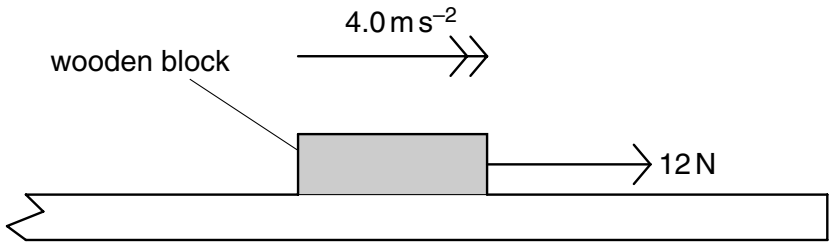
**1** A wooden block of mass 0.60 kg is on a rough horizontal surface. A force of 12 N is applied to the block and it accelerates at 4.0 m s$^{-2}$.




What is the magnitude of the frictional force acting on the block?

**A** 2.4 N

**B** 9.6 N

**C** 14 N

**D** 16 N

**2** A submarine descends vertically at constant velocity. The three forces acting on the submarine are viscous drag, upthrust and weight.

Which relationship between their magnitudes is correct?

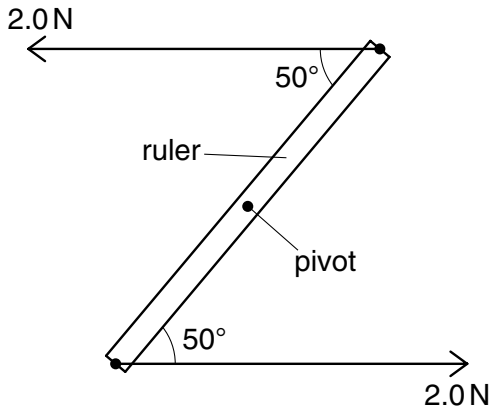
**A** weight < drag

**B** weight = drag

**C** weight < upthrust

**D** weight > upthrust

**3** A ruler of length 0.30 m is pivoted at its centre. Equal and opposite forces of magnitude 2.0 N are applied to the ends of the ruler, creating a couple as shown.

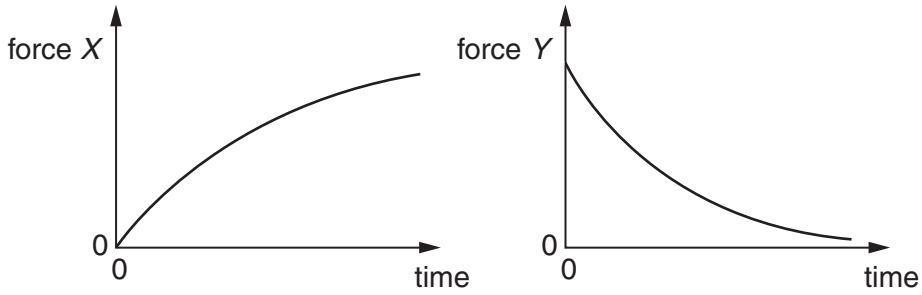



What is the magnitude of the torque of the couple on the ruler when it is in the position shown?

**A** 0.23 Nm **B** 0.39 Nm **C** 0.46 Nm **D** 0.60 Nm

**4** A ball falls from rest through air and eventually reaches a constant velocity.

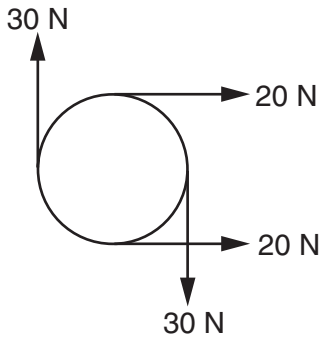
For this fall, forces *X* and *Y* vary with time as shown.




What are forces *X* and *Y*?

| | force *X* | force *Y* |
|---|---|---|
| **A** | air resistance | resultant force |
| **B** | air resistance | weight |
| **C** | upthrust | resultant force |
| **D** | upthrust | weight |

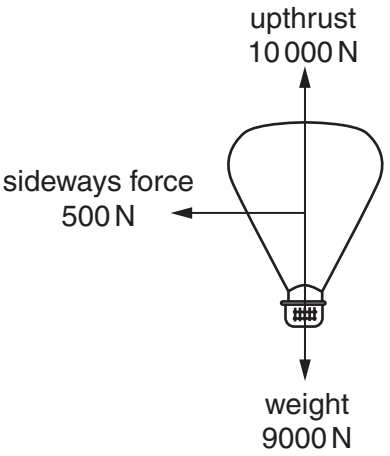
**5** The diagram shows four forces applied to a circular object.




Which of the following describes the resultant force and resultant torque on the object?

| | resultant force | resultant torque |
|---|---|---|
| **A** | zero | zero |
| **B** | zero | non-zero |
| **C** | non-zero | zero |
| **D** | non-zero | non-zero |

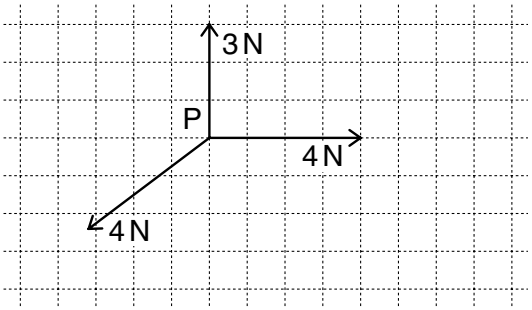
**6** A balloon is acted upon by three forces, weight, upthrust and sideways force due to the wind, as shown in the diagram.




What is the vertical component of the resultant force on the balloon?

