

Math SL EXPLORATION LAB 10

In this assignment, you will be review basic work with vectors.

PART A - Calc Inactive

1. [Maximum mark: 6]

Consider the vectors $\mathbf{a} = \begin{pmatrix} 2 \\ -3 \end{pmatrix}$ and $\mathbf{b} = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$.

(a) Find

(i) $2\mathbf{a} + \mathbf{b}$;

(ii) $|2\mathbf{a} + \mathbf{b}|$.

[4 marks]

Let $2\mathbf{a} + \mathbf{b} + \mathbf{c} = \mathbf{0}$, where $\mathbf{0}$ is the zero vector.

(b) Find \mathbf{c} .

[2 marks]

4. [Maximum mark: 7]

The line L is parallel to the vector $\begin{pmatrix} 3 \\ 2 \end{pmatrix}$.

(a) Find the gradient of the line L .

[2]

The line L passes through the point $(9, 4)$.

(b) Find the equation of the line L in the form $y = ax + b$.

[3]

(c) Write down a vector equation for the line L .

[2]

6. [Maximum mark: 8]

The line L passes through the point $(5, -4, 10)$ and is parallel to the vector $\begin{pmatrix} 4 \\ -2 \\ 5 \end{pmatrix}$.

(a) Write down a vector equation for line L .

[2 marks]

(b) The line L intersects the x -axis at the point P . Find the x -coordinate of P .

[6 marks]

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8. [Maximum mark: 17]

The line L_1 passes through the points $A(2, 1, 4)$ and $B(1, 1, 5)$.

(a) Show that $\vec{AB} = \begin{pmatrix} -1 \\ 0 \\ 1 \end{pmatrix}$. [1]

(b) Hence, write down

(i) a direction vector for L_1 ;

(ii) a vector equation for L_1 . [3]

Another line L_2 has equation $\mathbf{r} = \begin{pmatrix} 4 \\ 7 \\ -4 \end{pmatrix} + s \begin{pmatrix} 0 \\ -1 \\ 1 \end{pmatrix}$. The lines L_1 and L_2 intersect at the point P.

(c) Find the coordinates of P. [6]

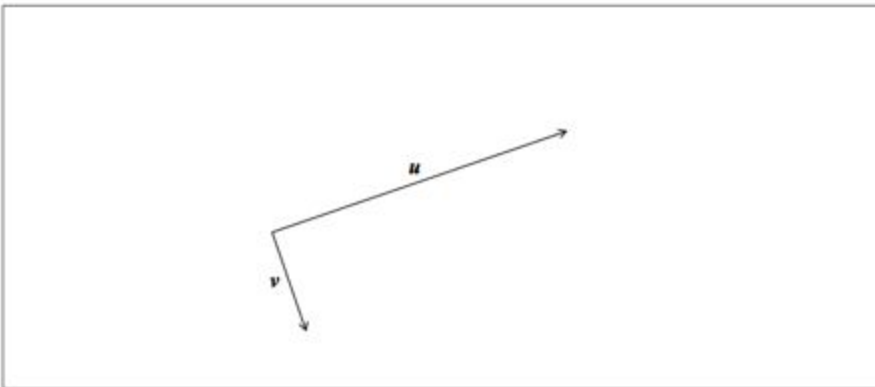
(d) (i) Write down a direction vector for L_2 .

(ii) Hence, find the angle between L_1 and L_2 . [7]

PART B - Calc Active

4. [Maximum mark: 6]

The following diagram shows two perpendicular vectors \mathbf{u} and \mathbf{v} .



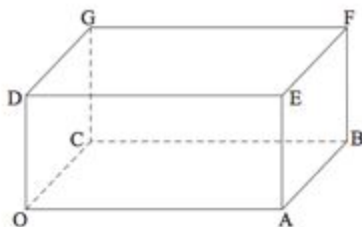
(a) Let $\mathbf{w} = \mathbf{u} - \mathbf{v}$. Represent \mathbf{w} on the diagram above. [2]

(b) Given that $\mathbf{u} = \begin{pmatrix} 3 \\ 2 \\ 1 \end{pmatrix}$ and $\mathbf{v} = \begin{pmatrix} 5 \\ n \\ 3 \end{pmatrix}$, where $n \in \mathbb{Z}$, find n . [4]

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8. [Maximum mark: 16]

The following diagram shows the cuboid (rectangular solid) OABCDEFG, where O is the origin, and $\vec{OA} = 4\mathbf{i}$, $\vec{OC} = 3\mathbf{j}$, $\vec{OD} = 2\mathbf{k}$.



- (a) (i) Find \vec{OB} .
- (ii) Find \vec{OF} .
- (iii) Show that $\vec{AG} = -4\mathbf{i} + 3\mathbf{j} + 2\mathbf{k}$. [5 marks]
- (b) Write down a vector equation for
- (i) the line OF;
- (ii) the line AG. [4 marks]
- (c) Find the obtuse angle between the lines OF and AG. [7 marks]

1. In this question, distance is in metres.

Toy airplanes fly in a straight line at a constant speed. Airplane 1 passes through a point A.

Its position, p seconds after it has passed through A, is given by
$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 3 \\ -4 \\ 0 \end{pmatrix} + p \begin{pmatrix} -2 \\ 3 \\ 1 \end{pmatrix}$$

- (a) (i) Write down the coordinates of A.
- (ii) Find the speed of the airplane in m s^{-1} . (4)

- (b) After seven seconds the airplane passes through a point B.
- (i) Find the coordinates of B.
- (ii) Find the distance the airplane has travelled during the seven seconds. (5)

(c) Airplane 2 passes through a point C. Its position q seconds after it passes through C is

given by
$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 2 \\ -5 \\ 8 \end{pmatrix} + q \begin{pmatrix} -1 \\ 2 \\ a \end{pmatrix}, a \in \mathbb{R}.$$

The angle between the flight paths of Airplane 1 and Airplane 2 is 40° . Find the two values of a .

(7)
(Total 16 marks)