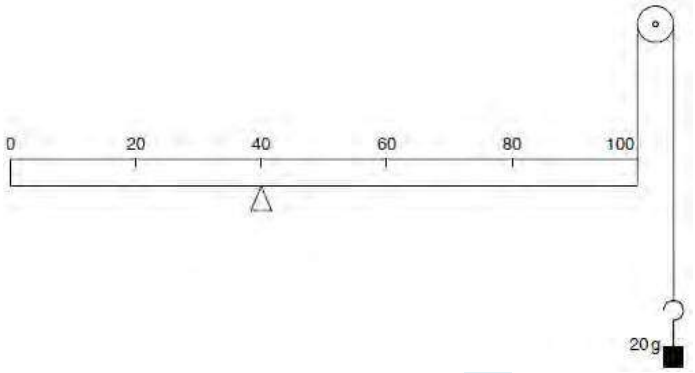
Force, Density & Pressure

TOPIC QUESTIONS (2)

Level	A Level
Subject	Physics
Exam Board	CIE
Paper Type	Multiple Choice

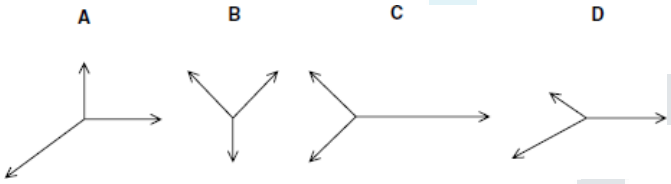
Time Allowed : 1Hour 10Min

1. 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.

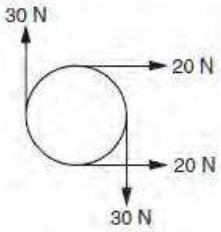


At which mark on the rule must a 50 g mass be suspended so that the rule balances?
A 4 cm **B** 36 cm **C** 44 cm **D** 96 cm

2. 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?



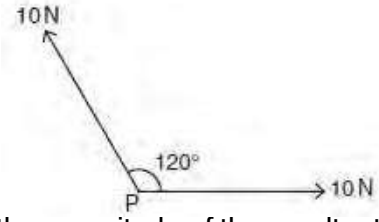
3. The diagram shows four forces applied to a circular object.



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

4. Two forces, each of 10 N, act at a point P as shown in the diagram. The angle between the directions of the forces is 120°.



What is the magnitude of the resultant force?

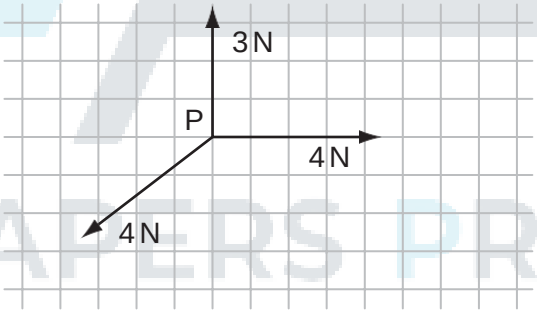
A 5N **B** 10N **C** 17N **D** 20N

5. 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 8Nm **B** 25Nm **C** 50Nm **D** 800Nm

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

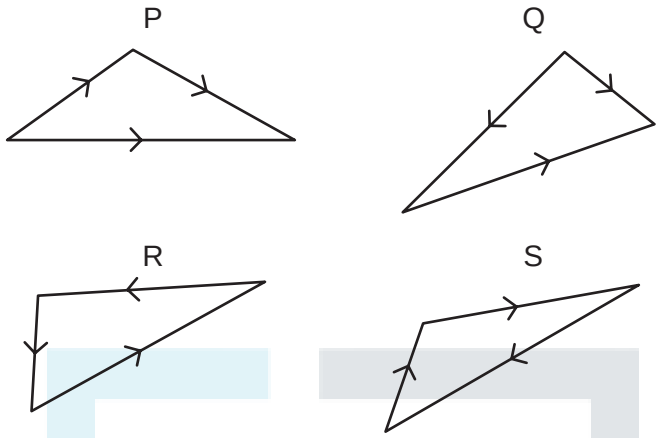


The magnitude of the resultant of these three forces is 1 N.

What is the direction of this resultant?

A ↓ **B** ↘ **C** ↙ **D** ↗

7. Which two vector diagrams represent forces in equilibrium?



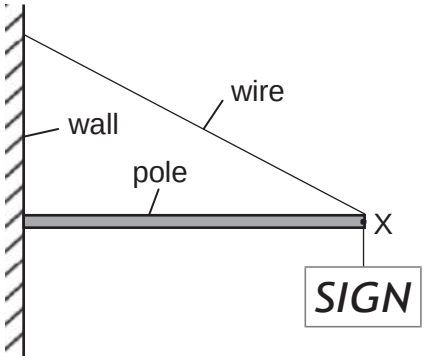
A P and Q

B Q and R

C R and S

D S and P

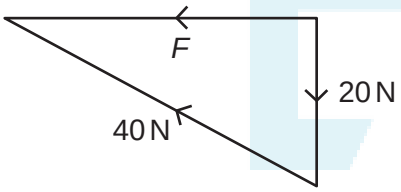
8. The diagram shows a sign of weight 20 N suspended from a pole, attached to a wall. The pole iskept in equilibrium by a wire attached at point X of the pole.



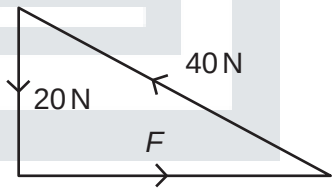
The force exerted by the pole at point X is *F*, and the tension in the wire is 40 N.

Which diagram represents the three forces acting at point X?

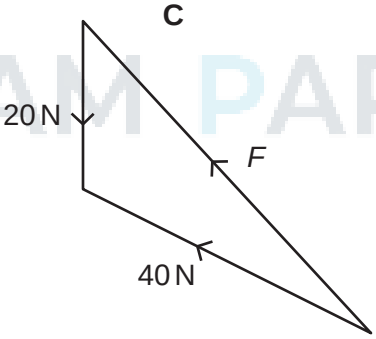
A



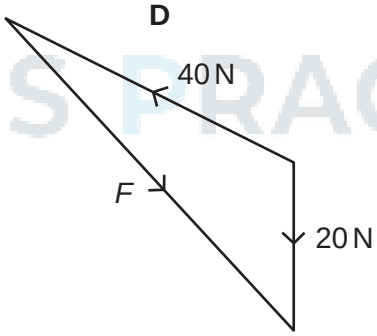
B



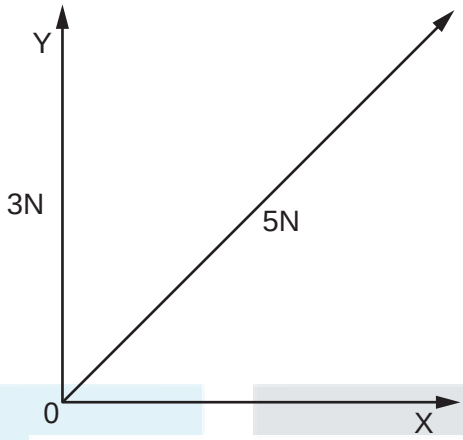
C



D



9. A force of 5 N may be represented by two perpendicular components OY and OX as shown in the diagram, which is **not** drawn to scale.



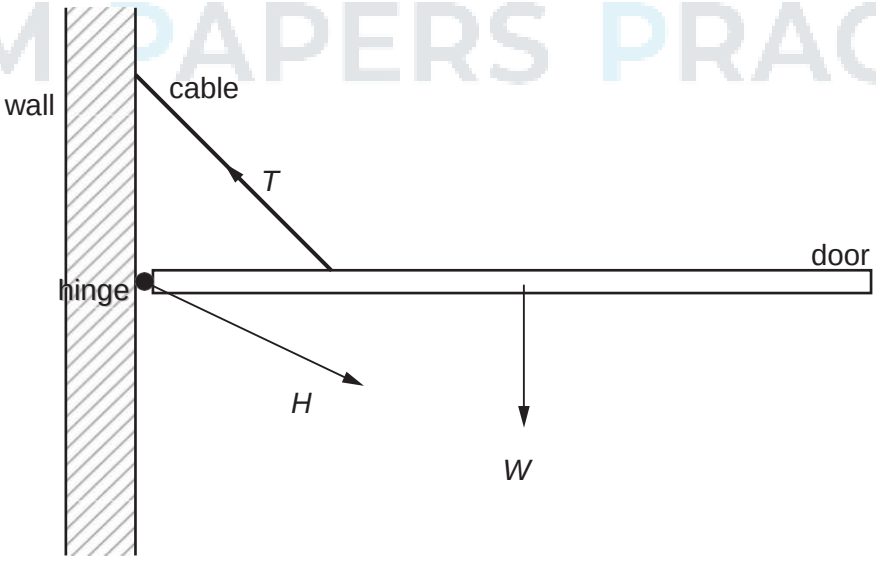
OY is of magnitude 3 N.

