

# Force, Density & Pressure

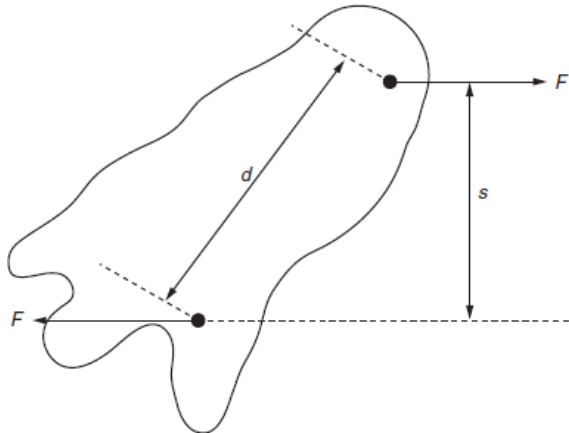
## TOPIC QUESTIONS (1)

<b>Level</b>	<b>A Level</b>
<b>Subject</b>	<b>Physics</b>
<b>Exam Board</b>	<b>CIE</b>
<b>Paper Type</b>	<b>Multiple Choice</b>

Time Allowed : 1Hour 10Min

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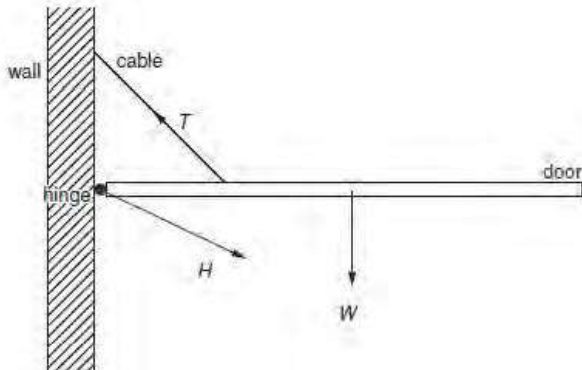
1. Two parallel forces, each of magnitude  $F$ , act on a body as shown.



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

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

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

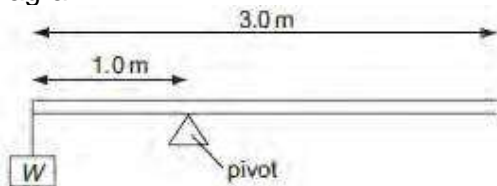


Three forces act on the door: the weight  $W$  of the door, the tension  $T$  in the cable, and the force  $H$  at the hinge.

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

- A  $H, T, W$    B  $T, H, W$    C  $W, H, T$    D  $W, T, H$

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

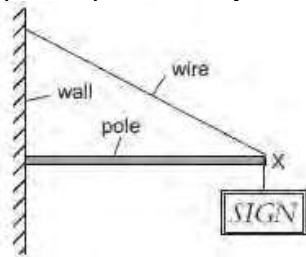


What is the value of  $W$  ?

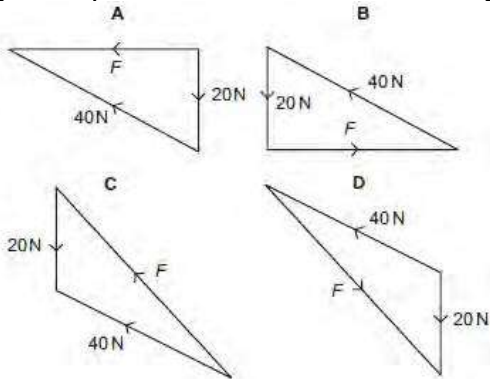
- A  $25\text{ N}$    B  $50\text{ N}$    C  $75\text{ N}$    D  $100\text{ N}$

4. The diagram shows a sign of weight  $20\text{ N}$  suspended from a pole, attached to a wall. The pole is

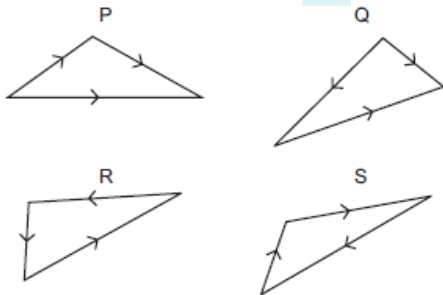
kept in equilibrium by a wire attached at point X of the pole.



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?

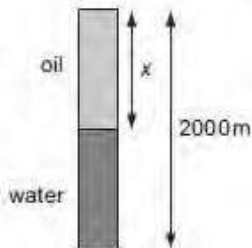


5. Which two vector diagrams represent forces in equilibrium?



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

6. A bore hole of depth 2000 m contains both oil and water as shown. The pressure at the bottom is 17.5 MPa. The density of the oil is  $830 \text{ kg m}^{-3}$  and the density of the water is  $1000 \text{ kg m}^{-3}$ .



What is the depth  $x$  of the oil?

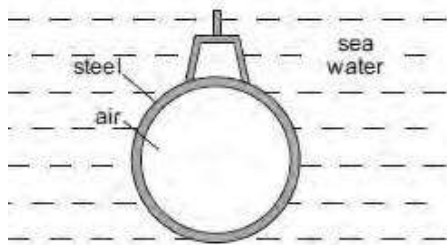
A 907 m    B 1000 m    C 1090 m    D 1270 m

7. A submarine carries a pressure meter so that the crew can work out how far they are below the surface of the sea. At the surface, the meter indicates a pressure of 100 kPa. The density of seawater is  $1030 \text{ kg m}^{-3}$ .

What is the depth below the surface when the meter reads 450 kPa? A 34.6 m    B 44.5 m    C 340 m    D 437 m

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

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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

9. Why does an ideal gas exert pressure on its container?

- A The molecules of the gas collide continually with each other.
- B The molecules of the gas collide continually with the walls of the container.
- C The molecules of the gas collide inelastically with the walls of the container.
- D The weight of the molecules exerts a force on the walls of the container.

10. The density of mercury is  $13.6 \times 10^3 \text{ kg m}^{-3}$ .

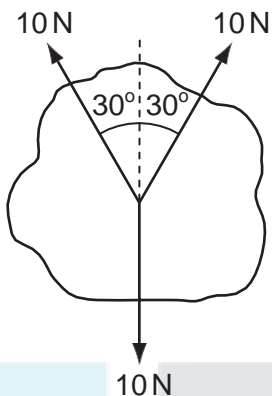
The pressure difference between the bottom and the top of a column of mercury is 100 kPa.  
What is the height of the column?