**A** 500 N **B** 1000 N **C** 10 000 N **D** 10 500 N

**7** The vector diagram shows three coplanar forces acting on an object at P.




The magnitude of the resultant of these three forces is 1 N.

What is the direction of this resultant?

**A** ↓ **B** ↘ **C** ↙ **D** ↗

**8** What is meant by the weight of an object?

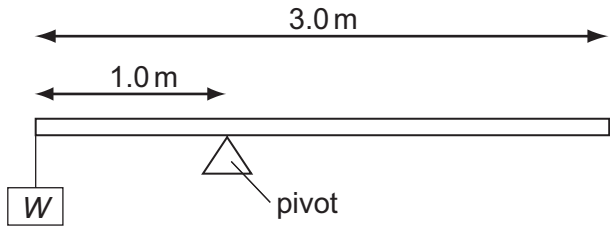
**A** the gravitational field acting on the object

**B** the gravitational force acting on the object

**C** the mass of the object multiplied by gravity

**D** the object's mass multiplied by its acceleration

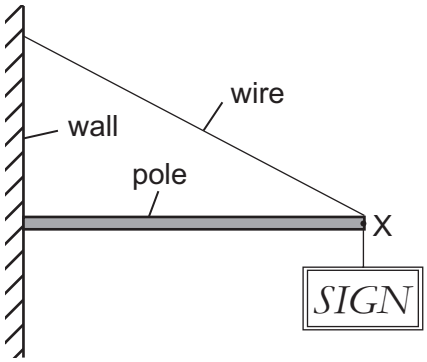
**9** A uniform beam of weight 50 N is 3.0 m long and is supported on a pivot situated 1.0 m from one end. When a load of weight *W* is hung from that end, the beam is in equilibrium, as shown in the diagram.




What is the value of *W*?

**A** 25 N **B** 50 N **C** 75 N **D** 100 N

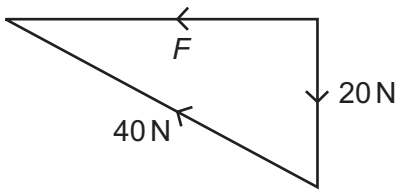
**10** The diagram shows a sign of weight 20 N suspended from a pole, attached to a wall. The pole is kept in equilibrium by a wire attached at point X of the pole.



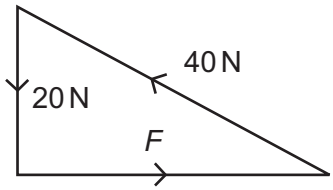

The force exerted by the pole at point X is *F*, and the tension in the wire is 40 N.

Which diagram represents the three forces acting at point X?

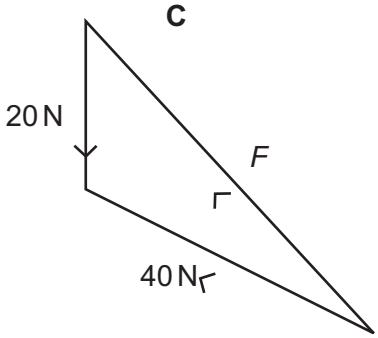
**A**



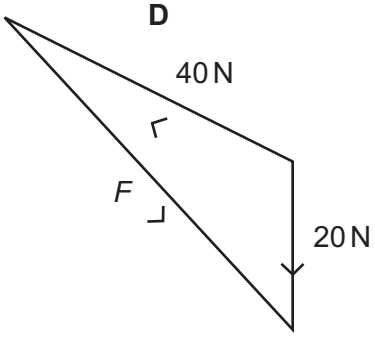

**B**



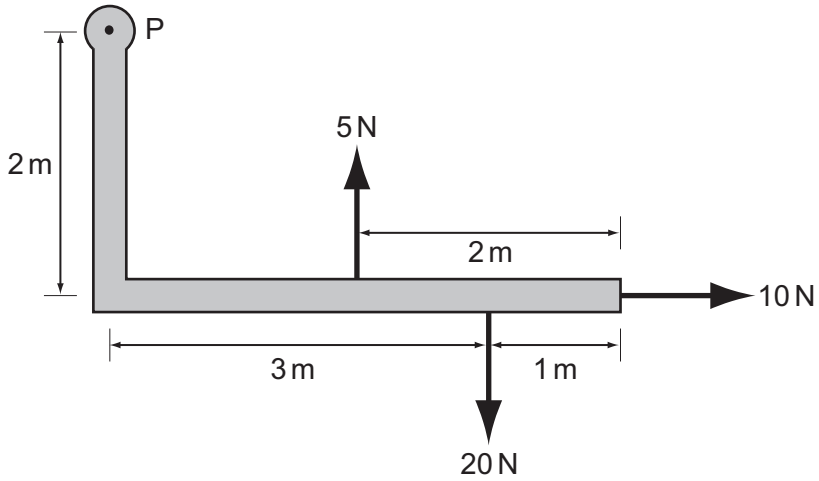

**C**




**D**



**11** An L-shaped rigid lever arm is pivoted at point P.

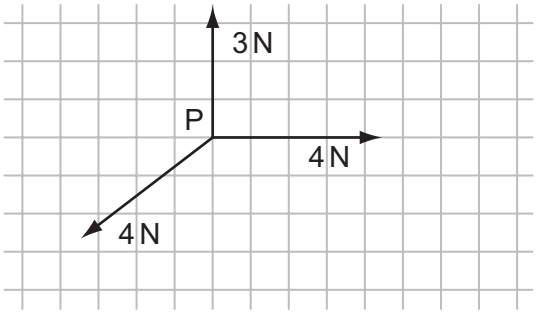



Three forces act on the lever arm, as shown in the diagram.

What is the magnitude of the resultant moment of these forces about point P?