What is the magnitude of OX?

A 2N **B** 3N **C** 4N **D** 5N

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

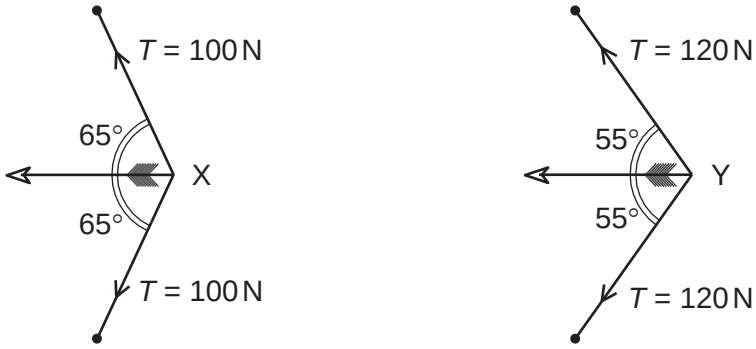
Three forces act on the door: the weight *W* of the door, the tension *T* in the cable, and the force *H* at the hinge.



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*

11. An archer draws his bowstring back to position X. The bowstring and arrow are shown. The tension *T* in the string is also shown. Then he draws the bowstring back further to position Y.



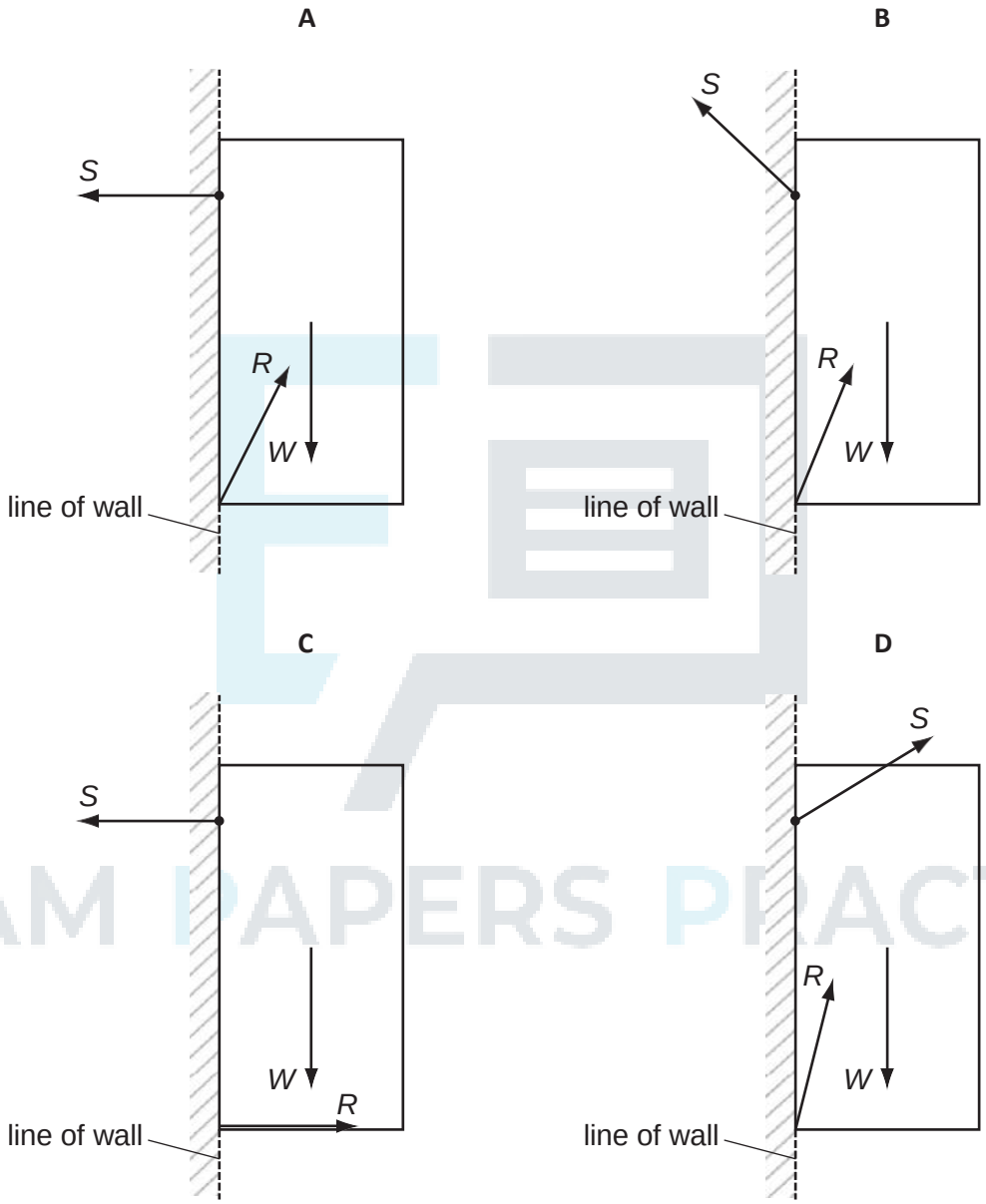
The resultant force on the arrow is greater when the arrow is released from position Y.

What is the increase in force?

A 15 N B 27 N C 40 N D 53 N

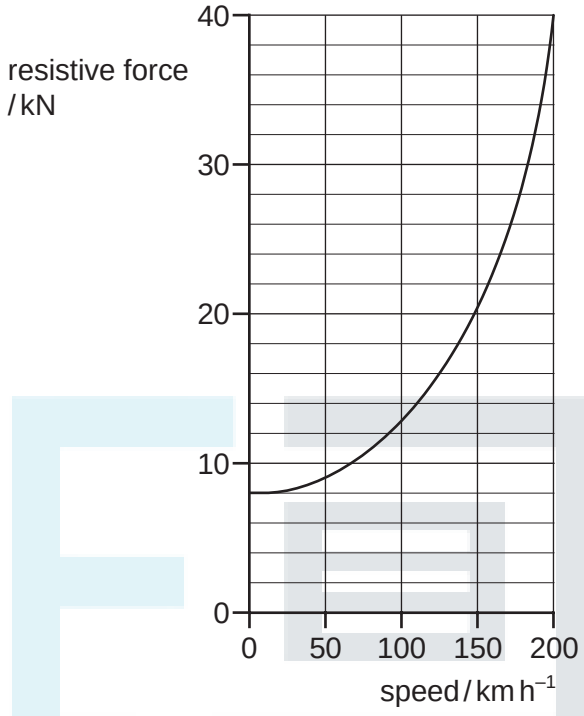
12. A cupboard is attached to a wall by a screw.

Which force diagram shows the cupboard in equilibrium, with the weight *W* of the cupboard, the force *S* that the screw exerts on the cupboard and the force *R* that the wall exerts on the cupboard?



13. The graph shows how the total resistive force acting on a train varies with its speed.

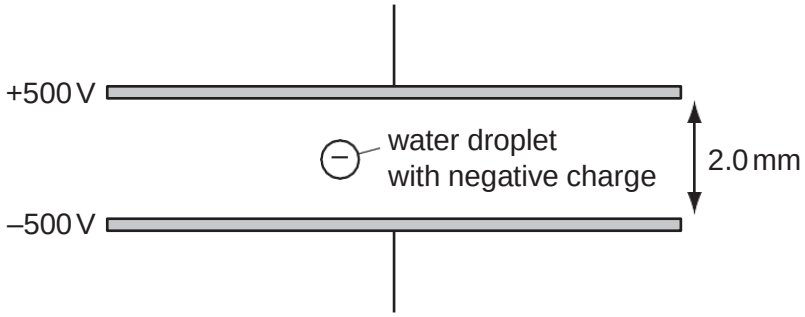
Part of this force is due to wheel friction, which is constant. The rest is due to wind resistance.



