5 A plane flies from an airport A to an airport B. The position vector of B relative to A is $(1200\mathbf{i} + 240\mathbf{j})$ km, where $\mathbf{i}$ is a unit vector due east and $\mathbf{j}$ is a unit vector due north. Because of the constant wind which is blowing, the flight takes 4 hours. The velocity in still air of the plane is $(250\mathbf{i} + 160\mathbf{j})$ kmh^{-1}. Find the speed of the wind and the bearing of the direction from which the wind is blowing. [6]

4 An ocean liner is travelling at 36 km h^{-1} on a bearing of 090°. At 0600 hours the liner, which is 90 km from a lifeboat and on a bearing of 315° from the lifeboat, sends a message for assistance. The lifeboat sets off immediately and travels in a straight line at constant speed, intercepting the liner at 0730 hours. Find the speed at which the lifeboat travels. [5]

2 The position vectors of points A and B, relative to an origin O, are $6\mathbf{i} - 3\mathbf{j}$ and $15\mathbf{i} + 9\mathbf{j}$ respectively.

(i) Find the unit vector parallel to $\overrightarrow{AB}$. [3]

The point C lies on AB such that $\overrightarrow{AC} = 2\overrightarrow{CB}$.

(ii) Find the position vector of C. [3]

To a cyclist travelling due south on a straight horizontal road at 7 ms^{-1}, the wind appears to be blowing from the north-east. Given that the wind has a constant speed of 12 ms^{-1}, find the direction from which the wind is blowing. [5]

1 The position vectors of the points A and B, relative to an origin O, are $\mathbf{i} - 7\mathbf{j}$ and $4\mathbf{i} + k\mathbf{j}$ respectively, where k is a scalar. The unit vector in the direction of $\overrightarrow{AB}$ is $0.6\mathbf{i} + 0.8\mathbf{j}$. Find the value of k. [4]

4 The position vectors of points A and B relative to an origin O are $-3\mathbf{i} - \mathbf{j}$ and $\mathbf{i} + 2\mathbf{j}$ respectively. The point C lies on AB and is such that $\overrightarrow{AC} = \frac{3}{5}\overrightarrow{AB}$. Find the position vector of C and show that it is a unit vector. [6]

9 A plane, whose speed in still air is 300 km h^{-1}, flies directly from X to Y. Given that Y is 720 km from X on a bearing of 150° and that there is a constant wind of 120 km h^{-1} blowing towards the west, find the time taken for the flight. [7]

9 At 10 00 hours, a ship P leaves a point A with position vector $(-4\mathbf{i} + 8\mathbf{j})$ km relative to an origin O, where $\mathbf{i}$ is a unit vector due East and $\mathbf{j}$ is a unit vector due North. The ship sails north-east with a speed of $10\sqrt{2}$ km h^{-1}. Find

(i) the velocity vector of P, [2]

(ii) the position vector of P at 12 00 hours. [2]

At 12 00 hours, a second ship Q leaves a point B with position vector $(19\mathbf{i} + 34\mathbf{j})$ km travelling with velocity vector $(8\mathbf{i} + 6\mathbf{j})$ km h^{-1}.

(iii) Find the velocity of P relative to Q. [2]

(iv) Hence, or otherwise, find the time at which P and Q meet and the position vector of the point where this happens. [3]

10 In this question, **i** is a unit vector due east and **j** is a unit vector due north.

At 0900 hours a ship sails from the point P with position vector $(2\mathbf{i} + 3\mathbf{j})$ km relative to an origin O. The ship sails north-east with a speed of $15\sqrt{2}$ km h^{-1}.

(i) Find, in terms of **i** and **j**, the velocity of the ship. [2]

(ii) Show that the ship will be at the point with position vector $(24.5\mathbf{i} + 25.5\mathbf{j})$ km at 1030 hours. [1]

(iii) Find, in terms of **i**, **j** and t, the position of the ship t hours after leaving P. [2]

At the same time as the ship leaves P, a submarine leaves the point Q with position vector $(47\mathbf{i} - 27\mathbf{j})$ km. The submarine proceeds with a speed of 25 km h^{-1} due north to meet the ship.

(iv) Find, in terms of **i** and **j**, the velocity of the ship relative to the submarine. [2]

(v) Find the position vector of the point where the submarine meets the ship. [2]

3 Given that $\overrightarrow{OA} = \begin{pmatrix} -17 \\ 25 \end{pmatrix}$ and $\overrightarrow{OB} = \begin{pmatrix} 4 \\ 5 \end{pmatrix}$, find

(i) the unit vector parallel to $\overrightarrow{AB}$, [3]

(ii) the vector $\overrightarrow{OC}$, such that $\overrightarrow{AC} = 3\overrightarrow{AB}$. [2]

10 In this question, $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$ is a unit vector due east and $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$ is a unit vector due north.

A lighthouse has position vector $\begin{pmatrix} 27 \\ 48 \end{pmatrix}$ km relative to an origin O. A boat moves in such a way that its position vector is given by $\begin{pmatrix} 4 + 8t \\ 12 + 6t \end{pmatrix}$ km, where t is the time, in hours, after 1200.

(i) Show that at 1400 the boat is 25 km from the lighthouse. [4]

(ii) Find the length of time for which the boat is less than 25 km from the lighthouse. [4]

where n is a positive integer and $\binom{}{r} = \frac{n!}{(n-r)!r!}$.