Mechanics

TOPIC- Forces (Vector)

Equilibrium

Forces-Equilibrium

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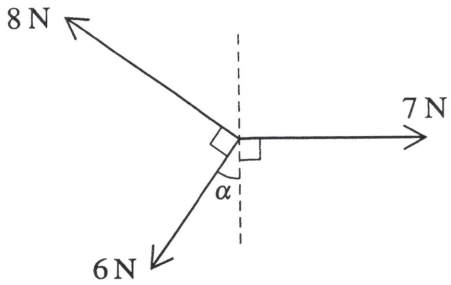

Coplanar forces of magnitudes 7 N, 6 N and 8 N act at a point in the directions shown in the diagram. Given that $\sin\alpha = \frac{3}{5}$, find the magnitude and direction of the resultant of the three forces. [5]

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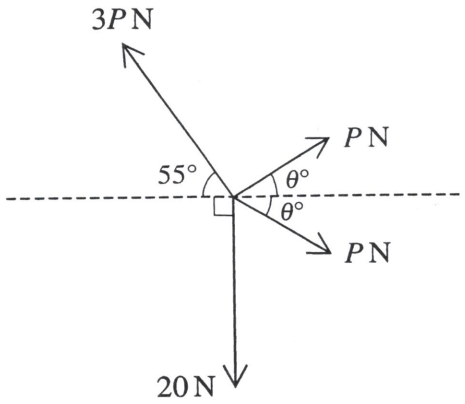

The four coplanar forces shown in the diagram are in equilibrium. Find the values of P and θ. [5]

J- 17- 43-2

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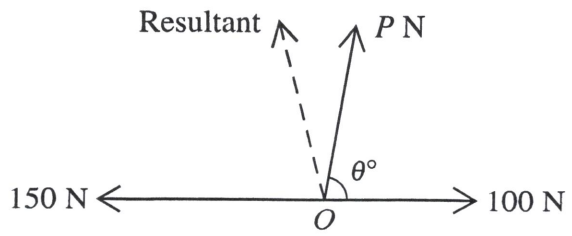

Three horizontal forces of magnitudes 150 N, 100 N and P N have directions as shown in the diagram. The resultant of the three forces is shown by the broken line in the diagram. This resultant has magnitude 120 N and makes an angle 75° with the 150 N force. Find the values of P and θ. [7]

N-A5-43-3

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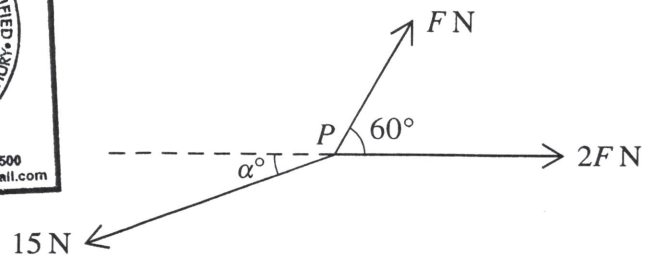

Three coplanar forces of magnitudes F N, $2F$ N and 15 N act at a point P, as shown in the diagram. Given that the forces are in equilibrium, find the values of F and α. [6]

N-16-41-4

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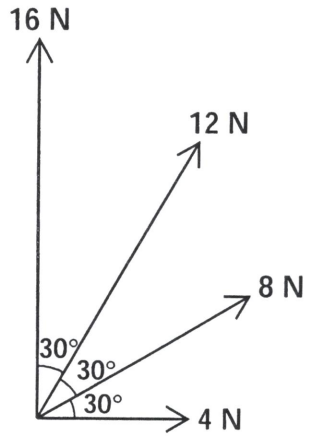

FIG. 1

Four coplanar forces of magnitudes 4 N, 8 N, 12 N and 16 N act at a point. The directions in which the forces act are shown in Fig. 1.