What is the ratio $\frac{\text{wind resistance}}{\text{wheel friction}}$ at a speed of 200 km h^{-1}?

A 4 B 5 C 8 D 10

14. A small water droplet of mass 3.0 µg carries a charge of -6.0×10^{-11} C. The droplet is situated in the Earth's gravitational field between two horizontal metal plates. The potential of the upper plate is +500 V and the potential of the lower plate is -500 V.



What is the motion of the droplet?

A It accelerates downwards.

B It remains stationary.

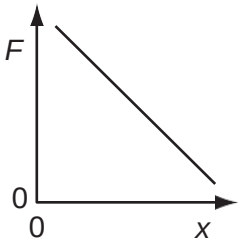
C It accelerates upwards.

D It moves upwards at a constant velocity.

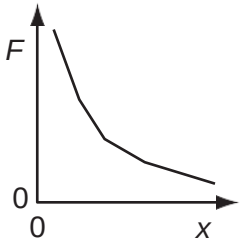
15. A horizontal bar is supported on a pivot at its centre of gravity. A fixed load is attached to one endof the bar. To keep the bar in equilibrium, a force *F* is applied at a distance *x* from the pivot.

How does *F* vary with *x*?

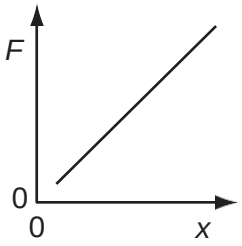
A



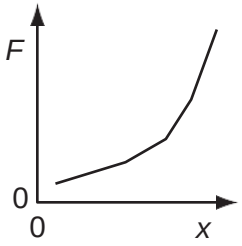
B



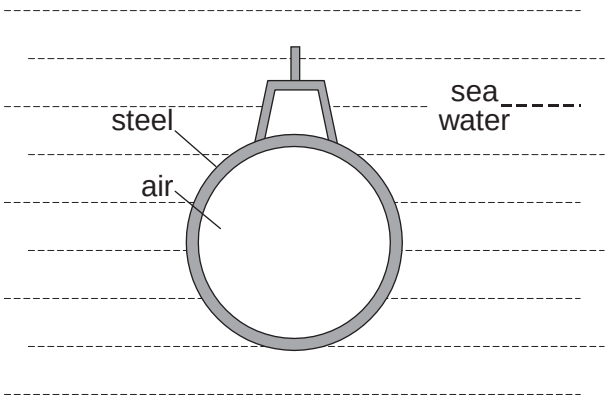
C



D



16. A submarine is in equilibrium in a fully submerged position.



What causes the upthrust on the submarine?

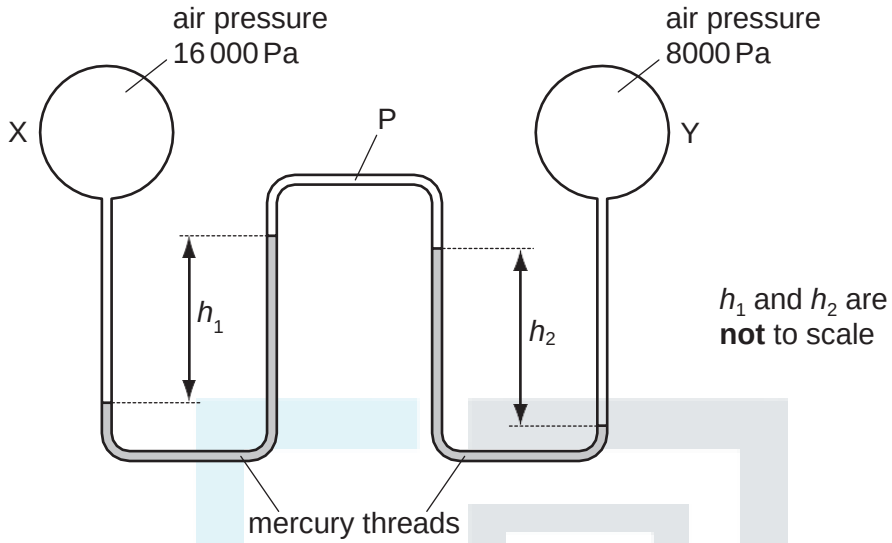
A The air in the submarine is less dense than sea water.

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 on the bottom of the submarine.

17. Two bulbs X and Y containing air at different pressures are connected by a tube P which contains two mercury threads.



The density of mercury is 13 600 kg m^{-3}.

Which pair of values of h_1 and h_2 is possible?

	h_1 / cm	h_2 / cm
A	4.0	2.0
B	6.0	6.0
C	12.0	18.0
D	18.0	12.0

18. The formula for hydrostatic pressure is $p = \rho gh$.

Which equation, or principle of physics, is used in the derivation of this formula?

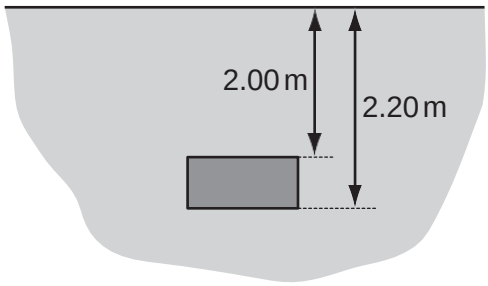
A density = $\frac{\text{mass}}{\text{volume}}$

B potential energy = mgh

C atmospheric pressure decreases with height

D density increases with depth

19. The diagram shows a rectangular block of mass 8.2 kg immersed in sea water of density $1.10 \times 10^3\,\text{kg}\,\text{m}^{-3}$.



What is the difference in pressure between the top and bottom surfaces of the block?

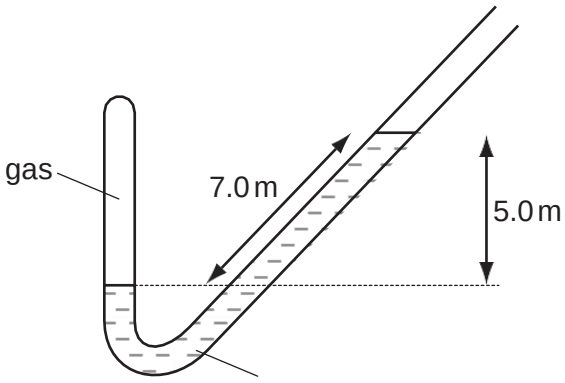
A $2.2 \times 10^2\,\text{Pa}$

B $2.2 \times 10^3\,\text{Pa}$

C $1.8 \times 10^4\,\text{Pa}$

D $2.3 \times 10^4\,\text{Pa}$

20. A pipe is closed at one end and contains gas, trapped by a column of water.



water

The atmospheric pressure is 1.0×10^5 Pa. The density of water is 1000 kg m^{-3}. What is the pressure of the gas? (Use g = 10 m s^{-2}.)

A 0.3×10^5 Pa

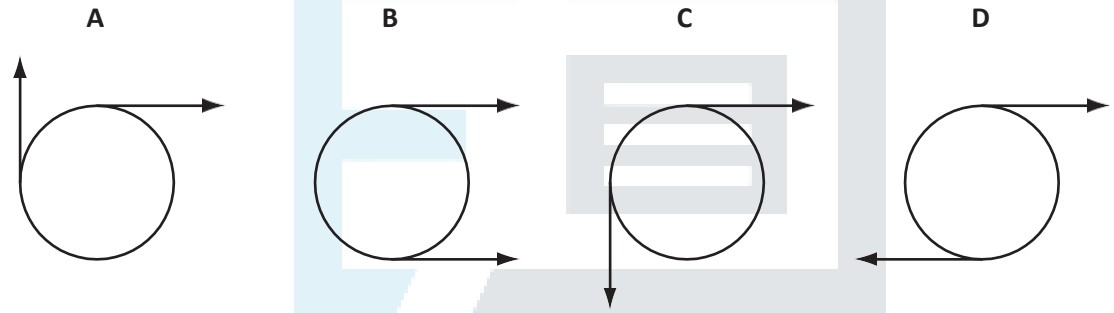
B 0.5×10^5 Pa

C 1.5×10^5 Pa

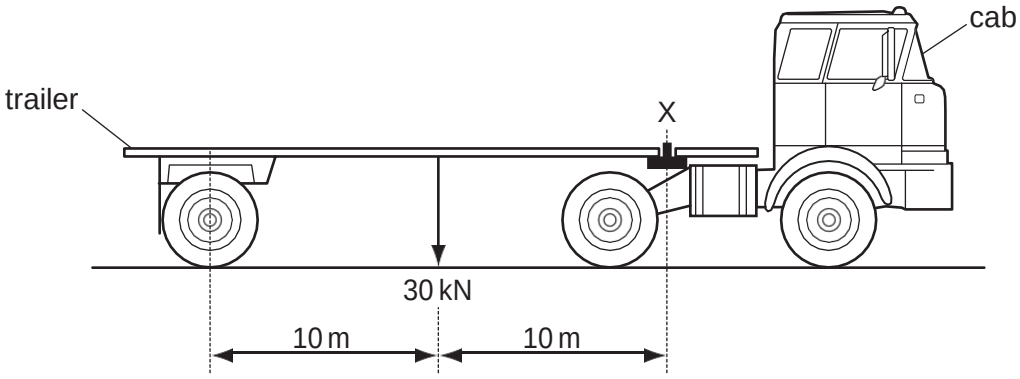
D 1.7×10^5 Pa

21. Two co-planar forces act on the rim of a wheel. The forces are equal in magnitude.

Which arrangement of forces provides only a couple?



