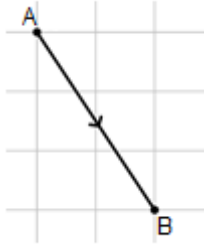
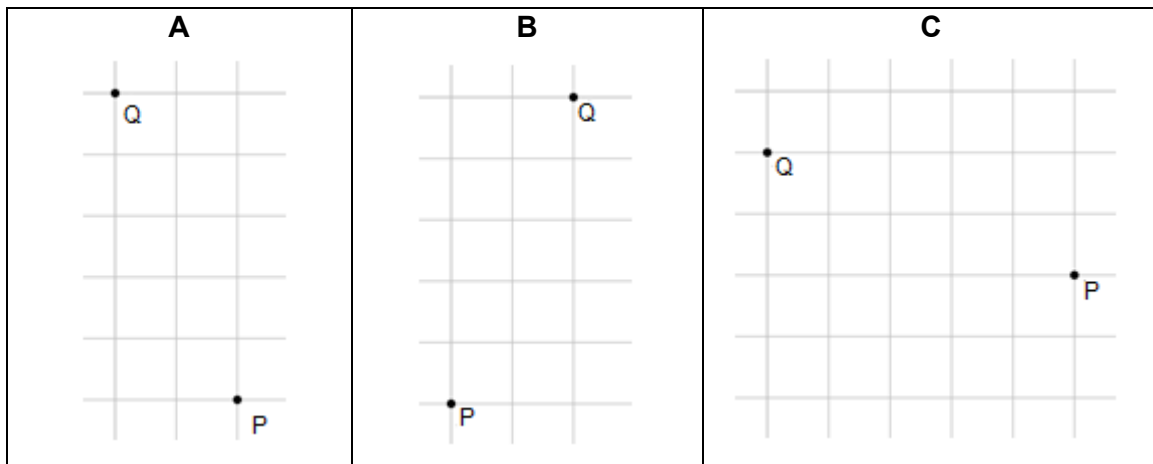


## Foundation Check In - 9.03 Plane vector geometry

1. Write the vector  $\overline{AB}$  as a column vector.



2. Which of these diagrams represents  $\overline{QP} = \begin{pmatrix} -2 \\ -5 \end{pmatrix}$ ?



3. Calculate  $\begin{pmatrix} 9 \\ -6 \end{pmatrix} - \begin{pmatrix} -4 \\ 4 \end{pmatrix}$ .
4. If  $\overline{AB} = \begin{pmatrix} -4 \\ 6 \end{pmatrix}$ , what is  $\overline{BA}$  written as a column vector?
5.  $\mathbf{a} = \begin{pmatrix} -4 \\ 3 \end{pmatrix}$  and  $\mathbf{b} = \begin{pmatrix} -3 \\ -9 \end{pmatrix}$ . Work out  $2\mathbf{a} - \mathbf{b}$ .
6. The vector  $\mathbf{p} = \begin{pmatrix} 5 \\ 7 \end{pmatrix}$  represents a journey that ends 5 km east and 7 km north from a starting point. Describe the journey that the vector  $-\mathbf{p}$  represents.
7.  $\overline{AB} = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$ ,  $\overline{BC} = \begin{pmatrix} -1 \\ -2 \end{pmatrix}$ ,  $\overline{CD} = \begin{pmatrix} -3 \\ 1 \end{pmatrix}$  and  $\overline{DA} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$ . Show that ABCD is a quadrilateral.
8.  $\begin{pmatrix} a \\ -3 \end{pmatrix}$  is parallel to  $\begin{pmatrix} 28 \\ 12 \end{pmatrix}$ . Show that the value of  $a$  is  $-7$ .

# GCSE (9–1)

# MATHEMATICS

9. Find the value of  $x$  and  $y$ .

$$\begin{pmatrix} 3 \\ y \end{pmatrix} + 2 \begin{pmatrix} x \\ -5 \end{pmatrix} = \begin{pmatrix} 15 \\ -10 \end{pmatrix}$$

10. Find the value of  $a$  and  $b$ .

$$a \begin{pmatrix} 2 \\ 2 \end{pmatrix} + b \begin{pmatrix} 4 \\ -3 \end{pmatrix} = \begin{pmatrix} 32 \\ 11 \end{pmatrix}$$

## Extension

The quadrilateral in question 7 is a parallelogram. How can we show this using the four given vectors?

Is it also a rectangle? Draw it. Are you sure?