J-43-05-5

(i) Find the magnitude and direction of the resultant of the four forces. [5]

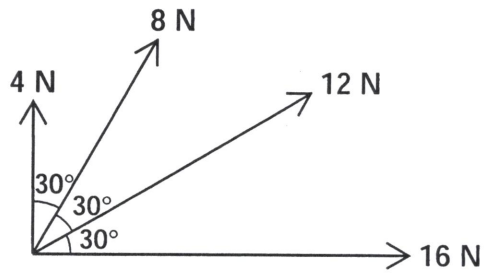

FIG. 2

The forces of magnitudes 4 N and 16 N exchange their directions and the forces of magnitudes 8 N and 12 N also exchange their directions (see Fig. 2).

(ii) State the magnitude and direction of the resultant of the four forces in Fig. 2. [2]

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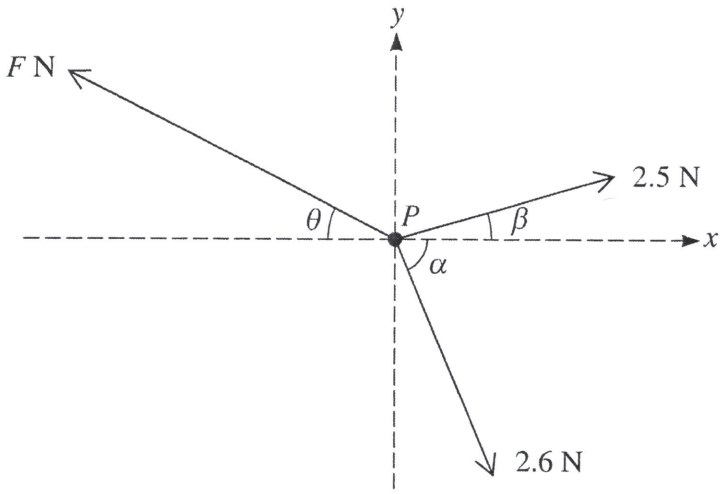

A particle P of mass 0.5 kg lies on a smooth horizontal plane. Horizontal forces of magnitudes F N, 2.5 N and 2.6 N act on P. The directions of the forces are as shown in the diagram, where $\tan\alpha = \frac{12}{5}$ and $\tan\beta = \frac{7}{24}$. J-13- 41-6

(i) Given that P is in equilibrium, find the values of F and $\tan\theta$. [6]

(ii) The force of magnitude F N is removed. Find the magnitude and direction of the acceleration with which P starts to move. [3]

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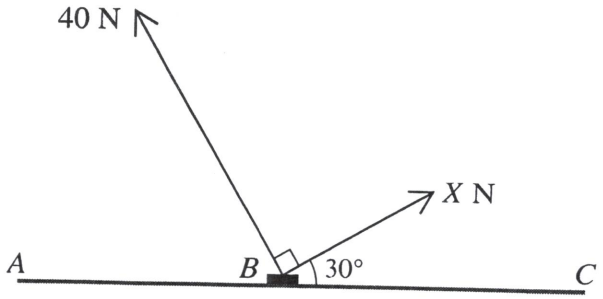

Forces of magnitude X N and 40 N act on a block B of mass 15 kg, which is in equilibrium in contact with a horizontal surface between points A and C on the surface. The forces act in the same vertical plane and in the directions shown in the diagram.

(i) Given that the surface is smooth, find the value of X. [2]

(ii) It is given instead that the surface is rough and that the block is in limiting equilibrium. The frictional force acting on the block has magnitude 10 N in the direction towards A. Find the coefficient of friction between the block and the surface. [5]

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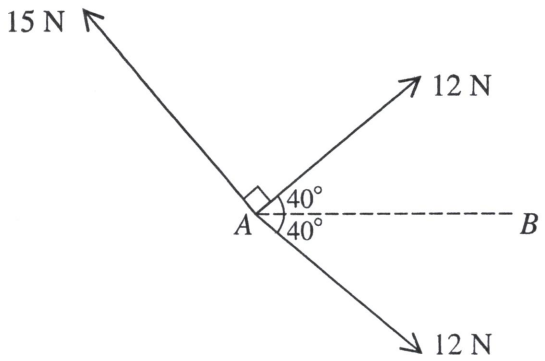

Three coplanar forces of magnitudes 15 N, 12 N and 12 N act at a point A in directions as shown in the diagram.

