DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

University Examinations 2013/2014 Academic Year

FIRST YEAR SPECIAL/SUPPLEMENTARY EXAMINATIONS FOR THE DEGREE BACHELOR OF SCIENCE IN **ELECTRICAL & ELECTRONIC** ENGINEERING/**TELECOMMUNICATION & INFORMATION** ENGINEERING/**MECHANICAL** ENGINEERING/**GEGIS/GEOSPATIAL INFORMATION SYSTEMS**

SPH 2170 : PHYSICS/SPH 2173 : PHYSICS FOR ENGINEERS

DATE: 17TH JULY 2014 TIME: 8.30 AM – 10.30 AM

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Instructions

1. **Answer QUESTION ONE and any other TWO questions**
2. **Use standard notation and SI units only**

Some useful constants

(i) $g = 10 m.s^{-2}$

(ii) Density of water $D = 1.0 X 10^3 kg.m^{-3}$

(iii) Water specified heat capacity $c_W = 4.2 X 10^3 J.kg^{-1} K^{-1}$

(iv) Standard atmospheric pressure $p_{atm} = 101.3 kPa$

(v) Universal gas constant $R = 8.314 J.mol^{-1} K^{-1}$

(vi) Specific heat capacity of ice $c_I = 2.1 X 10^3 J.kg^{-1}.K^{-1}$

(vii) Latent heat of fusion of ice $a_I = 3.6 X 10^5 J.kg^{-1}$

(viii) Latent heat of vaporization of water $a_W = 2.2 X 10^6 J.kg^{-1}$

(ix) Stefan -Boltzmann constant $\pm = 5.67 X 10^{-8} W.m^{-2} K^{-4}$

QUESTION ONE: COMPULSORY 30 MARKS

(a) Define these terms as they are used in mechanics and give the SI unit (name and symbol) of the quantity where appropriate (20 marks)

(i) Kinematics
(ii) Point particle
(iii) Position vector

(iv) Reference frame
(v) Trajectory
(vi) Displacement
(vii) Velocity
(viii) Tangential acceleration
(ix) Centre of curvature
(x) Centripetal force

(b) Define the following terms **(10 marks)**

(i) Thermodynamics
(ii) Temperature
(iii) Specific heat capacity
(iv) Radiation of heat
(v) Specific heat of vapourisation

<u>QUESTION TWO</u> **OPTIONAL** **20 MARKS**

(a) Briefly with the aid of diagram(s), explain the procedure of graduating a mercury thermometer **(3 marks)**

(b) Water ice is the only substance which decreases in volume as it melts! Could you explain this **(2 marks)**

(c) A certain $6g$ bullet melts at 300^0C and has a specific capacity of $0.20\frac{cal}{g.^0C}$ and a heat of fusion of $15\frac{cal}{g.}$. How much heat is needed to melt the bullet if it is originally at 0^0C **(4 marks)**

(d) Write down the equation of state of an ideal gas. Give the name, the value and the SI unit of each symbol involved **(6 marks)**

(e) The sun may be treated as a body at $5800K$. Given that its radius is $7X10^8m$ and $£ = 1$, what is the total power radiated? **(5 marks)**

<u>QUESTION THREE</u> **OPTIONAL** **20 MARKS**

(a) Distinguish a scalar and a vector physical quantity. Give two examples for each. Explain the parallelogram rule **(4 marks)**

(b) Deduce the expressions for velocity and displacement for rectilinear uniformly accelerated motion **(6 marks)**

(c) The position of a particle is by $x = 4 - 5t + 3t^2$ (i) What is its instantaneous velocity and (ii) acceleration at $t = 3s$ (iii) At what time the particle is at rest? **(6 marks)**

(d) An arrow fired vertically up lands $8s$ later! Find (a) Its maximum height (b) Its initial velocity **(4 marks)**

QUESTION FOUR: OPTIONAL 20 MARKS

(a) A circular steel wire of length $1.8m$ must not stretch more than $1.5mm$ when a load of $400N$ is applied. What is the minimum diameter required? The Young's modulus for steel is $200X10^9 \frac{N}{m^2}$ **(5 marks)**

(b) The displacement of a block attached to a spring is given by $x(t) = 0.2\sin(12t + 0.2), m$. Find:
(i) The acceleration when $x = 0.08m$
(ii) The earliest time (> 0) at which $x = +0.1m$ with $(v < 0)$ **(4 marks)**

(c) A simple pendulum of length $\ell = 0.4m$ is released when it makes an angle of 20^0 with the vertical. Find:
(i) Its period
(ii) Its speed at the lowest point
(iii) If the mass of the bob is $50g$ what is its total energy? **(5 marks)**

(d) The wave function of a wave is: $y(x,t) = 0.02\sin(0.4x + 50t + 0.8)$ where x and y are in cm. Find:
(i) The wavelength
(ii) The phase constant
(iii) The period
(iv) The amplitude
(v) The wave velocity
(vi) The particle velocity at $x = 1.0cm$ and $t = 0.5s$ **(6 marks)**

QUESTION FIVE: OPTIONAL 20 MARKS

(a) State and write down the mathematical expression of each of the Newton's laws of motion **(6 marks)**

(b) Define the following terms and give the mathematical expression and the SI unit for each: (i) Work (ii) Potential elastic energy(iii) kinetic energy (iv) power **(6 marks)**

(c) A $90g$ hockey puck with initial velocity of $10\frac{m}{s}$ slows down to $8\frac{m}{s}$ in $12m$. Find: (a) the frictional force, (b) the coefficient of friction **(4 marks)**

(d) A $500g$ block is dropped from a height of $60cm$ above the top of a vertical spring whose stiffness constant is $k = 120\frac{N}{m}$. Find the maximum compression **(4 marks)**

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