**A** 30 N m **B** 35 N m **C** 50 N m **D** 90 N m

**12** The vector diagram shows three coplanar forces acting on an object at P.




The magnitude of the resultant of these three forces is 1 N.

What is the direction of this resultant?

**A** ↓ **B** ↘ **C** ↙ **D** ↗

**13** A cyclist is riding at a steady speed on a level road.

According to Newton's third law of motion, what is equal and opposite to the backward push of the back wheel on the road?

**A** the force exerted by the cyclist on the pedals

**B** the forward push of the road on the back wheel

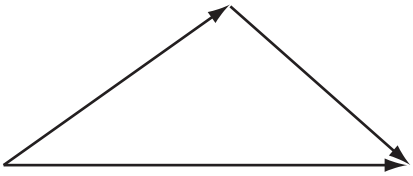
**C** the tension in the cycle chain

**D** the total air resistance and friction force

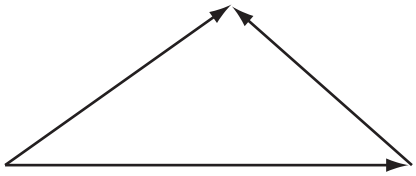
**14** The diagrams show three forces acting on a body.

In which diagram is the body in equilibrium?

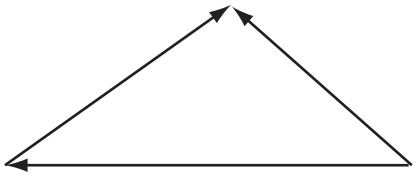
**A**



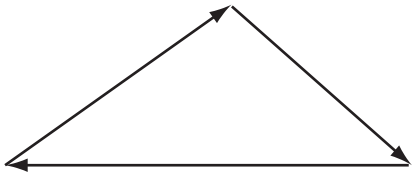
**B**



**C**



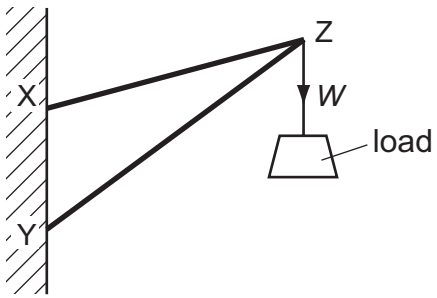
**D**



**15** Two rigid rods, XZ and YZ, are fixed to a vertical wall at points X and Y.

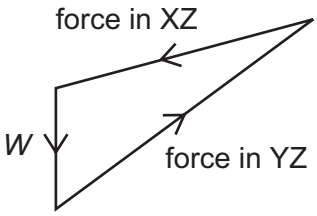
A load of weight *W* is hung from point Z.

The load is not moving.

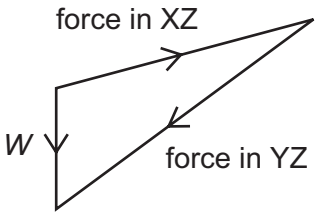



Which diagram shows the forces acting at point Z?

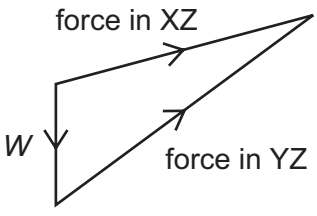
**A**



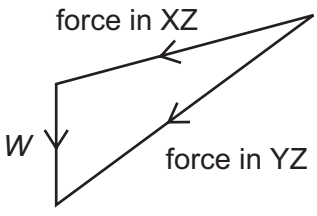

**B**



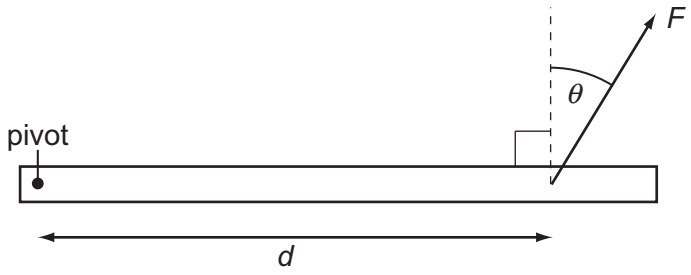

**C**




**D**



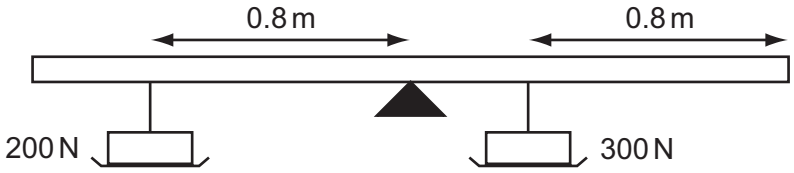
**16** A force $F$ is applied to a beam at a distance $d$ from a pivot. The force acts at an angle $\theta$ to a line perpendicular to the beam.




Which combination will cause the largest turning effect about the pivot?

| | $F$ | $d$ | $\theta$ |
|---|---|---|---|
| **A** | large | large | large |
| **B** | large | large | small |
| **C** | small | small | large |
| **D** | small | large | small |

**17** A rigid uniform bar of length 2.4 m is pivoted horizontally at its mid-point.




Weights are hung from two points of the bar as shown in the diagram. To maintain horizontal equilibrium, a couple is applied to the bar.

What is the torque and direction of this couple?

