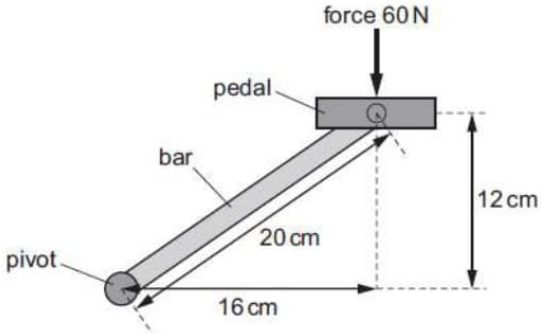
Moment of a force

Q1 (14/M/J/16/13):

A bicycle pedal is connected to a pivot by a metal bar, as shown.

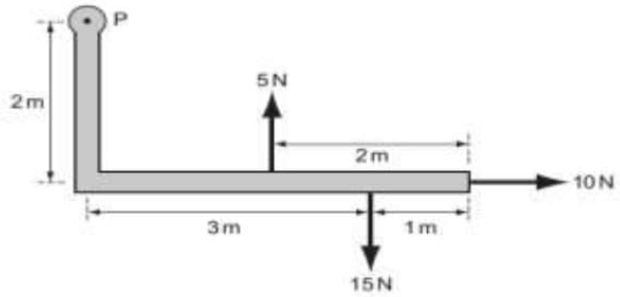


The force on the pedal is 60 N downwards. What is the moment of this force about the pivot?

A 7.2 N m B 9.6 N m C 12 N m D 1200 N m

Q2 (13/O/N/10/11):

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

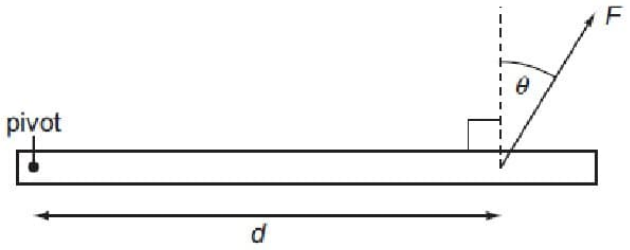


Three forces act on the lever arm, as shown in the diagram.
What is the magnitude of the resultant moment of these forces about point P?

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

Q3 (14/M/J/6/1):

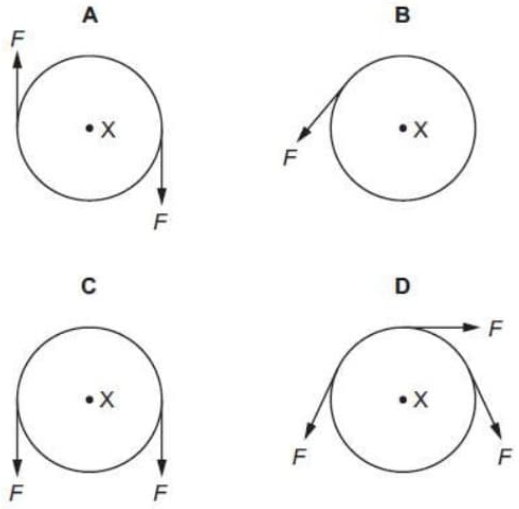
A force F is applied to a beam at a distance d from a pivot. The force acts at an angle θ to a line perpendicular to the beam.
Which combination will cause the largest turning effect about the pivot?



	F	D	θ
A	large	large	large
B	large	large	small
C	small	small	large
D	small	large	small

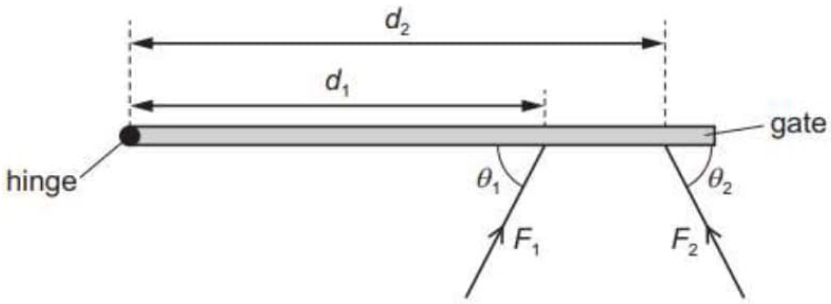
Q4 (13/O/N/17/11):

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?



Q5 (12/O/N/20/11)

Two people push a vertical gate to open it. The forces exerted by the people on the gate are shown.



One person is distance d_1 from the gate's hinge and pushes with horizontal force F_1 at angle θ_1 to the gate. The other person is at distance d_2 from the hinge and pushes with horizontal force F_2 at an angle θ_2 to the gate.

What is the total moment about the hinge due to forces F_1 and F_2?

A $(d_1 \times F_1 \cos\theta_1) + (d_2 \times F_2 \cos\theta_2)$

B $(d_1 \times F_1 \sin\theta_1) + (d_2 \times F_2 \sin\theta_2)$

C $(d_1 \times F_1 \cos\theta_1) - (d_2 \times F_2 \cos\theta_2)$

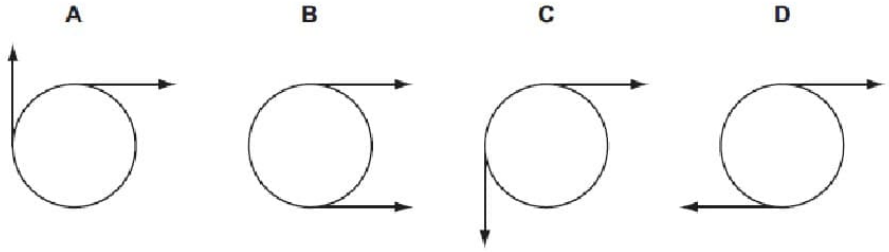
D $(d_1 \times F_1 \sin\theta_1) - (d_2 \times F_2 \sin\theta_2)$

Couple

Q1 (14/O/N/15/13):
Which statement best describes a couple?

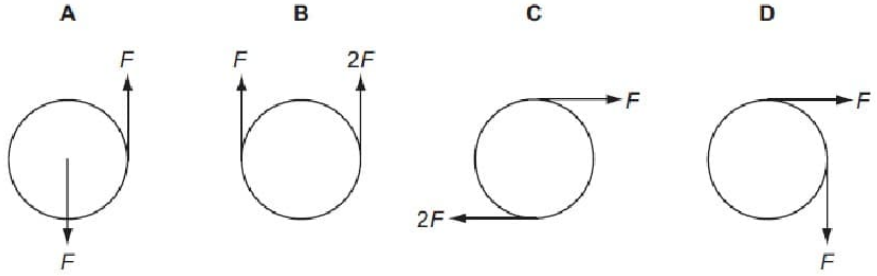
A a pair of forces of equal magnitude acting in opposite directions which produce rotational motion but not translational motion
B a pair of forces of equal magnitude acting in opposite directions which produce translational motion but not rotational motion
C a pair of forces of equal magnitude acting in the same direction which produce rotational motion but not translational motion
D a pair of forces of equal magnitude acting in the same direction which produce translational motion but not rotational motion

Q2 (14/M/J/16/12):
Two coplanar forces act on the rim of wheel. The forces are equal in magnitude.
Which arrangement of forces provides only a couple?

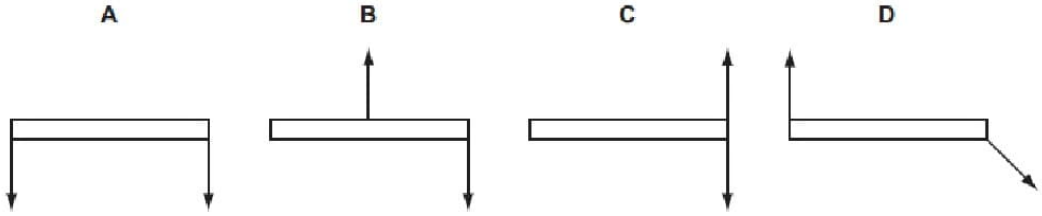


Which of the following describes the resultant force and resultant torque on the object?

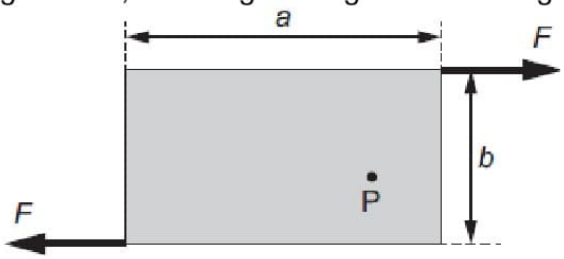
Q3 (15/O/N/15/12):
Which pair of forces acts only as a couple on the circular object?



Q4 (15/M/J/11/12):
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?



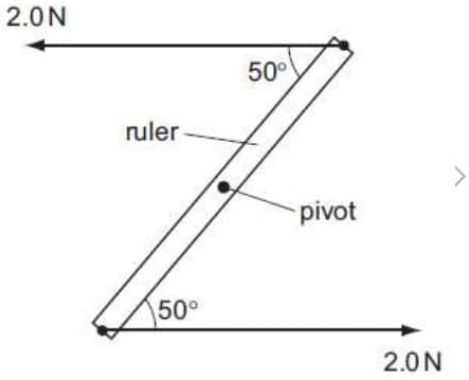
Q5 (12/O/N/17/13):
Two forces, each of magnitude F, act along the edges of a rectangular metal plate, as shown.



The plate has length a and width b. What is the torque about point P?

A Fa B Fb C 2Fa D 2Fb

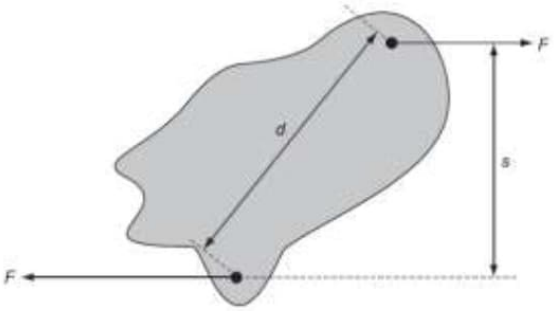
Q6 (14/O/N/11/11):
A ruler of length 0.30 m is pivoted at its center. Equal and opposite forces of magnitude 2.0 N are applied to the ends of the ruler, creating a couple as shown.



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

Q7 (14/O/N/10/11):
Two parallel forces, each of magnitude F, act on a body as shown.

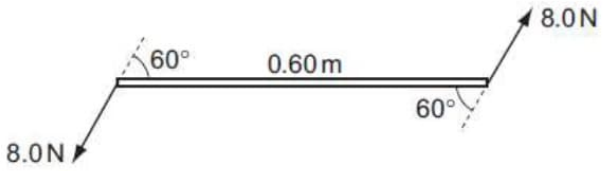


What is the magnitude of the torque on the body produced by these forces?

A Fd B Fs C 2Fd D 2F s

Q8 (13/M/J/7/1):

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°.

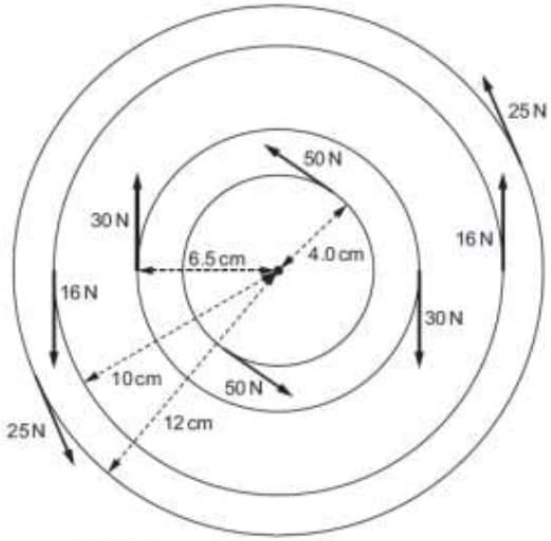


What is the torque of the couple exerted on the beam?

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

Q9 (11/M/J/17/12):

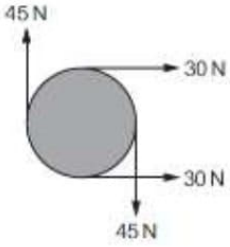
In a machine, many couples act on a rotating object as shown.



What is the resultant torque acting on the rotating object?

A 4.7 N m B 8.6 N m C 9.3 N m D 17.1 N m

Q10 (13/M/J/14/12):

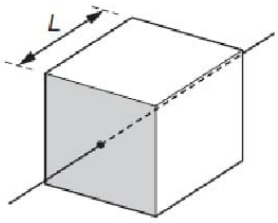


The diagram shows four forces applied to a circular object.

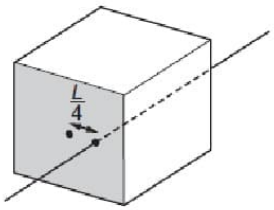
	resultant force	resultant torque
A	non-zero	non-zero
B	non-zero	zero
C	zero	non-zero
D	zero	zero

Q11 (12/O/N/17/12):

The diagram shows a solid cube with weight W and sides of length L. It is supported at rest 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 keep the cube at rest?