(i) Find the component of the resultant of the three forces

(a) in the direction of AB,

(b) perpendicular to AB. [3]

(ii) Hence find the magnitude and direction of the resultant of the three forces. [3]

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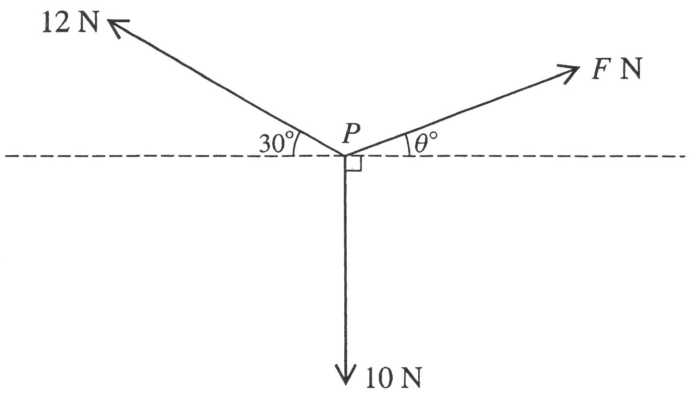

The three coplanar forces shown in the diagram act at a point P and are in equilibrium.

J- 42-11-4

(i) Find the values of F and θ. [6]

(ii) State the magnitude and direction of the resultant force at P when the force of magnitude 12 N is removed. [2]

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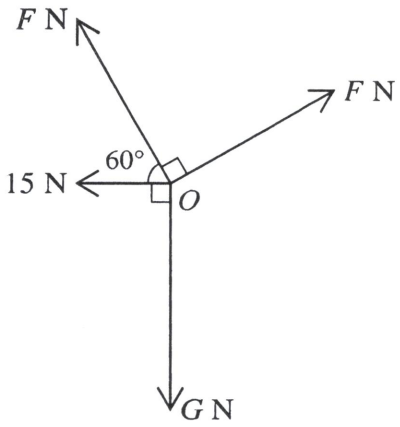

Four horizontal forces act at a point O and are in equilibrium. The magnitudes of the forces are F N, G N, 15 N and F N, and the forces act in directions as shown in the diagram.

(i) Show that $F = 41.0$, correct to 3 significant figures. [3]

(ii) Find the value of G. [2]

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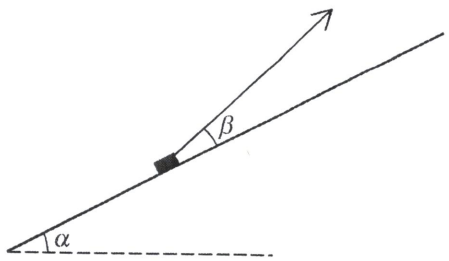

A small block of weight 5.1 N rests on a smooth plane inclined at an angle α to the horizontal, where $\sin\alpha = \frac{8}{17}$. The block is held in equilibrium by means of a light inextensible string. The string makes an angle β above the line of greatest slope on which the block rests, where $\sin\beta = \frac{7}{25}$ (see diagram). Find the tension in the string. N-13-42-1 [3]

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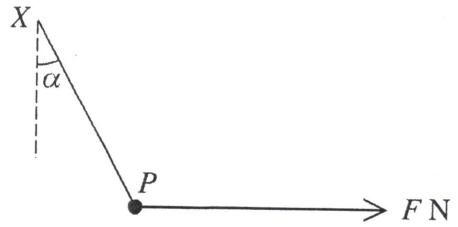
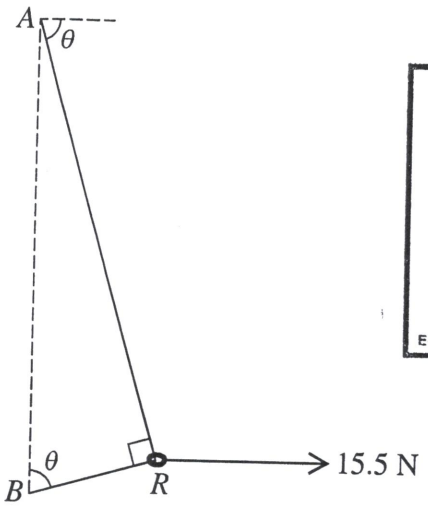


