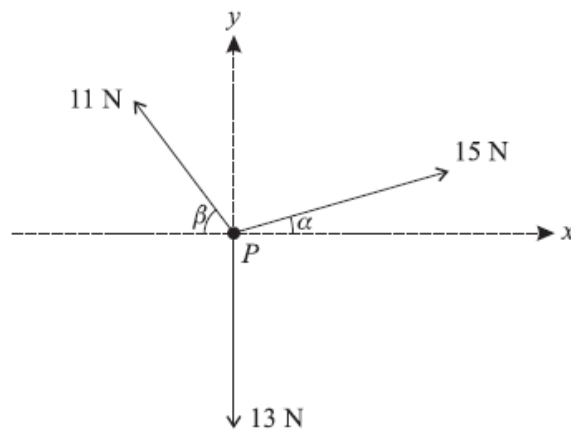


Topic X8 Mechanics (Post-TT B) [40]

1.

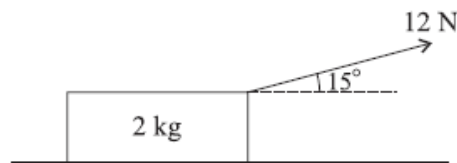


Three horizontal forces of magnitudes 15 N, 11 N and 13 N act on a particle P in the directions shown in the diagram. The angles α and β are such that $\sin \alpha = 0.28$, $\cos \alpha = 0.96$, $\sin \beta = 0.8$ and $\cos \beta = 0.6$.

- (i) Show that the component, in the y -direction, of the resultant of the three forces is zero. [4]
- (ii) Find the magnitude of the resultant of the three forces. [3]
- (iii) State the direction of the resultant of the three forces. [1]

(Total 8 marks)

2.



A block of mass 2 kg is at rest on a rough horizontal plane, acted on by a force of magnitude 12 N at an angle of 15° upwards from the horizontal (see diagram).

- (i) Find the frictional component of the contact force exerted on the block by the plane. [2]
- (ii) Show that the normal component of the contact force exerted on the block by the plane has magnitude 16.5 N, correct to 3 significant figures. [2]

It is given that the block is on the point of sliding.

- (iii) Find the coefficient of friction between the block and the plane. [2]

The force of magnitude 12 N is now replaced by a horizontal force of magnitude 20 N. The block starts to move.

- (iv) Find the acceleration of the block. [5]

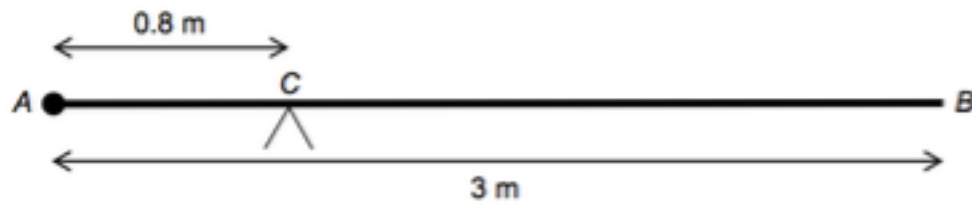
(Total 11 marks)

3.

A uniform rod, AB , has length 3 metres and mass 24 kg.

A particle of mass M kg is attached to the rod at A .

The rod is balanced in equilibrium on a support at C , which is 0.8 metres from A .



Find the value of M .

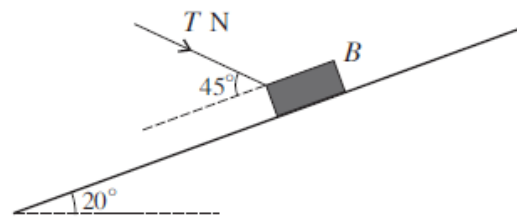
(Total 2 marks)

4.

A block B of weight 10 N is projected down a line of greatest slope of a plane inclined at an angle of 20° to the horizontal. B travels down the plane at constant speed.

- (i) (a) Find the components perpendicular and parallel to the plane of the contact force between B and the plane. [2]
(b) Hence show that the coefficient of friction is 0.364, correct to 3 significant figures. [2]

(ii)



B is in limiting equilibrium when acted on by a force of T N directed towards the plane at an angle of 45° to a line of greatest slope (see diagram). Given that the frictional force on B acts down the plane, find T . [7]

(Total 11 marks)

5.

A ball is projected from the origin. After 2.5 seconds, the ball lands at the point with position vector $(40\mathbf{i} - 10\mathbf{j})$ metres.

The unit vectors \mathbf{i} and \mathbf{j} are horizontal and vertical respectively.

Assume that there are no resistance forces acting on the ball.

- (a) Find the speed of the ball when it is at a height of 3 metres above its initial position. [6 marks]
(b) State the speed of the ball when it is at its maximum height. [1 mark]
(c) Explain why the answer you found in part (b) may not be the actual speed of the ball when it is at its maximum height. [1 mark]

(Total 8 marks)