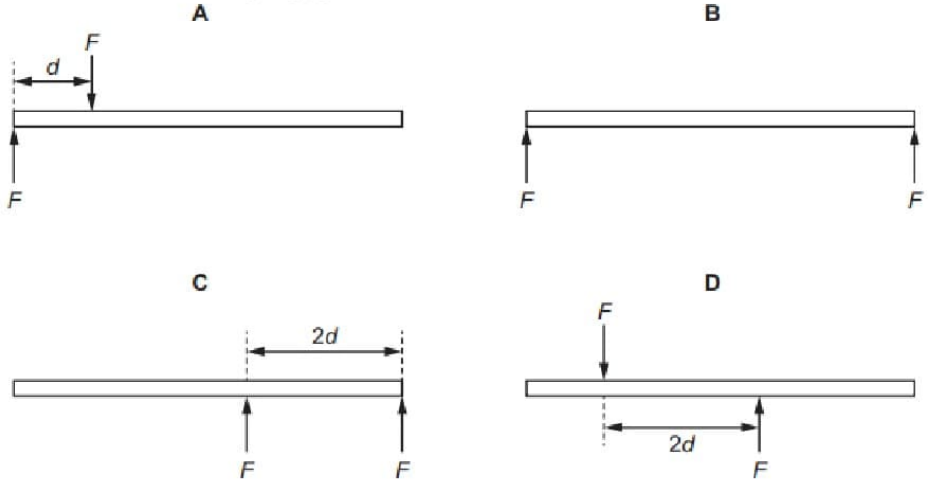
A $\frac{WL}{4}$ *anticlockwise* B $\frac{WL}{4}$ *clockwise*

C $\frac{WL}{2}$ *anticlockwise* D $\frac{WL}{2}$ *clockwise*

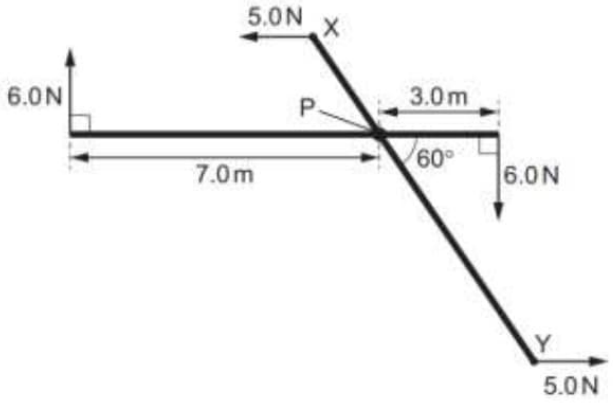
Q12 (12/F/M/21/12):

Two parallel forces, each of magnitude *F*, act on a rod of length 5*d*.

Which diagram shows the positions of the two forces that will produce the largest torque on the rod?



Q13 (13/O/N/24/12):
Four forces act about a point P, as shown.



The forces act in the same plane and produce no resultant moment about point P.
What is the length XY?

A 6.9m **B** 12m **C** 14m **D** 24m

Equilibrium

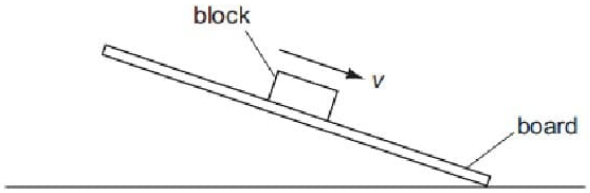
Q1 (13/M/J/14/13):
What is the condition for an object to be in equilibrium?

A The object's velocity and the resultant torque on it must both be zero.
B The object's velocity must be zero.
C The resultant force and the resultant torque on the object must both be zero.
D The resultant force on the object must be zero.

Q2 (13/O/N/15/11):
In which example is it not possible for the underlined body to be in equilibrium?

A an aeroplane climbs at a steady rate
B an aeroplane tows a glider at a constant altitude
C a speedboat changes direction at a constant speed
D two tug boats tow a ship into harbor

Q3 (12/O/N/8/1):
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.

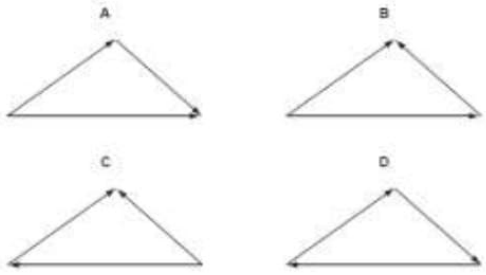


Which row describes the forces acting on the block when sliding with constant velocity?

	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

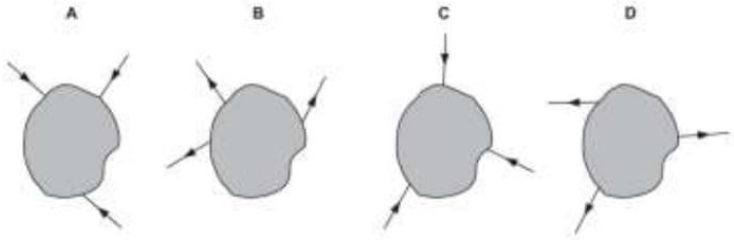
Q4 (13/M/J/6/1):

The diagram shows three forces acting on a body. In which diagram is the body in equilibrium?



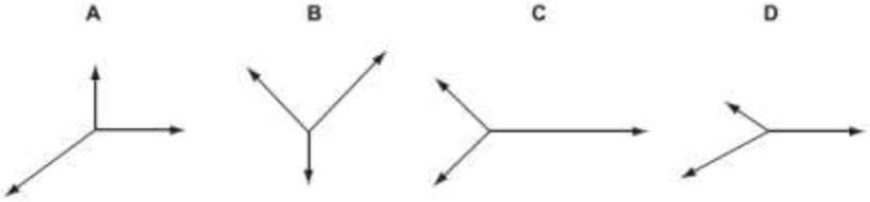
Q5 (12M/J/16/13):

Three coplanar forces act on an object in the directions shown. In which diagram could the object be in equilibrium?



Q6 (16/M/J/15/13):

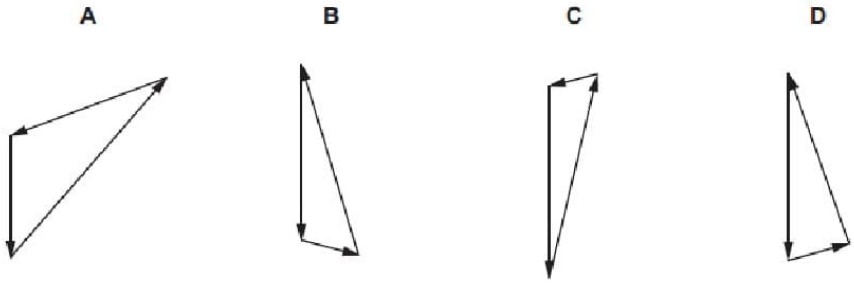
The diagrams represent systems of coplanar forces acting at a point. The lengths of the force vectors represent the magnitudes of the forces. Which system of forces is in equilibrium?



Q7 (10/O/N/14/12):

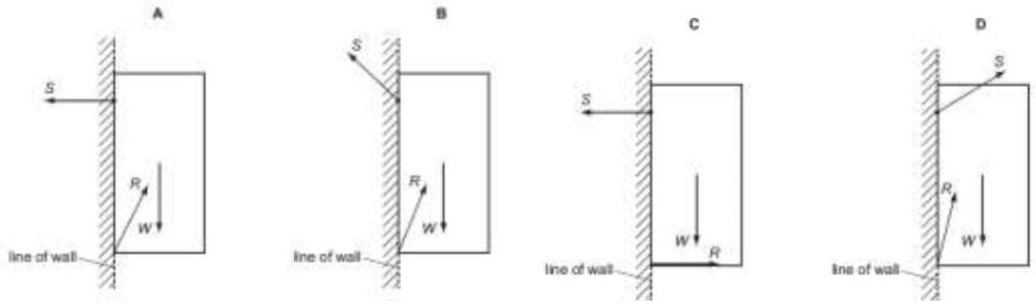
A glider is descending at constant speed at an angle of 15° to the horizontal. The diagram shows the directions of the lift L, air resistance R and weight W acting on the glider.

Which vector triangle could represent the forces acting on the glider?



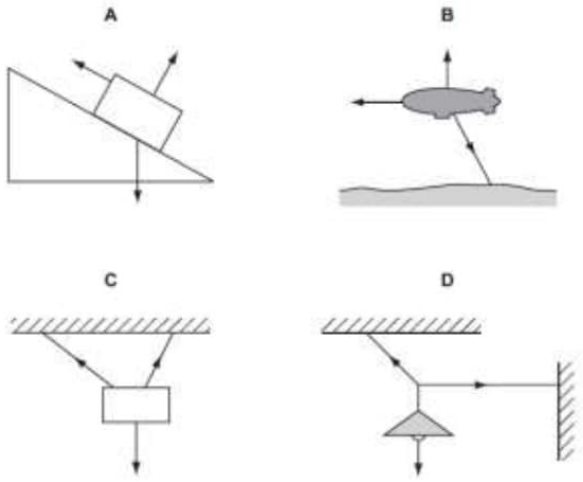
Q8 (14/O/N/13/13):

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?



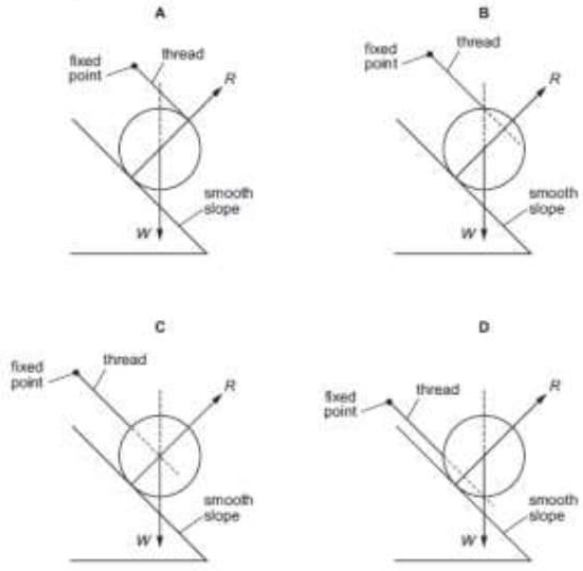
Q9 (17/O/N/12/13):

The diagrams show the forces acting on different bodies. Which body cannot be in equilibrium?



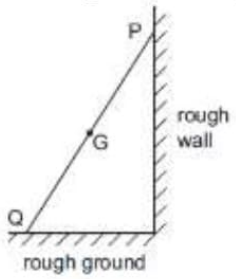
Q10 (14/O/N/14/13):

A cylinder of weight W is placed on a smooth slope. The contact force of the slope on the cylinder is R. A thread is attached to the surface of the cylinder. The other end of the thread is fixed. Which diagram shows the cylinder in equilibrium?

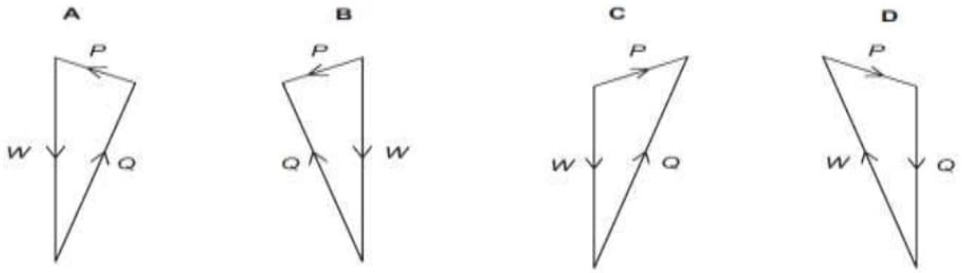


Q11 (13/O/N/11/11):

A ladder rests in equilibrium on rough ground against a rough wall.

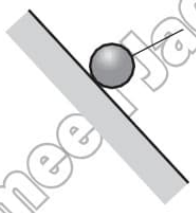


Its weight W acts through the centre of gravity G. Forces also act on the ladder at P and at Q. These forces are P and Q respectively. Which vector triangle represents the forces on the ladder?

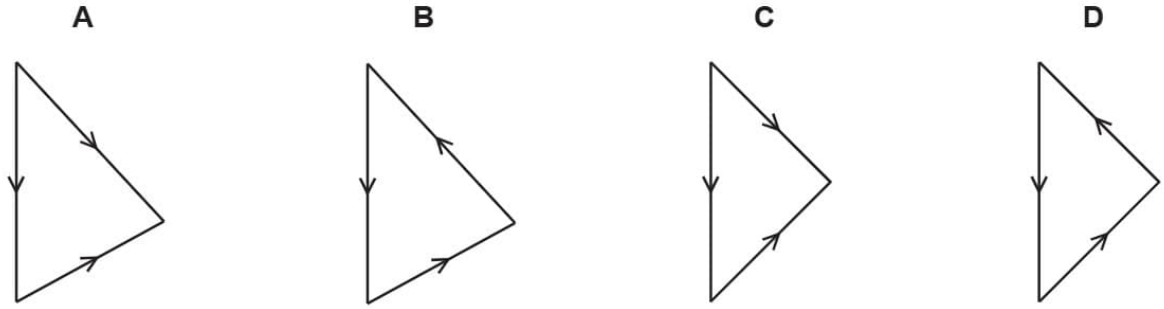


Q12 (13/O/N/20/11):

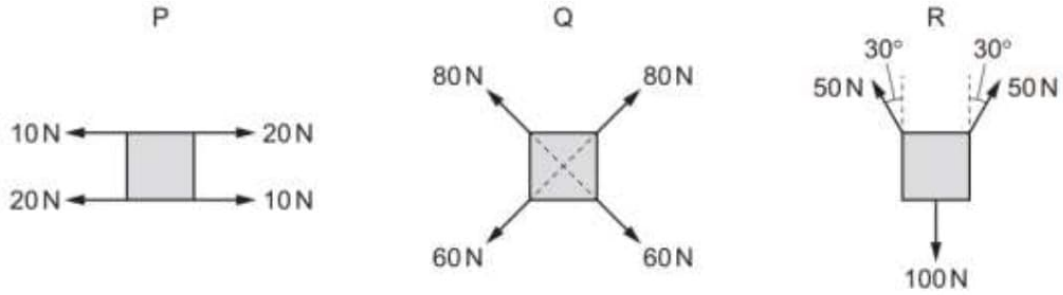
A ball is rolling down a slope at a constant speed. The three forces acting on the ball are its weight, the contact force normal to the slope and friction.



