

CHUKA



UNIVERSITY

SUPPLEMENTARY/ SPECIAL EXAMINATIONS

**EXAMINATION FOR THE AWARD OF DEGREE OF
BACHELOR OF**

MATH 123: VECTORS AND MECHANICS

STREAMS:**TIME: 2 HOURS****DAY/DATE: TUESDAY 02/02/2021****8.30 AM – 1.30 PM****INSTRUCTIONS:**

All questions are compulsory

Take $g = 10m/s^2$

QUESTION ONE (30 MARKS)

- (a) Define the following terms:
- | | |
|---------------------|----------|
| (i) Vector quantity | (1 mark) |
| (ii) Mechanics | (1 mark) |
| (iii) Projectile | (1 mark) |
| (iv) Acceleration | (1 mark) |
| (v) Velocity | (1 mark) |
- (b) Determine the angle between the vectors $\hat{a} = 3\hat{i} + \hat{j} - 2\hat{k}$ and $\hat{b} = 5\hat{i} - 5\hat{j} + \hat{k}$. (3 marks)
- (c) A projectile is launched at an initial velocity of $330m/s^2$ at an angle of 60° to the horizontal. Determine its range. (5 marks)
- (d) Determine the values of α such that the vectors $\hat{a} = \alpha - 2\hat{j} + \hat{k}$ and $\hat{b} = 2\alpha\hat{i} + \alpha\hat{j} - 4\hat{k}$ are perpendicular. (4 marks)
- (e) A particle moving in a straight line with constant acceleration travels 10 m in the first second and 15 m in the second second. Find the distance travelled in the third second. (5 marks)

- (f) Determine the volume of the parallelepiped spanned by the vectors $\hat{a} = \hat{i} + \hat{k}$, $\hat{b} = \hat{i} + \hat{j}$ and $\hat{c} = \hat{j} + \hat{k}$. (4 marks)

- (g) Given $\vec{AB} = \hat{a}$ and $\vec{AC} = \hat{b}$, show that the area of the triangle ABC is given by

$$Area = \frac{1}{2} \sqrt{(ab)^2 - (\hat{a} \cdot \hat{b})^2} \quad (4 \text{ marks})$$

QUESTION TWO (20 MARKS)

A helicopter, initially at rest on the ground, rise vertically with constant acceleration. When it is at a height of 60m, its upward speed is 5 m/s. When it is at a height of 240m, and still rising, an object A is released from the helicopter. Using $g = 10m/s^2$, calculate:

- (i) The initial velocity of A. (4 Marks)
- (ii) The time that A takes to reach the ground. (5 Marks)

After A is released, the helicopter continues to rise with a different constant acceleration. When it is at a height of 350m and rising with a speed of 15m/s, a second object B is released.

- (iii) Show that B takes 10s to reach the ground. (5 Marks)
- (iv) Find the time that elapses between the impacts of A and B on the ground. (6 Marks)

QUESTION THREE (20 MARKS)

- (a) Distinguish between vector and scalar quantities. (2 marks)
 - (b) A particle of mass m kg accelerates at $a \text{ ms}^{-2}$ due to an application of a force F N such that its velocity changes from the initial value V_0 to a final value V after t seconds. Show that $a = \frac{v^2 - v_0^2}{2s}$ where S is the displacement. (10 marks)
 - (c) A stone is dropped from a tower 125m high. When it has fallen through 20m, a second stone is thrown vertically downwards with a speed $u \text{ ms}^{-1}$ from the top of the tower. If both stones reach the ground at the same time, calculate the velocity with which the second stone hits the ground. (8 marks)
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