- A 0.75 m
- B 1.3 m
- C 7.4 m
- D 72 m

11. Which force is caused by a pressure difference?

- a. friction
- b. upthrust
- c. viscous force
- d. weight

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



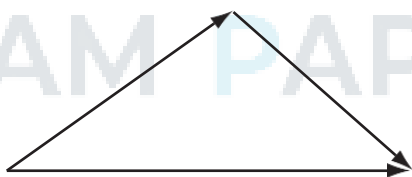
What is the magnitude of the resultant force?

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

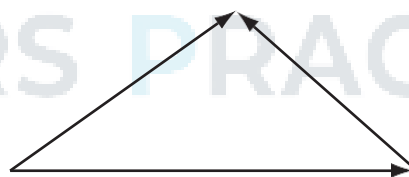
13. The diagrams show three forces acting on a body.

In which diagram is the body in equilibrium?

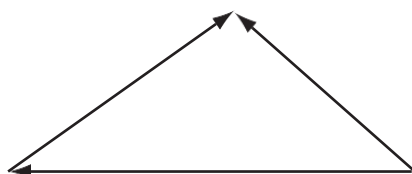
**A**



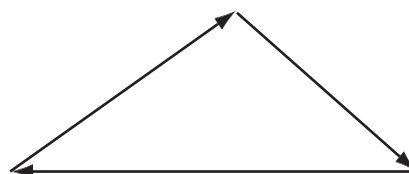
**B**



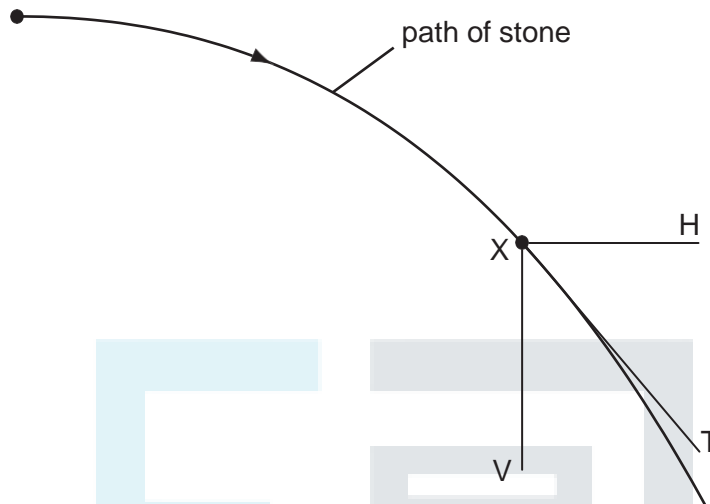
**C**



**D**



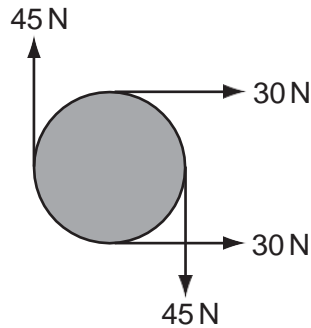
14. A stone is projected horizontally in a vacuum and moves along a path as shown. X is a point on this path. XV and XH are vertical and horizontal lines respectively through X. XT is the tangent to the path at X.



Along which direction or directions do forces act on the stone at X?

- A XV                      B XH                      C XV and XH                      D XT

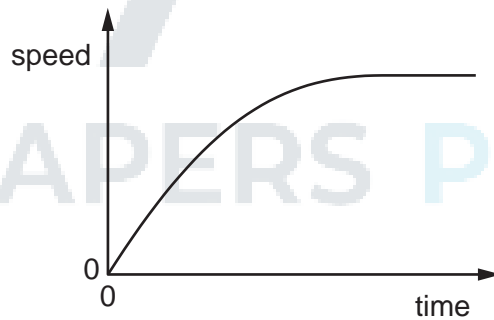
15. The diagram shows four forces applied to a circular object.



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

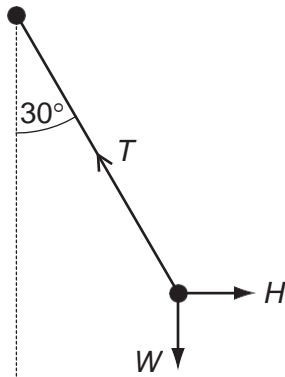
16. The graph shows the variation with time of the speed of a raindrop falling vertically through air.



Which statement is correct?

- A The acceleration decreases to produce a steady speed.
- B The acceleration increases as the speed increases.
- C The air resistance decreases as the speed increases.
- D The resultant force increases as the speed increases.

17. 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  $H = T \cos 30^\circ$
- B  $T = H \sin 30^\circ$
- C  $W = T \cos 30^\circ$
- D  $W = T \sin 30^\circ$





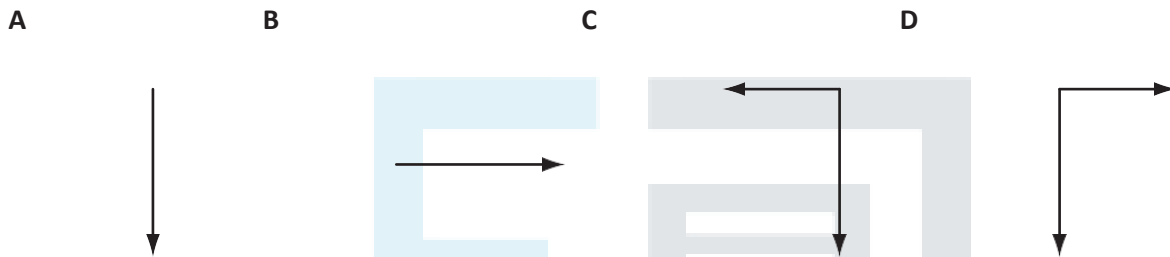
18. An astronaut of mass  $m$  in a spacecraft experiences a gravitational force  $F = mg$  when stationary on the launchpad.

What is the gravitational force on the astronaut when the spacecraft is launched vertically upwards with an acceleration of  $0.2g$ ?

- A  $1.2mg$       B  $mg$       C  $0.8mg$       D 0

19. An object in air is thrown upwards and towards the left.

Which diagram shows the force(s) acting on the body when it is at its highest point?



20. A particle is in a uniform field. The particle experiences a force in the opposite direction to the field.

Which field is the particle in, and on which property of the particle is the field acting?

	field	property of particle on which the field acts
A	electric	charge
B	electric	current
C	gravitational	mass
D	gravitational	weight

21. 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  $1020 \text{ kg m}^{-3}$ , what would be the approximate pressure at that depth?