Which diagram could represent these three forces?



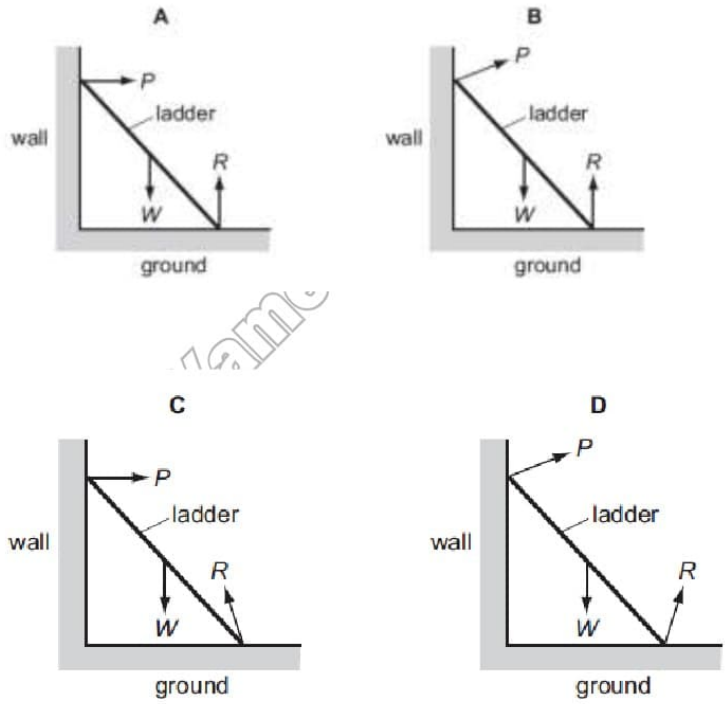
Q13 (15/O/N/24/13):
The diagrams show three rigid objects P, Q and R being subjected to different combinations of forces.



Which objects are in equilibrium?

A. P and Q **B.** P and R **C.** Q and R **D.** none of them

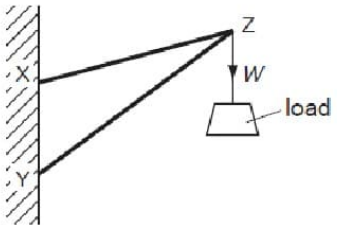
Q14 (14/M/J/12/12):
A ladder is positioned on icy (frictionless) ground and is leant against a rough wall. At the instant of release it begins to slide. Which diagram correctly shows the directions of the forces P, W and R acting on the ladder as it begins to slide?



Q15 (13/M/J/8/1):

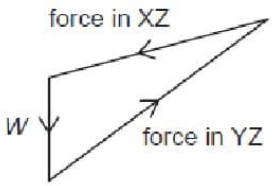
Two rigid rods, XZ and YZ, are fixed to a vertical wall at points X and Y.

A load of weight W is hung from point Z. The load is not moving.

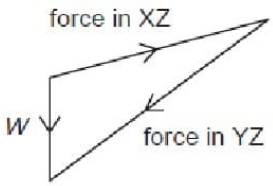


Which diagram shows the forces acting at Z?

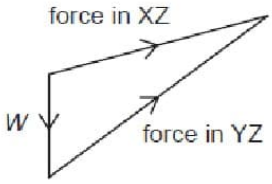
A



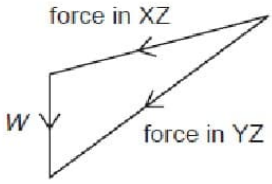
B



C

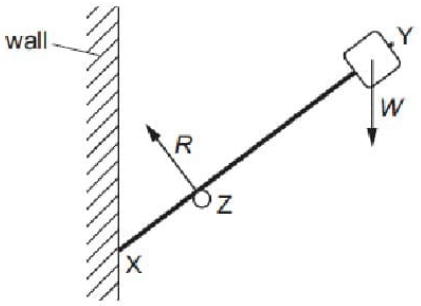


D



Q16 (12/M/J/16/12):

A light rigid rod XY has an object of weight W fixed at one end. The rod is in equilibrium, resting on a roller at Z and a vertical wall at X. The roller exerts a force R on the rod as shown. The diagram shows the directions, but not the magnitudes, of the forces R and W.



What is the direction of the force on the rod at X?

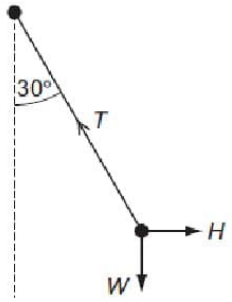
A

B

C

D

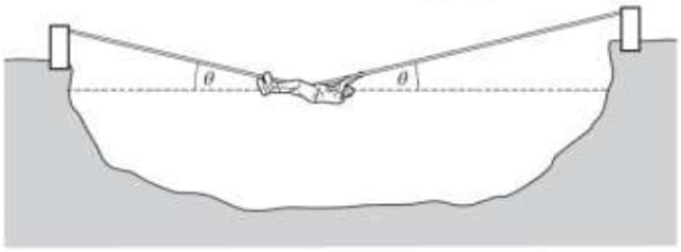
Q17 (2/O/N/13/12):
A pendulum bob is held stationary by a horizontal force H. The three forces acting on the bob are shown in the diagram.



The tension in the string of the pendulum is T. The weight of the pendulum bob is W.
Which statement is correct?

A $H = T \cos 30^0$ B $T = H \sin 30^0$
C $W = T \cos 30^0$ D $T = W \sin 30^0$

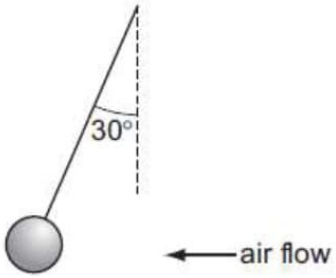
Q18 (11/O/N/10/12):
The diagram shows a rope bridge that a student makes on an adventure training course. The student has a weight W.



Which formula gives the tension T in the rope?

A $T = \frac{W}{2\cos\theta}$ B $T = \frac{W}{2\sin\theta}$ C $T = \frac{W}{\cos\theta}$ D $T = \frac{W}{\sin\theta}$

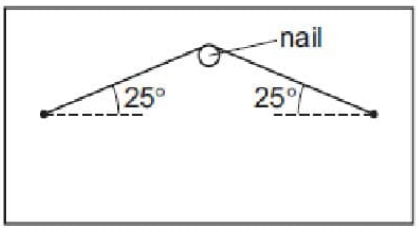
Q19 (15/O/N/12/11):
The diagram shows an experiment to measure the force exerted on a ball by a horizontal air flow.



The ball is suspended by a light string and weighs 0.15 N.
The deflection of the string from vertical is 30^0. What is the force on the ball from the air flow?

A 0.075 N B 0.087 N C 0.26 N D 0.30 N

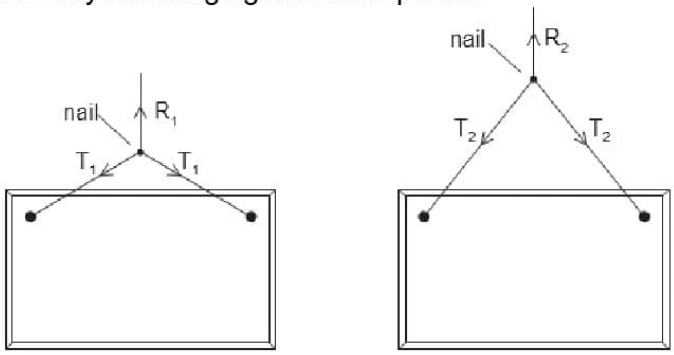
Q20 (18/O/N/12/12):
A picture on a wall is supported by a wire looped over a nail.



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

Q21 (11/M/J/14/11):
The diagrams show two ways of hanging the same picture

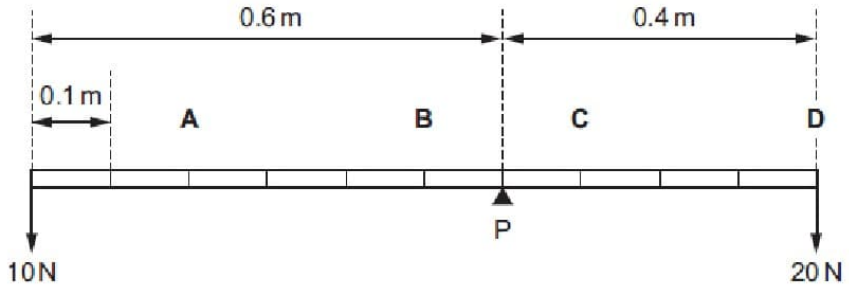


In both cases, a string is attached to the same points on the picture and looped symmetrically over a nail in a wall. The forces shown are those that act on the nail.
In diagram 1, the string loop is shorter than in diagram 2.
Which information about the magnitude of the forces is correct?

A $R_1 = R_2$ $T_1 = T_2$ B $R_1 = R_2$ $T_1 > T_2$

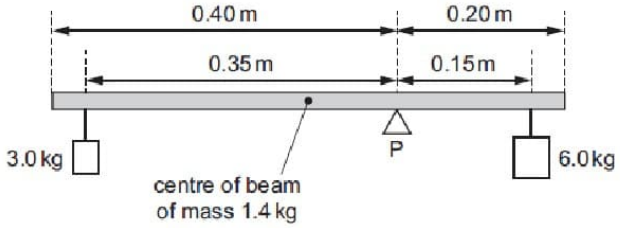
C $R_1 > R_2$ $T_1 < T_2$ D $R_1 < R_2$ $T_1 = T_2$

Q22 (12/M/J/17/12):
A uniform beam 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 at 0.1 m intervals. The weight of the beam is 100 N. At which point should a further weight of 20 N be attached to achieve equilibrium?



Q23 (11/M/J/17/13):

A uniform beam of mass 1.4 kg is pivoted at P as shown. The beam has a length of 0.60 m and P is 0.20 m from one end. Loads of 3.0 kg and 6.0 kg are suspended 0.35 m and 0.15 m from the pivot as shown.

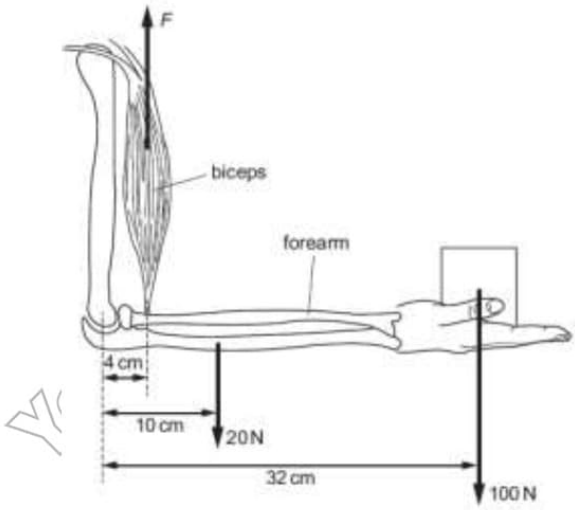


What is the torque that must be applied to the beam in order to maintain it in equilibrium?

A 0.010 N m B 0.10 N m C 0.29 N m D 2.8 N m

Q24 (12/M/J/14/11):

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.

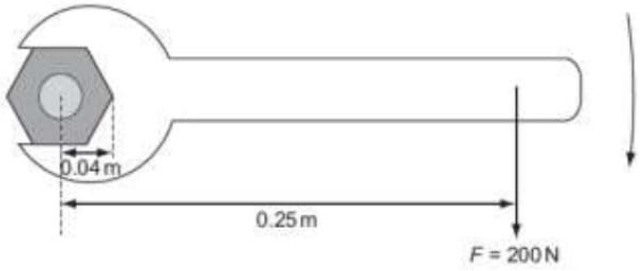


What is the vertical force F needed in the biceps?

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

Q25 (12/O/N/10/12):

A spanner is used to tighten a nut as shown.

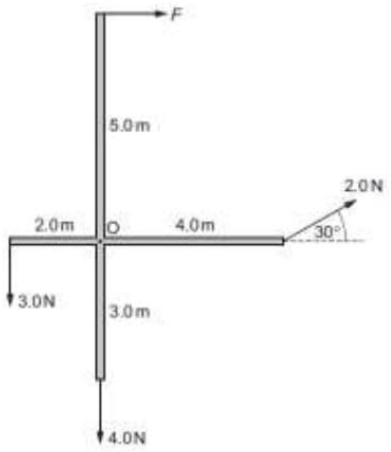


A force F is applied at right-angles to the spanner at a distance of 0.25 m from the centre of the nut. When the nut is fully tightened, the applied force is 200 N.
What is the resistive torque, in an anticlockwise direction, preventing further tightening?