A particle P of mass 0.3 kg is attached to one end of a light inextensible string. The other end of the string is attached to a fixed point X. A horizontal force of magnitude F N is applied to the particle, which is in equilibrium when the string is at an angle α to the vertical, where $\tan\alpha = \frac{8}{15}$ (see diagram). Find the tension in the string and the value of F. N-Mu-13-1 [4]

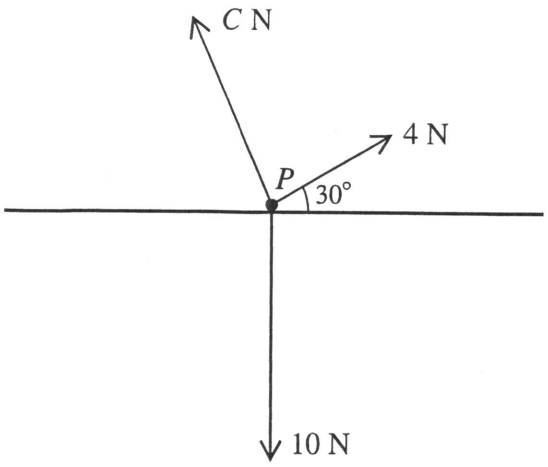
13



J-11-41-3

A small smooth ring R of weight 8.5 N is threaded on a light inextensible string. The ends of the string are attached to fixed points A and B, with A vertically above B. A horizontal force of magnitude 15.5 N acts on R so that the ring is in equilibrium with angle $ARB = 90°$. The part AR of the string makes an angle θ with the horizontal and the part BR makes an angle θ with the vertical (see diagram). The tension in the string is T N. Show that $T \sin \theta = 12$ and $T \cos \theta = 3.5$ and hence find θ. [6]

14

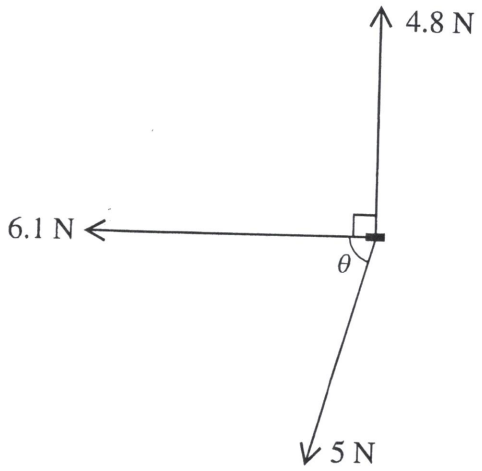


A particle P has weight 10 N and is in limiting equilibrium on a rough horizontal table. The forces shown in the diagram represent the weight of P, an applied force of magnitude 4 N acting on P in a direction at 30° above the horizontal, and the contact force exerted on P by the table (the resultant of the frictional and normal components) of magnitude C N. N-II-42-4

(i) Find the value of C. [3]

(ii) Find the coefficient of friction between P and the table. [2]

15



A small block of mass 1.25 kg is on a horizontal surface. Three horizontal forces, with magnitudes and directions as shown in the diagram, are applied to the block. The angle θ is such that $\cos\theta = 0.28$ and $\sin\theta = 0.96$. A horizontal frictional force also acts on the block, and the block is in equilibrium.