- A  $10^5 \text{ Pa}$       B  $10^6 \text{ Pa}$       C  $10^7 \text{ Pa}$       D  $10^8 \text{ Pa}$

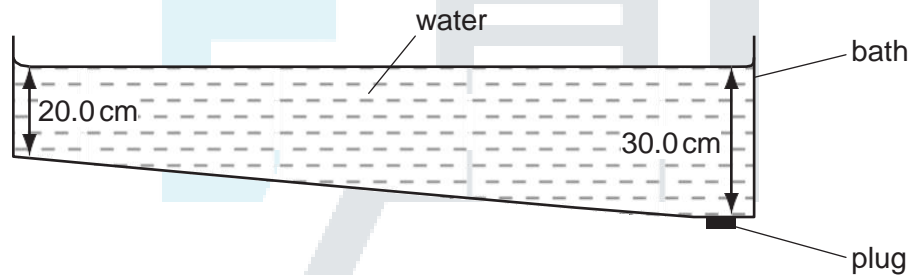
22. A beam of  $\alpha$ -particles collides with a lead sheet. Each  $\alpha$ -particle in the beam has a mass of  $6.6 \times 10^{-27} \text{ kg}$  and a speed of  $1.5 \times 10^7 \text{ m s}^{-1}$ .

$5.0 \times 10^4$   $\alpha$ -particles per second collide with an area of  $1.0 \text{ cm}^2$  of lead. Almost all of the  $\alpha$ -particles are absorbed by the lead so that they have zero speed after collision.

What is an estimate of the average pressure exerted on the lead by the  $\alpha$ -particles?

- A  $5.0 \times 10^{-15} \text{ Pa}$
- B  $5.0 \times 10^{-13} \text{ Pa}$
- C  $5.0 \times 10^{-11} \text{ Pa}$
- D  $5.0 \times 10^{-9} \text{ Pa}$

23. Water in a bath varies in depth from 20.0 cm at the shallow end to 30.0 cm at the end with the plug.

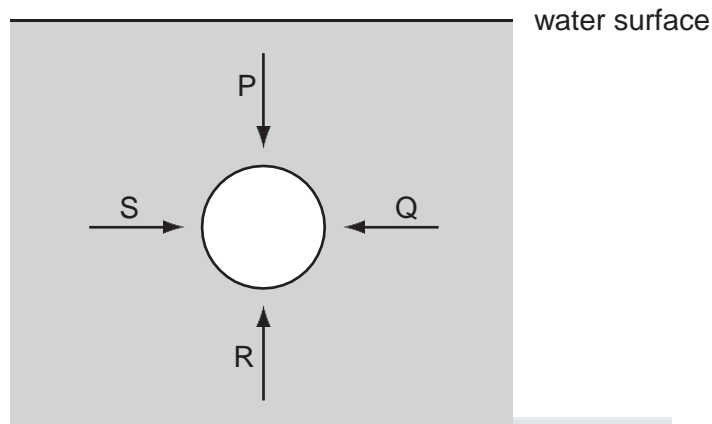


The density of the water is  $1000 \text{ kg m}^{-3}$ .

What is the pressure of the water acting on the plug?

- A 1960 Pa
- B 2450 Pa
- C 2940 Pa
- D 4900 Pa

24. The diagram represents a sphere under water. P, Q, R and S are forces acting on the sphere, due to the pressure of the water.

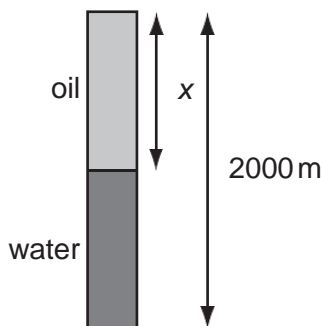


Each force acts perpendicularly to the sphere's surface. P and R act in opposite directions vertically. Q and S act in opposite directions horizontally.

Which information about the magnitudes of the forces is correct?

- A  $P < R$  and  $S = Q$
- B  $P > R$  and  $S = Q$
- C  $P = R$  and  $S = Q$  and  $P \neq S$
- D  $P = R$  and  $S = Q$  and  $P = S$

25. A bore-hole of depth 2000 m contains both oil and water as shown. The pressure due to the liquids at the bottom of the bore-hole is 17.5 MPa. The density of the oil is  $830 \text{ kg m}^{-3}$  and the density of the water is  $1000 \text{ kg m}^{-3}$ .

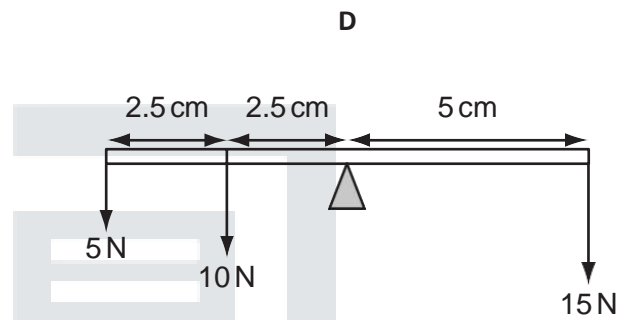
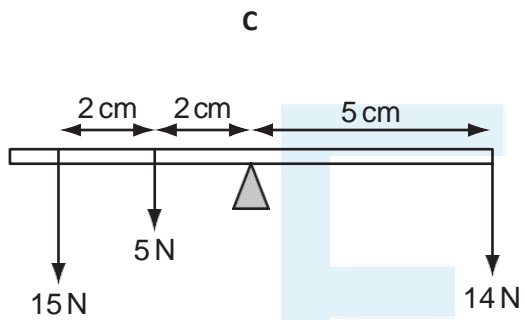
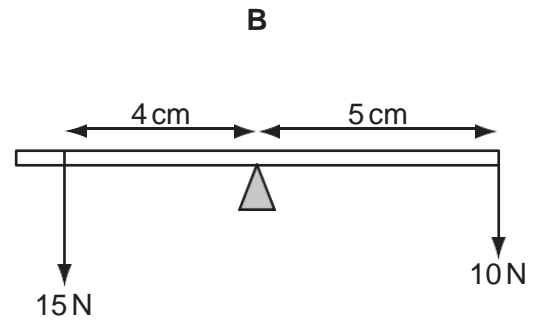
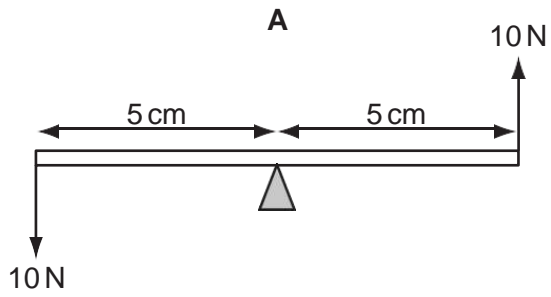


What is the depth  $x$  of the oil?