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

Q26 (15/O/N/15/13):

A cross-shaped structure, freely pivoted at O, has arms of lengths 5.0 m, 4.0 m, 3.0 m and 2.0 m. It is acted on by forces of 2.0 N, 3.0 N, 4.0 N and an unknown force F. The structure is in rotational equilibrium.

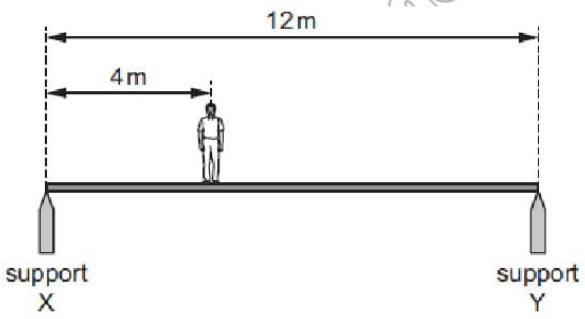


What is the magnitude of force F?

A 0.40 N B 2.0 N C 2.6 N D 4.4 N

Q27 (13/M/J/17/11):

A uniform horizontal footbridge is 12 m long and weighs 4000 N. It rests on two supports X and Y as shown.

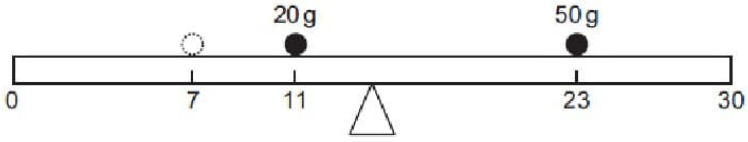


A man of weight 600 N is a distance of 4 m from support X.
What is the upward force on the footbridge from support X?

A 2200 N B 2300 N C 2400 N D 2600 N

Q28 (16/O/N/12/11):

A student balances a 30 cm ruler on a fulcrum set at the 15 cm mark. She then places a 50 g mass on the 23 cm mark and a 20 g mass on the 11 cm mark, as shown.

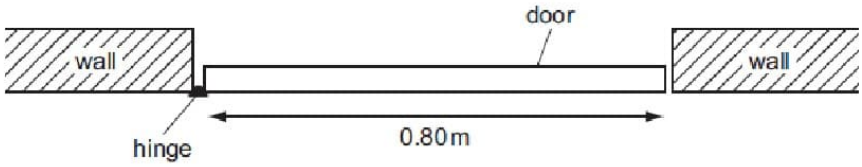


Which mass should she place on the 7 cm mark to restore the balance?

A 30 g B 40 g C 47 g D 133 g

Q29 (14/O/N/7/1):

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

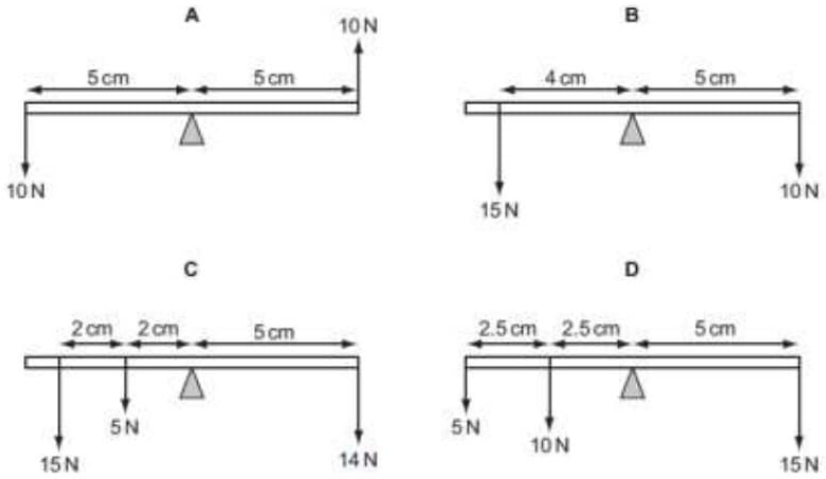


What is the minimum force that must be applied at the door's midpoint to ensure it opens?

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

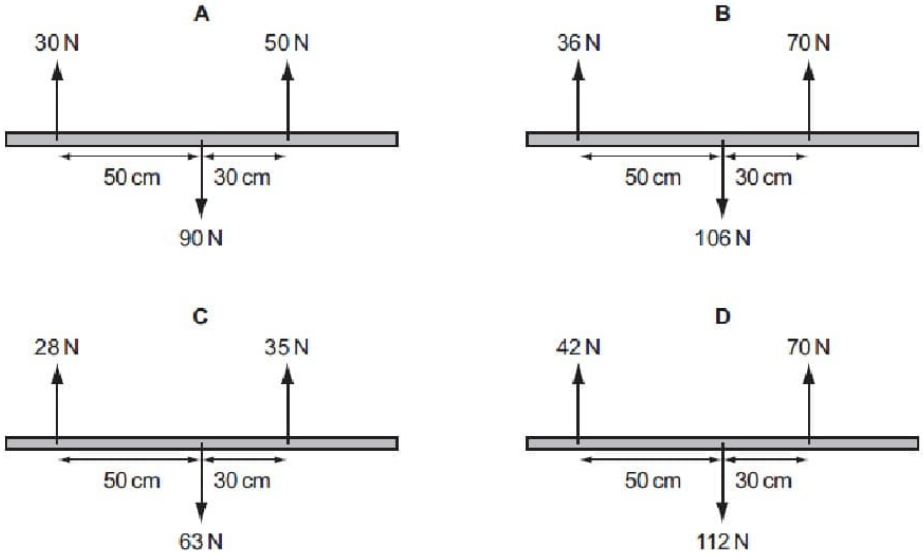
Q30 (17/O/N/12/12):

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?



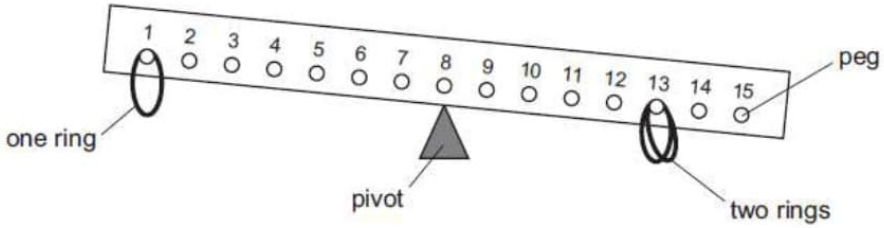
Q31 (16/O/N/12/13):

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?



Q32 (15/O/N/11/11):

The diagram shows a child's balancing game.

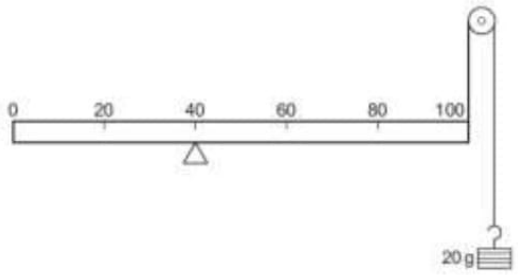


The wooden rod is uniform and all the rings are of equal mass. Two rings are hung on peg 13 and one on peg 1. On which hook must a fourth ring be hung in order to balance the rod?

A 2 B 3 C 5 D 6

Q33 (13/M/J/11/11):

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.

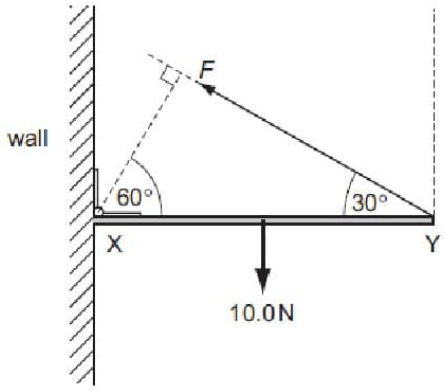


At which mark on the rule must a 50 g mass be suspended so that the rule balances?

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

Q34 (16/M/J/11/12):

A uniform rod XY of weight 10.0 N is freely hinged to a wall at X. It is held horizontal by a force F acting from Y at an angle of 30° to the horizontal, as shown.



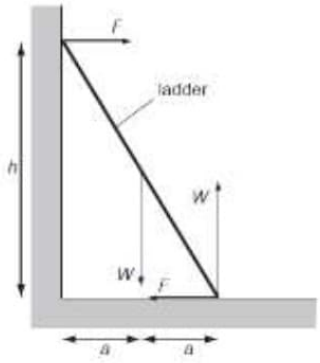
What is the value of F ?

A 5.0 N B 8.7 N C 10.0 N D 20.0 N

Q35 (14/M/J/8/1):

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 which act on the ladder.



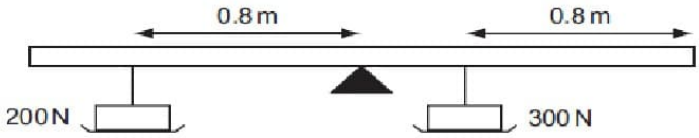
Which equation is formed by taking moments?

A $Wa + Fh = 2Wa$ B $Fa + Wa = Fh$

C $Wa + 2Wa = Fh$ D $Wa - 2Wa = 2Fh$

Q36 (15/M/J/6/1):

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.

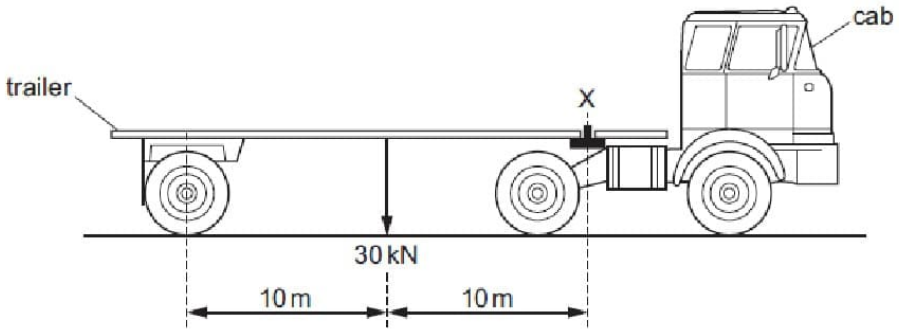
What is the torque and direction of this couple?

A 40 N m clockwise B 40 N m anticlockwise

C 80 N m clockwise D 80 N m anticlockwise

Q37 (14/M/J/16/11):

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

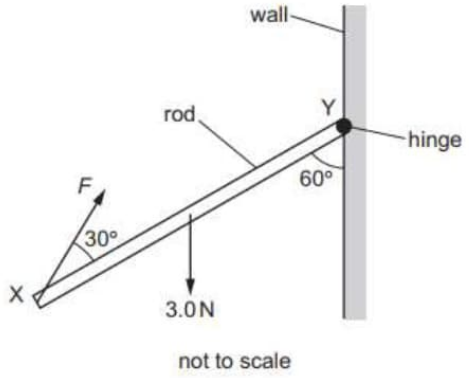


What is the upward force exerted at X by the cab on the trailer?

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

Q38 (12/M/J/24/12):

The diagram shows a uniform rod, XY, that is freely hinged toa vertical wall at end Y. The rod is at an angle of 60^0 to the wall.



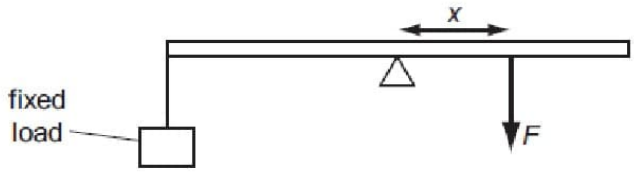
A force F acts at an angle of 30^0 to the rod at end X. The rod has a weight of 3.0N and is in equilibrium.

What is the magnitude of force F?

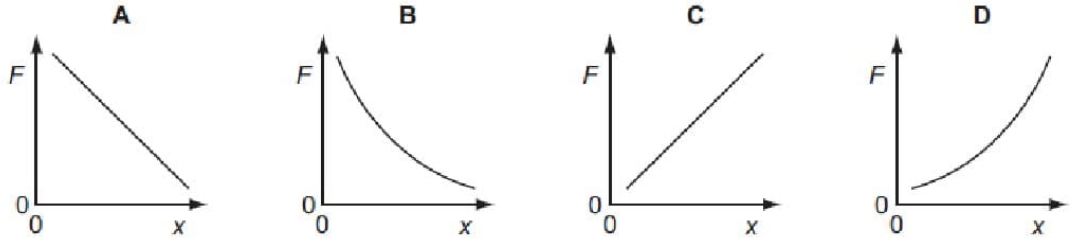
A. 0.87N B. 1.5N C. 2.6N D. 5.2N

Q39 (14/M/J/13/11):

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

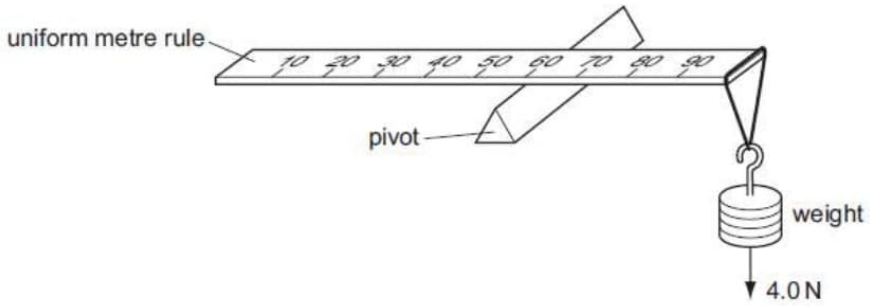


How does F vary with x?



