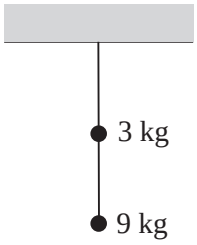
MECHANICS

1. Is the statement below *true* or *false*?

   The forces acting on a car as it travels at a constant speed on a circular path around a roundabout are in equilibrium.

2. A person of mass 72 kg stands on a horizontal surface. Calculate the magnitude of the normal reaction force acting on the person.

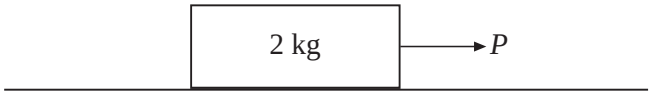
3. The diagram shows two particles of mass 3 kg and 9 kg. The particles are connected by light strings to a fixed point.



   (a) Calculate the tension in the *lower* string.

   (b) Calculate the tension in the *upper* string.

4. A block, of mass 2 kg, is at rest on a rough, horizontal surface. A horizontal force of magnitude P N acts on the block, as shown. The coefficient of friction between the block and the surface is 0.7.



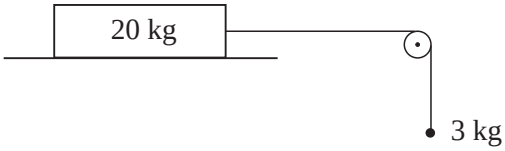
   What happens to the block if $P = 15.68$ N ?

   A : It remains at rest.

   B : It accelerates.

   C : It moves with constant velocity.

5. The diagram shows a block of mass 20 kg on a rough horizontal surface. It is attached by a light, inextensible string which passes over a smooth pulley, to a particle of mass 3 kg. The system remains at rest.



(a) Calculate the magnitude of the friction force acting on the block.

(b) The coefficient of friction between the block and the plane is μ.

Which of these statements is true?

A $\mu = \frac{3}{20}$ B $\mu \geq \frac{3}{20}$ C $\mu \leq \frac{3}{20}$

D $\mu > \frac{3}{20}$ E $\mu < \frac{3}{20}$

6. A particle of mass 8 kg, is at rest on a horizontal surface with a force of magnitude P N acting on it, in the direction shown in the diagram.

(a) The normal reaction force on the particle has magnitude R N.

Which of these statements is correct?

A $R = 78.4$ B $R \leq 78.4$ C $R \geq 78.4$

D $R < 78.4$ E $R > 78.4$

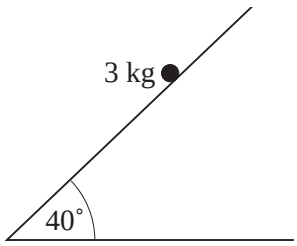
(b) The friction force on the particle has magnitude F N.

Which of these statements is correct?

A $F = 0$ B $F = P$ C $F > P$

D $F < P$ E $F \leq P$

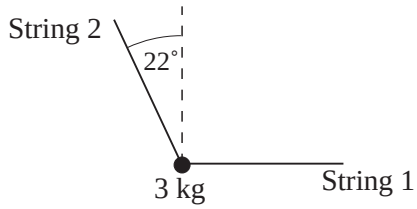
7. The diagram shows a particle of mass 3 kg that is at rest on a rough slope, inclined at $40°$ to the horizontal.



(a) Calculate the magnitude of the normal reaction force acting on the particle.

(b) Calculate the magnitude of the friction force acting on the particle.

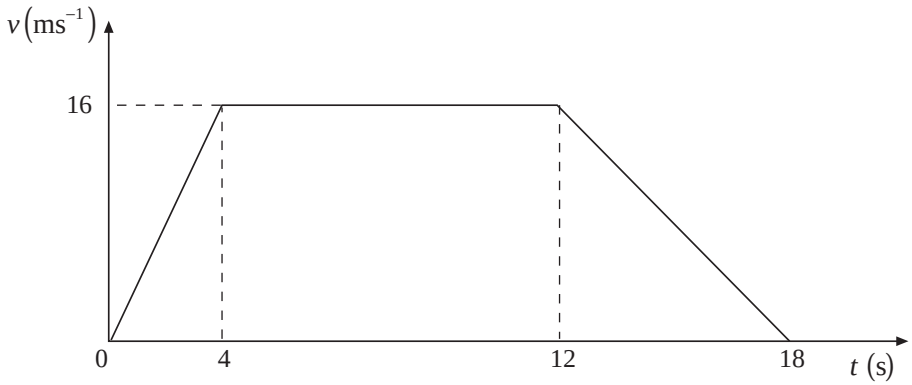
8. The diagram shows a particle of mass 3 kg, which is suspended by two strings. String 1 is horizontal and string 2 is at an angle $22°$ to the vertical.