- A 907 m
- B 1000 m
- C 1090 m
- D 1270 m

26. A rigid uniform beam is pivoted horizontally at its midpoint.  
Different vertical forces are applied to different positions on the beam.

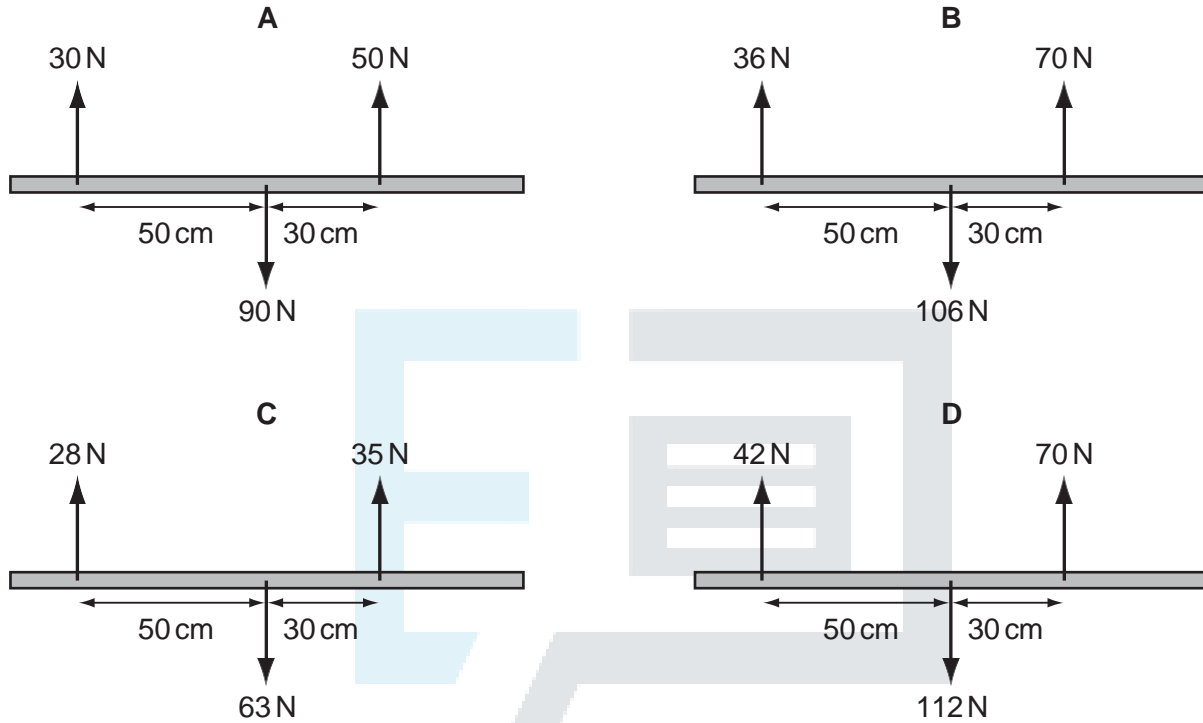
In which diagram is the beam in equilibrium?



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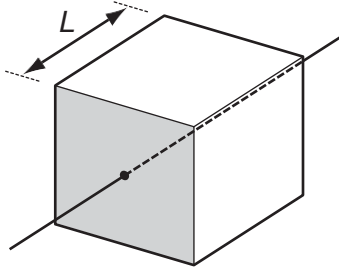
27. Four beams of the same length each have three forces acting on them.

Which beam has both zero resultant force and zero resultant torque acting?

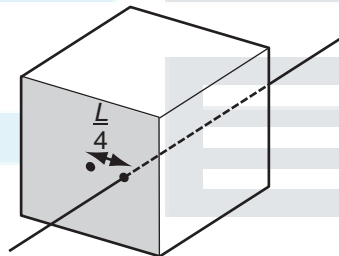


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28. The diagram shows a solid cube with weight  $W$  and sides of length  $L$ . It is supported by a frictionless spindle that passes through the centres of two opposite vertical faces. One of these faces is shaded.



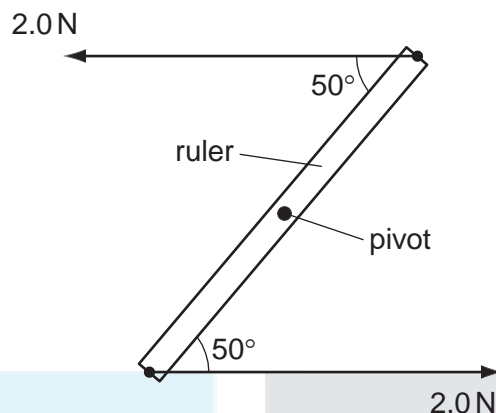
The spindle is now removed and replaced at a distance  $\frac{L}{4}$  to the right of its original position.



When viewing the shaded face, what is the torque of the couple that will now be needed to stop the cube from toppling?

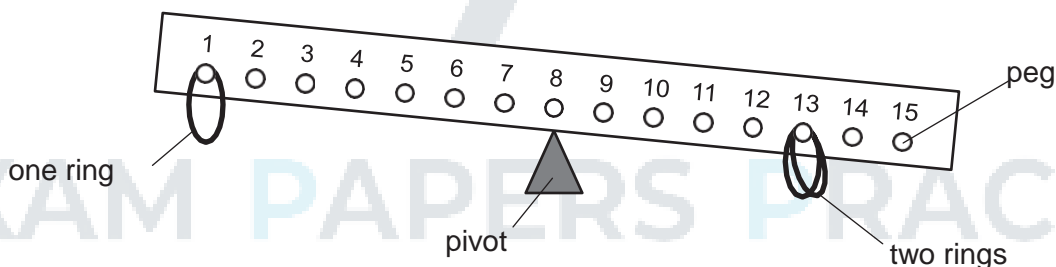
- a.  $\frac{WL}{2}$  anticlockwise
- b.  $\frac{WL}{2}$  clockwise
- c.  $\frac{WL}{4}$  anticlockwise
- d.  $\frac{WL}{4}$  clockwise

29. 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 N m      B 0.39 N m      C 0.46 N m      D 0.60 N m
30. The diagram shows a child's balancing game.



The wooden rod is uniform and all the rings are of equal mass. Two rings are hung on peg 13 and one on peg 1.

On which hook must a fourth ring be hung in order to balance the rod?