**A** 40 N m clockwise

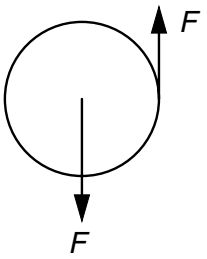
**B** 40 N m anticlockwise

**C** 80 N m clockwise

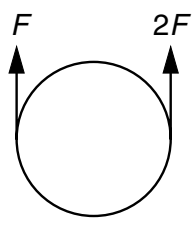
**D** 80 N m anticlockwise

**18** Which of the following pairs of forces, acting on a circular object, constitutes a couple?

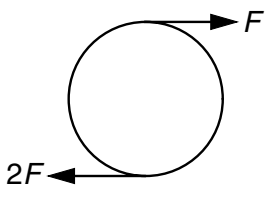
**A**



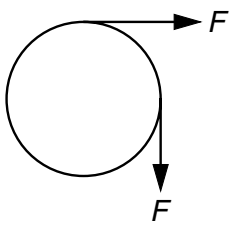

**B**




**C**

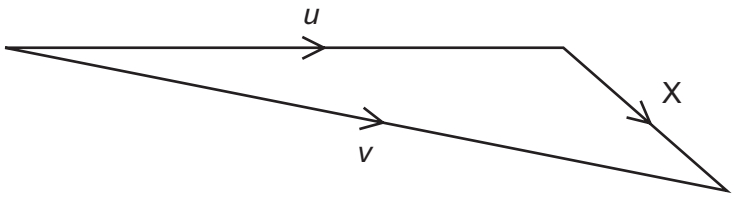



**D**



**19** An object has an initial velocity $u$. It is subjected to a constant force $F$ for $t$ seconds, causing a constant acceleration $a$. The force is **not** in the same direction as the initial velocity.

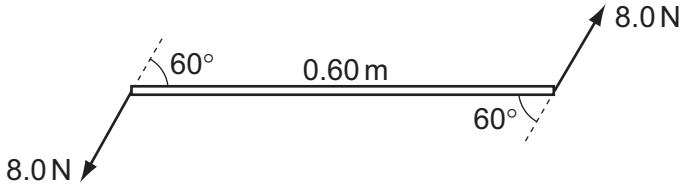
A vector diagram is drawn to find the final velocity $v$.




What is the length of side X of the vector diagram?

**A** $F$ **B** $Ft$ **C** $at$ **D** $u + at$

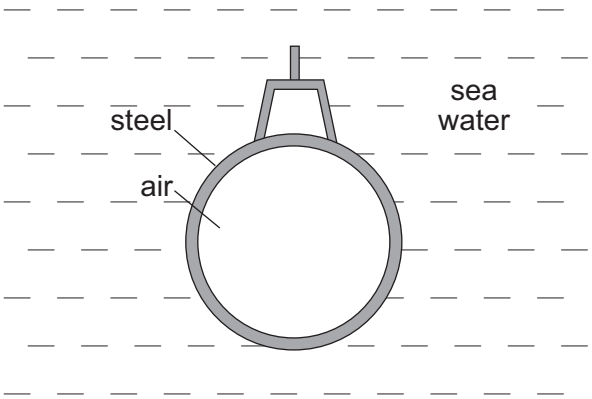
**20** Two 8.0 N forces act at each end of a beam of length 0.60 m. The forces are parallel and act in opposite directions. The angle between the forces and the beam is 60°.




What is the torque of the couple exerted on the beam?

**A** 2.4 N m **B** 4.2 N m **C** 4.8 N m **D** 9.6 N m

**21** A submarine is in equilibrium in a fully submerged position.




What causes the upthrust on the submarine?

**A** The air in the submarine is less dense than sea water.

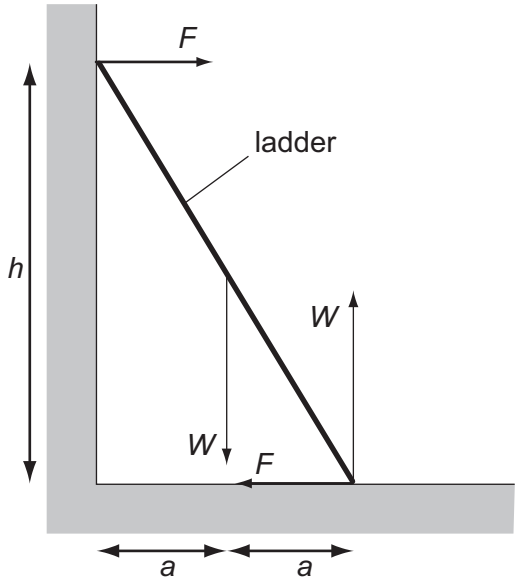
**B** The sea water exerts a greater upward force on the submarine than the weight of the steel.

**C** The submarine displaces its own volume of sea water.

**D** There is a difference in water pressure acting on the top and bottom of the submarine.

**22** A uniform ladder rests against a vertical wall where there is negligible friction. The bottom of the ladder rests on rough ground where there is friction. The top of the ladder is at a height *h* above the ground and the foot of the ladder is at a distance 2*a* from the wall.

The diagram shows the forces which act on the ladder.




Which equation is formed by taking moments?

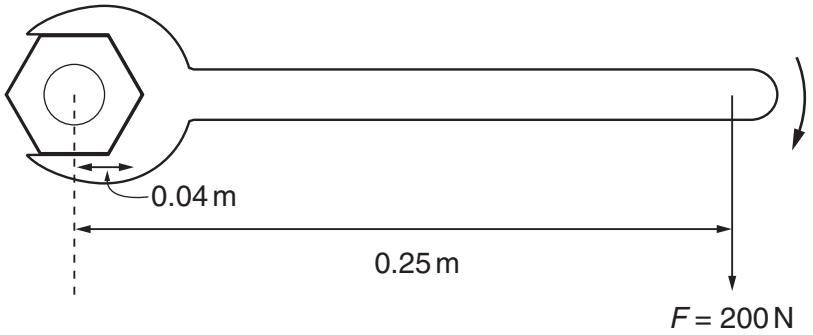
**A** $Wa + Fh = 2Wa$

**B** $Fa + Wa = Fh$

**C** $Wa + 2Wa = Fh$

**D** $Wa - 2Wa = 2Fh$

**23** A spanner is used to tighten a nut as shown.




A force *F* is applied at right-angles to the spanner at a distance of 0.25 m from the centre of the nut. When the nut is fully tightened, the applied force is 200 N.

