Lower 6 Chapter 11

Vectors

Chapter Overview

1. Add/scale factors and show vectors are parallel.
2. Calculate magnitude and direction of a vector.
3. Understand and use position vectors.
4. Solve geometric problems.
5. Understand speed vs velocity.

9 **Vectors**	9.1	Use vectors in two dimensions.	Students should be familiar with column vectors and with the use of $\mathbf{i}$, and $\mathbf{j}$ unit vectors.
	9.2	Calculate the magnitude and direction of a vector and convert between component form and magnitude/direction form.	Students should be able to find a unit vector in the direction of $\mathbf{a}$, and be familiar with the notation $\lvert\mathbf{a}\rvert$
	9.3	Add vectors diagrammatically and perform the algebraic operations of vector addition and multiplication by scalars, and understand their geometrical interpretations.	The triangle and parallelogram laws of addition. Parallel vectors.
	9.4	Understand and use position vectors; calculate the distance between two points represented by position vectors.	$\overrightarrow{OB} - \overrightarrow{OA} = \overrightarrow{AB} = \mathbf{b} - \mathbf{a}$ The distance d between two points (x_1, y_1) and (x_2, y_2) is given by $d^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2$
	9.5	Use vectors to solve problems in pure mathematics and in context, (including forces).	For example, finding position vector of the fourth corner of a shape (e.g. parallelogram) $ABCD$ with three given position vectors for the corners A, B and C finding position vector of a point C on a line through A and B dividing AB in a given ratio, where position vectors of A and B are given. Contexts such as velocity, displacement, kinematics and forces will be covered in Paper 3, Sections 6.1, 7.3 and 8.1–8.4

Vector basics

Whereas a **coordinate** represents a **position** in space, a **vector** represents a **displacement** in space.

- A vector has 2 properties:
  - <u>Direction</u>
  - <u>Magnitude</u> (i.e. length)

If P and Q are points then $\overrightarrow{PQ}$ is the vector between them.

- If two vectors $\overrightarrow{PQ}$ and $\overrightarrow{RS}$ have the same magnitude and direction, **they're the same vector** and are **parallel**.

- $\overrightarrow{AB} = -\overrightarrow{BA}$ and the two vectors are parallel, equal in magnitude but in **opposite directions**.

- Triangle Law for vector addition:

$$\overrightarrow{AB} + \overrightarrow{BC} = \overrightarrow{AC}$$

The vector of multiple vectors is known as the **resultant vector.** (you will encounter this term in Mechanics)

- Vector **subtraction** is defined using vector addition and negation:
$$\boldsymbol{a}-\boldsymbol{b}=\boldsymbol{a}+(-\boldsymbol{b})$$

- The zero vector $\mathbf{0}$ (a bold 0), represents no movement.

$$\overrightarrow{PQ}+\overrightarrow{QP}=\mathbf{0}$$

In 2D: $\mathbf{0}=\begin{pmatrix}0\\0\end{pmatrix}$

- A **scalar** is a normal number, which can be used to 'scale' a vector.
  - The **direction** will be the **same**.
  - But the **magnitude** will be **different** (unless the scalar is 1).

- Any vector parallel to the vector $\boldsymbol{a}$ can be written as $\lambda\boldsymbol{a}$, where λ is a scalar.

  The implication is that if we can write one vector **as a multiple of** another, then we can show they are parallel.

Example

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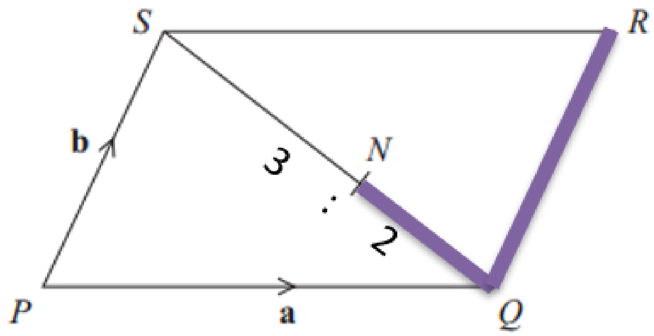

PQRS is a parallelogram.
N is the point on *SQ* such that $SN : NQ = 3 : 2$
$\overrightarrow{PQ} = \mathbf{a}$ $\quad \overrightarrow{PS} = \mathbf{b}$

(a) Write down, in terms of **a** and **b**, an expression for $\overrightarrow{SQ}$.

(b) Express $\overrightarrow{NR}$ in terms of **a** and **b**.

Test your understanding

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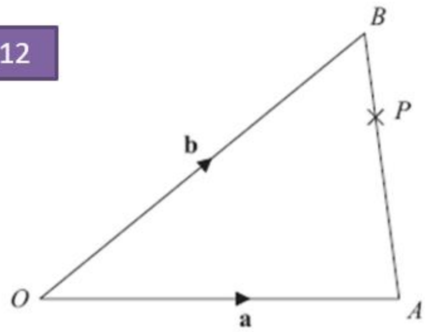

Diagram **NOT** accurately drawn

OAB is a triangle.

$\overrightarrow{OA} = \mathbf{a}$
$\overrightarrow{OB} = \mathbf{b}$

(a) Find $\overrightarrow{AB}$ in terms of **a** and **b**.

....
(1)

P is the point on *AB* such that $AP : PB = 3 : 1$

(b) Find $\overrightarrow{OP}$ in terms of **a** and **b**.
Give your answer in its simplest form.

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Exercise 11A Pg 234/235