- A 2                      B 3                      C 5                      D 6
31. A cylindrical block of wood has a cross-sectional area  $A$  and weight  $W$ . It is totally immersed in water with its axis vertical. The block experiences pressures  $p_t$  and  $p_b$  at its top and bottom surfaces respectively. Which of the following expressions is equal to the upthrust on the block?
- A  $(p_b - p_t)A + W$       C  $(p_b - p_t)A$   
 B  $(p_b - p_t)$               D  $(p_b - p_t)A - W$

32. A mass of a liquid of density  $\rho$  is thoroughly mixed with an equal mass of another liquid of density  $2\rho$ . No change of the total volume occurs. What is the density of the liquid mixture?

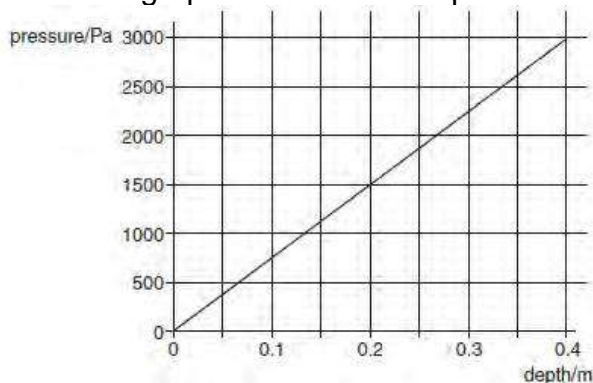
- A  $\frac{4}{3}\rho$       B  $\frac{3}{2}\rho$       C  $\frac{5}{3}\rho$       D  $3\rho$

33. At a depth of 20 cm in a liquid of density  $1800 \text{ kgm}^{-3}$ , the pressure due to the liquid is  $p$ . Another liquid has a density of  $1200 \text{ kgm}^{-3}$ .

What is the pressure due to this liquid at a depth of 60 cm?

- A  $\frac{p}{2}$     B  $\frac{3p}{2}$     C  $2p$     D  $3p$

34. The graph shows how the pressure exerted by a liquid varies with depth below the surface.



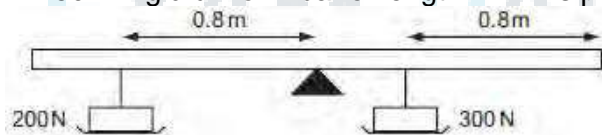
What is the density of the liquid?

- A  $600 \text{ kgm}^{-3}$     B  $760 \text{ kgm}^{-3}$     C  $5900 \text{ kgm}^{-3}$     D  $7500 \text{ kgm}^{-3}$

35. An object, immersed in a liquid in a tank, experiences an upthrust. What is the physical reason for this upthrust?

- A The density of the body differs from that of the liquid.  
 B The density of the liquid increases with depth.  
 C The pressure in the liquid increases with depth.  
 D The value of  $g$  in the liquid increases with depth

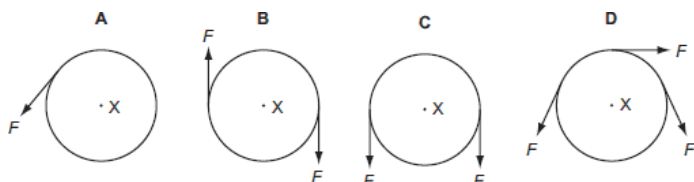
36. A rigid uniform bar of length 2.4 m is pivoted horizontally at its mid-point.



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?

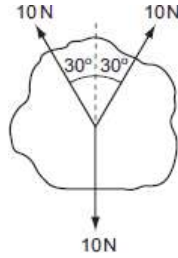
- A 40 N m clockwise                      B 40 N m anticlockwise  
 C 80 N m clockwise                      D 80 N m anticlockwise

37. 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  $2Fr$  about  $X$ ?



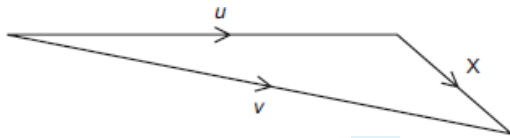
38. Three coplanar forces, each of magnitude 10 N, act through the same point of a body in the directions shown.





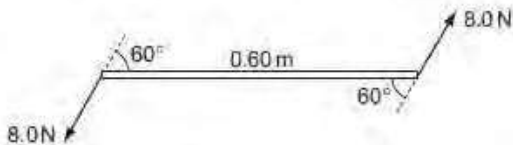
What is the magnitude of the resultant force?  
 A 0 N    B 1.3 N    C 7.3 N    D 10 N

39. 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  $u + at$

40. Two  $8.0\text{ N}$  forces act at each end of a beam of length  $0.60\text{ m}$ . The forces are parallel and act in opposite directions. The angle between the forces and the beam is  $60^\circ$ .

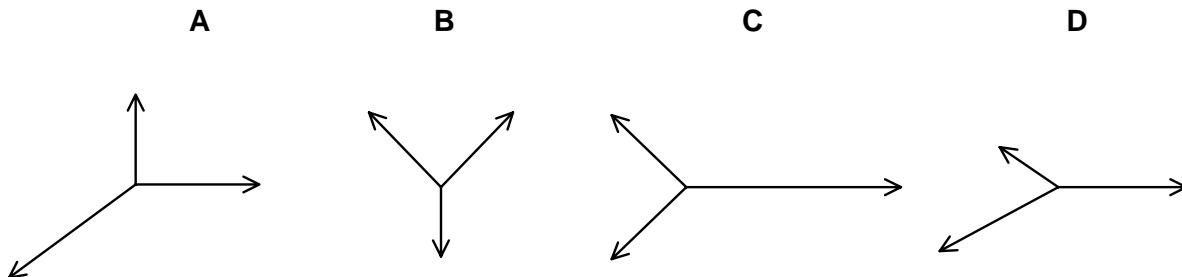


What is the torque of the couple exerted on the beam?

