Higher Check In - 9.03 Plane vector geometry

In questions 1 and 2, ,  and .

1. Work out .
2. Work out .
3. Point A has coordinates (7, 4). Point B has coordinates (11, –4). Work out .
4. A and B are the centres of the two regular congruent hexagons shown below. Express  in terms of **p** and **q**.



**Not to scale**

1. A and B are the points such that  and  M is the midpoint of line AB. Find the vector .
2. Explain how you can determine that the vectors  and  are parallel without needing to draw them.
3. ,  and . Show that A, B and C are points on a single straight line.
4. ABC and APQ are triangles. B is the midpoint of AP and C is the midpoint of AQ.  and . Prove that  is parallel to .

**c**

**b**

C

Q

B

A

**Not to scale**

P

1.  and . Work out **c** if 
2. On the diagram below, and . B is the point on line AC such that

AB : BC  3 : 2. Express  in terms of **a** and **c**.

O

**Not to scale**

2**c**

5**a**

C

B

A

**Extension**

The diagonals of a parallelogram bisect each other (i.e. the diagonals cross so that they meet at their midpoints: this cuts each diagonal into two parts of equal length). Use vector methods to prove that this is always true for a parallelogram.

Answers

1. 
2. 
3. 
4. 
5. .

.

Alternatively, the coordinates of A and B could be used to find the midpoint (–2, –3.5) which could then be converted to a position vector.

1. Since  one of the vectors is a scalar multiple of the other and therefore they are parallel.
2. . . Since  then  is parallel to . As they share a common point (B), the three points ABC must be on a single straight line.
3. .  and , so . Since  then  is parallel to .
4. Dividing  by 3 gives  so .
5. . . . .

**Extension**

The opposite sides of a parallelogram are equal in length and parallel, therefore they can be represented by the same vector.

**b**

**a**

S

R

Q

P

**a**

**b**

**Not to scale**

Diagonal  and diagonal . Since these diagonals are not parallel, they will cross at a point. If X is the point where they cross, we can describe  by  and also by  where *r* and *s* are fractions. Since these describe the same journey, they are equal so .

Comparing the coefficients of **a** on each side we get  (this tells us they cross the same fraction along each diagonal, although we do not yet know what fraction.)

Comparing the coefficients of **b** on each side we get . Since  we have  so  and .

Therefore the point where the two diagonals meet is halfway along each diagonal i.e. the diagonals bisect each other.

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| **Assessment Objective** | **Qu.** | **Topic** | **R** | **A** | **G** |  | **Assessment Objective** | **Qu.** | **Topic** | **R** | **A** | **G** |
| AO1 | 1 | Carry out arithmetic with vectors |  |  |  |  | AO1 | 1 | Carry out arithmetic with vectors |  |  |  |
| AO1 | 2 | Carry out arithmetic with vectors |  |  |  |  | AO1 | 2 | Carry out arithmetic with vectors |  |  |  |
| AO1 | 3 | Find a vector |  |  |  |  | AO1 | 3 | Find a vector |  |  |  |
| AO1 | 4 | Use vectors in geometric arguments |  |  |  |  | AO1 | 4 | Use vectors in geometric arguments |  |  |  |
| AO1 | 5 | Use vectors to find a midpoint |  |  |  |  | AO1 | 5 | Use vectors to find a midpoint |  |  |  |
| AO2 | 6 | Use vector methods to show two vectors are parallel |  |  |  |  | AO2 | 6 | Use vector methods to show two vectors are parallel |  |  |  |
| AO2 | 7 | Use vectors to prove three points are on a single straight line |  |  |  |  | AO2 | 7 | Use vectors to prove three points are on a single straight line |  |  |  |
| AO2 | 8 | Use vectors in a geometric proof |  |  |  |  | AO2 | 8 | Use vectors in a geometric proof |  |  |  |
| AO3 | 9 | Solve a problem involving vectors |  |  |  |  | AO3 | 9 | Solve a problem involving vectors |  |  |  |
| AO3 | 10 | Use vectors in geometric arguments |  |  |  |  | AO3 | 10 | Use vectors in geometric arguments |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
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| AO2 | 6 | Use vector methods to show two vectors are parallel |  |  |  |  | AO2 | 6 | Use vector methods to show two vectors are parallel |  |  |  |
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| AO2 | 8 | Use vectors in a geometric proof |  |  |  |  | AO2 | 8 | Use vectors in a geometric proof |  |  |  |
| AO3 | 9 | Solve a problem involving vectors |  |  |  |  | AO3 | 9 | Solve a problem involving vectors |  |  |  |
| AO3 | 10 | Use vectors in geometric arguments |  |  |  |  | AO3 | 10 | Use vectors in geometric arguments |  |  |  |