Q40 (15/O/N/13/12):

A uniform metre rule of weight 2.0 N is pivoted at the 60 cm mark. A 4.0 N weight is suspended from one end, causing the rule to rotate about the pivot.

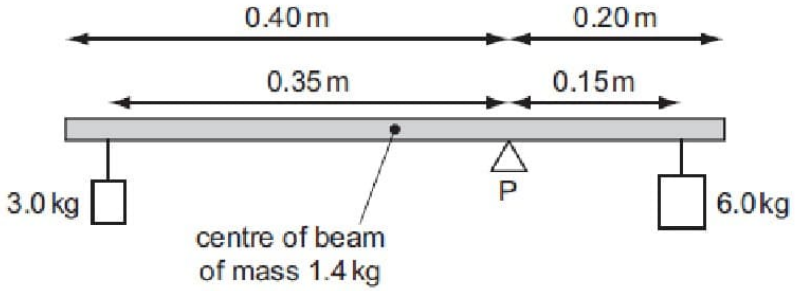


At the instant when the rule is horizontal, what is the resultant turning moment about the pivot?

A zero B 1.4 N m C 1.6 N m D 1.8 N m

Q41 (14/M/J/13/12):

A uniform beam of mass 1.4 kg is pivoted at P as shown. The beam has a length of 0.60 m and P is 0.20 m from one end. Loads of 3.0 kg and 6.0 kg are suspended 0.35 m and 0.15 m from the pivot as shown.

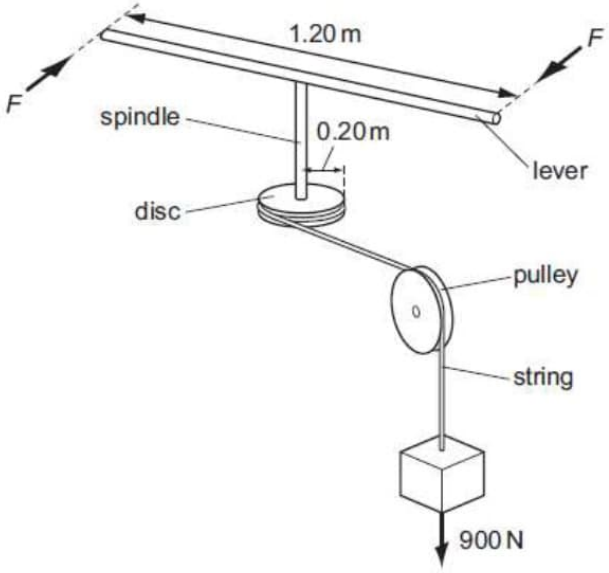


What torque must be applied to the beam in order to maintain it in equilibrium?

A 0.010 N m B 0.10 N m C 0.29 N m D 2.8 N m

Q42 (13/M/J/14/11):

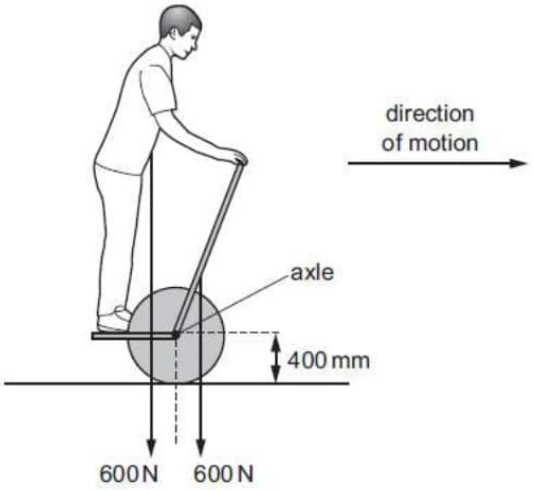
A spindle is attached at one end to the centre of a lever of length 1.20 m and at its other end to the centre of a disc of radius 0.20 m. A string is wrapped round the disc, passes over a pulley and is attached to a 900 N weight.



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

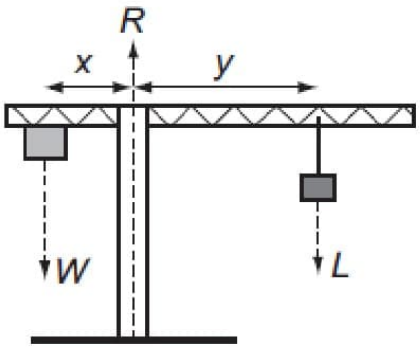
Q43 (14/O/N/17/11):
The diagram shows a motorized vehicle for carrying one person.



The vehicle has two wheels on one axle. The passenger stands on a platform between the wheels. The weight of the machine is 600 N. Its centre of mass is 200 mm in front of the axle. The wheel radius is 400 mm. When stationary, a passenger of weight 600 N stands with his centre of mass 200 mm behind the axle to balance the machine. The motor is now switched on to provide a horizontal force of 90 N at the ground to move the vehicle forwards. How far and in which direction must the passenger move his centre of mass to maintain balance?

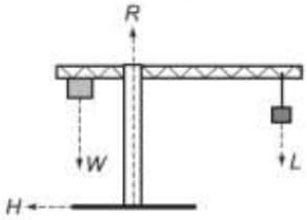
A 60 mm backwards
B 60 mm forwards
C 140 mm backwards
D 140 mm forwards

Q44 (15/M/J/12/11):
The diagram shows a crane supporting a load L.



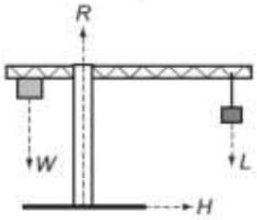
A mass provides a balancing load W. The position of the load is such that the system is perfectly balanced with Wx = Ly. The ground provides a reaction force R. The distance x does not change. If the load is moved further out so that the distance y increases and the crane does not topple, which statement is correct?

A

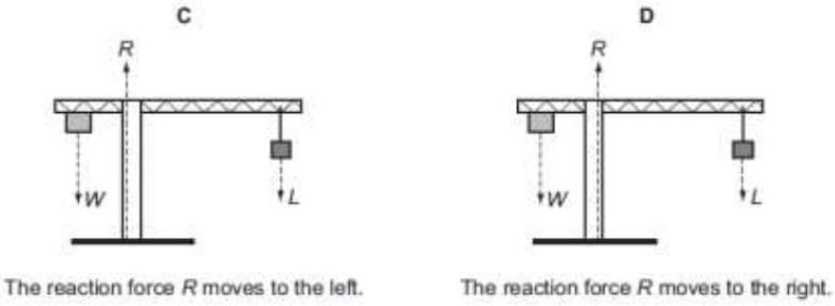


A horizontal force *H* acts on the base of the support column towards the left.

B



A horizontal force *H* acts on the base of the support column towards the right.

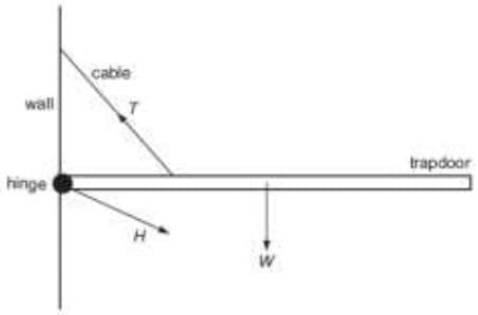


The reaction force *R* moves to the left. The reaction force *R* moves to the right.

Q45 (16/M/J/13/11):

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.

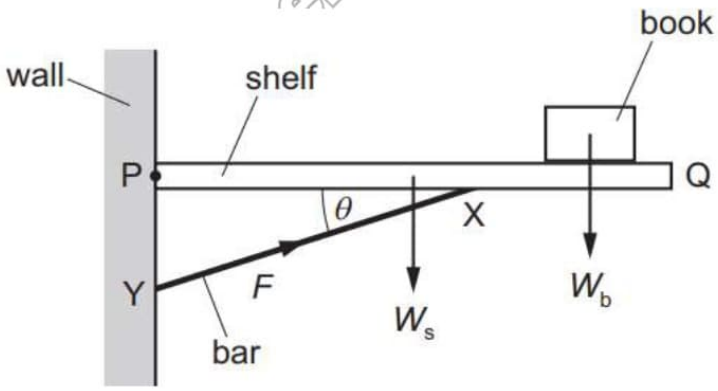


Which list gives the three forces in increasing order of magnitude?

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

Q46(13/O/N/20/13)

A shelf PQ is attached to a vertical wall at P and supports a book. The shelf is held horizontal by a rigid bar XY, as shown.



The weight of the shelf is W_s and the weight of the book is W_b. The bar is at an angle θ to the shelf and exerts a force F on the shelf. The shelf is in equilibrium. What are the magnitudes of the horizontal and the vertical components of the force of the wall on the shelf at P?

	horizontal component	vertical component
A	$F \cos \theta$	$(W_s + W_b - F \cos \theta)$
B	$F \cos \theta$	$(W_s + W_b - F \sin \theta)$
C	$F \sin \theta$	$(W_s + W_b - F \cos \theta)$
D	$F \sin \theta$	$(W_s + W_b - F \sin \theta)$

Density And Pressure

Q1 (19/O/N/6/1):

Which statement defines the density of the substance?

A the force per unit area acting on the substance
B the increase in length per unit length of the substance
C the mass per unit volume of the substance
D the work done per unit time by the substance

Q2 (1/O/N/16/12):

Concrete has a density of 2400 kg m^{-3}.
Which mass of concrete fills a rectangular space of dimensions 8.0 cm × 90 cm × 110 cm?

A 79 kg B 190 kg C 790 kg D 1900

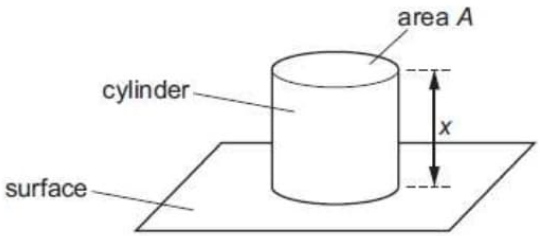
Q3 (20/M/J/15/13):

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

Q4 (13/M/J/16/11):

A solid metal cylinder stands on a horizontal surface, as shown



The cylinder has length x and cross-sectional area A. The cylinder exerts a pressure p on the surface. The acceleration of free fall is g.
Which expression gives the density of the metal of the cylinder?

A $\frac{gx}{p}$ B $\frac{p}{gx}$ C $\frac{gx}{pA}$ D $\frac{pA}{gx}$

Q5 (18/O/N/9/12):

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 kg m^{-3} B 1900 kg m^{-3}

C 19 000 kg m^{-3} D 190 000 kg m^{-3}

Q6 (14/M/J/17/11):

A metal block has a mass of 750 g. 60% of the mass is magnesium and the remainder is copper.

The density of magnesium is $1.7\,g\,cm^{-3}$.

The density of copper is $9.0\,g\,cm^{-3}$.

What is the density of the block?

A $2.5\,g\,cm^{-3}$ B $4.6\,g\,cm^{-3}$ C $5.4\,g\,cm^{-3}$ D $10.7\,g\,cm^{-3}$

Q7 (13/M/J/16/12):

In a large container in an oil refinery, three oils of different densities are mixed. No chemical activity occurs.

The mixture consists of

1200 kg of oil of density 1100 kgm^{-3},
1500 kg of oil of density 860 kgm^{-3},
4000 kg of oil of density 910 kgm^{-3},

What is the density of the mixture?

A $927\,kg\,m^{-3}$ B $957\,kg\,m^{-3}$ C $1010\,kg\,m^{-3}$ D $1080\,kg\,m^{-3}$

Q8 (19/M/J/11/11):

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 the density 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 $950\,kg\,m^{-3}$

Q9 (20/O/N/13/13):

Gold has a density of 19.3 g cm^{-3}.
The volume occupied by a single atom of gold may be considered to be a cube with sides of length 2.6 × 10^{-8} cm.
What is the mass of a gold atom?

A 3.4×10^{-25} g B 3.4×10^{-22} g

C 1.3×10^{-17} g D 1.3×10^{-14} g

Q10 (11/O/N/13/12):

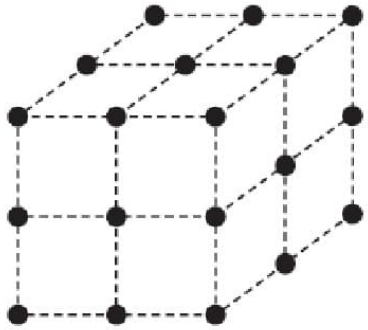
A beam of α-particles collides with a lead sheet. Each α-particle in the beam has a mass of 6.6×10^{-27} kg and speed of 1.5×10^{7} ms^{-1}.
5.0 × 10^{4} α-particles per second collide with an area of 1.0 cm^{2} of lead. Almost all of the α-particles are absorbed by lead so that they have zero speed after collision.
What is the estimate of the average pressure exerted on the lead by the α-particles?

A 5.0×10^{-15} Pa B 5.0×10^{-13} Pa

C 5.0×10^{-11} Pa D 5.0×10^{-9} Pa

Q11 (21/M/J/15/11):

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.
What is the shortest distance between the centers of two adjacent atoms?