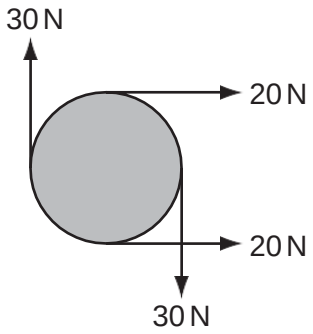
22. A trailer of weight 30 kN is hitched to a cab at X, as shown in the diagram.



What is the upward force exerted by the cab on the trailer at X?

A 3 kN B 15 kN C 30 kN D 60 kN

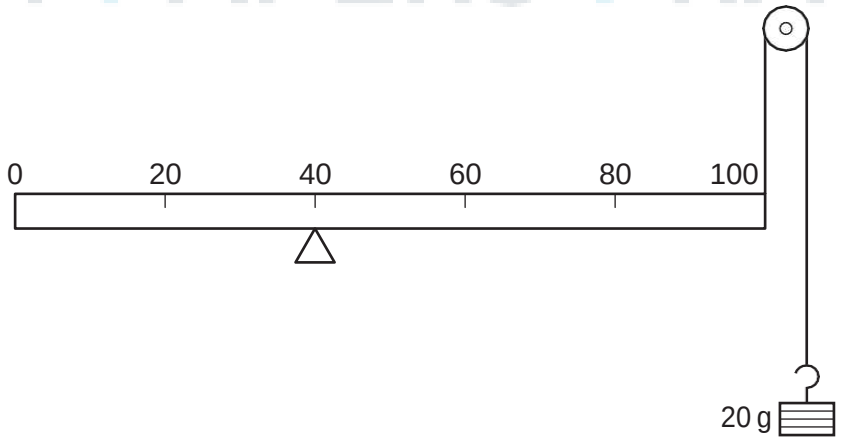
23. The diagram shows four forces applied to a circular object.



Which row 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

24. A uniform metre rule of mass 100 g is supported by a pivot 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.

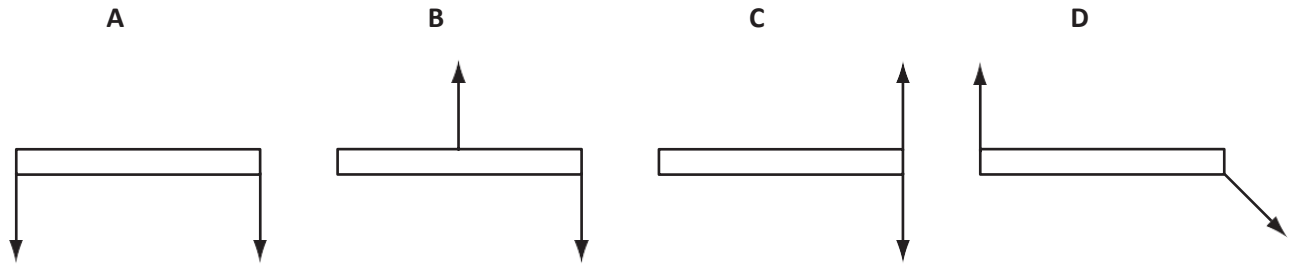


At which mark on the rule must a 50 g mass be suspended so that the rule balances?

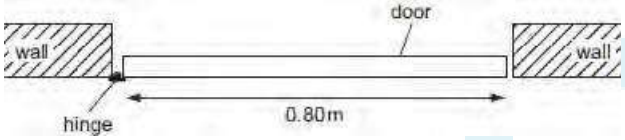
A 4 cm B 36 cm C 44 cm D 64 cm

25. The diagrams all show a pair of equal forces acting on a metre rule.

Which diagram shows forces that provide a couple and zero resultant force?



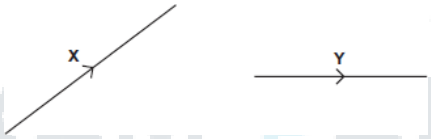
26. The diagram shows a plan view of a door which requires a moment of 12 N m to open it.



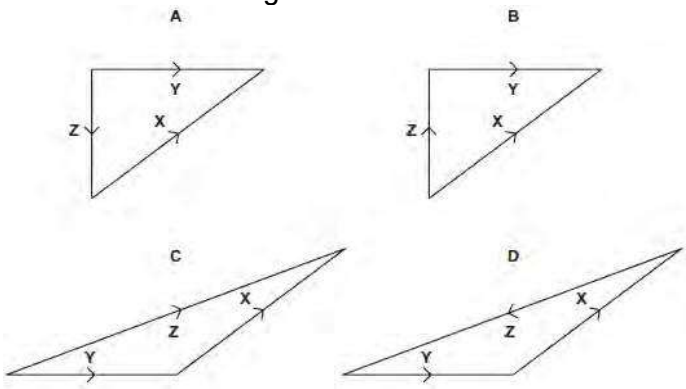
What is the minimum force that must be applied at the door's midpoint to ensure it opens?

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

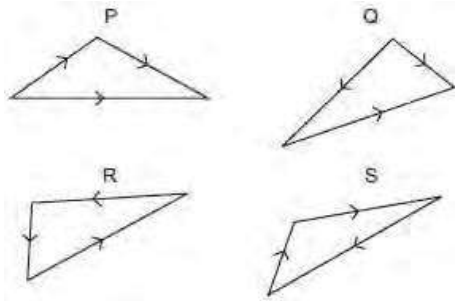
27. The diagram shows two vectors X and Y.



In which vector triangle does the vector Z show the magnitude and direction of vector X-Y?

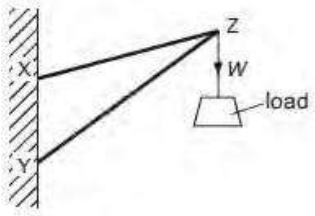


28. Which two vector diagrams represent forces in equilibrium?

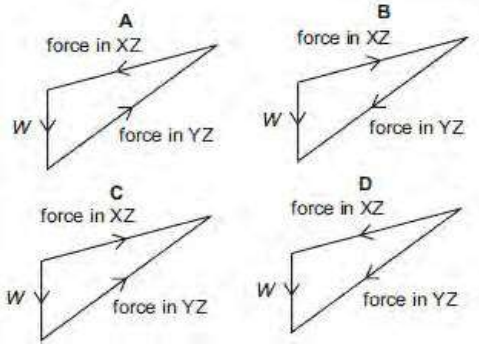


A P and Q **B** Q and R **C** R and S **D** S and P

29. 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. Theload is not moving.

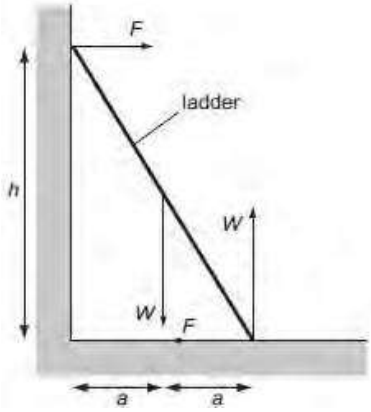


Which diagram shows the forces acting at point Z?



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

The diagram shows the forces which act on the ladder.



Which equation is formed by taking moments?

