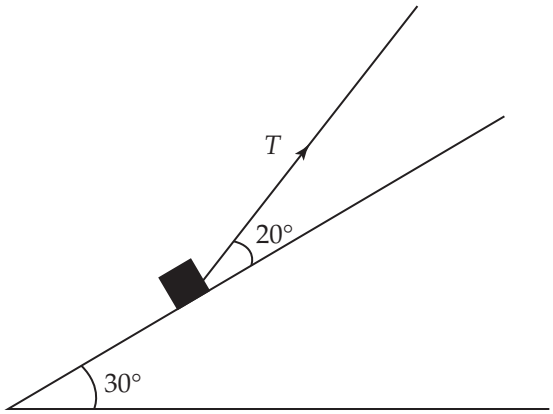
## Examination Exercise 4

1.




A box of mass 1.5 kg is placed on a plane which is inclined at an angle of 30° to the horizontal. The coefficient of friction between the box and the plane is $\frac{1}{3}$. The box is kept in equilibrium by a light string which lies in a vertical plane containing a line of greatest slope of the plane. The string makes an angle of 20° with the plane, as shown in the diagram. The box is in limiting equilibrium and is about to move up the plane. The tension in the string is $T$ newtons. The box is modelled as a particle.

Find the value of $T$. [E]

2. Two forces $\mathbf{F}_1 = (2\mathbf{i} + 3\mathbf{j})$ N and $\mathbf{F}_2 = (\lambda\mathbf{i} + \mu\mathbf{j})$ N, where $\lambda$ and $\mu$ are scalars, act on a particle. The resultant of the two forces is $\mathbf{R}$, where $\mathbf{R}$ is parallel to the vector $\mathbf{i} + 2\mathbf{j}$.

   (a) Find, to the nearest degree, the acute angle between the line of action of $\mathbf{R}$ and the vector $\mathbf{i}$.

   (b) Show that $2\lambda - \mu + 1 = 0$.

   Given that the direction of $\mathbf{F}_2$ is parallel to $\mathbf{j}$,

   (c) find, to 3 significant figures, the magnitude of $\mathbf{R}$. [E]

3. Three forces $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}_3$ act on a particle and

   $\mathbf{F}_1 = (-3\mathbf{i} + 7\mathbf{j})$ newtons, $\mathbf{F}_2 = (\mathbf{i} - \mathbf{j})$ newtons, $\mathbf{F}_3 = (p\mathbf{i} + q\mathbf{j})$ newtons.

   (a) Given that this particle is in equilibrium, determine the value of $p$ and the value of $q$.

   The resultant of the forces $\mathbf{F}_1$ and $\mathbf{F}_2$ is $\mathbf{R}$.

   (b) Calculate, in N, the magnitude of $\mathbf{R}$.

   (c) Calculate, to the nearest degree, the angle between the line of action of $\mathbf{R}$ and the vector $\mathbf{j}$. [E]