

CHUKA



UNIVERSITY

UNIVERSITY SUPPLEMENTARY/SPECIAL EXAMINATIONS.

FIRST YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN PHYSICS

MATH 113/123: VECTORS AND MECHANICS

STREAMS:

TIME: 2 HOURS

DAY/DATE: THURSDAY 13/09/2018

8.30 A.M - 10.30 A.M

QUESTION ONE – [30 MARKS]

(a) (i) If $\vec{AB}=\vec{a}$ and $\vec{AC}=\vec{b}$, show that the area of the triangle ABC is given by Area=

$$\frac{1}{2} \sqrt{ab^2 - a \cdot b}$$

[4 Marks]

(ii) Hence or otherwise find the area of the triangle whose vertices are A(1,-1,3) , B(-1,1,3) and C(-2,1,1). [4 Marks]

(b) A particle moving in a straight line with constant acceleration travels 10m in the first second and 15m in the second second. Find:

(i) the initial velocity and the acceleration. [4 Marks]

(ii) the distance travelled in the third second. [4 Marks]

(c) Given $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c}$, show that \vec{a} is perpendicular to $\vec{b} - \vec{c}$. [4 Marks]

(d) The resultant of two forces 4P and 5P acting at a point is $\sqrt{11}$ P. Find:

(i) the angle between the forces [4 Marks]

(ii) the direction of the resultant to the horizontal [4 Marks]

(iii) the line of action of the resultant. [2 Marks]

QUESTION TWO - [20 MARKS]

- (a) State without proof Lami's theorem. [2 Marks]
- (b) A particle of mass 3kg is held in equilibrium on a smooth plane of angle 36° to the horizontal by the force \mathbf{P} Newton acting at an angle of 48° to the plane. Find the value of \mathbf{P} and the normal reaction of the plane on the particle. [5 Marks]
- (c) If \mathbf{a} and \mathbf{b} are two non-zero vectors, show that vector addition is commutative. [5 Marks]
- (d) A particle moving in a straight line with constant acceleration travels 10m in the first second and 15m in the second second. Find:
- (i) the initial velocity and the acceleration. [4 Marks]
 - (ii) the distance travelled in the third second. [4 Marks]

QUESTION THREE - [20 MARKS]

- (a) 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 $g = \frac{10\text{ m}}{\text{s}^2}$, calculate:
- (i) The initial velocity of A. [4 Marks]
 - (ii) The time that A takes to reach the ground. [6 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.
- (i) Show that B takes 10s to reach the ground. [4 Marks]
 - (ii) Find the time that elapses between the impacts of A and B on the ground. [6 Marks]
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