One way of testing if a parallelogram is a rectangle is to find the lengths of the inside diagonals from corner to corner; if they are equal in length it is a rectangle. What are the vectors of the inside diagonals  $\overline{AC}$  and  $\overline{BD}$ ? How could you work out how long these vectors are?

# GCSE (9–1) MATHEMATICS

## Answers

1.  $\begin{pmatrix} 2 \\ -3 \end{pmatrix}$

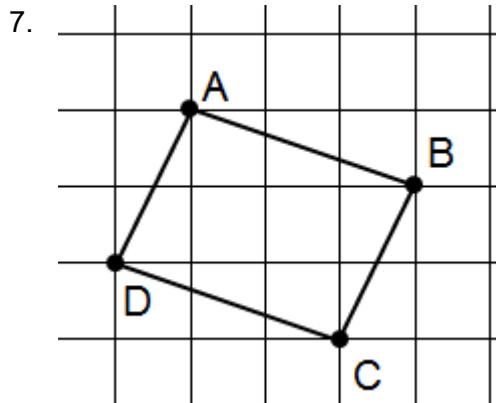
2. **B**

3.  $\begin{pmatrix} 9 \\ -6 \end{pmatrix} - \begin{pmatrix} -4 \\ 4 \end{pmatrix} = \begin{pmatrix} 9 - -4 \\ -6 - 4 \end{pmatrix} = \begin{pmatrix} 13 \\ -10 \end{pmatrix}$

4.  $\begin{pmatrix} 4 \\ -6 \end{pmatrix}$

5.  $\begin{pmatrix} -8 \\ 6 \end{pmatrix} - \begin{pmatrix} -3 \\ -9 \end{pmatrix} = \begin{pmatrix} -5 \\ 15 \end{pmatrix}$

6. 5 km west, 7 km south



Alternatively, without drawing, we know that each vector represents a straight line.  $\overline{AB} + \overline{BC} + \overline{CD} + \overline{DA} = 0$  so these vectors form a closed 4-sided shape. The shape is therefore a quadrilateral.

8. If  $\begin{pmatrix} a \\ -3 \end{pmatrix}$  is parallel to  $\begin{pmatrix} 28 \\ 12 \end{pmatrix}$ , then  $\begin{pmatrix} 28 \\ 12 \end{pmatrix}$  must be  $\begin{pmatrix} a \\ -3 \end{pmatrix}$  multiplied by a value.

$12 \div -3 = -4$ , so the value  $\begin{pmatrix} a \\ -3 \end{pmatrix}$  is multiplied by  $-4$ .  $28 \div -4 = a = -7$ .

9. The top row gives  $3 + 2x = 15$  so  $x = 6$ . The bottom row gives  $y + 2 \times -5 = -10$  so  $y = 0$ .

10. The vector equation could be represented by the simultaneous equations

$$2a + 4b = 32$$

$$2a - 3b = 11$$

Solving these gives  $a = 10$ ,  $b = 3$ .

# GCSE (9–1)

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## Extension

The quadrilateral is a parallelogram, since opposite sides (AB and DC, and AD and BC) are parallel.

Drawing a diagram may not convince you about whether it is a rectangle: it looks quite 'rectangle like' (the inside angles are approximately 82 and 98 degrees).

The diagonals are  $\overline{AC} = \begin{pmatrix} 2 \\ -3 \end{pmatrix}$  and  $\overline{BD} = \begin{pmatrix} -4 \\ -1 \end{pmatrix}$ . We can work out the lengths of these

vectors by using Pythagoras' theorem. The length of  $\overline{AC}$  is  $\sqrt{2^2 + (-3)^2} = \sqrt{13} = 3.61$ . The length of  $\overline{BD}$  is  $\sqrt{(-4)^2 + (-1)^2} = \sqrt{17} = 4.12$ . Since the diagonals are not equal in length, this parallelogram cannot be a rectangle.

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# GCSE (9–1)

# MATHEMATICS

Assessment Objective	Qu.	Topic	R	A	G
AO1	1	Represent a 2-dimensional vector as a column vector			
AO1	2	Recognise representation of a column vector on a square grid			
AO1	3	Subtract column vectors			
AO1	4	Understand reverse vectors			
AO1	5	Calculate with column vectors			
AO2	6	Represent a 2-dimensional vector in a navigation context			
AO2	7	Interpret column vectors			
AO2	8	Understand scalar multiplication of vectors			
AO3	9	Find two unknowns in a vector equation			
AO3	10	Solve simultaneous equations in vector form			

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