What is the resistive torque, in an anticlockwise direction, preventing further tightening?

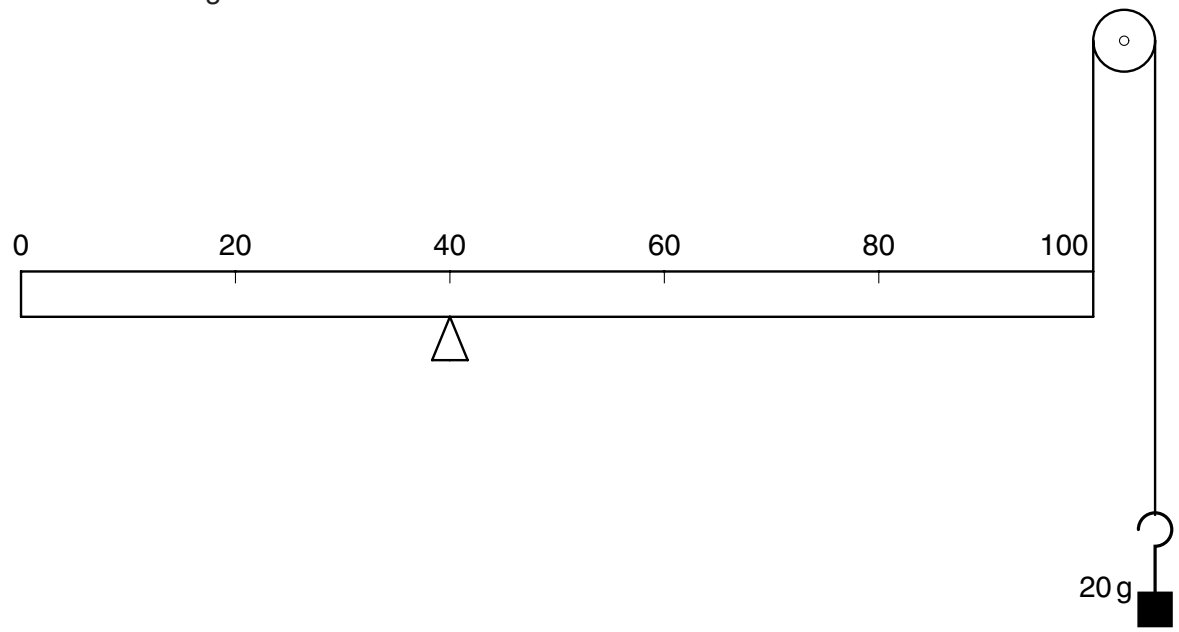
**A** 8 N m

**B** 25 N m

**C** 50 N m

**D** 800 N m

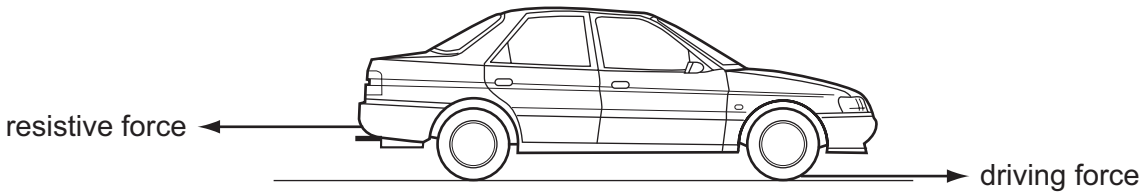
**24** A uniform metre rule of mass 100 g is supported by a knife-edge at the 40 cm mark and a string at the 100 cm mark. The string passes round a frictionless pulley and carries a mass of 20 g as shown in the diagram.




At which mark on the rule must a 50 g mass be suspended so that the rule balances?

**A** 4 cm **B** 36 cm **C** 44 cm **D** 96 cm

**25** A car of mass 750 kg has a horizontal driving force of 2.0 kN acting on it. It has a forward horizontal acceleration of 2.0 $m\,s^{-2}$.




What is the resistive force acting horizontally?

**A** 0.5 kN **B** 1.5 kN **C** 2.0 kN **D** 3.5 kN

**26** A ball is falling at terminal speed in still air. The forces acting on the ball are upthrust, viscous drag and weight.

What is the order of increasing magnitude of these three forces?