(a) Calculate the tension in string 2.

(b) Calculate the tension in string 1.

9. A velocity-time graph for a short journey along a straight line is shown below.



(a) Calculate the distance travelled at a constant speed.

(b) Calculate the total distance travelled.

(c) What is the acceleration during the first 4 seconds of the journey?

10. A stone is released from rest at a height 20 m above ground level. Assume that as it falls it does not experience any air resistance.

(a) Calculate the speed of the stone when it hits the ground.

(b) Calculate the time that it takes the stone to fall to the ground.

11. A particle moves from the point A with position vector $(3\mathbf{i} + 4\mathbf{j})$ metres to the point B with position vector $(120\mathbf{i} - 110\mathbf{j})$ metres in 10 seconds, moving with constant acceleration.

The particle had velocity $(\mathbf{i} - \mathbf{j})$ ms^{-1} at A.

(a) Determine the distance between the two points.

(b) Determine the average velocity of the particle.

(c) Calculate the acceleration of the particle.

(d) Calculate the velocity of the particle at B.

12. Three forces, F_1, F_2 and F_3, are in equilibrium, with

$$\mathbf{F}_1 = a\mathbf{i} + b\mathbf{j} \text{ and } \mathbf{F}_2 = c\mathbf{i} + d\mathbf{j}$$

(a) Calculate $\mathbf{F}_3$.

(b) Determine the magnitude of $\mathbf{F}_3$.

13. A man stands inside a train that is travelling at a constant speed along a straight line. He drops a ball.

Are the statements below *true* or *false*?

A To an observer outside the train, the ball appears to move backwards and downwards.

B To the man, the ball appears to move backwards and downwards.

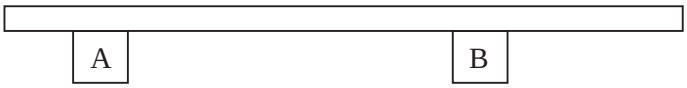
14. A lift has mass 800 kg. It is moving upwards and has an acceleration – 0.1 ms^{-2}. The lift is supported by a single cable.

Determine the tension in the cable.

15. A particle of mass 3 kg slides down a slope inclined at an angle $50°$ to the horizontal. The coefficient of friction between the particle and the slope is 0.3.

Calculate the acceleration of the particle.

16. The diagram shows a shelf resting on two supports.



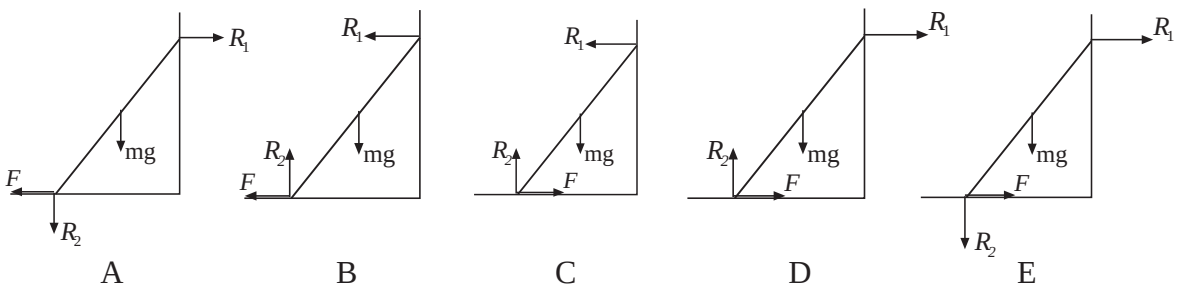
Are the following statements *true* or *false*?

A There are two reaction forces acting on the shelf.

B Putting a parcel on the shelf at B would increase the reaction force at A.

17. The diagrams below are intended to show the forces acting on a ladder that leans against a smooth wall.

Which diagram is correct?



18. A simple pendulum consists of a small mass on the end of a light string. It swings so that the mass describes an arc of a circle. Which of the diagrams below shows the forces on the mass when it is

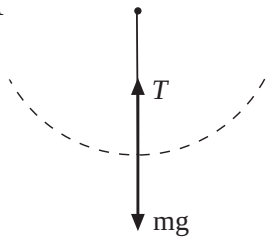
    (i) swinging from left to right and not at the lowest position,

    (ii) swinging from right to left and not at the lowest position,

    (iii) at its lowest position ?

    Assume that there are no resistance forces.