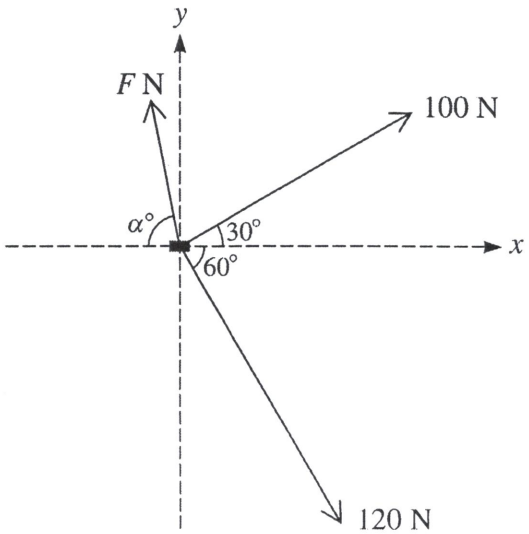
(i) Show that the magnitude of the frictional force is 7.5 N and state the direction of this force. [4]

(ii) Given that the block is in limiting equilibrium, find the coefficient of friction between the block and the surface. [2]

The force of magnitude 6.1 N is now replaced by a force of magnitude 8.6 N acting in the same direction, and the block begins to move.

(iii) Find the magnitude and direction of the acceleration of the block. [3]

16



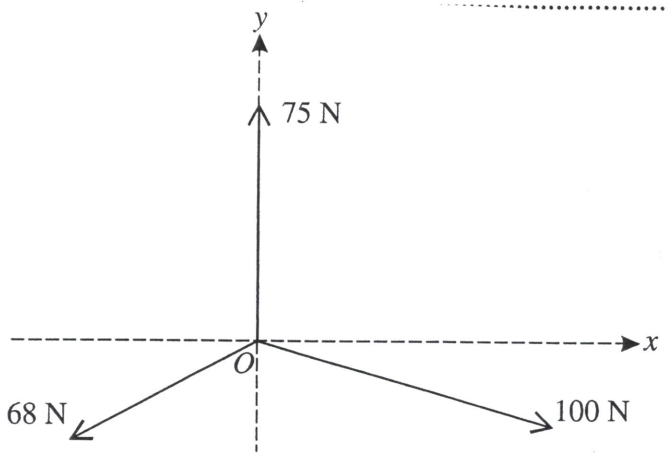
A small box of mass 40 kg is moved along a rough horizontal floor by three men. Two of the men apply horizontal forces of magnitudes 100 N and 120 N, making angles of 30° and 60° respectively with the positive **x**-direction. The third man applies a horizontal force of magnitude F N making an angle of $\alpha°$ with the negative **x**-direction (see diagram). The resultant of the three horizontal forces acting on the box is in the positive **x**-direction and has magnitude 136 N.

J-13-43-6

(i) Find the values of F and α. [6]

(ii) Given that the box is moving with constant speed, state the magnitude of the frictional force acting on the box and hence find the coefficient of friction between the box and the floor. [3]

17



Three coplanar forces of magnitudes 68 N, 75 N and 100 N act at an origin O, as shown in the diagram. The components of the three forces in the positive x-direction are -60 N, 0 N and 96 N, respectively. Find

N-12-42-4

(i) the components of the three forces in the positive y-direction, [3]

(ii) the magnitude and direction of the resultant of the three forces. [4]

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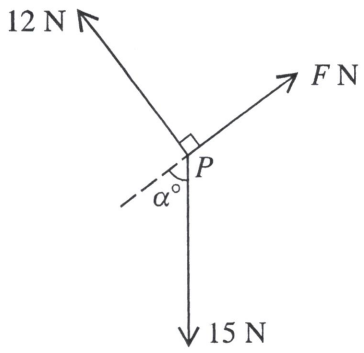

Three coplanar forces of magnitudes F N, 12 N and 15 N are in equilibrium acting at a point P in the directions shown in the diagram. Find α and F. J-M2-42-4 [4]