A  $2.4\text{ N m}$     B  $4.2\text{ N m}$     C  $4.8\text{ N m}$     D  $9.6\text{ N m}$

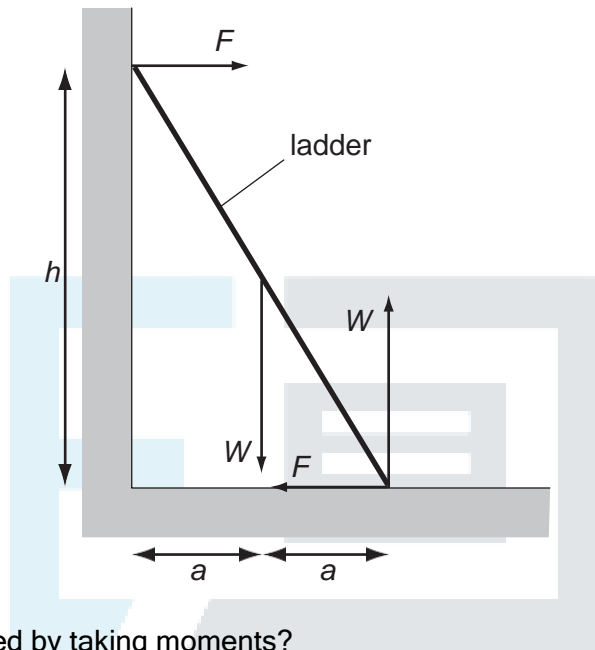
41. The diagrams represent systems of coplanar forces acting at a point. The lengths of the force vectors represent the magnitudes of the forces.

Which system of forces is in equilibrium?



42. 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  $2a$  from the wall.

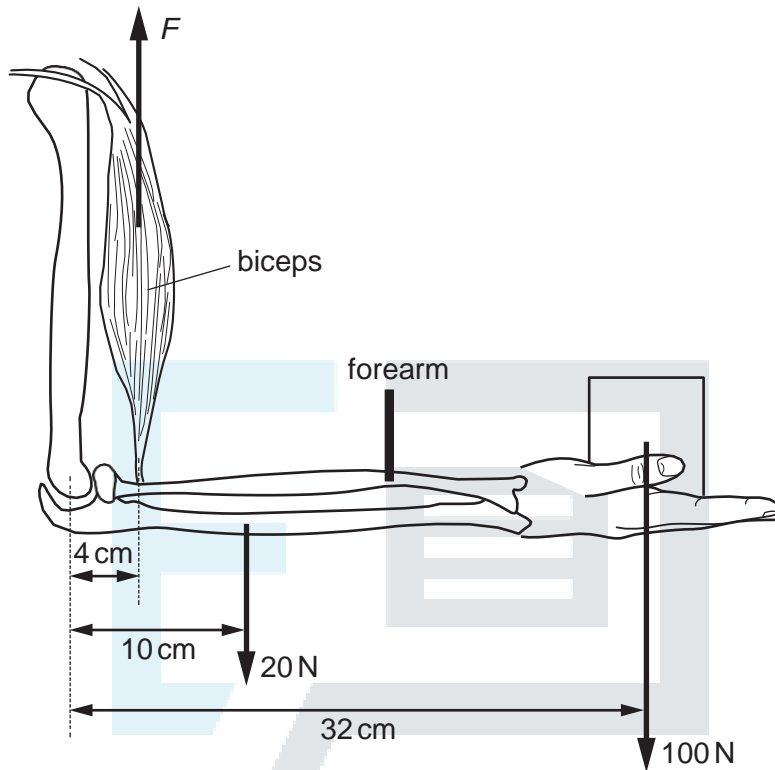
The diagram shows the forces that act on the ladder.



Which equation is formed by taking moments?

- A  $Wa + Fh = 2Wa$
- B  $Fa + Wa = Fh$
- C  $Wa + 2Wa = Fh$
- D  $Wa - 2Wa = 2Fh$

43. A man holds a 100 N load stationary in his hand. The combined weight of the forearm and hand is 20 N. The forearm is held horizontal, as shown.



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

A 750 N

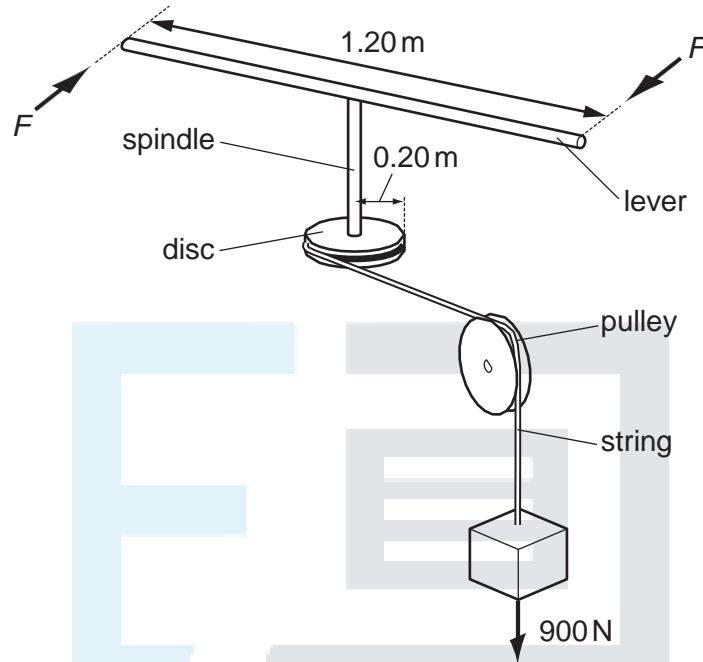
B 800 N

C 850 N

D 900 N

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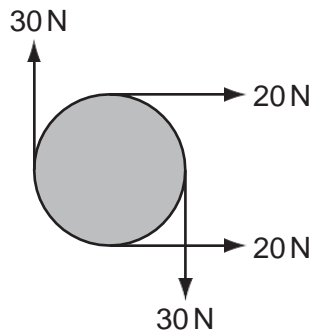
44. A spindle is attached at one end to the centre of a lever of length 1.20 m and at its other end to the centre of a disc of radius 0.20 m. A string is wrapped round the disc, passes over a pulley and is attached to a 900 N weight.



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

45. 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

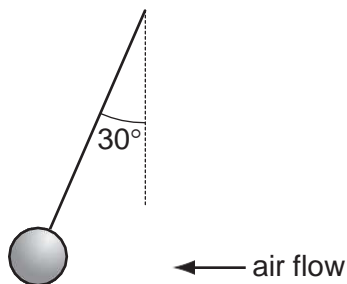


C	non-zero	zero
D	non-zero	non-zero



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46. The diagram shows an experiment to measure the force exerted on a ball by a horizontal air flow.



The ball is suspended by a light string and weighs  $0.15\text{ N}$ .

