TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR BACHELOR OF SCIENCE IN BULIDING&CIVIL ENGINEERING, BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING, BACHELOR OF SCIENCE IN MECHANICAL &AUTOMOTIVE ENGINEERING, BACHELOR OF TECHNOLOGY IN MARINE ENGINEERING, BACHELOR OF SCIENCE IN CIVIL & BUILDING ENGINEERING, BACHELOR OF SCIENCE IN MATHEMATICS & COMPUTER SCIENCE,BACHELOR OF SCIENCE IN STATISTICS &COMPUTER SCIENCE, BACHELOR OF SCIENCE IN FOOD TECHNOLOGY & QUALITY ASSURANCE, BACTHELOR OF TECHNOLOGY IN INFORMATION TECHNOLOGY
(BSEE, BTEE, BSCE, BTCE, BSME, BTME, BTMA BMCS, BSSC, BSFQ & BTIT)

SPH 2170/SPH 2102/SPH2173/APS 4101/APS 4151: PHYSICS I/PHYSICS FOR ENGINEERS I
SPECIAL/ SUPPLIMENTARY EXAMINATIONS

SERIES: SEPTEMBER 2018 TIME ALLOWED: 2HOURS

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Instructions to Candidates:

Answer question one (compulsory) and any other two questions. All the symbols have their usual meanings. You may take:

Acceleration due to gravity g = $9.8ms^{-1}$
Electron rest mass m = 9.11×10^{-31} kg
Bolts man constant **K** = 1.38×10^{-23} Jmol/K
Triple point of water =273.16K
Speed of light **in** vacuo = 3.0×10^{s}m/s
Universal gas constant **R** = 8.3 14Jmol/ K
Universal gravitation constant G = $6.673 \times 10^{-11}Nm^2/kg^2$
Specific heat capacity of copper =400Jkg/ K
Specific heat capacity of water =4200Jkg/K
Specific heat capacity of aluminium =900 Jkg/K
Latent heat of fusion of water =$2.1 \times 10'^{1}$ J/kg
Latent heat of vaporization of water =$2.2 \times 10''^{6}$ J/kg

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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 **(**2marks)

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

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

c) Two similar spheres of equal mass with initial velocities u_1 and u_2 respectively undergo an elastic collision. If $u_1 = 2$ $u_2 = 20ms\text{-}^2$, determine their velocities after collision (3 marks)

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

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

$\omega = \frac{k}{m}$,*where* k is the spring constant and m mass of object **(3marks)**

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

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

(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 2.5×10^{-2} Nm $^{-1}$ **(3marks)**

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

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

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 1.5×10^4 Pa at the triple point of water and a pressure of 2.05×10^4 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)**

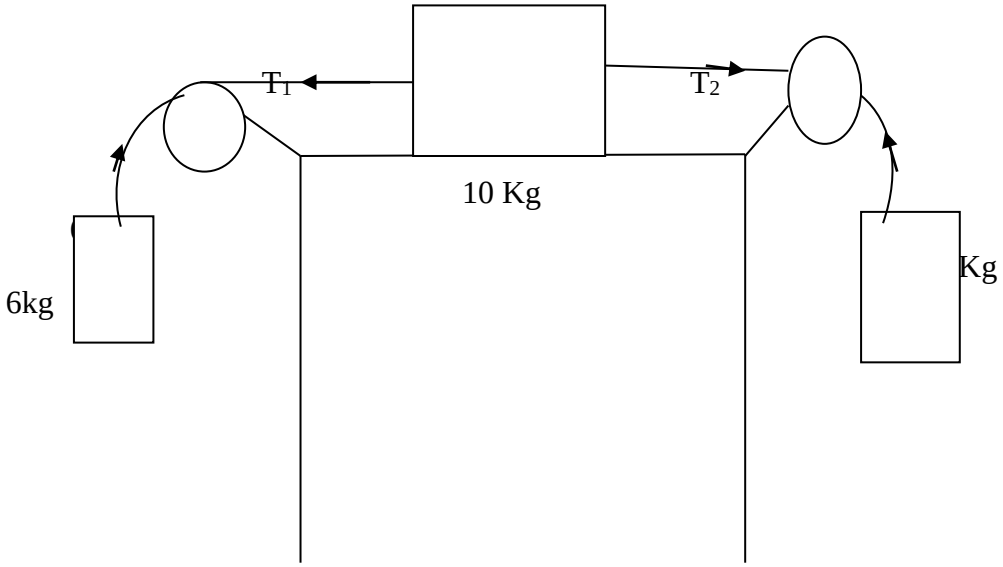
(ii) Show that the third equation is given by: $V^2 = u^2 + 2as$ **(2 marks)**

(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



c) The position of a per hide is given as x= (7-2t+3t^2) metres .Determine:

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

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

iii. The acceleration at 2s **(2 marks)**

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

Question Three

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

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

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

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

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 x 10^3 Pa and temperature of 273K **(2marks)**

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

$y = 2\sin 2\pi\left(\frac{t}{0.01} + \frac{x}{30}\right)$, where x and y are in cm and t in seconds. What is the:

(i) The amplitude **(2marks)**
(ii) The wavelength **(2marks)**
(iii) The frequency and **(2marks)**
(iv) The 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 ^{0}C must be added to 1.0 L 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 = 100 Gpa)

Question Five

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

(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)**