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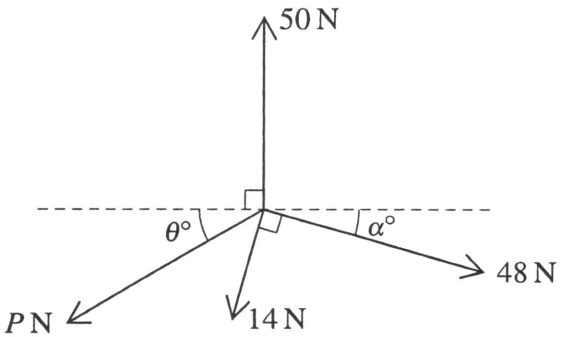

Coplanar forces of magnitudes 50 N, 48 N, 14 N and P N act at a point in the directions shown in the diagram. The system is in equilibrium. Given that $\tan\alpha = \frac{7}{24}$, find the values of P and θ. [6]

J-16-41-4

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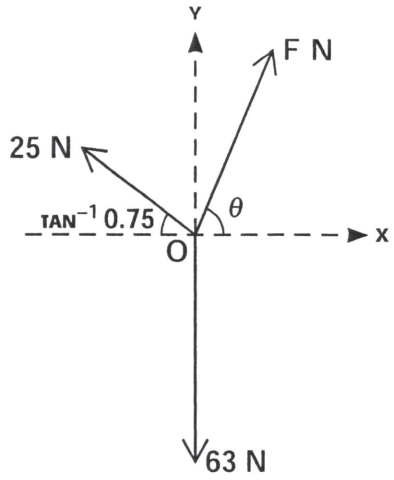

Three horizontal forces of magnitudes F N, 63 N and 25 N act at O, the origin of the **x**-axis and **y**-axis. The forces are in equilibrium. The force of magnitude F N makes an angle θ anticlockwise with the positive **x**-axis. The force of magnitude 63 N acts along the negative **y**-axis. The force of magnitude 25 N acts at $\tan^{-1} 0.75$ clockwise from the negative **x**-axis (see diagram). Find the value of F and the value of $\tan \theta$. J-15-41-2 [5]

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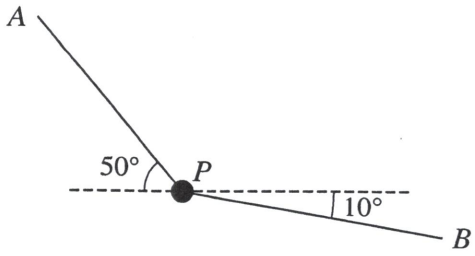

The diagram shows a small object P of mass 20 kg held in equilibrium by light ropes attached to fixed points A and B. The rope PA is inclined at an angle of 50° above the horizontal, the rope PB is inclined at an angle of 10° below the horizontal, and both ropes are in the same vertical plane. Find the tension in the rope PA and the tension in the rope PB. N-16-43-2 [5]

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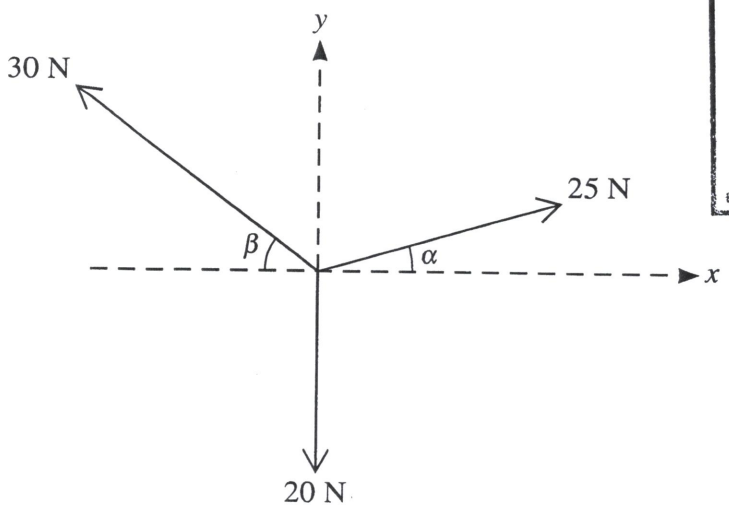

Three coplanar forces act at a point. The magnitudes of the forces are 20 N, 25 N and 30 N, and the directions in which the forces act are as shown in the diagram, where $\sin\alpha = 0.28$ and $\cos\alpha = 0.96$, and $\sin\beta = 0.6$ and $\cos\beta = 0.8$.

