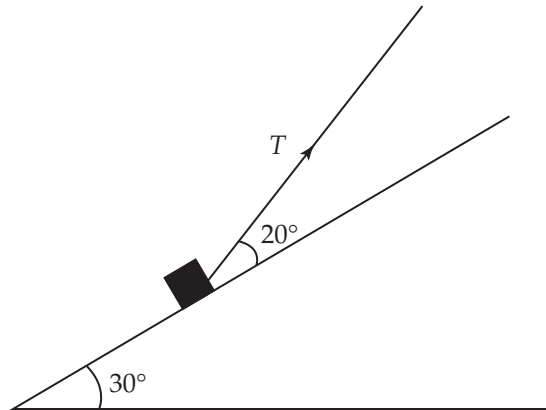


Examination Exercise 4

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 λ and μ 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]