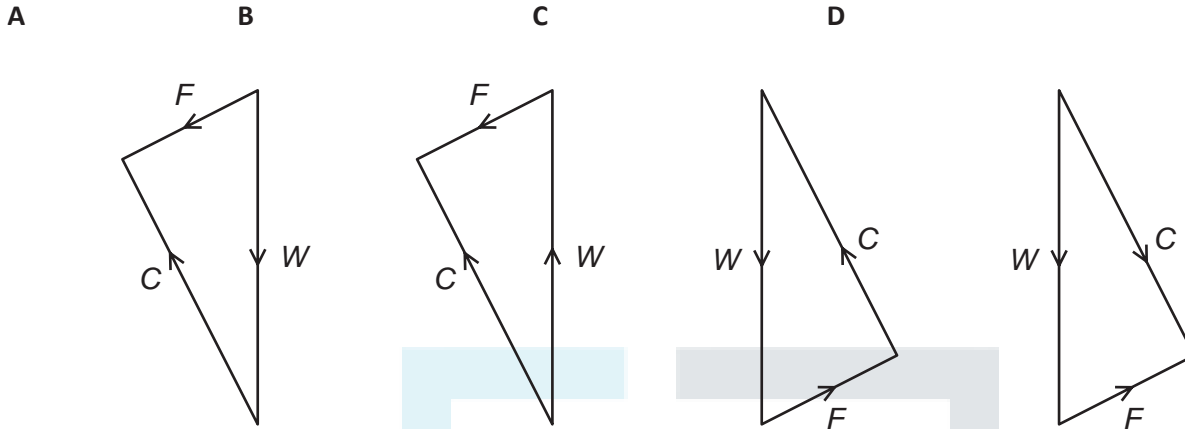
The deflection of the string from vertical is  $30^\circ$ .

What is the force on the ball from the air flow?

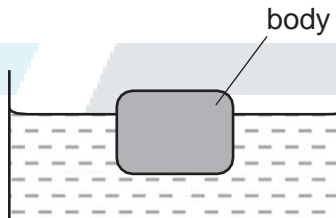
- A  $0.075\text{ N}$       B  $0.087\text{ N}$       C  $0.26\text{ N}$       D  $0.30\text{ N}$

47. A sledge slides down a slope at a constant velocity. The three forces that act on the sledge are the normal contact force  $C$ , the weight  $W$  and a constant frictional force  $F$ .

Which diagram represents these forces acting on the sledge?



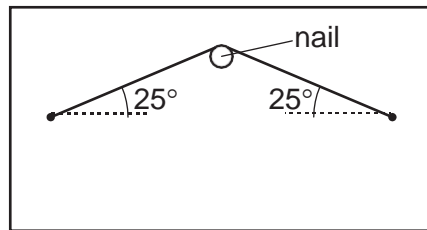
48. A stationary body floats in water.



Which statement about the forces acting on the body is correct?

- A The gravitational force is equal to the viscous force.
- B The gravitational force is greater than the upthrust.
- C The upthrust is zero.
- D The viscous force is zero.

49. A picture on a wall is supported by a wire looped over a nail.



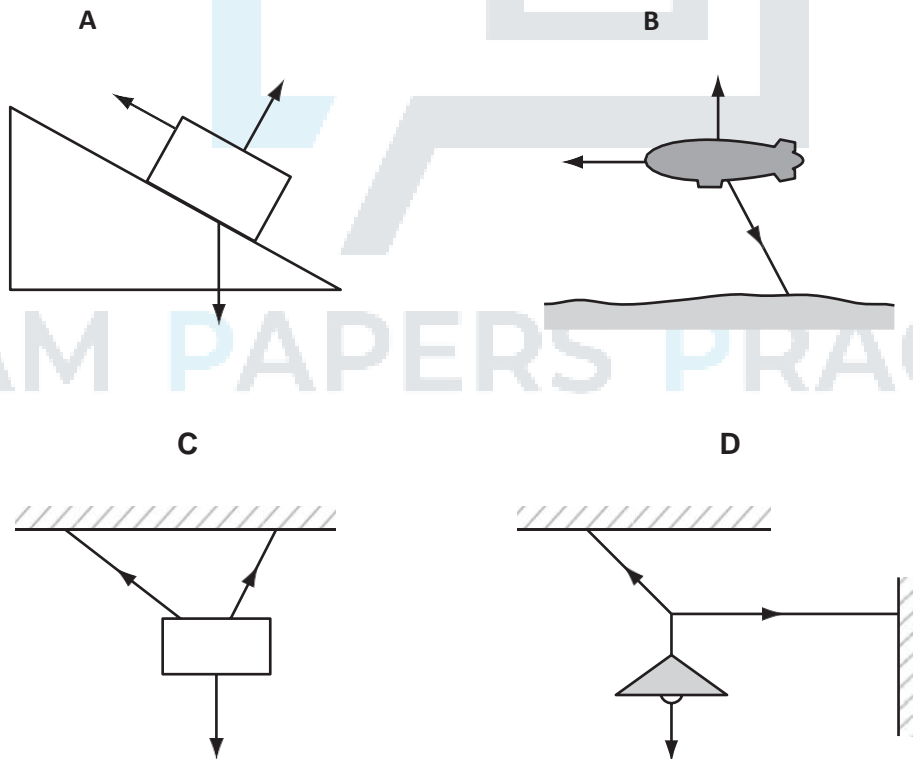
The mass of the picture is 4.2 kg.

What is the tension in the supporting wire?

- A 5.0 N      B 23 N      C 49 N      D 97 N

50. The diagrams show the forces acting on different bodies.

Which body cannot be in equilibrium?





51. The pressure at sea level is approximately 100 000 Pa. The density of sea water is  $1030 \text{ kg m}^{-3}$ .

What is the approximate pressure 80 m below the surface of the sea?

- A 100 000 Pa    B 180 000 Pa    C 800 000 Pa    D 900 000 Pa

52. An object, immersed in a liquid in a tank, experiences an upthrust.

What is the physical reason for this upthrust?

- A The density of the body differs from that of the liquid.  
B The density of the liquid increases with depth.  
C The pressure in the liquid increases with depth.  
D The value of  $g$  in the liquid increases with depth.

53. Atmospheric pressure at sea level has a value of 100 kPa. The density of sea water is  $1020 \text{ kg m}^{-3}$ .

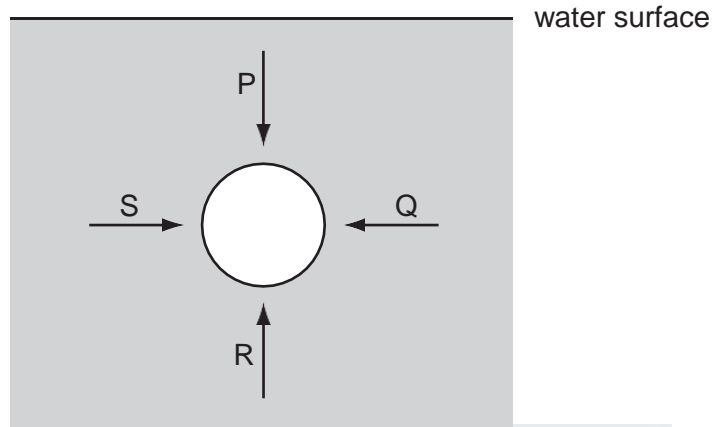
At what depth in the sea would the total pressure be 110 kPa?