**A** upthrust → viscous drag → weight

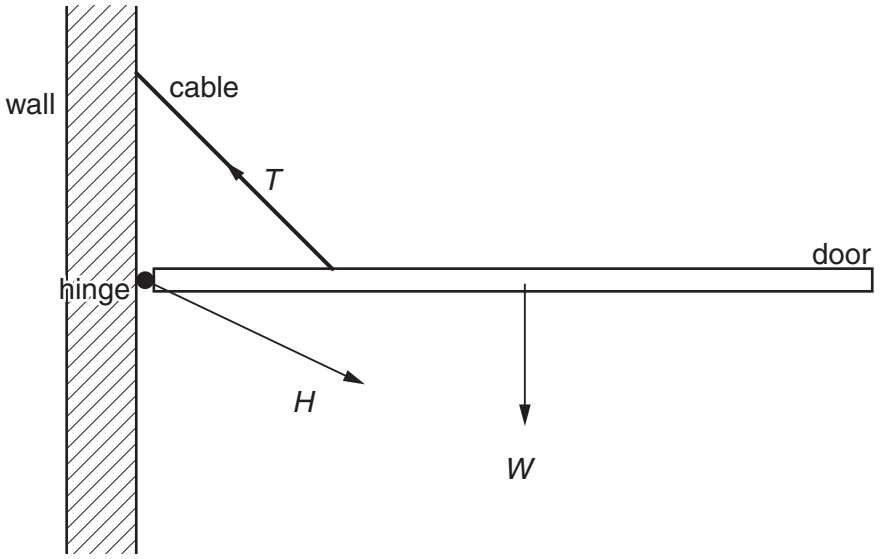
**B** viscous drag → upthrust → weight

**C** viscous drag → weight → upthrust

**D** weight → upthrust → viscous drag

**27** A hinged door is held closed in the horizontal position by a cable.

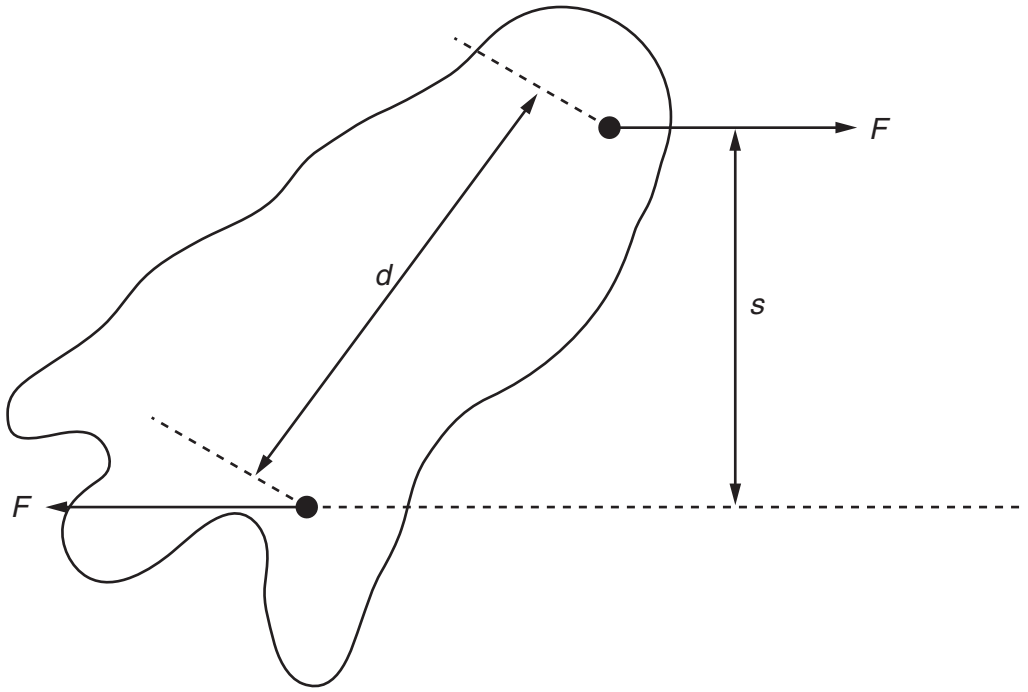
Three forces act on the door: the weight *W* of the door, the tension *T* in the cable, and the force *H* at the hinge.




Which list gives the three forces in **increasing** order of magnitude?

**A** *H*,*T*,*W** **B** *T*,*H*,*W** **C** *W*,*H*,*T** **D** *W*,*T*,*H*

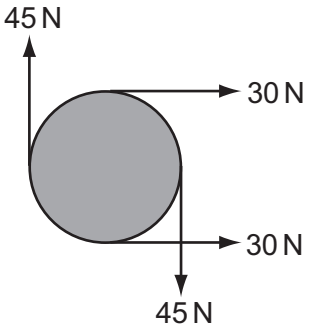
**28** Two parallel forces, each of magnitude *F*, act on a body as shown.




What is the magnitude of the torque on the body produced by these forces?

**A** *Fd* **B** *Fs* **C** 2*Fd* **D** 2*Fs*

**29** The diagram shows four forces applied to a circular object.

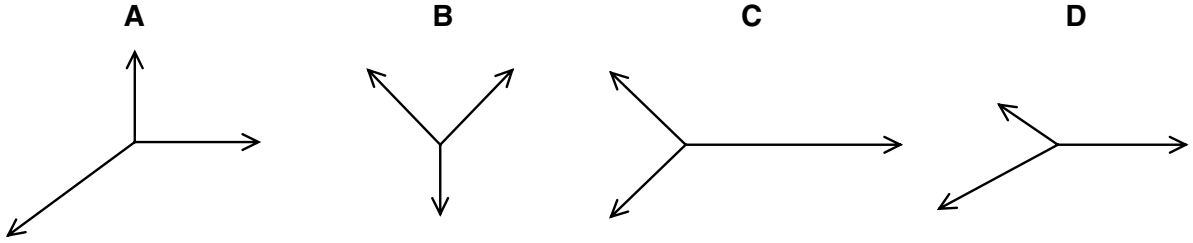



Which of the following describes the resultant force and resultant torque on the object?

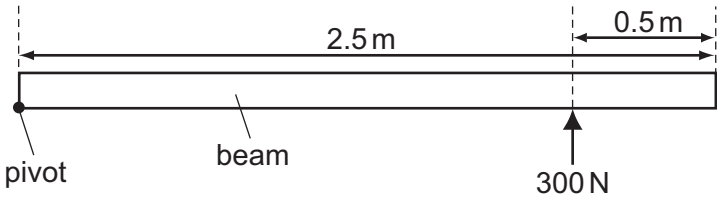
| | resultant force | resultant torque |
|---|---|---|
| **A** | non-zero | non-zero |
| **B** | non-zero | zero |
| **C** | zero | non-zero |
| **D** | zero | zero |

**30** The diagrams represent systems of coplanar forces acting at a point. The lengths of the force vectors represent the magnitudes of the forces.