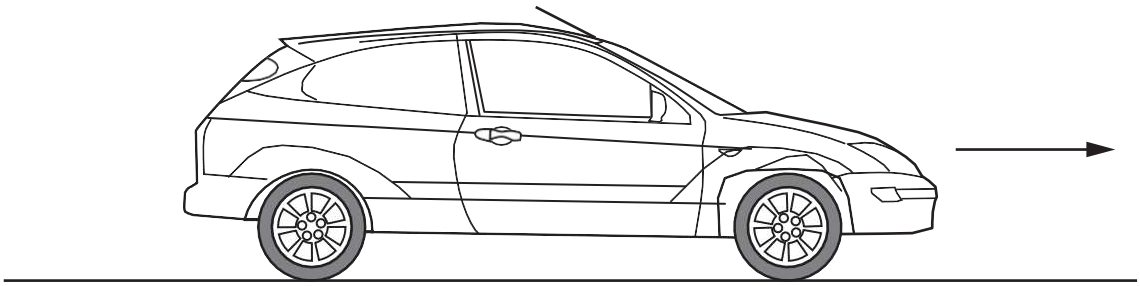
A W a + F h = 2W a

B F a + W a = F h

C W a + 2W a = F h

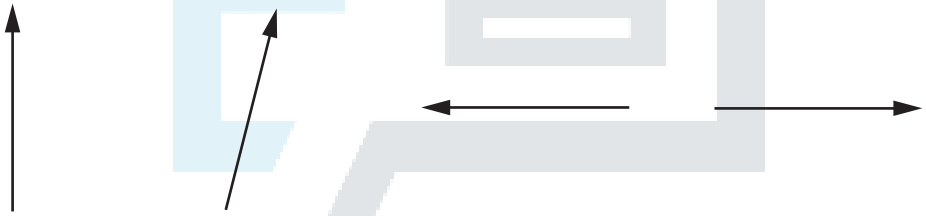
D W a - 2W a = 2F h

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

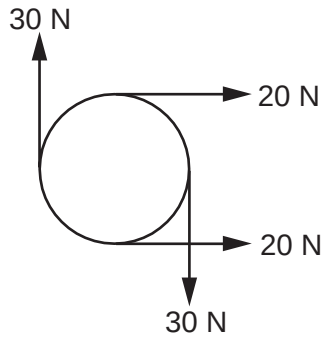


Which diagram best shows the direction of the total force exerted by the road on the front wheels?

A **B** **C** **D**



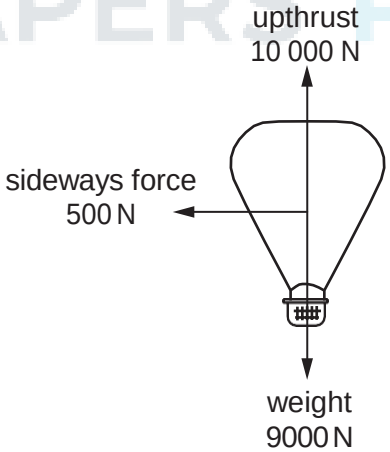
32. The diagram shows four forces applied to a circular object.



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

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

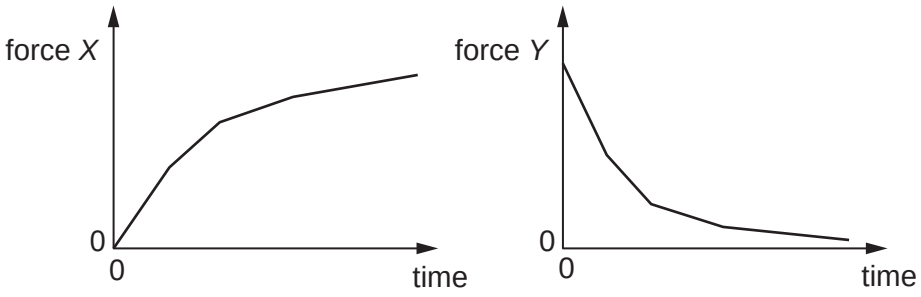


What is the vertical component of the resultant force on the balloon?

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

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

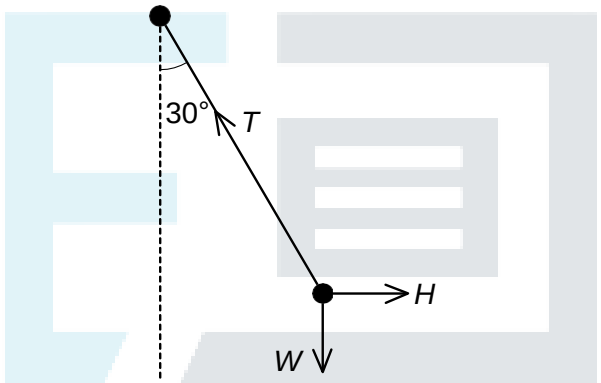
For this fall, forces *X* and *Y* vary with time as shown.



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

35. A pendulum bob is held stationary by a horizontal force *H*. The three forces acting on the bob are shown in the diagram.



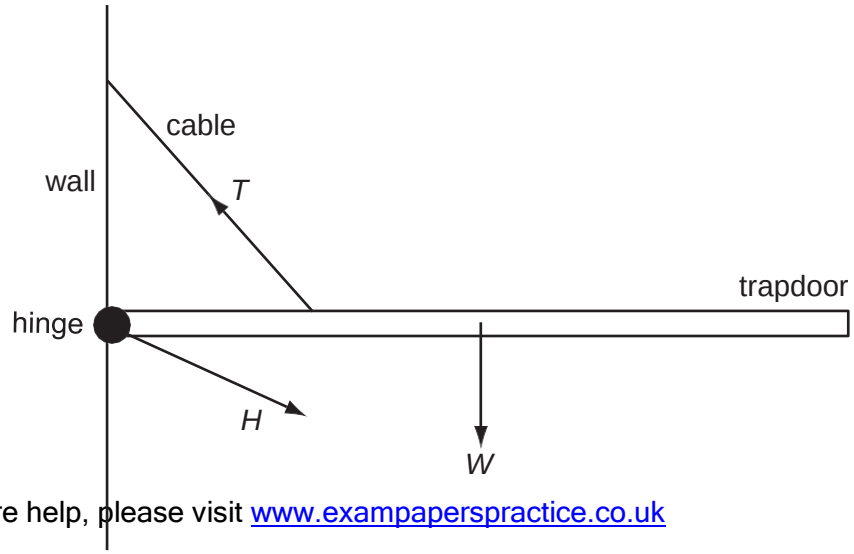
The tension in the string of the pendulum is *T*. The weight of the pendulum bob is *W*.

Which statement is correct?

A $H = T\cos30°$ **B** $T = H\sin30°$ **C** $W = T\cos30°$ **D** $W = T\sin30°$

36. A hinged trapdoor is held closed in the horizontal position by a cable.

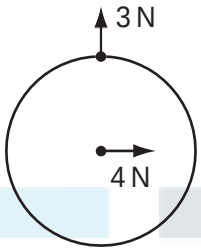
Three forces act on the trapdoor: the weight *W* of the door, the tension *T* in the cable and the force *H* at the hinge.



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

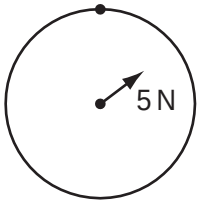
A *H*,*T*,*W* B *T*,*H*,*W* C *W*,*H*,*T* D *W*,*T*,*H*

37. Two forces act on a circular disc as shown.

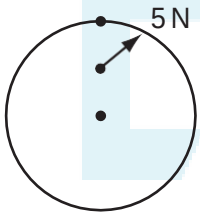


Which diagram shows the line of action of the resultant force?

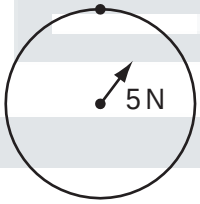
A



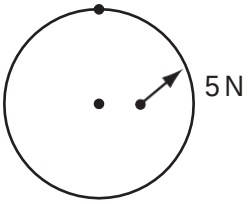
B



C



D



38. A strong wind of speed 33 m s^{-1} blows against a wall. The density of the air is 1.2 kg m^{-3}. The wallhas an area of 12 m^2 at right angles to the wind velocity. The air has its speed reduced to zero
when it hits the wall.

What is the approximate force exerted by the air on the wall?