A 3.8×10^{-29} m B 6.2×10^{-15} m
C 3.4×10^{-10} m D 3.0×10^{-9} m

Q12 (21/M/J/11/12):

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

Q13 (11/M/J/16/13):

The IKAROS satellite has mass 320 kg and moves through space using a solar sail of area 20 m^2.
The average solar wind pressure is 1.0×10^{-5} $N m^{-2}$.
What is the acceleration of the satellite caused by the solar wind?

A 3.1×10^{-8} $m s^{-2}$ B 6.3×10^{-7} $m s^{-2}$

C 3.2×10^{-3} $m s^{-2}$ D 6.4×10^{-2} $m s^{-2}$

Q14 (15/M/J/16/12):

The density of air on the Earth decreases almost linearly with height from 1.22 $kg m^{-3}$ at sea level to 0.74 $kg m^{-3}$ at an altitude of 5000 m.
Atmospheric pressure at the Earth's surface on a particular day is 100 000 Pa. The value of g between the Earth's surface and an altitude of 5000 m can be considered to have a constant value of
9.7 $m s^{-2}$. What will be the atmospheric pressure at an altitude of 5000m?

A 36000 Pa B 48000 Pa C 52000 Pa D 59000 Pa

Pressure due to Liquid

Q1 (18/M/J/13/13):
The formula for hydrostatic pressure is $p = \rho gh$.
Which equation, or principle of physics, is used in the derivation of this formula?

A $density = \frac{mass}{volume}$ B potential energy = mgh
C atmospheric pressure decreases with height D density increases with depth

Q2 (15/O/N/17/11):
The derivation of the pressure equation $\Delta p = \rho g \Delta h$ uses a number of relationships between quantities. Which relationship is not used in the derivation of this equation?

A density = $\frac{\text{mass}}{\text{volume}}$ B potential energy = mass × acceleration of free fall × height

C pressure = $\frac{force}{area}$ D weight = mass × acceleration of free fall

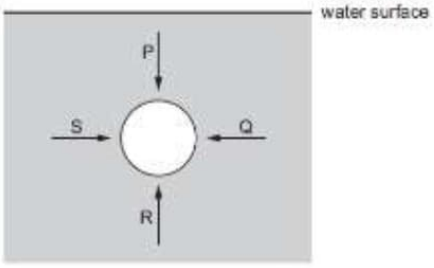
Q3 (15/M/J/16/13):
For a change in depth Δh in a liquid of density ρ, the change in pressure Δp is given by $\Delta p = \Delta h \rho g$ where g is the acceleration of free fall.
What is the equation, or principle of physics, used in the derivation of this formula?

A atmospheric pressure decreases with height
B change in gravitational potential energy = mass x $g\Delta h$
C $\rho = \frac{mass}{volume}$
D the density of a fluid increases with depth

Q4 (17/M/J/10/11):
Atmospheric pressure at sea level has a value of 100 kPa. The density of sea water is 1020 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

Q5 (13/M/J/17/13):
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 < S D P = R and S = Q and P = S

Q6 (22/M/J/14/13):

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 would be the approximate pressure at that depth?

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

Q7 (15/M/J/7/1):

The density of mercury is 13.6×10^3 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

Q8 (18/O/N/7/1):

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 kgm^{-3}.
What is the depth below the surface when the meter reads 450 kPa?

A 34.6m B 44.5m C 340m D 437m

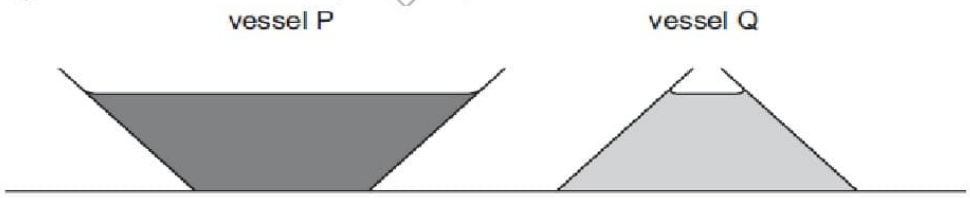
Q9 (20/O/N/11/12):

A horizontal plate of area 0.036 m^2 is beneath the surface of a liquid of density 930 kg m^{-3}. The force 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

Q10 (20/M/J/11/12):

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

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

Q11 (19/O/N/10/11):

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 kgm^{-3}, what would be approximate pressure at the depth?

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

Q12 (20/O/N/10/12):

The pressure at sea level is approximately 100 000 Pa. The density of sea water is 1030 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

Q13 (18/M/J/14/12):

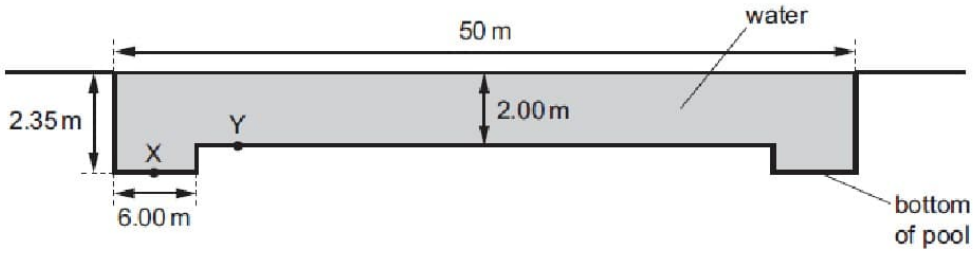
Liquid Q has twice the density of liquid R. At depth x in liquid R, the pressure due to the liquid is 4 kPa.

At what depth in liquid Q is the pressure due to the liquid 7 kPa?

A $\frac{2x}{7}$ B $\frac{7x}{8}$ C $\frac{8x}{7}$ D $\frac{7x}{2}$

Q14 (20/O/N/15/12):

The diagram shows the cross-section of an Olympic-size swimming pool filled with water. It is not drawn to scale. The density of the water is 1000 kg m^{-3}.

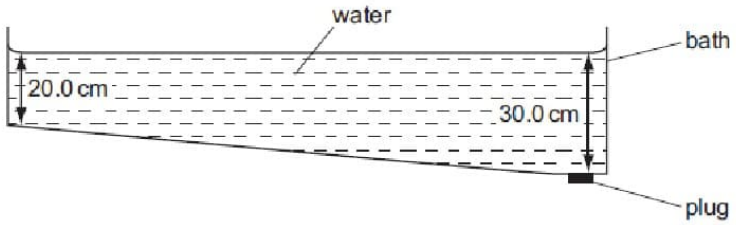


What is the difference in pressure between X and Y?

A 0.35 kPa B 3.4 kPa C 21.3 kPa D 58.9 kPa

Q15 (22/O/N/13/12):

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 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

Q16 (20/M/J/15/12):

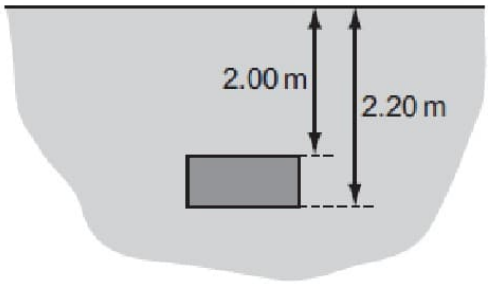
The maximum pressure that granite rock can withstand is 2.0×10^8 N m^{-2}. Above this pressure, the rock begins to flow like a liquid. The density of granite is 2.7×10^3 kg m^{-3}.

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

A 3.8×10^3 m **B** 7.6×10^3 m **C** 3.7×10^4 m **D** 7.4×10^4 m

Q17 (23/O/N/12/13):

The diagram shows a rectangular block of mass 8.2 kg immersed in sea water of density 1.10×10^3 kg m^{-3}.



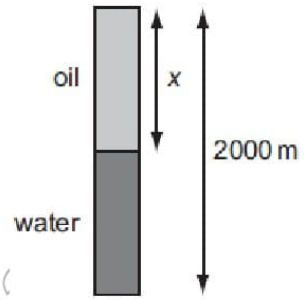
What is the difference in pressure between the top and bottom surfaces of the block?

A 2.2×10^2 Pa B 2.2×10^3 Pa

C 1.8×10^4 Pa D 2.3×10^4 Pa

Q18 (21/M/J/13/11):

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 kg m^{-3} and the density of the water is 1000 kg m^{-3}.

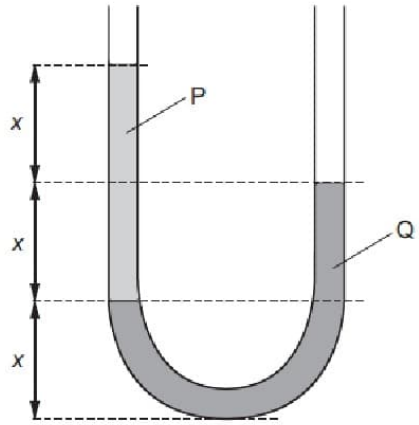


What is the depth x of the oil?

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

Q19 (22/O/N/14/13):

The diagram shows two liquids, labelled P and Q, which do not mix. The liquids are in equilibrium in an open U-tube.



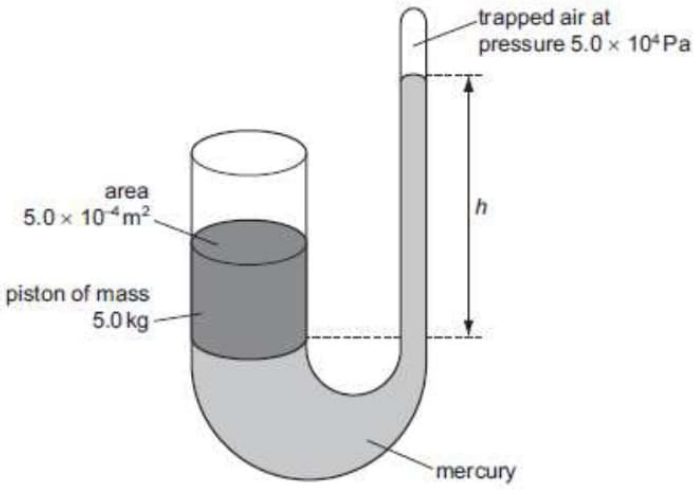
What is the ratio $\frac{density\ of\ P}{density\ of\ Q}$?

A $\frac{1}{2}$ B $\frac{2}{3}$ C $\frac{3}{2}$ D 2

Q20 (19/O/N/15/11):

A U-tube closed at one end contains mercury. Air at a pressure of 5.0×10^4 Pa is trapped at the closed end. The other end is open to the atmosphere and is fitted with a piston of mass 5.0 kg and cross-sectional area 5.0×10^{-4} m^2.

The density of mercury is 13 600 kg m^{-3} and atmospheric pressure is 1.01×10^5 Pa.

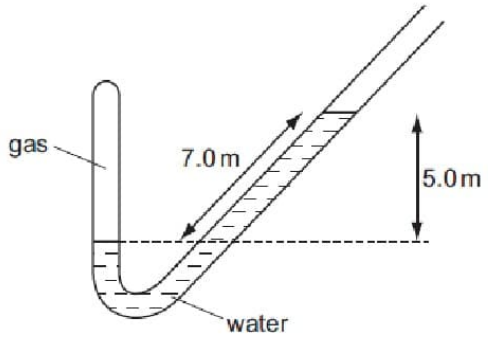


What is the height h of the mercury column?

A 37 cm B 44 cm C 74 cm D 110 cm

Q21 (23/M/J/12/12):

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



The atmospheric pressure is 1.0×10^5 Pa. The density of water is $1000\,kg\,m^{-3}$.

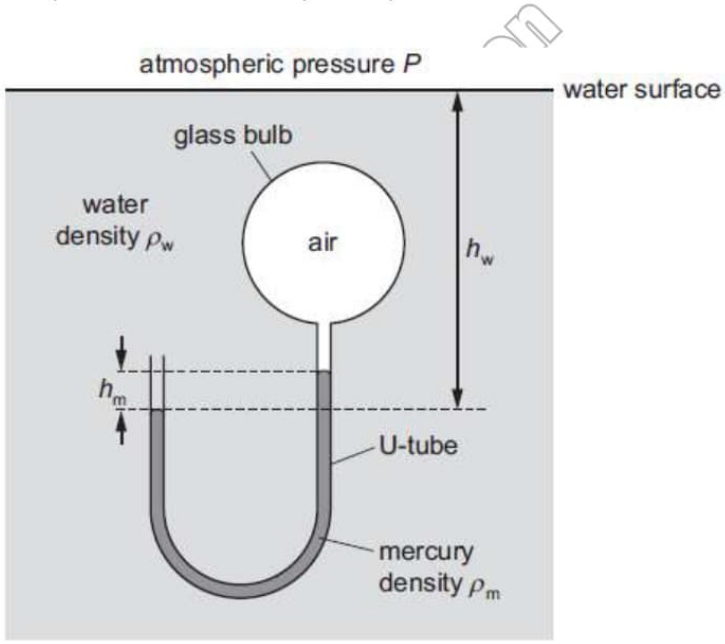
What is the pressure of the gas? (Use $g = 10\,m\,s^{-2}$.)