Which system of forces is in equilibrium?



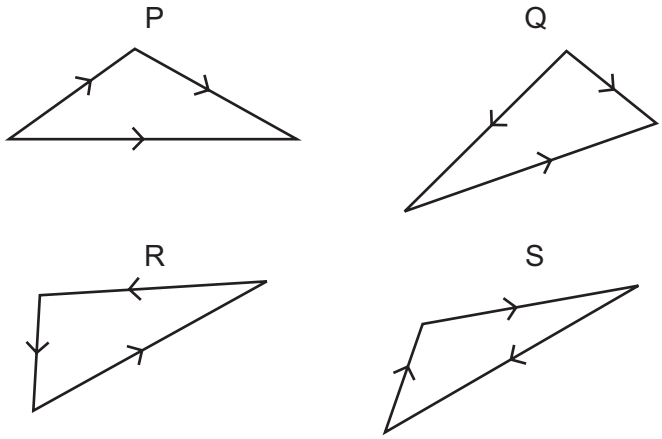

**31** A long uniform beam is pivoted at one end. A force of 300 N is applied to hold the beam horizontally.




What is the weight of the beam?

**A** 300 N **B** 480 N **C** 600 N **D** 960 N

**32** Which two vector diagrams represent forces in equilibrium?




**A** P and Q

**B** Q and R

**C** R and S

**D** S and P

**33** What is meant by the weight of an object?

**A** the gravitational field acting on the object

**B** the gravitational force acting on the object

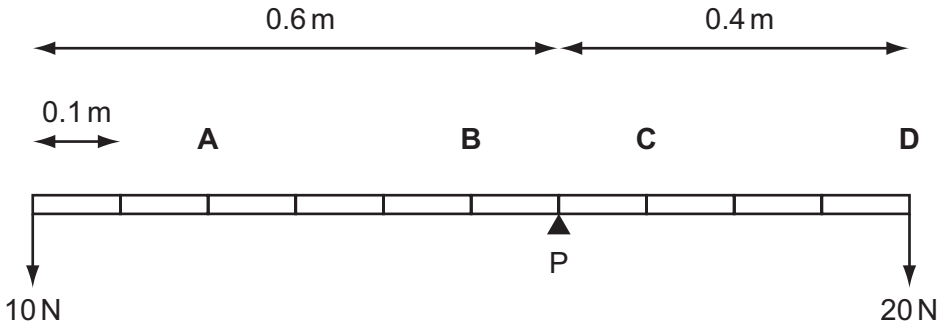
**C** the mass of the object multiplied by gravity

**D** the object's mass multiplied by its acceleration

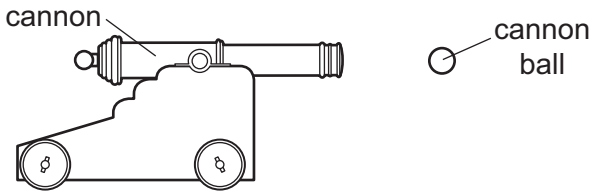
**34** A uniform beam of weight 100 N is pivoted at P as shown. Weights of 10 N and 20 N are attached to its ends.

The length of the beam is marked off at 0.1 m intervals.

At which point should a further weight of 20 N be attached to achieve equilibrium?



**35** The diagram shows a cannon ball fired from a cannon.



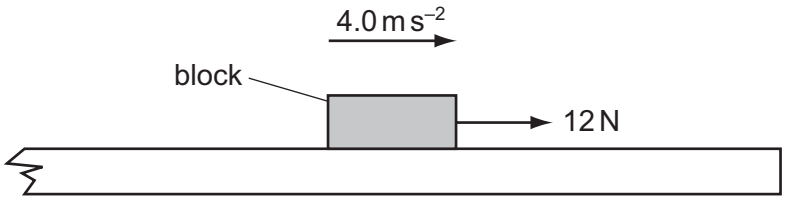

The mass of the cannon is 1000 kg and the mass of the cannon ball is 10 kg.

The recoil velocity of the cannon is $5\,m\,s^{-1}$ horizontally.

What is the horizontal velocity of the cannon ball?

**A** $200\,m\,s^{-1}$ **B** $500\,m\,s^{-1}$ **C** $2000\,m\,s^{-1}$ **D** $5000\,m\,s^{-1}$

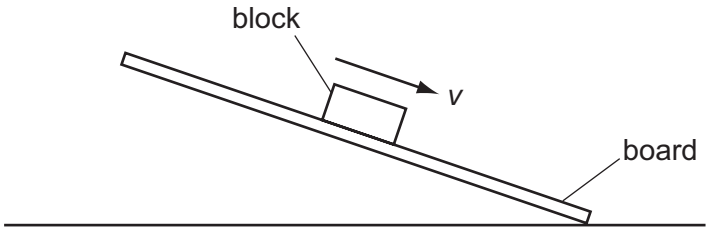
**36** A block of mass 0.60 kg is on a rough horizontal surface. A force of 12 N is applied to the block and it accelerates at $4.0\,m\,s^{-2}$.




What is the magnitude of the frictional force acting on the block?

**A** 2.4N **B** 5.3 N **C** 6.7 N **D** 9.6 N

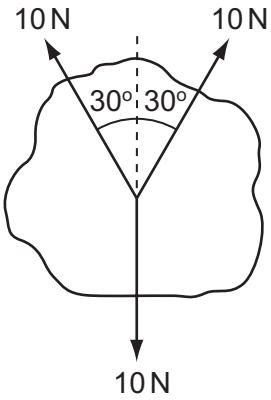
**38** A wooden block rests on a rough board. The end of the board is then raised until the block slides down the plane of the board at constant velocity *v*.




