? **(3 marks)**

d) Find the volume of 1 mole of an ideal gas at STP (i.e. a pressure of 1.013×10^5 Pa and temperature of 273K) **(2 marks)**

e) The equation of a certain travelling traverse wave is:

$y = 2\sin 2\pi\left(t/0.01 + x/30\right)$

, where x and y are in cm and t in seconds. What are:

(i) The amplitude **(2 marks)**
(ii) The wavelength **(2 marks)**
(iii) The frequency and **(2 marks)**
(iv) he speed of propagation of the wave **(1 mark)**

Question Four

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

b) How many 20g ice cubes whose initial temperature is -10°C must be added to 1.0L of hot water show initial temperature is 90°C, for the final mixture to have a temperature of 10°C. Take specific heat capacity of water as 4200Jkg^{-1}k^{-1}, specific heat capacity of ice as 2100Jkg^{-1}k^{-1} and latent heat of fusion of ice as 3.36 x 105Jkg^{-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. Buttleness **(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 305 mm long is pulled with stress of 276 Mpa. If the deformation is entirely elastic, what would be the resultant elongation? **(4 marks)**
(E of Copper = 100Gpa)

Question Five

a) (i) State Kepler's laws of planetary motion
(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 $T = 2\pi\sqrt{\frac{l\cos\theta}{g}}$, where l is the length of the pendulum and g the gravitational acceleration **(5 marks)**