



THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

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MAIN EXAMINATION

SEPTEMBER – DECEMBER 2019 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS

REGULAR PROGRAMME

PHY 201: MECHANICS II

Date: DECEMBER 2019

Duration: 2 Hours

INSTRUCTIONS: Answer Question ONE and ANY other TWO Questions

Q1. a) Define the following terms:

(5marks)

- i) Torque
- ii) Rigid body
- iii) Escape speed
- iv) simple harmonic motion
- v) Resonance

b) A body of mass 0.2kg is executing simple harmonic motion with an amplitude of 0.02m and a frequency of 20HZ. Calculate the period of oscillation and the acceleration at the end of the oscillation

(4marks)

c) Show that the period in a simple pendulum is obtained by

$$T = 2\pi\sqrt{\frac{l}{g}}$$

(3marks)

d) A block whose mass m is 680 g is fastened to a spring whose spring constant k is 65 N/m. The block is pulled a distance $x = 11$ cm from its equilibrium position at $x = 0$ on a frictionless surface and released from rest at $t = 0$.

Calculate :

i) The angular frequency

(3marks)

ii) The frequency

(2mark)

iii) The period of the resulting motion?

(1mark)

iv) What is the maximum speed V_m of the oscillating block,?

(3marks)

e) State Kepler's laws

(3marks)

f) A playful astronaut releases a bowling ball, of mass $m = 7.20$ kg, into circular orbit about Earth at an altitude h of 350 km. What is the mechanical energy E of the ball in its orbit?

(3marks)

g) Show that the kinetic energy of a satellite in a circular orbit is given by

$$K.E = \frac{-U}{2}$$

(3marks)

Q2. a) What is gravitation

(1mark)

i) State Newton's law of gravitation

(2marks)

ii) Two particles, particle 1 of mass $m_1 = 6.0$ kg and particles 2 $m_2 = 4.0$ kg, and distance $a = 2.0$ cm. What is the net gravitational force F_1 ?

(3marks)

b) State Kepler's third law of periods.

(2marks)

c) Show that the kinetic energy of a satellite in a circular orbit is given

$$\text{by } K.E = \frac{-GMm}{2r}$$

(4marks)

- d) What must the separation be between a 5.2 kg particle and a 2.4 kg particle for their gravitational attraction to have a magnitude of 10^{-12} N?

2.3X

(4marks)

- e) What linear speed must an Earth satellite have to be in a circular orbit at an altitude of 160 km above Earth's surface?

(2marks)

- f) What is the period of revolution?

(2marks)

- Q3. a) Define the following terms:

(4marks)

- i) Angular velocity
 - ii) Rotational inertia
 - iii) Angular momentum
 - iv) Rotational axis
- b) State the law of angular momentum

(2marks)

- c) Show that the kinetic energy for angular motion is given by $K.E = \frac{1}{2} I \omega^2$

(4marks)

- d) An astronaut is being tested in a centrifuge. The centrifuge has a radius of 10 m and, in starting, rotates according to $\omega = 0.30t^2$, where t is in seconds and ω is in radians. When $t = 5.0$ s, what are the magnitudes of the astronaut's :

- i) Angular velocity

(2marks)

- ii) Linear velocity

(2marks)

- iii) Tangential acceleration

(2marks)

iv) Radial acceleration

(2marks)

v) Kinetic energy

(2marks)

Q4. a) Differentiate between damped oscillations and simple harmonic motion

(2marks)

b) Given that the displacement for a particle is given by $X(t) = X_m \cos(\omega t + \phi)$
.Find

i) The velocity of the particle after a time t

(2marks)

ii) The acceleration of the particle

(2marks)

iii) The kinetic energy for the particle

(3marks)

c) State Hooke's law

(2marks)

d) A spring attached to a mass m exhibits simple harmonic motion. Find its angular frequency and period in terms of mass (m) and spring constant (k)

(6marks)

e) A block has mass $m = 2.72 \times 10^5$ kg and is designed to oscillate at frequency $f = 10.0$ Hz and with amplitude $x_m = 20.0$ cm. What is the total mechanical energy E of the spring-block system?

(3marks)

Q5. a) Differentiate between a periodic and linear motion

(2marks)

b) For the damped oscillator of a body of $m = 250$ g, $k = 85$ N/m, and $b = 70$ g/s. What is the period of the motion?

(3marks)

c) An object undergoing simple harmonic motion takes 0.25 s to travel from one point of zero velocity to the next such point. The distance between those points is 36 cm. Calculate:

(6marks)

- i) The period
 - ii) Frequency
 - iii) Amplitude of the motion.
- d) What linear speed must an Earth satellite have to be in a circular orbit at an altitude of 160 km above Earth's surface?

(2marks)

- e) What is the period of revolution

(2marks)

- f) State the principle of superposition of forces

(2marks)

- g) Show that a simple pendulum exhibits a simple harmonic motion

(3marks)

END