



**DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY**

**UNIVERSITY EXAMINATION 2015/2016**

**FIRST YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR THE DEGREE OF  
BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC/ CIVIL/  
MECHATRONIC/MECHANICAL ENGINEERING/BACHELOR OF SCIENCE IN GEOMATIC  
ENGINEERING AND GEOSPATIAL INFORMATION SYSTEMS**

**SPH 2170 /SPH 2173 : PHYSICS I / PHYSICS FOR ENGINEERS**

**DATE: 5<sup>TH</sup> JULY 2016**

**TIME: 2.00-4.00 PM**

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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**

- $g = 10m.s^{-2}$
- Density of water  $D = 1.0 \times 10^3 kg.m^{-3}$
- Water specified heat capacity  $c_w = 4.2 \times 10^3 J.kg^{-1}K^{-1}$
- Standard atmospheric pressure  $p_{atm} = 101.3kPa$
- Universal gas constant  $R = 8.314 J.mol^{-1}K^{-1}$
- Specific heat capacity of ice  $c_i = 2.1 \times 10^3 J.kg^{-1}.K^{-1}$
- Latent heat of fusion of ice  $\lambda_i = 3.6 \times 10^5 J.kg^{-1}$
- Latent heat of vaporization of water  $\lambda_w = 2.2 \times 10^6 J.kg^{-1}$
- Stefan -Boltzmann constant  $\sigma = 5.67 \times 10^{-8} W.m^{-2}K^{-4}$

**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

**QUESTION TWO****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  $300^{\circ}C$  and has a specific capacity of  $0.20 \frac{cal}{g \cdot ^{\circ}C}$  and a heat of fusion of  $15 \frac{cal}{g}$ . How much heat is needed to melt the bullet if it is originally at  $0^{\circ}C$  **(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  $7 \times 10^8 m$  and  $\epsilon = 1$ , what is the total power radiated? **(5 marks)**

**QUESTION THREE****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  $200 \times 10^9 \frac{N}{m^2}$  **(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  $20^\circ$  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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