

Force and Equilibrium

Question Paper

Level	Pre U
Subject	Maths
Exam Board	Cambridge International Examinations
Topic	Mechanics- Force and Equilibrium
Booklet	Question Paper

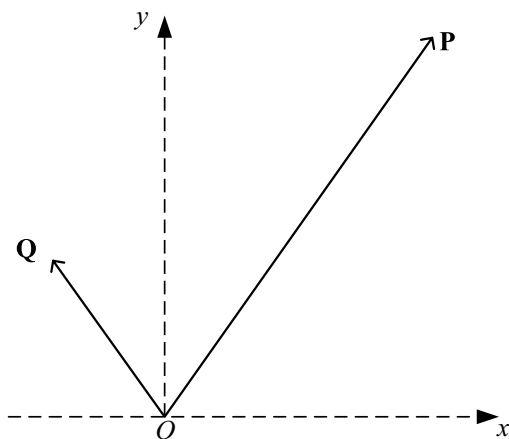
Time Allowed: 49 minutes

Score: /41

Percentage: /100

Grade Boundaries:

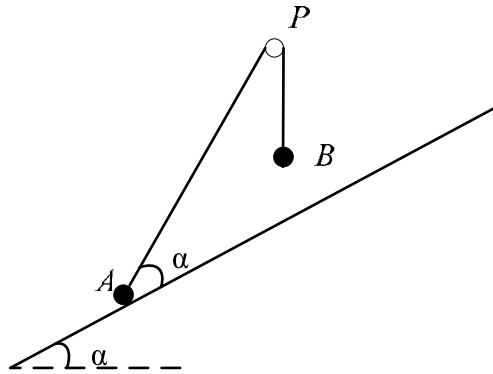
1



The diagram shows two horizontal forces **P** and **Q** acting at the origin O of rectangular coordinates Oxy . The components of **P** in the x - and y -directions are 12 N and 17 N respectively. The components of **Q** in the x - and y -directions are -5 N and 7 N respectively.

- (i) Write down the components, in the x - and y -directions, of the resultant of **P** and **Q**. [2]
- (ii) Hence, or otherwise, calculate the magnitude of this resultant and the angle the resultant makes with the positive x -axis. [4]

2



Particles A and B of masses $2m$ and m , respectively, are attached to the ends of a light inextensible string. The string passes over a smooth fixed pulley P . The particle A rests in equilibrium on a rough plane inclined at an angle α to the horizontal, where $\alpha \leq 45^\circ$ and B is above the plane. The vertical plane defined by APB contains a line of greatest slope of the plane, and PA is inclined at angle 2α to the horizontal (see diagram).

(i) Show that the normal reaction R between A and the plane is $mg(2 \cos \alpha - \sin \alpha)$. [3]

(ii) Show that $R \geq \frac{1}{2} mg \sqrt{2}$. [3]

The coefficient of friction between A and the plane is μ . The particle is about to slip down the plane.

(iii) Show that $0.5 < \tan \alpha \leq 1$. [3]

(iv) Express μ as a function of $\tan \alpha$ and deduce its maximum value as α varies. [3]

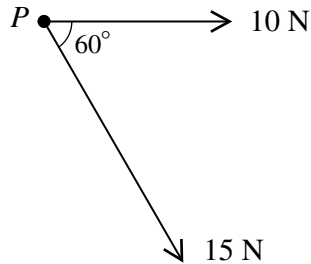
3 A particle is being held in equilibrium by the following set of forces (in newtons).

$$\mathbf{F}_1 = 5\mathbf{i} - 8\mathbf{j}, \quad \mathbf{F}_2 = -3\mathbf{i} - 4\mathbf{j}, \quad \mathbf{F}_3 = 6\mathbf{i} + 6\mathbf{j} \quad \text{and} \quad \mathbf{F}_4.$$

(i) Find \mathbf{F}_4 in terms of \mathbf{i} and \mathbf{j} . [2]

(ii) Hence find the magnitude and direction of \mathbf{F}_4 . [4]

4



The diagram shows two forces of magnitudes 10 N and 15 N acting in a horizontal plane on a particle P .

- (i) Find the component of the 15 N force which is parallel to the 10 N force. [2]
- (ii) Write down the component of the 15 N force which is perpendicular to the 10 N force. [1]
- (iii) Hence, or otherwise, calculate the magnitude and direction of the resultant force on P . [4]

5 Two forces \mathbf{F}_1 and \mathbf{F}_2 are given by

$$\mathbf{F}_1 = 13\mathbf{i} + 4\mathbf{j} - 3\mathbf{k}, \quad \mathbf{F}_2 = -2\mathbf{i} + 6\mathbf{j} + \mathbf{k},$$

in which the units of the components are newtons. A third force, \mathbf{F}_3 , of magnitude 6 N acts parallel to the vector $2\mathbf{i} - 2\mathbf{j} + \mathbf{k}$.

- (i) Find the two possible resultants of \mathbf{F}_1 , \mathbf{F}_2 and \mathbf{F}_3 , and show that they have the same magnitude. [5]

A particle, P , of mass 2 kg is initially at rest at the origin. The only forces acting on P are \mathbf{F}_1 and \mathbf{F}_2 .

- (ii) Find the magnitude of the acceleration of P . [3]
- (iii) Find the time taken for P to travel 60 m. [2]