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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: Applications of Vectors

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. The plane Π has equation $2x - y + 3z = 6$. The line L passes through the point $A(1, -1, 2)$ and is perpendicular to Π. **(3 marks)**

   (a) Write down a direction vector of L.
   (b) Find the coordinates of the point where L meets Π.

2. Let $a = i + 2j - k$ and $b = 2i - j + 3k$. **(3 marks)**

   (a) Find $a \times b$.
   (b) Hence find the area of the parallelogram with adjacent sides a and b.

3. A force $F = 3i + 4j$ (in newtons) acts on a particle which moves in a straight line from $A(1, 1)$ to $B(4, 5)$ (distances in metres). **(4 marks)**

   (a) Find the displacement vector $\vec{AB}$.
   (b) Find the work done by F in moving the particle from A to B.

Answers written in the margins will not be marked.
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4. The plane Π_1 has equation $x + 2y - 2z = 3$ and the plane Π_2 has equation $2x - y + 2z = 1$. **(6 marks)**

(a) Find the acute angle between Π_1 and Π_2.

(b) Find a vector equation of the line of intersection of Π_1 and Π_2.

(c) Find the shortest distance from the point $P(1, 1, 1)$ to Π_1.

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SECTION A(2) (24 marks)

5. Let $\boldsymbol{a}$ and $\boldsymbol{b}$ be non-zero vectors with $|\boldsymbol{a}| = 2$, $|\boldsymbol{b}| = 3$ and $\boldsymbol{a} \cdot \boldsymbol{b} = 4$. **(7 marks)**

(a) Find $|\boldsymbol{a} + \boldsymbol{b}|$ and $|\boldsymbol{a} - \boldsymbol{b}|$.

(b) Find the angle between $\boldsymbol{a} + \boldsymbol{b}$ and $\boldsymbol{a} - \boldsymbol{b}$, giving your answer correct to 3 significant figures.

(c) Show that $(\boldsymbol{a} + \boldsymbol{b}) \times (\boldsymbol{a} - \boldsymbol{b})$ is parallel to $\boldsymbol{a} \times \boldsymbol{b}$.

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6. In a triangle OAB, $\vec{OA} = a$ and $\vec{OB} = b$. The point M is the midpoint of OA and the point N lies on AB such that $AN : NB = 2 : 1$. The lines OM... (note OM is just the segment OA) — instead, the lines BN... **(8 marks)**

Use this corrected statement: The lines MN and OB produced meet at the point P.

(a) Express $\vec{MN}$ in terms of a and b.
(b) Given that $\vec{OP} = k\,b$, find the value of k.
(c) Find the ratio $MN : NP$.

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7. **(9 marks)**

The line L has equation $\mathbf{r} = \begin{pmatrix} 1 \\ 0 \\ 2 \end{pmatrix} + t\begin{pmatrix} 2 \\ 1 \\ -1 \end{pmatrix}$, and the plane Π has equation $3x - y + 2z = 7$.

(a) Show that L is not parallel to Π and find the point of intersection Q of L and Π.

(b) Find the acute angle between L and Π, correct to 3 significant figures.

(c) The point $A(1, 0, 2)$ lies on L. Find the shortest distance from A to Π, and hence find the distance from A to Q.

(d) Find the coordinates of the foot of the perpendicular from A to Π.

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SECTION B (10 marks)

8. Let a, b, c be position vectors of the points A, B, C with respect to the origin O, where a, b are not parallel. **(10 marks)**

(a) The point D is defined by $\vec{OD} = a + b$ and the point E by $\vec{OE} = 2a - b$. Show that A, B, E are collinear and state the ratio $AE : EB$.

(b) The lines CD and OE meet at X. Given that $\vec{OX} = s\,\vec{OE}$ and $\vec{CX} = t\,\vec{CD}$, express c in terms of a, b, s and t, and deduce that $s = t$.

(c) Hence, given further that $c = a + 3b$, find the values of s and t, and the ratio $CX : XD$.

END OF PAPER

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