MASENO UNIVERSITY

UNIVERSITY EXAMINATIONS 2016/2017

FIRST YEAR FIRST SEMESTER EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION SCIENCE WITH INFORMATION TECHNOLOGY

MAIN CAMPUS

SPH 101: MECHANICS

Date: 1st December, 2016 Time: 12.00 - 3.00 pm

INSTRUCTIONS:

- Answer question ONE and any other TWO questions.

MASENO UNIVERSITY

Department of Physics and Materials Science

2016/2017 FIRST SEMESTER EXAMINATIONS

SPH 101 : MECHANICS

Answer **Question One** and **any other two** questions. Question One carries 30 marks, while the other questions carry 20 marks each.

Question One

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

(ii) For a body of mass m moving on a straight line with displacement x, define (1) speed (2) linear momentum (3) kinetic energy (4) acceleration (5) applied force

(5 marks)

(b) (i) Write down Newton's equation of motion (1 mark)

(ii) Prove that the total **linear momentum is conserved**

(5 marks)

(iii) If the force is constant, determine the impulsive linear momentum at time t **(4 marks)**

(c) If the body moves with uniform acceleration a, show that the kinetic energy can be obtained in the form $T = T_0 + F(x - x_0)$ where T_0 is the initial kinetic energy, given that the body starts with initial speed v_0 and initial displacement x_0, under the constant external force F.

(8 marks)

(ii) Show that for a body under a time varying external force $F(t)=\cos t$, where t is the time, the linear momentum is obtained as

$p=p_0+\sin t$ where P_0 is the initial linear momentum

(7 marks)

(b) A body of mass $2Kg$ is projected upwards with kinetic energy $20J$ at an angle of inclination 60^0 above the horizontal line. If the acceleration due to gravity is $g=9.81ms^{-2}$, determine

(i) the maximum height it can achieve **(7 marks)**

(ii) the time of flight. **(4 marks)**

Question Four

(a) A linear harmonic oscillator of angular frequency ω is governed by Newton's equation of motion

$$\frac{d^2x}{dt^2}=-\omega^2x$$

where x is the displacement. Determine

(i) the potential energy of the oscillator **(3 marks)**

(ii) the speed of the oscillator **(7 marks)**

(b)(i) Apply Newton's third law of motion to derive the equation of conservation of linear momentum for two directly colliding bodies

(4 marks)

(ii) A ball of mass $1Kg$ moving with speed $15ms^{-1}$ collides directly with another ball of mass $0.8Kg$ moving with speed $18ms^{-1}$ in the opposite