# KIBABII UNIVERSITY

## UNIVERSITY EXAMINATIONS
## 2022/2023 ACADEMIC YEAR

### FIRST YEAR FIRST SEMESTER
### MAIN EXAMINATIONS

**FOR THE DEGREE OF B.Ed (SCIENCE)**

**COURSE CODE:** SPH 114

**COURSE TITLE:** MECHANICS

**DURATION:** 2 HOURS

**DATE: 21/12/2022** **TIME: 2:00-4:00PM**

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**INSTRUCTIONS TO CANDIDATES**

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.

KIBU observes ZERO tolerance to examination cheating

**QUESTION ONE [30 Marks]**

a) What is the meaning of the word *dimension* in physics? Differentiate between speed and velocity. [4]

b) Find the magnitude of the resultant sum of the two vectors $\vec{a} = (2.0\vec{i} + 4.0\vec{j})m$ and $\vec{b} = (5.0\vec{i} + 2.0\vec{j})m$ lying in the x-y plane. [4]

c) Using dimensional analysis, determine the units of acceleration. [3]

d) A coin is thrown vertically upward from the ground with the speed of 10 m/s. How long does it take to reach the highest point? What is the maximum height reached by the coin? ($g=9.81 m/s^2$). [4]

e) State the states of equilibrium. [3]

f) Given the two displacements $\vec{D} = (6.0\hat{i} + 3.0\hat{j} - 1.0\hat{k})m$ and $\vec{E} = (4.0\hat{i} - 5.0\hat{j} + 8.0\hat{k})$ find the magnitude of the displacement $2\vec{D} - \vec{E}$. [4]

g) What is a conservative force? Give an example. [2]

h) Find the angle between the vectors $\vec{A} = 2.00\hat{i} + 3.00\hat{j} + 1.00\hat{k}$ and $\vec{B} = -4.00\hat{i} + 2.00\hat{j} - 1.00\hat{k}$ [4]

i) State the law of conservation of linear momentum. [2]

**QUESTION TWO [20 Marks]**

a) i) State Newton's second Law of motion. [2]

ii) An object of mass 2.0 kg is attached to the hook of a spring balance, and latter is suspended vertically from the roof of a lift. What is the reading on the spring balance when the lift is (i) ascending with an acceleration of 20 $cm/s^2$ (ii) descending with an acceleration of 10 $m/s^2$ ? [5]

iii) A force of 200N pulls a box of mass 50 kg and overcomes a constant frictional force of 40 N. What is the acceleration of the sledge? [3]

b) State two effects of force on an object. [2]

c) The road at a circular turn of radius 10m is banked by an angle of $10^0$. With what speed should a vehicle on the turn so that the normal contact force is able to provide the necessary centripetal force? ($g=9.8 m/s^2$) [3]

d) A particle starts from rest with a constant acceleration. At a time, t seconds, the speed is found to be 100m/s and one second latter the speed becomes 150 m/s. Find:

i. The acceleration [2]

ii. The distance travelled during the $(t+1)^{th}$ second. [3]

**QUESTION THREE [20 Marks]**

a) State the assumptions of projectile motion. [2]

b) A shell is projected with a velocity of 100 m/s with an elevation of $30^0$ to the horizontal. Obtain the equations of motion. ($g=9.81\ m/s^2$) [5]

c) A stone is projected with a horizontal velocity of 10 m/s from the top of a cliff 50 m above sea-level. Calculate the range at sea-level, and the velocity of impact. [10]

d) A particle starts from origin at t=0 with initial velocity having an x-component of 20 m/s and a y-component of -15 m/s. The particle moves in in the x-y plane with an x-component of acceleration only, given by $a_x=4.0\ m/s^2$. Determine the components of velocity vector at any time and the total velocity vector at any time. [3]

**QUESTION FOUR [20 Marks]**

a) State the principle of conservation of mechanical energy [2]

b) Four particles A, B, C and D having masses m, 2m, 3m and 4m respectively are placed in order at the corners of a square of side a. Locate the center of mass [6]

c) Starting from rest, a fan takes five second to attain the maximum speed of 400rpm (revolution per minute). Assuming a constant acceleration, find the time taken by the fan in attaining half the maximum speed. [3]

d) Define moment of inertia. Show that the moment of inertia of a uniform rod about a perpendicular bisector is given by $I=\frac{Ml^2}{12}$ [9]

**QUESTION FIVE [20 Marks]**

a) Define linear momentum of a particle. [2]

b) A bullet of mass 20 g travelling horizontally at 100 m/s, embeds itself in the center of a block of wood mass 1 kg which is suspended by light vertical strings 1 m long. Calculate the maximum inclination of the strings to the vertical. ($g=9.8\ m/s^2$) [5]

c) Derive the four kinematic equations of linear motion for a particle moving with constant acceleration. [6]

d) A block of mass 2.5 kg is kept on a horizontal rough surface. It is found that the block does not slide if a horizontal force less than 15N is applied to it. Also it is found that it takes a 5 seconds to slide through the first 10m if a horizontal force of 15N is applied and the block is gently pushed to start the motion. Taking $g=10\ m/s^2$, calculate the coefficient of static and kinetic friction between the block and the surface. [7]