SOUTH EASTERN KENYA UNIVERSITY

UNIVERSITY EXAMINATIONS 2016/2017

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (PHYSICS), BACHELOR OF SCIENCE (ELECTRONICS), BACHELOR OF SCIENCE (GEOLOGY), BACHELOR OF SCIENCE (METEOROLOGY) AND BACHELOR OF EDUCATION (SCIENCE)

SPH 101: MECHANICS I

DATE: 16TH DECEMBER, 2016 TIME: 1.30-3.30 P.M

INSTRUCTIONS TO THE CANDIDATES

(a) This paper consists of **FIVE** questions

(b) Answer question **ONE** and **ANY OTHER TWO** questions

Question One (30 marks)

a) Given that the velocity of light in vacuum $C = 3.0 \times 10^8 m/s$ Calculate;

i) The distance from the earth to the sun given that light from the sun takes 8 minutes to reach the earth **(2 marks)**

ii) The distance in metres to a star 1.4 light years (ly) away **(2 marks)**

iii) The time taken to see a book 3m away **(2marks)**

b) A vector $\hat{P} = 2\hat{\imath} + 3\hat{\jmath} - 4\hat{k}$

i) Define the term unit vector **(1 mark)**

ii) Find the magnitude of $\hat{P}$ **(2 marks)**

iii) Find the unit vector in the direction of $\hat{P}$ **(2 marks)**

c) A particle motion at point A is described by velocity u, displacement $x = 0$ at time $t = 0$ and final velocity v displacement x after time$t = t_{\circ}$. If its acceleration is uniform;

i) Derive the second equation of linear motion **(2 marks)**

ii) Show that $v^2 = u^2 + 2ax$ **(2 marks)**

iii) A stone thrown vertically upwards takes 10s to attain it maximum height. Find this height (Take $g = 10m/s^2$) **(2 marks)**

d) Based on newton's first law of motion define the following

i) Force **(2 marks)**

ii) A Straight line **(2 marks)**

e) A liquid of density $900kg/m^3$ flows through a horizontal pipe that has a cross-sectional area of $1.9 \times 10^{-2}m^2$ in region *A* and a cross-sectional area of $9.5 \times 10^{2}m^2$ in region *B.* The pressure difference between the two regions is$7.2 \times 10^{3}Pa$. What is

i) The volume flow rate? **(2 marks)**

ii) The mass flow rate? **(2 marks)**

f) Given two types of collisions; elastic and inelastic collisions

i) Write the expression for kinetic energy for elastic collision **(2 marks)**

ii) Find u_1 and u_2 given $m_1 = 2kg$, $m_2 = 1kg$, $v_1 = 3m/s$ $v_2 = 2m/s^2$ for an elastic collision **(3 marks)**

Question Two (20 marks)

a) Two vectors are defined as $\hat{P} = 3\hat{\imath} - 5\hat{\jmath} + 2\hat{k}$ and $\hat{Q} = 2\hat{\imath} + 3\hat{\jmath} - 7\hat{k}$

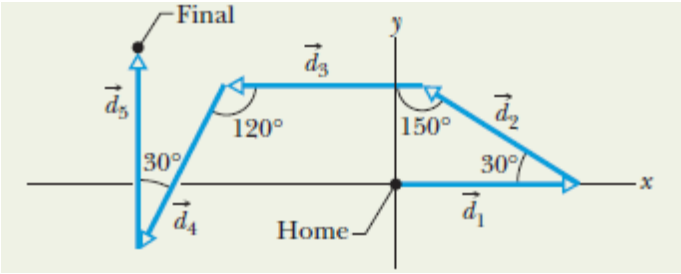
i) Define the term cross product **(1 marks)**

ii) Find the DOT product $\hat{P}.\hat{Q}$ **(3 marks)**

iii) Find the cross product $\hat{P} \times \hat{Q}$ **(3 marks)**

iv) Calculate the angle between $\hat{P}.\hat{Q}$ **(3 marks)**

b) The figure below shows the path followed by a desert ant looking for food



i) Evaluate x-component of each of the vectors $d_{x1}\ to\ d_{x5}$ **(3 marks)**

