1 Fig. 2 shows two forces acting at A. The figure also shows the perpendicular unit vectors **i** and **j** which are respectively horizontal and vertically upwards.

The resultant of the two forces is **F** N.

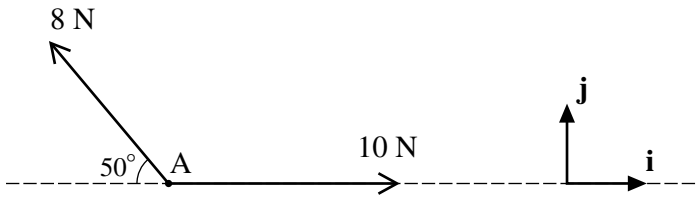

Fig. 1

(i) Find **F** in terms of **i** and **j**, giving your answer correct to three significant figures. **[3]**

(ii) Calculate the magnitude of **F** and the angle that **F** makes with the upward vertical. **[3]**

2 Force **F** is $\begin{pmatrix} 4 \\ 1 \\ 2 \end{pmatrix}$ N and force **G** is $\begin{pmatrix} -6 \\ 2 \\ 4 \end{pmatrix}$ N.

(i) Find the resultant of **F** and **G** and calculate its magnitude. [4]

(ii) Forces **F**, 2**G** and **H** act on a particle which is in equilibrium. Find **H**. [3]

3 A box of mass 5 kg is at rest on a rough horizontal floor.

(i) Find the value of the normal reaction of the floor on the box. [1]

The box remains at rest on the floor when a force of 10 N is applied to it at an angle of 40° to the upward vertical, as shown in Fig. 3.

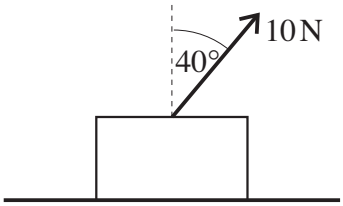

Fig. 3

(ii) Draw a diagram showing all the forces acting on the box. [2]

(iii) Calculate the new value of the normal reaction of the floor on the box and also the frictional force. [4]

4 Fig. 4 shows forces of magnitudes 20 N and 16 N inclined at 60°.

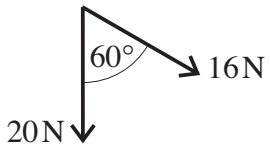

Fig. 4

(i) Calculate the component of the resultant of these two forces in the direction of the 20 N force. [1]

(ii) Calculate the magnitude of the resultant of these two forces. [3]

These are the only forces acting on a particle of mass 2 kg.

(iii) Find the magnitude of the acceleration of the particle and the angle the acceleration makes with the 20 N force. [3]

5 A particle is in equilibrium when acted on by the forces $\begin{pmatrix} x \\ -7 \\ z \end{pmatrix}$, $\begin{pmatrix} 4 \\ y \\ -5 \end{pmatrix}$ and $\begin{pmatrix} 5 \\ 4 \\ -7 \end{pmatrix}$, where the units are newtons.

(i) Find the values of x, y and z. [4]

(ii) Calculate the magnitude of $\begin{pmatrix} 5 \\ 4 \\ -7 \end{pmatrix}$. [2]

6 A small box B of weight 400 N is held in equilibrium by two light strings AB and BC. The string BC is fixed at C. The end A of string AB is fixed so that AB is at an angle α to the vertical where $\alpha < 60°$. String BC is at 60° to the vertical. This information is shown in Fig. 5.

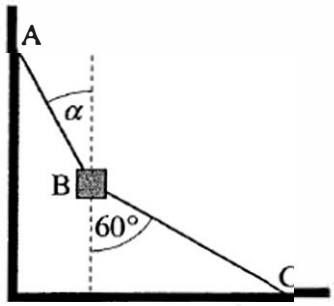

Fig. 5

(i) Draw a labelled diagram showing all the forces acting on the box. [1]

(ii) In one situation string AB is fixed so that $\alpha = 30°$.

By drawing a triangle of forces, or otherwise, calculate the tension in the string BC and the tension in the string AB. [4]

(iii) Show carefully, but briefly, that the box cannot be in equilibrium if $\alpha = 60°$ and BC remains at 60° to the vertical. [2]