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TUTGATHER PRACTICE PAPER

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2027

MATHEMATICS Extended Part Module M2
PAPER

Question-Answer Book

Candidate Number

TUTGATHER
PRACTICE PAPER · NOT AN OFFICIAL HKEAA PAPER

1 hour 5 minutes

This paper must be answered in English

Topic practice: Scalar Product and Vector Product

INSTRUCTIONS

(1) This paper consists of THREE sections, A(1), A(2) and B.

(2) Attempt ALL questions in this paper. Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins.

(3) Unless otherwise specified, all working must be clearly shown.

(4) Unless otherwise specified, numerical answers should be either exact or correct to 3 significant figures.

(5) The diagrams in this paper are not necessarily drawn to scale.

(6) Calculators and mathematical drawing instruments may be used.

(7) The marks for each question are shown in brackets.

(8) No extra time will be given after the 'Time is up' announcement.

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SECTION A(1) (16 marks)

1. It is given that $\boldsymbol{a} = 2\boldsymbol{i} - \boldsymbol{j} + 3\boldsymbol{k}$ and $\boldsymbol{b} = \boldsymbol{i} + 4\boldsymbol{j} - 2\boldsymbol{k}$. Find $\boldsymbol{a} \cdot \boldsymbol{b}$ and hence find the angle between $\boldsymbol{a}$ and $\boldsymbol{b}$, giving your answer correct to 3 significant figures. **(3 marks)**

2. Let $\boldsymbol{p} = 3\boldsymbol{i} + \boldsymbol{j} - 2\boldsymbol{k}$ and $\boldsymbol{q} = \boldsymbol{i} - 2\boldsymbol{j} + \boldsymbol{k}$. Find $\boldsymbol{p} \times \boldsymbol{q}$ and verify that the result is perpendicular to both $\boldsymbol{p}$ and $\boldsymbol{q}$. **(3 marks)**

3. A triangle ABC has $\vec{AB} = 2\boldsymbol{i} + 3\boldsymbol{j} - \boldsymbol{k}$ and $\vec{AC} = \boldsymbol{i} - \boldsymbol{j} + 2\boldsymbol{k}$. Find the area of triangle ABC. **(4 marks)**

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4. Let $u = i + 2j + 2k$ and $v = 2i - j + 2k$. **(6 marks)**

(a) Find the projection of u onto v (as a vector).

(b) Find the shortest distance from the point $P(1, 2, 2)$ to the line L through the origin with direction v.

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SECTION A(2) (24 marks)

5. The points $A(1, 0, 2)$, $B(3, 1, 1)$ and $C(0, 2, 4)$ are given. **(7 marks)**

(a) Find $\vec{AB} \times \vec{AC}$.

(b) Hence find the area of triangle ABC.

(c) Find a unit vector perpendicular to the plane ABC.

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6. A parallelepiped has three edges emanating from a vertex given by $a = i + j$, $b = j + k$ and $c = i + k$. **(8 marks)**

(a) Find the volume of the parallelepiped.

(b) Find the area of the face spanned by a and b.

(c) Hence find the perpendicular distance between that face and the opposite parallel face.

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7. The line L_1 passes through $A(1, 2, 3)$ with direction $d_1 = i - j + 2k$, and the line L_2 passes through $B(2, 0, 1)$ with direction $d_2 = 2i + j - k$. **(9 marks)**

(a) Show that L_1 and L_2 are not parallel and find $d_1 \times d_2$.

(b) Find the shortest distance between the two skew lines.

(c) Find the acute angle between L_1 and L_2.

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SECTION B (10 marks)

8. Let a, b, c be non-zero vectors in three dimensions. **(10 marks)**

(a) Prove the vector triple product identity $a \times (b \times c) = (a \cdot c)b - (a \cdot b)c$ by taking $a = i$, $b = j$, $c = k$ and then stating the general result.

(b) Using (a), show that $a \times (b \times c) + b \times (c \times a) + c \times (a \times b) = 0$.

(c) Given $a = i + j$, $b = j + k$, $c = i + k$, verify the identity in (b) by direct computation.

END OF PAPER

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