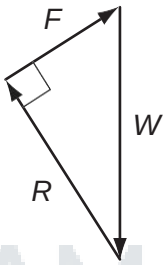
A 330 N B 400 N C 480 N D 16 000 N

39. A vehicle is at rest on a slope. It is considered to have three forces acting on it to keep it inequilibrium.

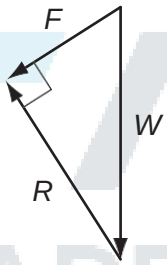
They are its weight *W*, a normal reaction force *R* and a frictional force *F*.

Which triangle of forces is correct?

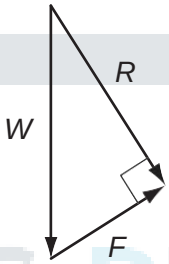
A



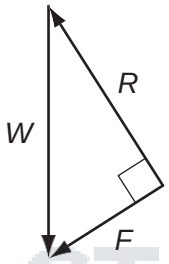
B



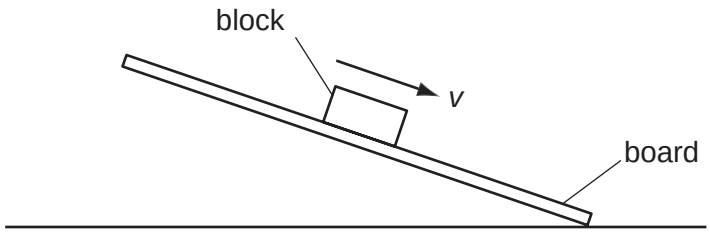
C



D



40. A wooden block rests on a rough board. The end of the board is then raised until the block slidesdown 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

41. A horizontal plate of area 0.036 m^2 is beneath the surface of a liquid of density 930 kg m^{-3}. Theforce on the plate due to the pressure of the liquid is 290 N.

What is the depth of the plate beneath the surface of the liquid?

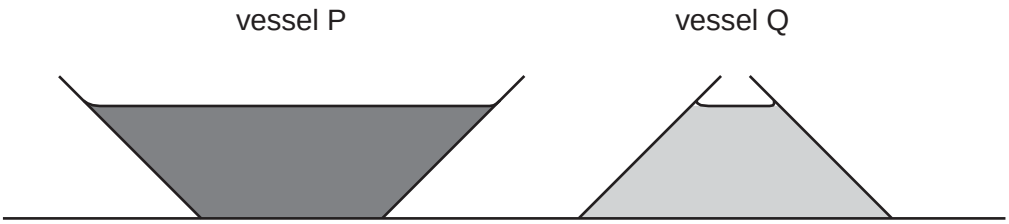
A 0.88 m B 1.13 m C 8.7 m D 9.1 m

42. 1.5 m^3 of water is mixed with 0.50 m^3 of alcohol. The density of water is 1000 kg m^{-3} and thedensity of alcohol is 800 kg m^{-3}.

What is the density of the mixture with volume 2.0 m^3?

A 850 kg m^{-3} B 900 kg m^{-3} C 940 kg m^{-3} D 950 kg m^{-3}

43. The diagram shows two vessels, P and Q, both with sides inclined at 45°.



Vessel P tapers outwards and vessel Q tapers inwards, as shown.

Both vessels contain a liquid. The depth of the liquid in the vessels is the same. The liquid in vessel P is twice as dense as the liquid in vessel Q.

What is the ratio $\frac{\text{pressure due to the liquid on the base of P}}{\text{pressure due to the liquid on the base of Q}}$?

A $\frac{2}{1}$ B $\frac{\sqrt{2}}{1}$ C $\frac{1}{\sqrt{2}}$ D $\frac{1}{2}$

44. Two solid substances P and Q have atoms of mass M_P and M_Q respectively. They have n_P and n_Q atoms per unit volume.

The density of P is greater than the density of Q.

What must be correct?

A $M_P > M_Q$

B $n_P > n_Q$

C $M_P n_P > M_Q n_Q$

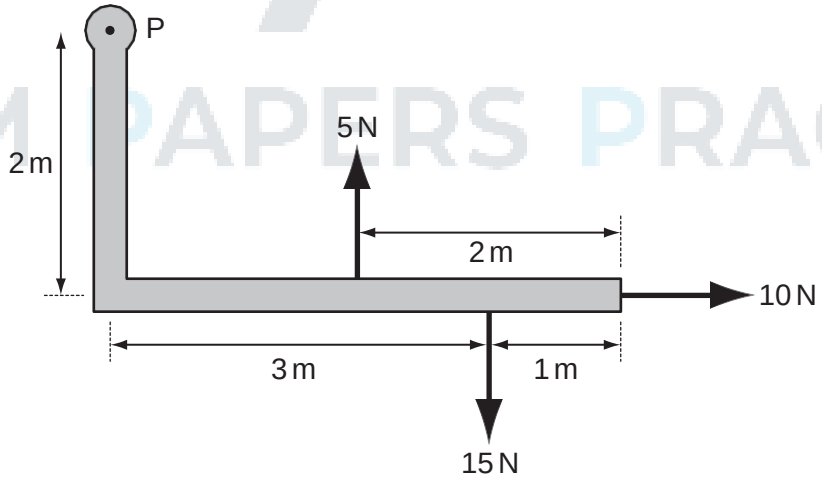
D $\frac{M_P}{n_P} > \frac{M_Q}{n_Q}$

45. The Mariana Trench in the Pacific Ocean has a depth of about 10 km.

Assuming that sea water is incompressible and has a density of about 1020 kg m^{-3}, what wouldbe the approximate pressure at that depth?

A 10^5 Pa B 10^6 Pa C 10^7 Pa D 10^8 Pa

46. A rigid L-shaped lever arm is pivoted at point P.

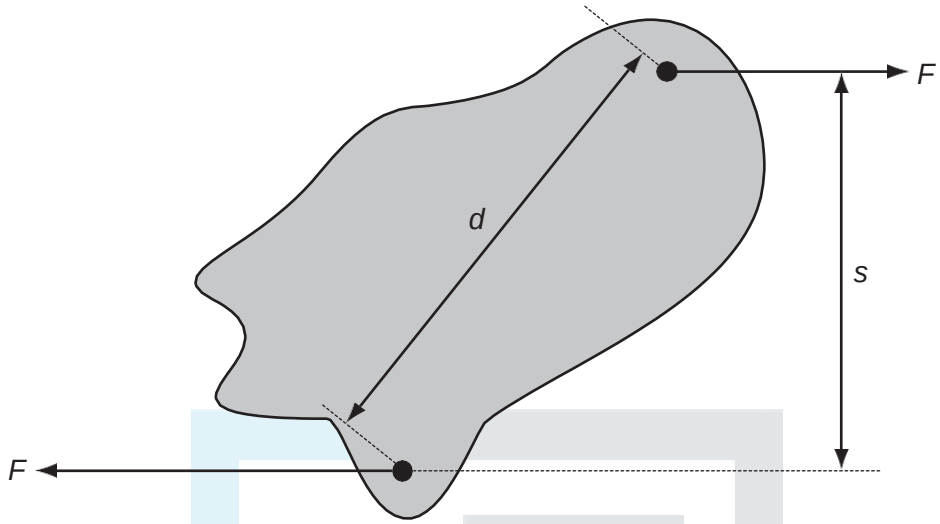


Three forces act on the lever arm, as shown in the diagram.

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

A 15 N m B 20 N m C 35 N m D 75 N m

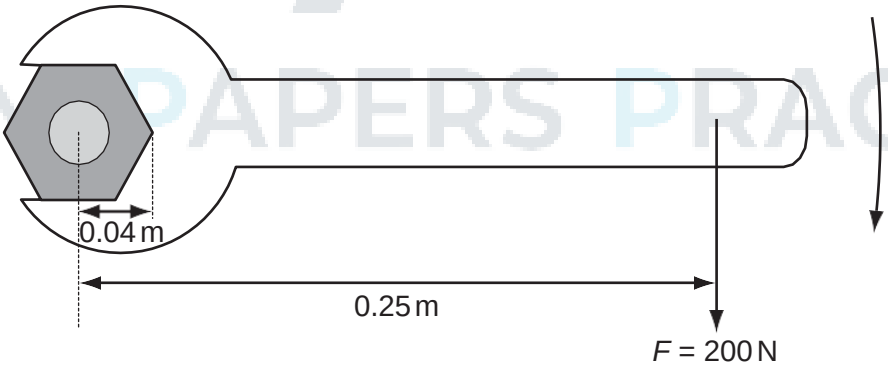
47. Two parallel forces, each of magnitude F, act on a body as shown.