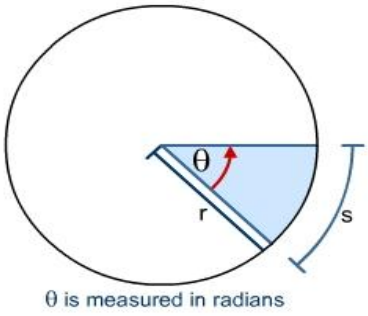
ii) Evaluate y-component of each of the vectors $d_{y1}\ to\ d_{y5}$ **(3 marks)**

iii) Find the resultant vector R defined by d_{net} from home to final **(2 marks)**

iv) Determine the direction of R **(2 marks)**

Question Three (20 marks)

a) The motion of a body along a circular path is depicted in the following diagram



i) If the angle subtended by the arc S is measured in radians, define the term radian **(2 marks)**

ii) Write the expression for its linear velocity v and hence show that $\omega = 2\pi f$ **(3 marks)**

iii) Derive the expression of its angular acceleration *a* in terms of *v* and radius *r* **(5 marks)**

b) An object of mass 50kg is placed stationary along the earths equator

i) Calculate the linear velocity v of the object due to the spinning of the earth along its axis (take radius of the earth $R_E = 6400km$) **(4 marks)**

ii) Find the centripetal force produced on the body due the earth's rotation **(3 marks)**

iii) Accurate measurement of acceleration due gravity g at the equator gives $g = 9.783m/s^2$ what would be the value of g if the earth stopped spinning about its axis? **(3 marks)**

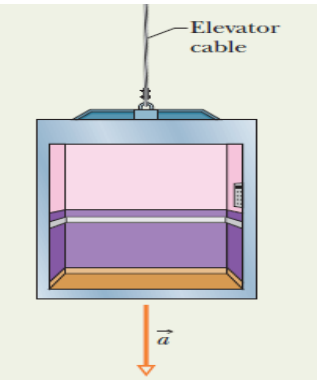
Question Four (20 marks)

a) Given a body of mass m moving at a velocity v

i) Show that newton's law second law is given by $F = ma$ **(5 marks)**

ii) Show that its kinetic energy is given $KE = \frac{1}{2}mv^2$ **(5 marks)**

b) An elevator cab of mass $m = 500kg$ is descending with speed $v_i = 4.0m/s$ when its supporting cable begins to slip, allowing it to fall with constant acceleration



i) What is the work done **Wg** on the cab by the gravitational force F_g during the fall through a distance $d = 12m$ **(2 marks)**

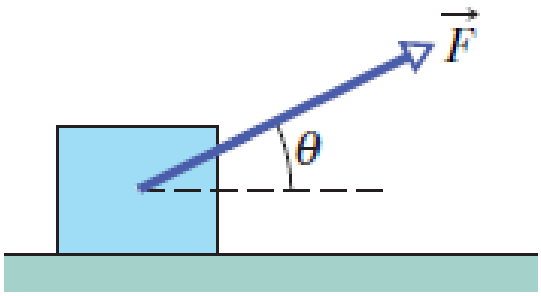
ii) During the 12 m fall, what is the work $\mathbf{W_T}$ done on the cab by the upward pull of the elevator cable? **(4 marks)**

iii) What is the net work W done on the cab during the fall? **(2 marks)**

iv) What is the cab's kinetic energy at the end of the 12 m fall? **(2 marks)**

Question Five (20 marks)

a) A block is placed on a flat surface and pulled by force F as shown

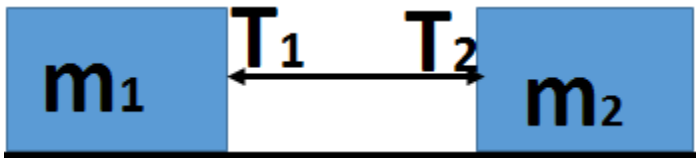


i) Indicate three other forces acting on the block **(3 marks)**

ii) Show that it acceleration a can be expressed as $a = \frac{Fcos\theta - \mu(mg - Fsin\theta)}{m}$ **(3 marks)**

iii) Given that $a = 0.847m/s^2$ $F = 10N$ $g = 10m/s^2$ and $m = 20kg$ determine the value of angle θ **(4 marks)**

b) Two blocks of mass m_1 and m_2 are joined together by a string as shown



i) Show that tension on the string can be obtained from the expression

$$T_0 = m_1 \times \frac{F}{(m_1+m_2)}$$ **(4 mark)**

ii) Find the tension on the string given that the force acting is 20N **(2 marks)**

c) Derive an expression for the minimum force required remove a wheel of radius R from a vertical depression of depth D **(4 marks)**