N-14-42-2

(i) Show that the resultant of the three forces has a zero component in the x-direction. [2]

(ii) Find the magnitude and direction of the resultant of the three forces. [2]

(iii) The force of magnitude 20 N is replaced by another force. The effect is that the resultant force is unchanged in magnitude but reversed in direction. State the magnitude and direction of the replacement force. [1]

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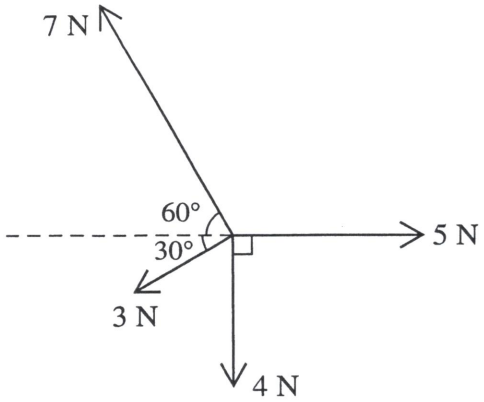

Four coplanar forces act at a point. The magnitudes of the forces are 5 N, 4 N, 3 N and 7 N, and the directions in which the forces act are shown in the diagram. Find the magnitude and direction of the resultant of the four forces. J-14-41-3 [6]

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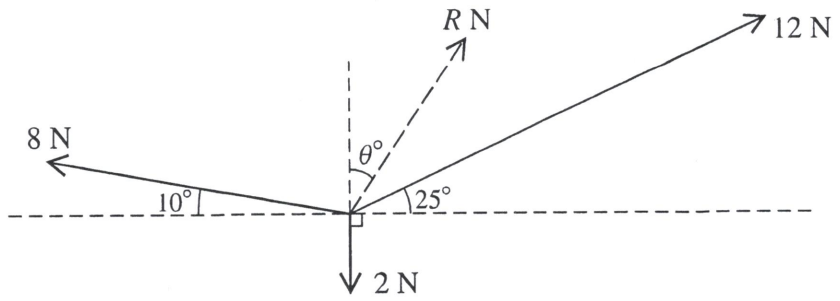

Three coplanar forces of magnitudes 8 N, 12 N and 2 N act at a point. The resultant of the forces has magnitude R N. The directions of the three forces and the resultant are shown in the diagram. Find R and θ. [7]

N-12-M1-9

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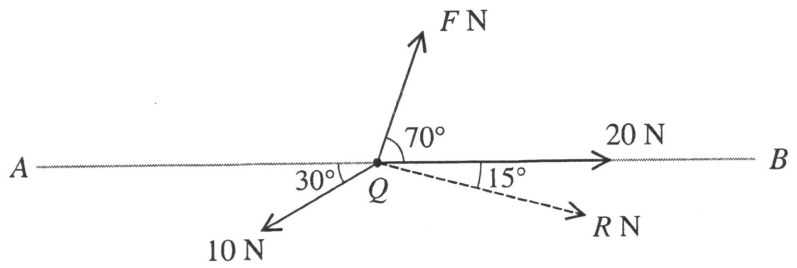

7-15-M1
5

A small bead Q can move freely along a smooth horizontal straight wire AB of length 3 m. Three horizontal forces of magnitudes F N, 10 N and 20 N act on the bead in the directions shown in the diagram. The magnitude of the resultant of the three forces is R N in the direction shown in the diagram.