A



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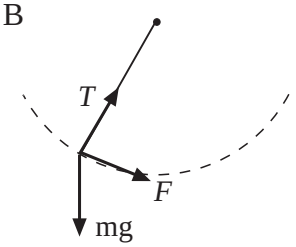

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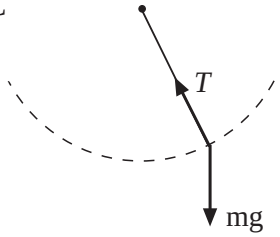

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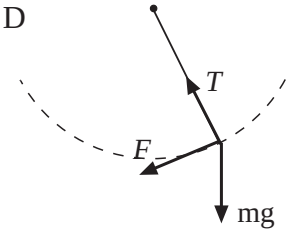
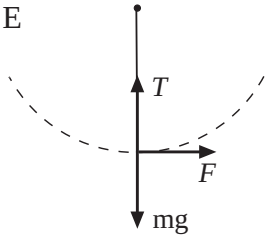


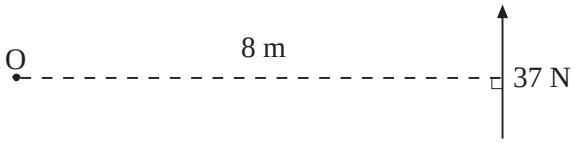
E



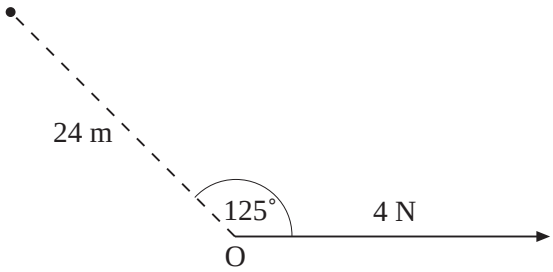
19. A car has mass 1500 kg and is travelling at $10\ \text{ms}^{-1}$, when it hits a stationary car of mass 1000 kg. After the collision the two cars move together.

    Calculate the speed of the two cars after the collision.

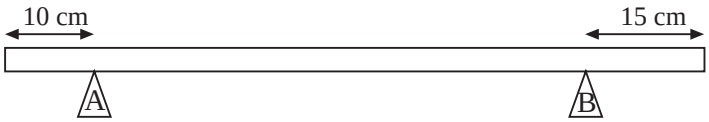
20. What is the moment of the force shown below about the point O ?



21. What is the moment of the force shown below about the point O ?

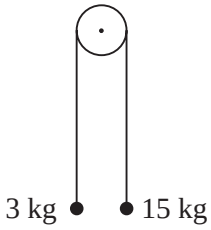


22. A uniform plank of mass 10 kg and length 200 cm, rests on two supports as shown in the diagram below.



Calculate the magnitude of the reaction forces acting on the plank at A and B.

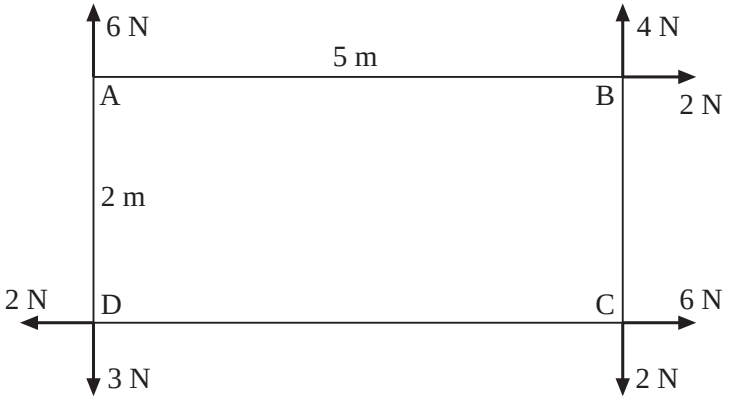
23. Two particles are connected by a light, inextensible string that passes over a light, smooth pulley, as shown in the diagram. The particles are released from rest.



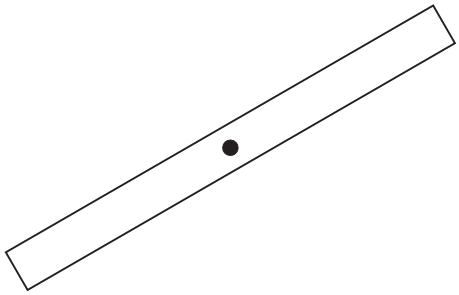
(a) Calculate the acceleration of the system

(b) Calculate the tension in the string.

24. The diagram shows the forces that act on a rectangular lamina. Determine the total moment of these forces about the corner A.



25. The diagram shows a uniform beam that is smoothly pivoted at its centre to a vertical wall. It is held in the position shown and released.



Are the statements below *true* or *false*?

A The beam moves to a horizontal position.

B The beam moves to a vertical position.

26. Two balls, A and B, are initially at the same height above the ground. Ball A is released so that it falls vertically from rest. Ball B is projected horizontally. Both balls are set into motion at the same time.

Are the statements below *true* or *false*?

A The balls hit the ground at the same time.

B The balls are travelling at the same speed when they hit the ground.