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

A Fd B Fs C $2Fd$ D $2Fs$

48. A spanner is used to tighten a nut as shown.

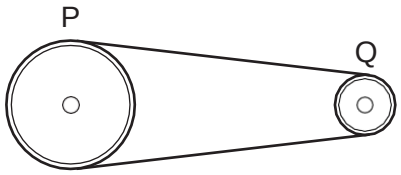


A force F is applied at right-angles to the spanner at a distance of 0.25 m from the centre of the nut. When the nut is fully tightened, the applied force is 200 N.

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

A 8 N m B 42 N m C 50 N m D 1250 N m

49. The diagram shows two pulley wheels connected by a belt.



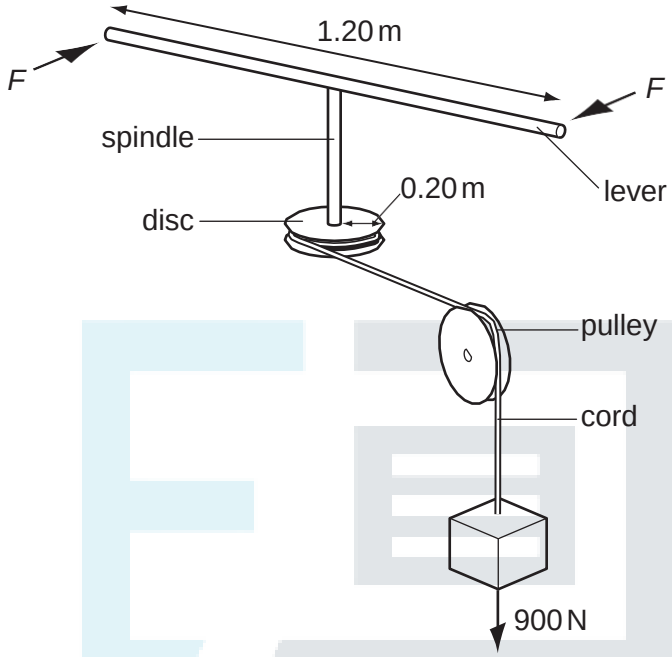
Wheel Q is driven by a motor and rotates clockwise at a constant rate. Wheel Q puts tension in the top portion of the belt, which in turn drives the wheel P. The lower portion of the belt is slack and has no tension. The weight of the belt and frictional forces are negligible.

The diameter of P is 150 mm. The diameter of Q is 100 mm. The torque applied to Q is 3.0 N m.

What is the tension in the belt and the torque on wheel P?

	tension in top of belt / N	torque on wheel P / N m
A	20	2
B	30	4
C	40	2
D	60	4

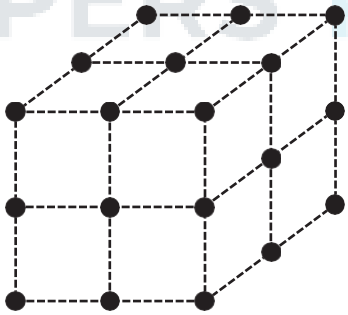
50. A spindle is attached at one end to the centre of a lever 1.20 m long and at its other end to the centre of a disc of radius 0.20 m. A cord is wrapped round the disc, passes over a pulley and is attached to a 900 N weight.



What is the minimum force *F*, applied to each end of the lever, that could lift the weight?

A 75 N B 150 N C 300 N D 950 N

51. The diagram shows the arrangement of atoms in a particular crystal.



Each atom is at the corner of a cube.

The mass of each atom is 3.5×10^{-25} kg. The density of the crystal is 9.2×10^{3} kg m^{-3}.

What is the shortest distance between the centres of two adjacent atoms?

A 3.8×10^{-29} m

B 6.2×10^{-15} m

C 3.4×10^{-10} m

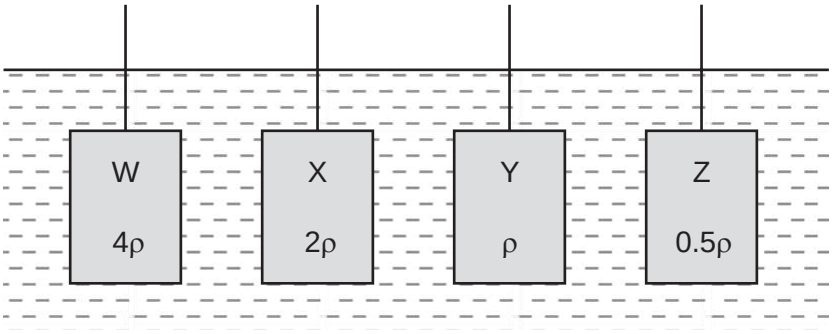
D $3.0 \times 10^{-9}\,\text{m}$

52. The maximum pressure that granite rock can withstand is $2.0 \times 10^{8}\,\text{N m}^{-2}$. Above this pressure,the rock begins to flow like a liquid. The density of granite is $2.7 \times 10^{3}\,\text{kg m}^{-3}$.

What would be the height of a pure granite mountain whose base is just beginning to flow?

A $3.8 \times 10^{3}\,\text{m}$ B $7.6 \times 10^{3}\,\text{m}$ C $3.7 \times 10^{4}\,\text{m}$ D $7.4 \times 10^{4}\,\text{m}$

53. Four cuboids with identical length, breadth and height are immersed in water. The cuboids are held at the same depth and in identical orientations by vertical rods, as shown.



Water has density ρ.
Cuboid W is made of material of density 4ρ.
Cuboid X is made of material of density 2ρ.
Cuboid Y is made of material of density ρ.
Cuboid Z is made of material of density 0.5ρ.

Which statement is correct?

A The upthrust of the water on each of the cuboids is the same.

B The upthrust of the water on W is twice the upthrust of the water on X.

C The upthrust of the water on X is twice the upthrust of the water on W.

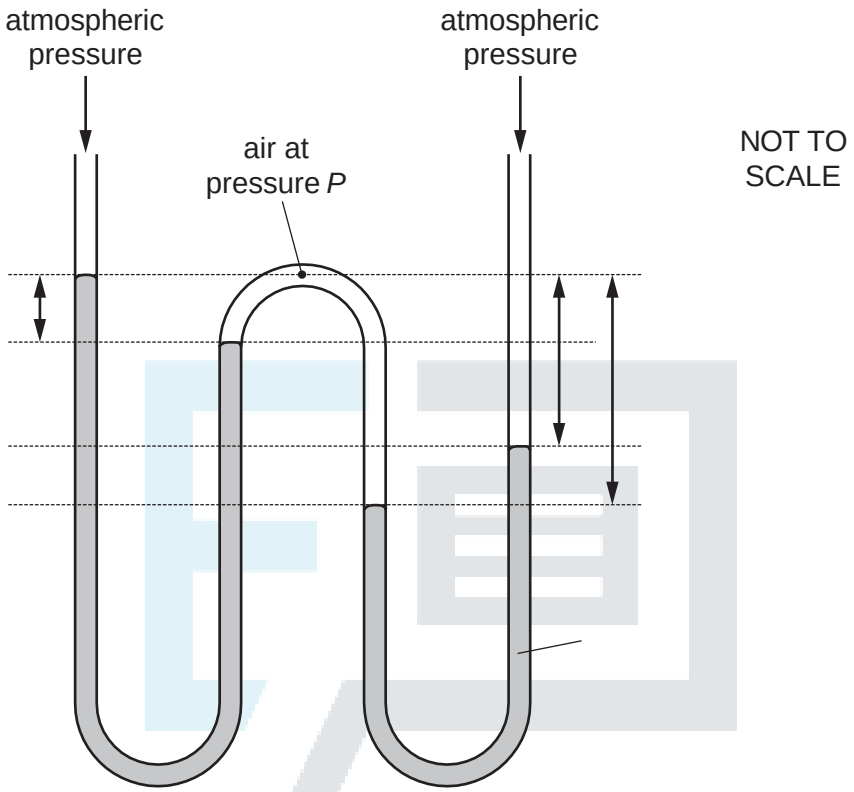
D The upthrust of the water on Y is zero.

54. When ice melts, it contracts.

Which row is correct for ice turning into water?

	distance between molecules	density
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

55. A W-shaped tube contains two amounts of mercury, each open to the atmosphere. Air at pressure P is trapped in between them. The diagram shows two vertical distances x and y.

