UNIVERSITY
OF
JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT: **PURE AND APPLIED MATHEMATICS**

MODULE: **APM1EB1** (Pre-2017 code: APM1A1E)
VECTOR ALGEBRA AND VECTOR GEOMETRY

CAMPUS: **AUCKLAND PARK KINGSWAY**

SSA EXAM

DATE:JANUARY 2019 **DURATION: 120 MINUTES**
ASSESSOR: **MR JM HOMANN**
MODERATOR: **DR GJ KEMP**
MARKS: 50

Instructions and remarks:

1. This question paper consists of 1 page(s), excluding this one.
2. Vectors are indicated throughout by the bar notation. For example, $\overline{a}$.
3. You will be penalised if you fail to distinguish between vectors and scalars by means of notation.
4. You will be penalised if you do not use the same notation as described in each question.
5. The use of pocket calculators is permitted.
6. You may answer the questions in any order, however you must clearly indicate the question number. Furthermore, rule off after each question.
7. Only use vector algebraic methods for solving these problems. Do not assume any geometrical results which are not given in a problem. You may, however, assume the result of V1.6.3 as a given.

QUESTION 1 [10 MARKS]

Correct to one tenth of a second, what is the period of the Earth's rotation about its own axis (1 Earth year = 365.25637 days)?

QUESTION 2 [10 MARKS]

The methane molecule (CH_4) has a tetrahedral configuration: the C-atom is at the centre of a cube and the four H-atoms are situated at corners of the cube in such a way that the distances between them are maximal. Determine the angle subtended at the C-atom by any two H-atoms.

QUESTION 3 [10 MARKS]

Show that the internal bisector of an angle of a triangle divides the opposite side in the ratio of the other two sides.

QUESTION 4 [10 MARKS]

Use the vector product to prove the law of sines for a triangle.

QUESTION 5 [10 MARKS]

Solve the following equation for $\overline{r}$:

$$\overline{r} \cdot \overline{a} = \alpha,$$
$$\overline{r} \times \overline{b} = \overline{c}, \text{ and}$$
$$\overline{a} \cdot \overline{b} = 0.$$

You may find the following identity helpful:

$$\overline{d} \times (\overline{e} \times \overline{f}) = (\overline{d} \cdot \overline{f})\,\overline{e} - (\overline{d} \cdot \overline{e})\,\overline{f}.$$