- A 1.0 m    B 9.8 m    C 10 m    D 11 m

54. A rectangular metal bar exerts a pressure of 15 200 Pa on the horizontal surface on which it rests. If the height of the metal bar is 80 cm, what is the density of the metal?

- A  $190 \text{ kg m}^{-3}$   
B  $1900 \text{ kg m}^{-3}$   
C  $19.0 \text{ kg m}^{-3}$   
D  $190 \text{ kg m}^{-3}$

55. The diagram represents a sphere under water. P, Q, R, and S are forces acting on the sphere, due to the pressure of the water.

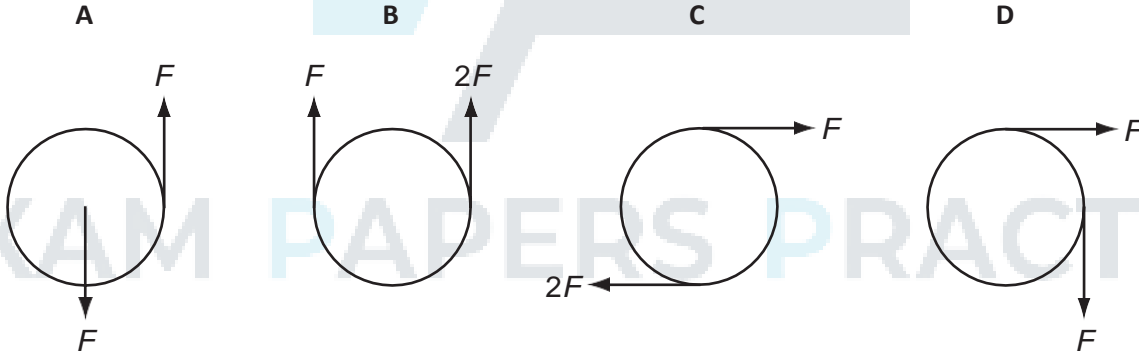


Each force acts perpendicularly to the sphere's surface. P and R act in opposite directions vertically. Q and S act in opposite directions horizontally.

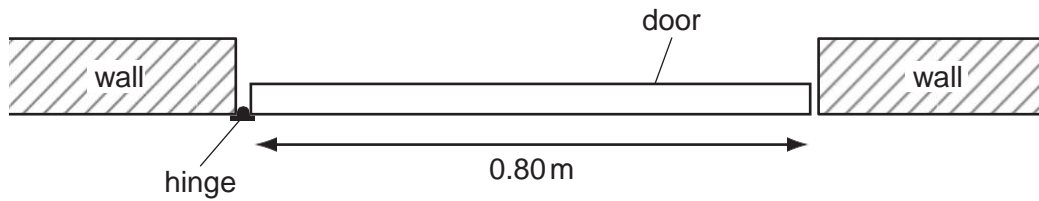
Which information about the magnitudes of the forces is correct?

- A**  $P < R$  ;  $S = Q$     **B**  $P > R$  ;  $S = Q$     **C**  $P = R$  ;  $S = Q$     **D**  $P = R = S = Q$

56. Which pair of forces acts as a couple on the circular object?



57. 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

58. 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  $60^\circ$ .

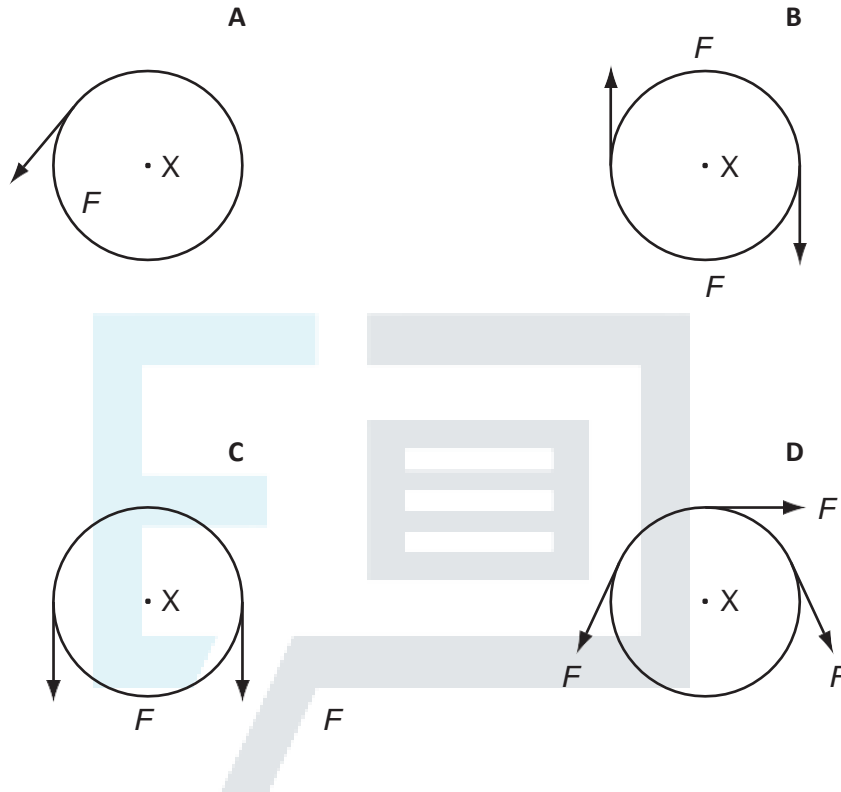


What is the torque of the couple exerted on the beam?

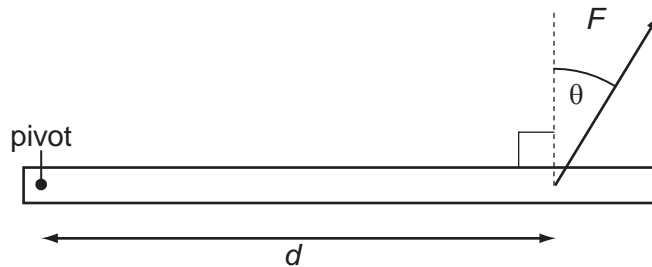
- A 2.4 N m      B 4.2 N m      C 4.8 N m      D 9.6 N m

59. 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  $2Fr$  about  $X$ ?



60. 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



EXAM PAPERS PRACTICE