A 0.3×10^5 Pa B 0.5×10^5 Pa

C 1.5×10^5 Pa D 1.7×10^5 Pa

Q22 (15/O/N/17/12):

Air is trapped inside a glass bulb which is immersed in water and attached to a U-tube containing mercury. The densities of water and mercury are ρ_w and ρ_m respectively. The surface of the water is open to the atmosphere where atmospheric pressure is P.



The acceleration of free fall is g.

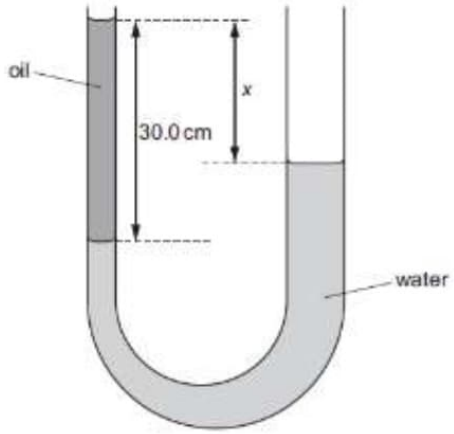
What is the pressure of the air in the glass bulb?

A $P + g\rho_w h_w + g\rho_m h_m$ B $P + g\rho_w h_w - g\rho_m h_m$

C $g\rho_w h_w + g\rho_m h_m$ D $g\rho_w h_w - g\rho_m h_m$

Q23 (19/O/N/15/13):

A U-tube has one arm of area of cross-section A and the other of cross-section 4A. The tube contains water of density 1000 kg m^{-3} and oil of density 850 kg m^{-3}, as shown?

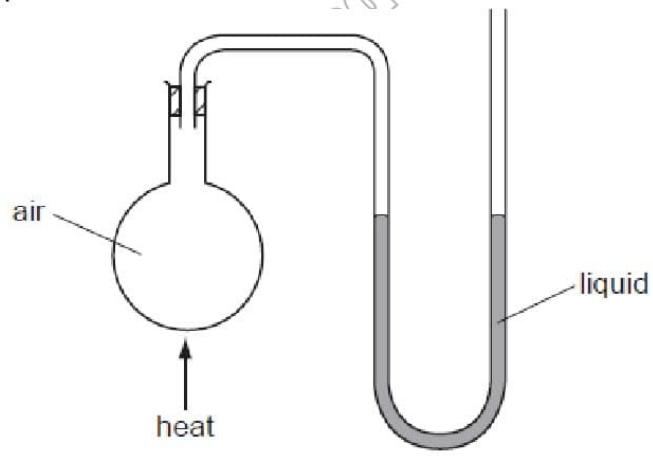


The column of oil on top of the water in the left-hand arm is of length 30.0 m.
What is the difference in height x between the levels in the two arms of the tube?

A 4.5 cm B 6.2 cm C 23.8 cm D 25.5 cm

Q24 (18/O/N/9/1):

The diagram shows a flask connected to a U-tube containing liquid. The flask contains air at atmospheric pressure.

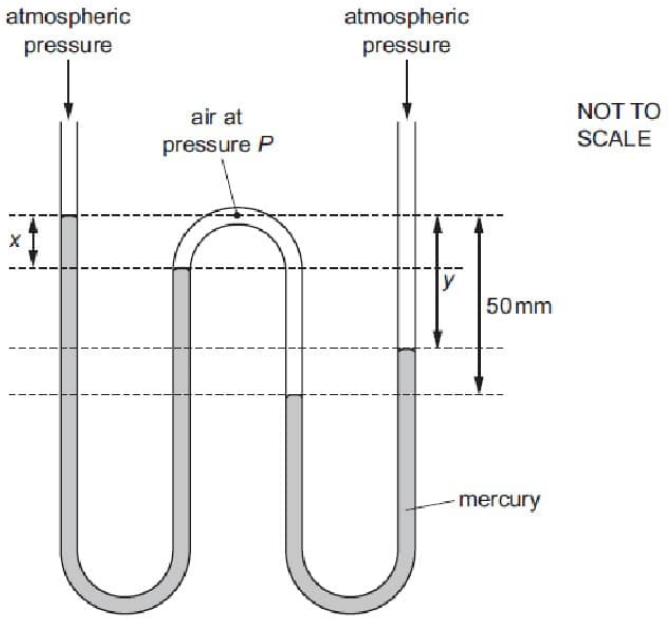


The flask is now gently heated and the liquid level in the right-hand side of the U-tube rises through a distance h. The density of the liquid is ρ.
What is the increase in pressure of the heated air in the flask?

A $h\rho$ B $\frac{1}{2}h\rho g$ C $h\rho g$ D $2h\rho g$

Q25 (21/M/J/15/13):

A W-shaped tube contain 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.



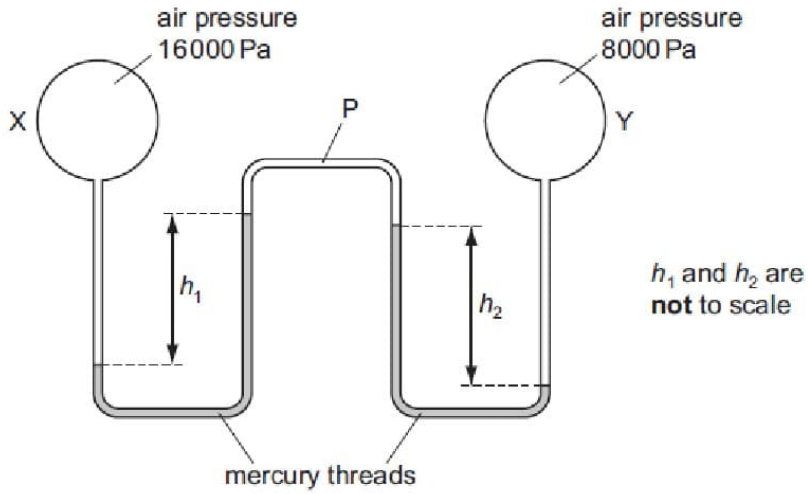
Atmospheric pressure is equal to the pressure that would be exerted by a column of mercury of height 760 mm. The pressure P is expressed in this way.

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

Q26 (20/M/J/13/12):

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 h1 and h2 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

Types of Forces

Q 1(14/M/J/10/11):

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.

Q 2 (13/M/J/12/11):

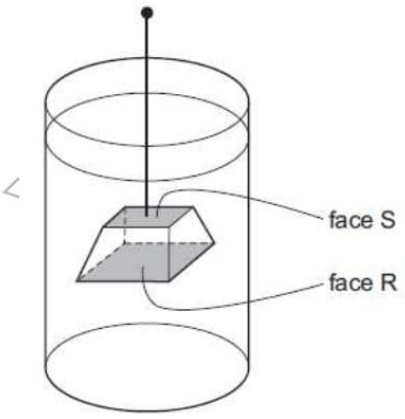
A cylindrical block of wood has cross-sectional area A and weight W. It is totally immersed in water with its axis vertical. The block experiences pressures p_t and p_b at its top and bottom surfaces respectively.
Which expression is equal to the upthrust on the block?

A $(p_b - p_t)A + W$ B $(p_b - p_t)$

C $(p_b - p_t)A$ D $(p_b - p_t)A - W$

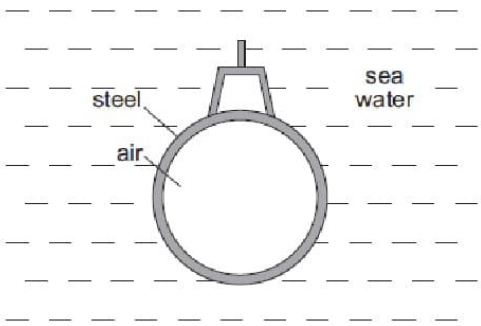
Q 3(11/O/N/17/12):

The diagram shows a block of copper suspended in water.
The block experiences an upthrust from the water.
Which statement is the basis of an explanation for this upthrust?



A Copper is more dense than water.
B The area of face R is greater than the area of face S.
C The density of water increases with depth.
D The pressure of water increases with depth.

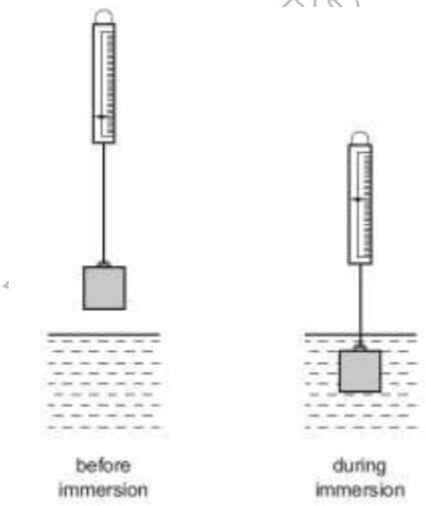
Q4 (11/M/J/13/12):
A submarine is in equilibrium in a fully submerged position.



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.
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.

Q5 (13/O/N/10/12):
The diagrams show a metal cube suspended from a spring balance before and during immersion in water.

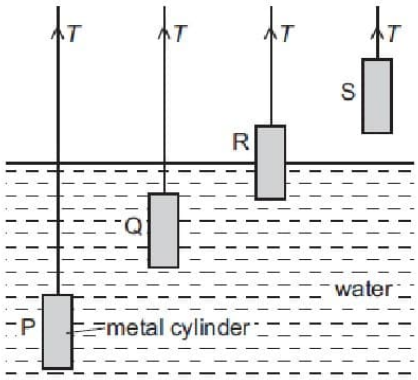


A reduction in the balance reading occurs as a consequence of the immersion.
Which statement is correct?

A The balance reading will be further reduced if the cube is lowered further into the water.
B The balance reading during immersion corresponds to the upthrust of the water on the cube.
C The forces acting on the vertical sides of the cube contribute to the change in the balance reading.
D The gravitational pull on the cube is unchanged by the immersion.

Q6 (10/M/J/17/12):

A metal cylinder is suspended vertically in equilibrium by a cord. The diagram shows the cylinder in four different positions P, Q, R and S.

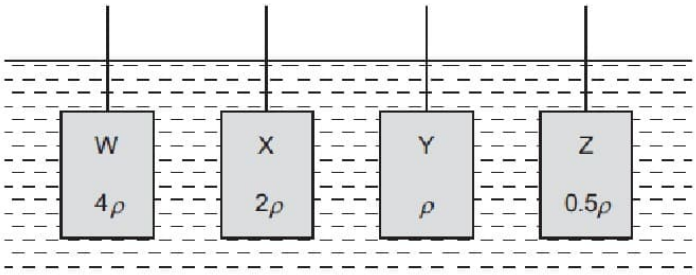


Which statement explains the variation of the tension T in the cord?

A At P and at Q, the tension T in the cord is the same because the difference in pressure between the top and bottom of the cylinder is the same.
B At Q, the tension T in the cord is less than at P because, at smaller depth, liquid pressure is smaller.
C At R, the tension T in the cord is less than at P because atmospheric pressure is less than water pressure.
D At S, the tension T in the cord is greater than at P because atmospheric pressure at S exerts no force on the top or bottom of the cylinder.

Q7 (14/M/J/15/13):

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.

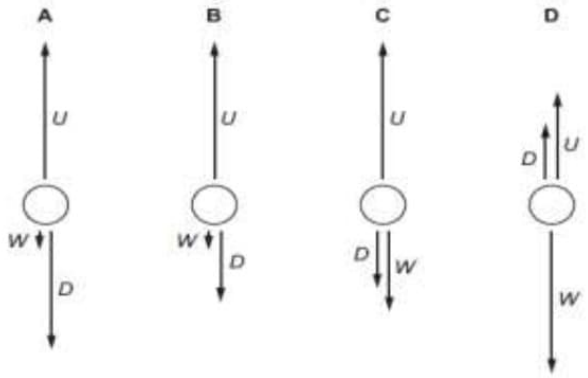


Water has density ρ.
Cuboid W is made of material of density 4ρ.
Cuboid X is made of material of density 2ρ.
Cuboid Y is made of material of density ρ.
Cuboid Z is made of material of density 0.5ρ
Which statement is correct?

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.

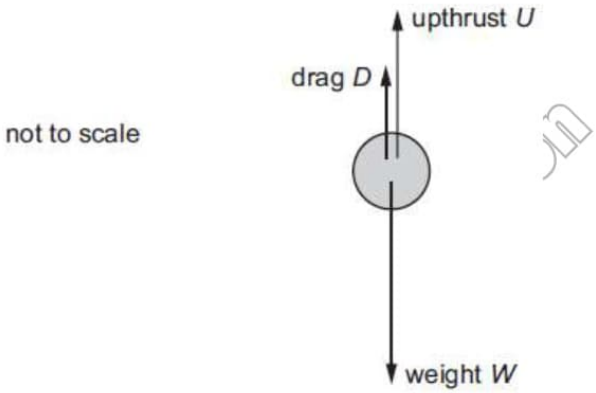
Q8 (12/M/J/17/13)

An air bubble is rising through a liquid at a constant speed. The forces on it are the upthrust U, the viscous drag D and its weight W. Which diagram shows the directions and relative sizes of the forces?



Q9 (13/O/N/17/13)

A solid sphere falls at constant (terminal) velocity in a liquid. The three forces acting on the sphere are shown in the diagram.