(i) Find the values of F and R. [5]

(ii) Initially the bead is at rest at A. It reaches B with a speed of $11.7\,\text{m s}^{-1}$. Find the mass of the bead. [3]

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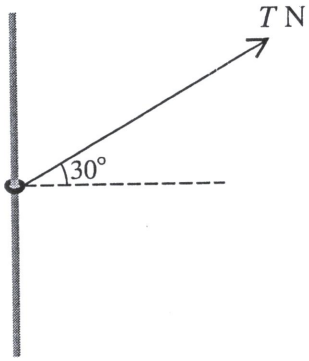
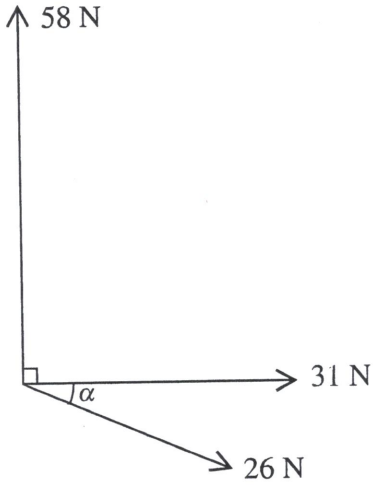


The diagram shows a ring of mass 2 kg threaded on a fixed rough vertical rod. A light string is attached to the ring and is pulled upwards at an angle of 30° to the horizontal. The tension in the string is T N. The coefficient of friction between the ring and the rod is 0.24. Find the two values of T for which the ring is in limiting equilibrium. N–11–43–6 [8]

27



Coplanar forces of magnitudes 58 N, 31 N and 26 N act at a point in the directions shown in the diagram. Given that $\tan\alpha = \frac{5}{12}$, find the magnitude and direction of the resultant of the three forces. [6]

N-4-43-2

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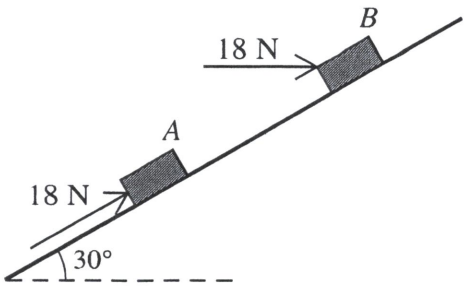

N-14-41-2

Small blocks A and B are held at rest on a smooth plane inclined at 30° to the horizontal. Each is held in equilibrium by a force of magnitude 18 N. The force on A acts upwards parallel to a line of greatest slope of the plane, and the force on B acts horizontally in the vertical plane containing a line of greatest slope (see diagram). Find the weight of A and the weight of B. [4]

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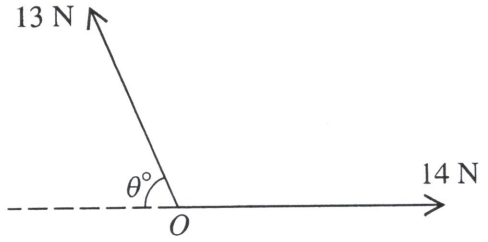

Forces of magnitudes 13 N and 14 N act at a point O in the directions shown in the diagram. The resultant of these forces has magnitude 15 N. Find

J-12-41-2

(i) the value of θ, [3]

(ii) the component of the resultant in the direction of the force of magnitude 14 N. [2]

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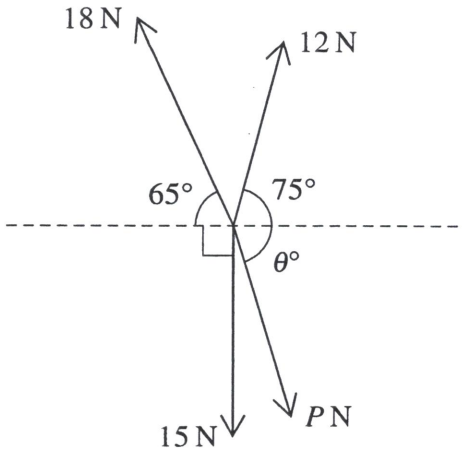

J-18-43-3

The coplanar forces shown in the diagram are in equilibrium. Find the values of P and θ. [6]