



KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

FIRST YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BSC (PHYSICS)

COURSE CODE: SPH 114

COURSE TITLE: MECHANICS

DURATION: 2 HOURS

DATE: 26/01/2022

TIME: 2-4PM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of 4 printed pages. Please Turn Over



KIBU observes ZERO tolerance to examination cheating

Question One (30 marks)

- a) State the following laws;
- i) Law of conservation of energy. (1 mark)
 - ii) Newton's first law of motion (1 mark)
- b) What is classical mechanics? (2 marks)
- c) Differentiate between rotational and translational motion in kinematics. (2 marks)
- d) A ranger standing on a tower 10m high fires horizontally a bullet from a gun at a speed of 20m/s. Find;
- i) The time of flight. (3 marks)
 - ii) The range, R, of the bullet. (3 marks)
- e) A stone is thrown vertically upwards at 10m/s. Find the time taken to reach a maximum height. (3 marks)
- f) A particle of mass 10 kg travelling at $(i+3j)$ m/s hits the back of another particle of mass 15kg travelling at $(2i-j)$ m/s. Find their total momentum before collision. (3 marks)
- g) A point has rectangular coordinates; (3, 4). Convert this into polar coordinates. (4 marks)
- h) A point has polar coordinate $(5, 30^\circ)$. Convert this into rectangular coordinates. (4 marks)
- i) Differentiate between a vector and a scalar quantity giving an example of each. (4 marks)

Question Two (20 marks)

- a) State the law of interaction of forces. (1 mark)
- b) State LAMI'S theorem for three forces in equilibrium. (3 marks)
- c) Name some practical application of the impulse of a force. (3 marks)
- d) A car of mass 3,000kg moving at a speed of 30m/s collides head on with a lorry of mass 8,000kg travelling at a speed of 12m/s. After collision, the wreckage of the two moved a distance of 10m before stopping. Find
- i) The velocity of the wreckage. (4 marks)
 - ii) The deceleration. (4 marks)
- e) $v^2 = u^2 + 2ax$ Where, u and v, are the initial and final speeds of the body, a, is the linear acceleration and, x, is the distance covered. (5 marks)

Question Three (20 marks)

- a) State Archimedes's principle. (1 mark)
- b) What is kinematics? Give two examples of such motion. (4 marks)

- c) The center of mass of a three particle system is given as $(-5, 4)$. If the masses of the particles are 1kg, 2kg, and 3kg, respectively with coordinates of (x_1, y_1) , $(2, 1)$, and $(1, -3)$, find (x_1, y_1) . (5 marks)
- d) A kettle rated 4.5Kw is used to heat 5 kg of water for a minute. Find the room temperature of water if the final temperature is 30.62°C . (Take specific heat capacity of water to be 4.2J/g/K) (5 marks)
- e) A body released from the top of a tower 100m high. Find the time taken and the velocity which it hits the ground with. Take $g=9.8\text{m/s}^2$. (5 marks)

Question Four (20 marks)

- a) Three particles of masses $m_1 = 1.2\text{kg}$, $m_2 = 2.5\text{kg}$, $m_3 = 3.4\text{kg}$ form an equilateral triangle of edge length 140 cm. The coordinates of the three particles are $(0, 0)$, $(140\text{cm}, 0)$ and $(70\text{ cm}, 121\text{ cm})$ respectively. Find the center of mass of this three particle system. (5 marks)
- b) A particle starts upward motion with a velocity of $(2\mathbf{i} + 3\mathbf{j})\text{ m/s}$. How high will it be after 0.5 s. Take $g=9.82\text{ m/s}^2$. (5 marks)
- c) Show whether the following equation is dimensionally correct or not.

$w = \frac{1}{2}mv^2 - mgh$ where, w , is the work done, m , is the mass of the object, v , is the speed of the body, g , is the gravitational force and h , is the height of motion. (5 marks)

- d) A particle P of mass 6kg has velocity $(4\mathbf{i} + 2\mathbf{j})\text{ m/s}$ collides head on with another particle of mass 10kg travelling with a velocity of $(\mathbf{i} - 4\mathbf{j})\text{ m/s}$. Find their common velocity after collision (5 marks)

Question Five (20 marks)

- a) What is dimensional analysis? (2 marks)
- b) Differentiate between a one dimensional and a two dimensional kinematics. Give an example of each. (4marks)
- c) Write down the four assumptions for free fall motion. (4 marks)
- d) Show whether the following equations are dimensionally correct or not.

$v = ut + at$ Where, u and v , are the initial and final speeds of the body, a , is the linear acceleration and, t , is the time of motion. (5 marks)

- e) Three particles of masses $m_1 = 1.\text{kg}$, $m_2 = 2.5\text{kg}$, $m_3 = 3.4\text{kg}$ from an equilateral triangle of edge length 140 cm. The coordinates of the three particles are $(0, 0)$, $(140\text{cm}, 0)$ and $(70\text{ cm}, 121\text{ cm})$ respectively. Find the center of mass of this three particle system. (5 marks)