1 The vectors **P**, **Q** and **R** are given by

$$\mathbf{P} = 5\mathbf{i} + 4\mathbf{j}, \quad \mathbf{Q} = 3\mathbf{i} - 5\mathbf{j}, \quad \mathbf{R} = -8\mathbf{i} + \mathbf{j}.$$

(i) Find the vector $\mathbf{P} + \mathbf{Q} + \mathbf{R}$. **[1]**

(ii) Interpret your answer to part **(i)** in the cases

(*A*) **P**, **Q** and **R** represent three forces acting on a particle, **[1]**

(*B*) **P**, **Q** and **R** represent three stages of a hiker's walk. **[1]**

2 The vectors **P**, **Q** and **R** are given by

$$\mathbf{P} = 5\mathbf{i} + 4\mathbf{j}, \quad \mathbf{Q} = 3\mathbf{i} - 5\mathbf{j}, \quad \mathbf{R} = -8\mathbf{i} + \mathbf{j}.$$

(i) Find the vector $\mathbf{P} + \mathbf{Q} + \mathbf{R}$. **[1]**

(ii) Interpret your answer to part **(i)** in the cases

(*A*) **P**, **Q** and **R** represent three forces acting on a particle, **[1]**

(*B*) **P**, **Q** and **R** represent three stages of a hiker's walk. **[1]**

3 In this question the unit vectors **i** and **j** are pointing east and north respectively.

(i) Calculate the bearing of the vector $-4\mathbf{i} - 6\mathbf{j}$. **[2]**

The vector $-4\mathbf{i} - 6\mathbf{j} + k(3\mathbf{i} - 2\mathbf{j})$ is in the direction $7\mathbf{i} - 9\mathbf{j}$.

(ii) Find k. **[4]**

4 A small box has weight **W** N and is held in equilibrium by two strings with tensions $\mathbf{T}_1$ N and $\mathbf{T}_2$ N. This situation is shown in Fig. 2 which also shows the standard unit vectors **i** and **j** that are horizontal and vertically upwards, respectively.

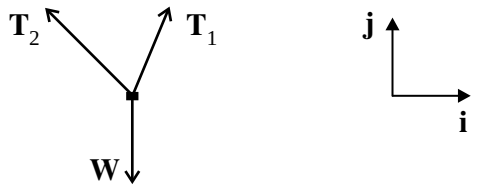

Fig. 2

The tension $\mathbf{T}_1$ is $10\mathbf{i} + 24\mathbf{j}$.

(i) Calculate the magnitude of $\mathbf{T}_1$ and the angle between $\mathbf{T}_1$ and the vertical. **[3]**

The magnitude of the weight is w N.

(ii) Write down the vector **W** in terms of w and **j**. **[1]**

The tension $\mathbf{T}_2$ is $k\mathbf{i} + 10\mathbf{j}$, where k is a scalar.

(iii) Find the values of k and of w. **[3]**

5 A particle has a position vector **r**, where $\mathbf{r} = 4\mathbf{i} - 5\mathbf{j}$ and **i** and **j** are unit vectors in the directions east and north respectively.

(i) Sketch **r** on a diagram showing **i** and **j** and the origin O. [1]

(ii) Calculate the magnitude of **r** and its direction as a bearing. [4]

(iii) Write down the vector that has the same direction as **r** and three times its magnitude. [1]

6 Force $\mathbf{F}_1$ is $\begin{pmatrix} 6 \\ 13 \end{pmatrix}$ N and force $\mathbf{F}_2$ is $\begin{pmatrix} 3 \\ 5 \end{pmatrix}$, where $\begin{pmatrix} \\ 0 \end{pmatrix}$ and $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$ are vectors east and north respectively.

(i) Calculate the magnitude of $\mathbf{F}_1$, correct to three significant figures. [2]

(ii) Calculate the direction of the force $\mathbf{F}_1 - \mathbf{F}_2$ as a bearing. [3]

Force $\mathbf{F}_2$ is the resultant of all the forces acting on an object of mass 5 kg.

(iii) Calculate the acceleration of the object and the change in its velocity after 10 seconds. [3]