Which row describes the forces acting on the block when sliding with constant velocity?

| | frictional force on block | resultant force on block |
|---|---|---|
| **A** | down the plane | down the plane |
| **B** | down the plane | zero |
| **C** | up the plane | down the plane |
| **D** | up the plane | zero |

**39** Three coplanar forces, each of magnitude 10 N, act through the same point of a body in the directions shown.




What is the magnitude of the resultant force?

**A** 0 N **B** 1.3 N **C** 7.3 N **D** 10 N

**40** Which force is caused by a pressure difference?

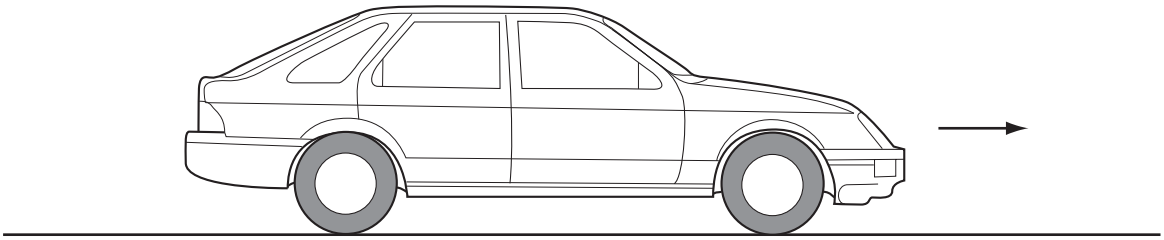
**A** friction

**B** upthrust

**C** viscous force

**D** weight

**41** A car with front-wheel drive accelerates in the direction shown.



Which diagram best shows the direction of the total force exerted by the road on the front wheels?

**A**



**B**

**C**

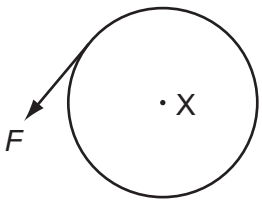


**D**

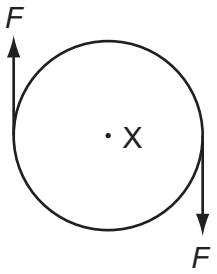
**42** A rigid circular disc of radius *r* has its centre at X. A number of forces of equal magnitude *F* act at the edge of the disc. All the forces are in the plane of the disc.

Which arrangement of forces provides a moment of magnitude 2*Fr* about X?

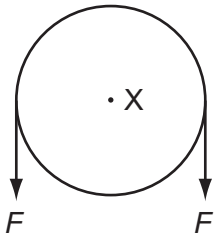
**A**



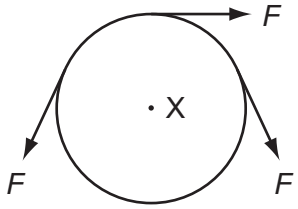

**B**



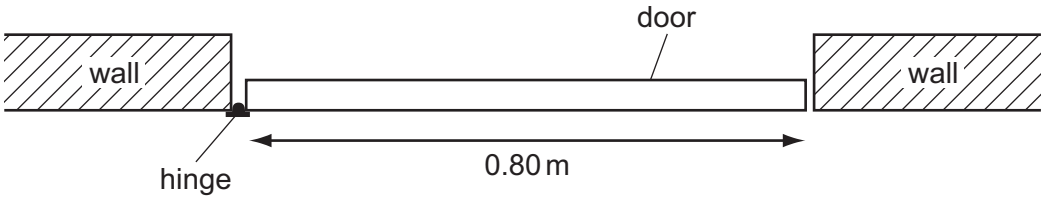

**C**




**D**




**43** The diagram shows a plan view of a door which requires a moment of 12 N m to open it.

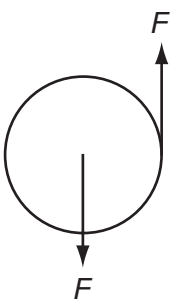



What is the minimum force that must be applied at the door's midpoint to ensure it opens?

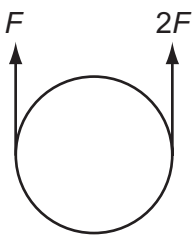
**A** 4.8 N **B** 9.6 N **C** 15 N **D** 30 N

**44** Which pair of forces acts as a couple on the circular object?

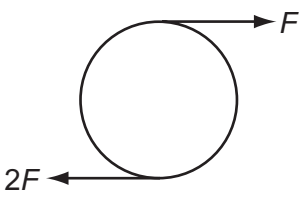
**A**



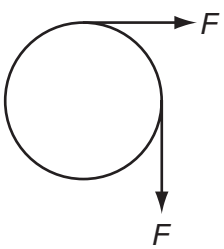

**B**




**C**

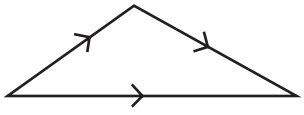



**D**

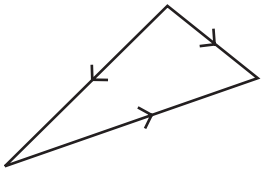


**45** Which two vector diagrams represent forces in equilibrium?

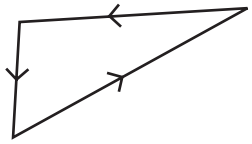
P



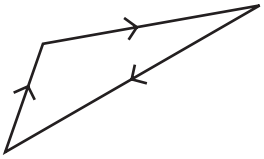
Q



R



S



**A** P and Q **B** Q and R **C** R and S **D** S and P