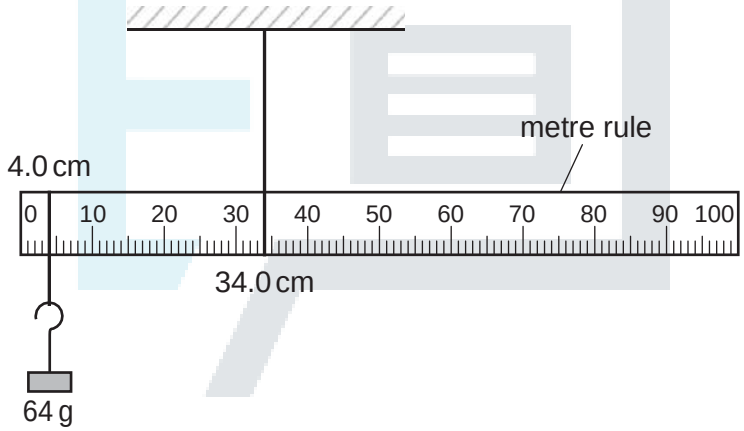


Atmospheric pressure is equal to the pressure that would be exerted by a column of mercury of height 760 mm. The pressure P is expressed in this way.

Which values of x, y and P are possible?

	x / mm	y / mm	P / mm of mercury
A	20	20	780
B	20	30	780
C	30	20	810
D	30	30	790

56. A uniform metre rule is pivoted at the 34.0 cm mark, as shown.



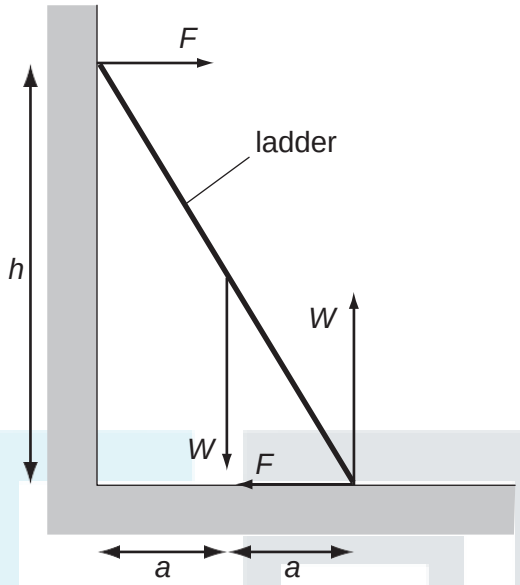
The rule balances when a 64 g mass is hung from the 4.0 cm mark.

What is the mass of the metre rule?

A 38 g B 44 g C 120 g D 136 g

57. 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 that act on the ladder.



Which equation is formed by taking moments?

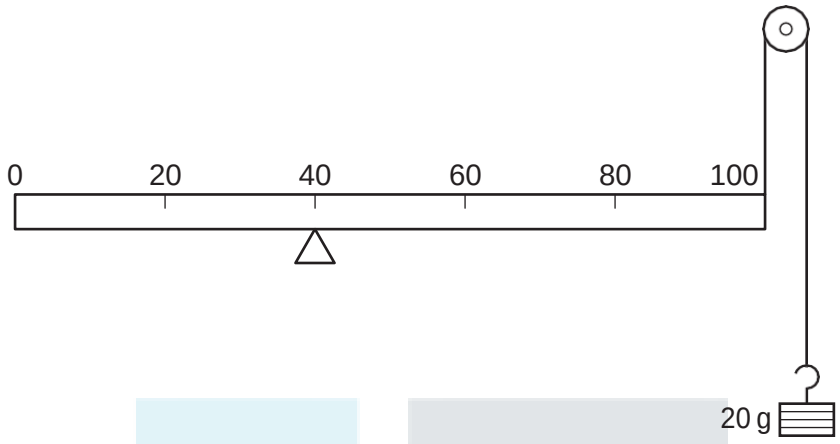
A $Wa + Fh = 2Wa$

B $Fa + Wa = Fh$

C $Wa + 2Wa = Fh$

D $Wa - 2Wa = 2Fh$

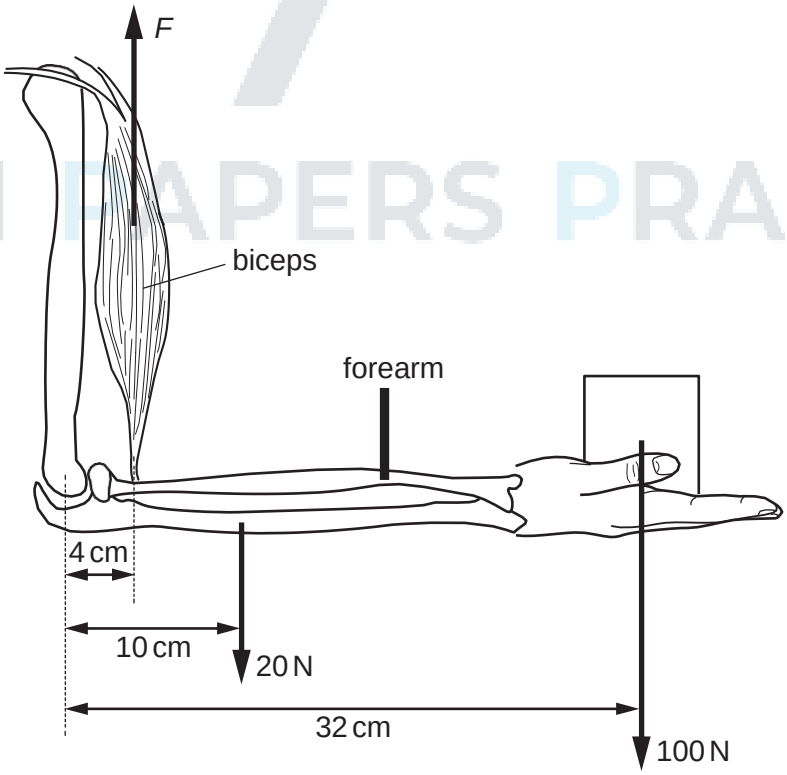
58. A uniform metre rule of mass 100 g is supported by a pivot at the 40 cm mark and a string at the 100 cm mark. The string passes round a frictionless pulley and carries a mass of 20 g as shown in the diagram.



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 64 cm

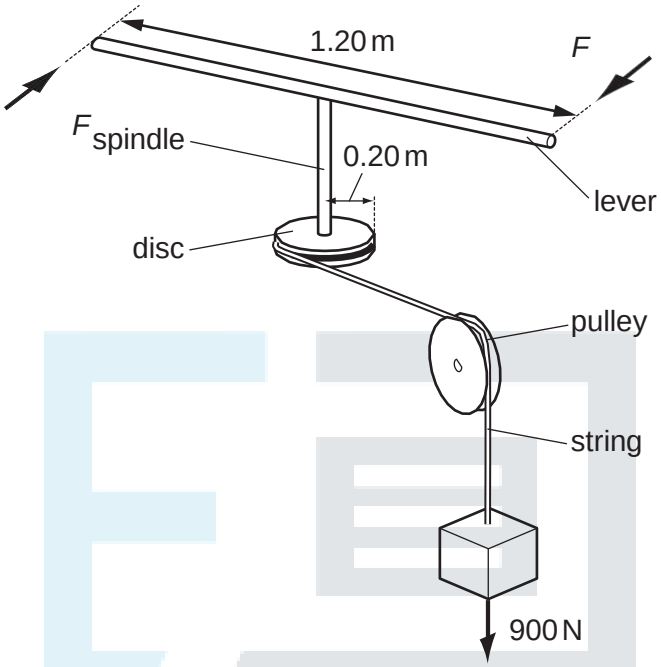
59. A man holds a 100 N load stationary in his hand. The combined weight of the forearm and hand is20 N. The forearm is held horizontal, as shown.



What is the vertical force *F* needed in the biceps?

A 750 N B 800 N C 850 N D 900 N

6o. A spindle is attached at one end to the centre of a lever of length 1.20 m and at its other end to the centre of a disc of radius 0.20 m. A string is wrapped round the disc, passes over a pulley andis attached to a 900 N weight.



What is the minimum force *F*, applied to each end of the lever, that could lift the weight?

A 75 N B 150 N C 300 N D 950 N