MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR EXAMINATION FOR BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

SUPPLEMENTARY EXAMINATION

ECU 101: PHYSICS FOR ENGINEERS I

DATE: 30/8/2017 **TIME: 2:00 – 4:00 PM**

INSTRUCTIONS:

Answer question ONE which is compulsory and any other TWO

Take: Acceleration due to gravity, g = 10 N/Kg (m/s²)

SECTION A:

1. (a) From the Van der Wall's equation for real gases

$$\left(p + \frac{a}{v^2}\right) = \frac{RT}{(v - b)}$$

Where v-volume, T – Temperature and R – Universal molar gas constant, a and b are constants. Find the dimensions of *a* and *b*

(4 marks)

(b) A 300N force $\boldsymbol{F}$ makes an angle of 145° with the positive x-axis. Find the horizontal and vertical components $\boldsymbol{F_x}$ and $\boldsymbol{F_y}$ of this force. Sketch the forces **F**, $\boldsymbol{F_x}$ and $\boldsymbol{F_y}$

(5 marks)

(c) State the Newton's first law of motion (2 marks)

(d) In projectile motion, explain why horizontal velocity is independent of acceleration due to gravity (2 marks)

(e) Given two vectors **A** and **B**, show the **A** x **B** = **- B** x **A** (3 marks)

(f) The position of particle xm is given by the equation $x(t) = 2t^2 + 3t + 4$. At $t = 2$ seconds, Find (i) The position (2 marks)

(ii) The velocity (3 marks)

(iii) The acceleration (2 marks)

(g) A wave is given by the equation

$y = 5sin30\pi(t - \frac{x}{240})$ where x and y are in centimeters and t in seconds; Find the

(i) Displacement when $t = 0$ and $x = 2$cm (3 marks)

(ii) Frequency of the wave (2 marks)

(iii) Velocity of the wave (1 mark)

(iv) Wavelength of the wave (1 mark)

SECTION B: ANSWER ANY TWO QUESTIONS

2. (a) A projectile is shot with a initial velocity v_o at an angle θ to the horizontal. Show that

(i) The range R = $\frac{v_0^2 sin2\theta}{g}$ (5 marks)

(ii) The range R, is maximum when $\theta = 45°$ (2 marks)

(iii) The maximum height reached $y_{max} = \frac{v_0^2 sin2\theta}{2g}$ (3 marks)

(b) A what angle θ is the range and maximum height reached equal (3 marks)

(c) A rocket was fired vertically upwards at a constant acceleration of 20 m/s^2. After one minute, its fuel was exhausted therefore it continued moving as a free particle. What was the total maximum height reached by the rocket. (7 marks)

3. A mass of 0.5 kg extends a light spring by 2 cm from its unstretched position. When the spring is then stretched through 4 cm and released, it oscillates freely,

(a) Find the period and frequency of the oscillations produced (4 marks)

(b) Determine the maximum speed and maximum acceleration of the system (4 marks)

(c) For the oscillating mass at halfway from the mean position, calculate:-

(i) Its velocity

(ii) Its acceleration

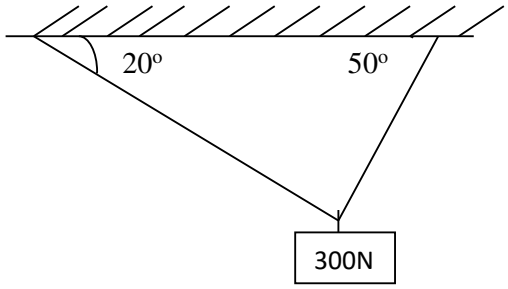
(iii) Its Kinetic energy

(iv) Its Potential energy (8 marks)

(d) Determine the equation of the displacement of the body as a function of time

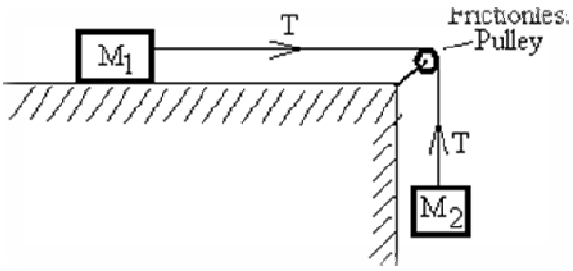
(4 marks)

4. (a) A weight of 300N is suspended by two strings, A and B making angles of 20° and 50° to the horizontal respectively. Find the tension on the strings



(12 marks)

(b) The figure below shows two masses M_1 and M_2 attached to each other using an inextensible string of negligible mass



If the masses accelerate over a frictionless table at a m/s^2 when the tension on the string is T, show that:

(i) $a = \frac{M_2}{M_1 + M_2} g$ (6 marks)

(ii) $T = \frac{M_1 M_2}{M_1 + M_2} g$ (4 marks)

5. (a) An iron rod has a diameter of 6 cm at a temperature of 30 °C. It is 0.01 mm too large to pass through a hole in a brass plate. At what temperature of both ball and the plate, will the ball just pass through the hole? State any assumption made.

(10 marks)

(b) How much energy is required to heat 10 kg of ice at -10 °C to steam at 120 °C .

(6 marks)

(c) A bob moves in a horizontal circle of radius R at a constant speed *V*. If the string makes an angle θ with the vertical show that tan θ = $\frac{V^2}{Rg}$ (4 marks)

Take *Coefficient of linear expansion of iron* = $1.2\times 10^{-5}K^{-1}$

Coefficient of linear expansion of brass = $1.9\times 10^{-5}K^{-1}$

Specific heat capacity of ice = $1.2\times 10^{3}JKg^{-1}K^{-1}$

Specific heat capacity of water = $4.2\times 10^{3}JKg^{-1}K^{-1}$

Specific heat capacity of steam = $2\times 10^{3}JKg^{-1}K^{-1}$

Latent heat of fusion of water = $2.1\times 10^{3}JKg^{-1}$

Latent heat of vaporisation of water = $2.2\times 10^{3}JKg^{-1}$