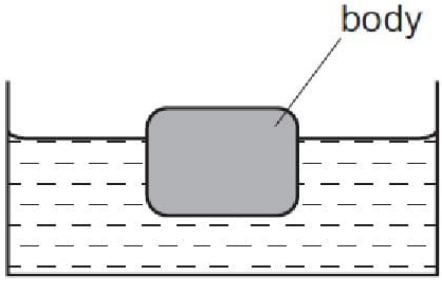


How are the three forces related?

A W + D = U B W > U + D
C W – U = D D W < D + U

Q10 (16/O/N/12/12):

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.

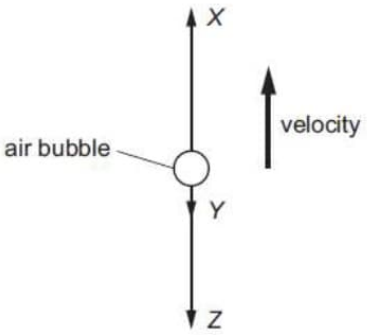
Q11 (11/O/N/14/12):

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

Q12 (15/M/J/15/13):

An air bubble in a tank of water is rising with constant velocity. The forces acting on the bubble are X, Y and Z as shown.

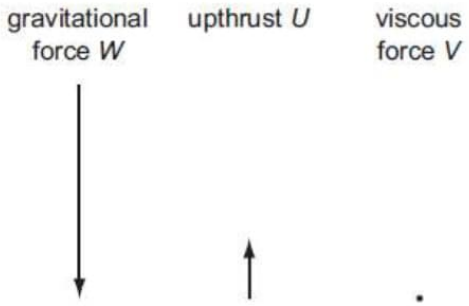


What describes the three forces?

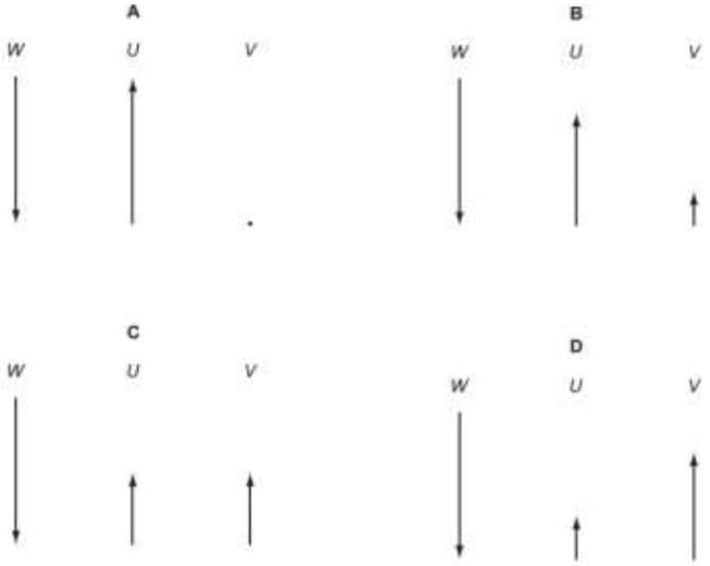
A Z is the viscous drag on the bubble, Y is the weight of the bubble, X is the upthrust on the bubble and X = Y + Z.
B Z is the viscous drag on the bubble, Y is the weight of the bubble, X is the upthrust on the bubble and X > Y + Z.
C Z is the weight of the bubble, Y is the viscous drag on the bubble, X is the upthrust on the bubble and X = Y + Z.
D Z is the weight of the bubble, Y is the viscous drag on the bubble, X is the upthrust on the bubble and X > Y + Z.

Q13 (15/O/N/12/13):

A hailstone, initially stationary at the base of a cloud, falls vertically towards the Earth. The diagram shows the magnitudes and directions of the forces acting on the hailstone as it starts to drop.



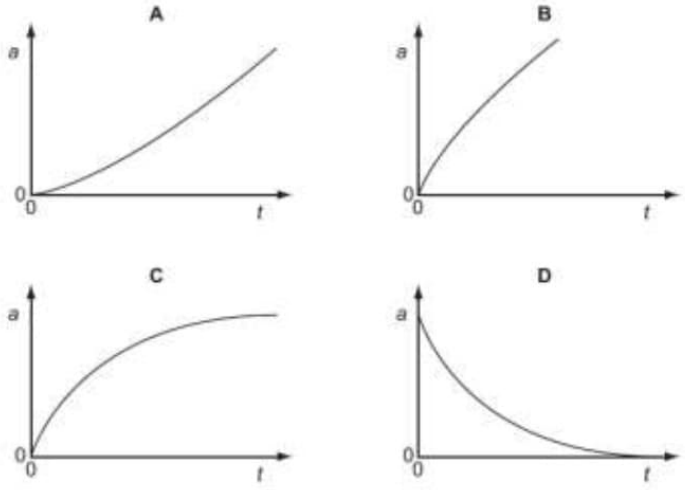
Which diagram shows the magnitudes and directions of these forces when the hailstone attains a terminal (constant) speed in the air (of uniform density)?



Q14 (16/M/J/12/12):

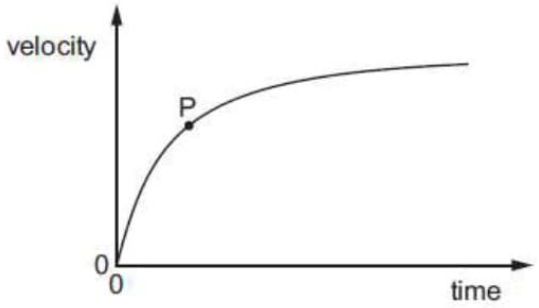
A sphere is released from rest in a viscous fluid.

Which graph represents the variation with time t of the acceleration a of the sphere?

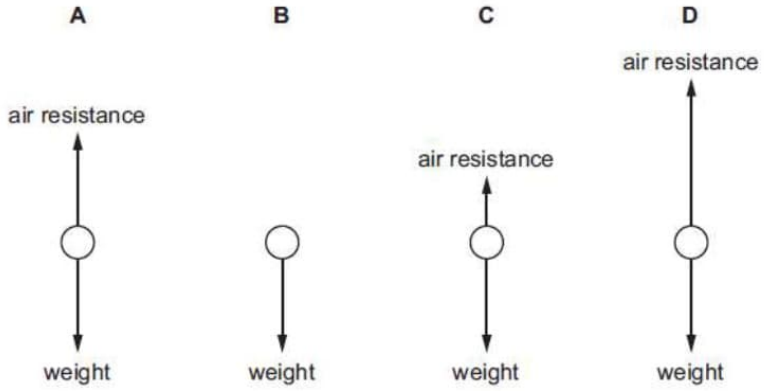


Q15 (10/M/J/16/12):

A sphere falls from rest through the air. The graph shows the variation with time of the sphere's velocity.

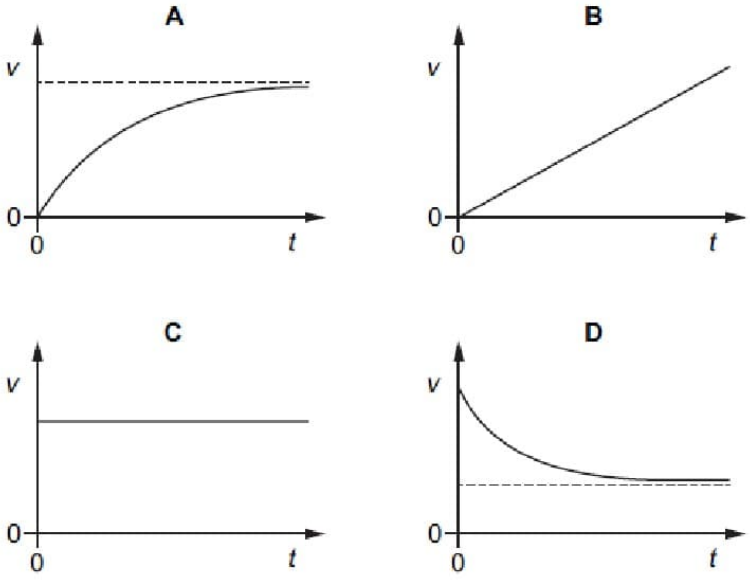


Which diagram shows the forces acting on the sphere when it is at the velocity corresponding to point P on the graph?



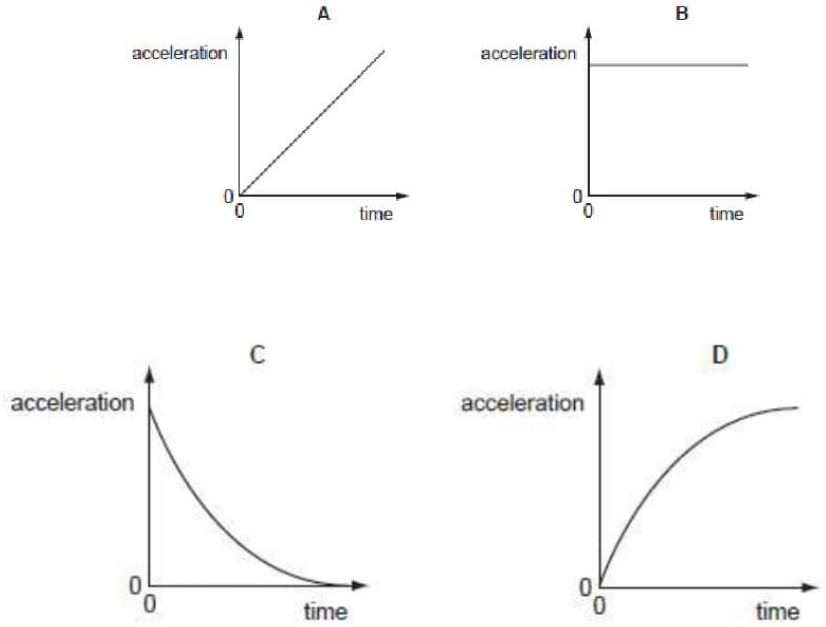
Q16 (11/O/N/18/13)

A rigid, hollow sphere is immersed deep in water and released from rest. It experiences an upthrust which propels it towards the surface of the water. Which graph best shows the variation with time *t* of its upward velocity *v*?



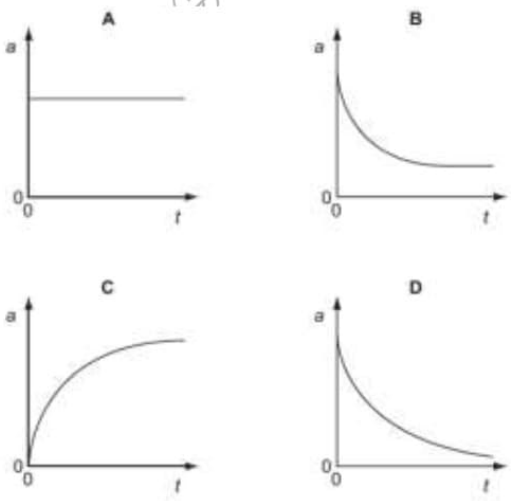
Q17 (8/M/J/8/1):

A football is dropped from the top of a tall building.
Which acceleration-time graph best represents the motion of the football through the air?



Q18 (7/O/N/11/11):

A tennis ball is released from rest at the top of a tall building.
Which graph best represents the variation with time t of the acceleration a of the ball as it falls, assuming that the effect of air resistance is not negligible?



Q19 (9/O/N/11/11):

A body falling in a uniform gravitational field encounters air resistance. The air resistance increases until terminal velocity is reached. Which factor does not affect its terminal velocity?

A the density of the air
B the height from which the body falls
C the mass of the body
D the shape of the body

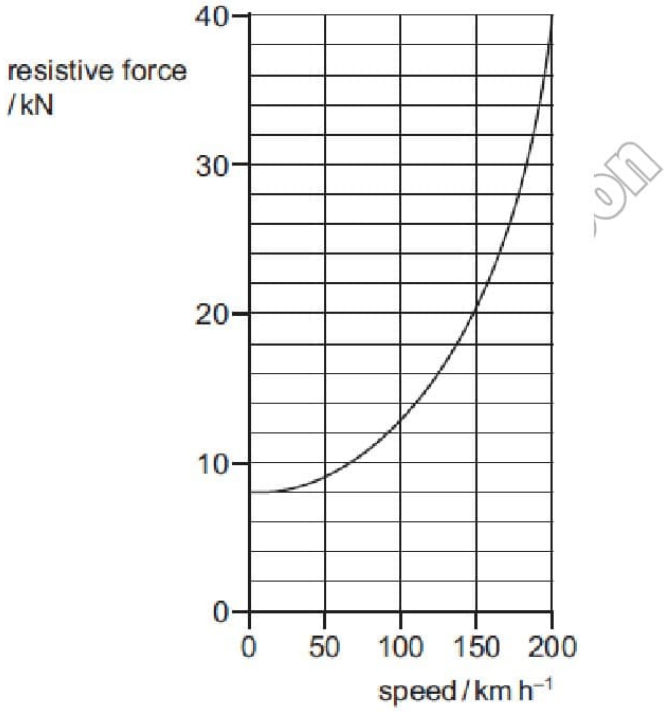
Q20 (7/O/N/11/12):

A stone of mass m is dropped from a tall building. There is significant air resistance. The acceleration of free fall is g. When the stone reaches its terminal velocity, which information is correct?

	magnitude of the acceleration of the stone	magnitude of the force of gravity on the stone	magnitude of the force of air resistance on the stone
A	g	mg	mg
B	zero	mg	mg
C	zero	zero	mg
D	zero	zero	zero

Q21 (16/O/N/13/13):

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.

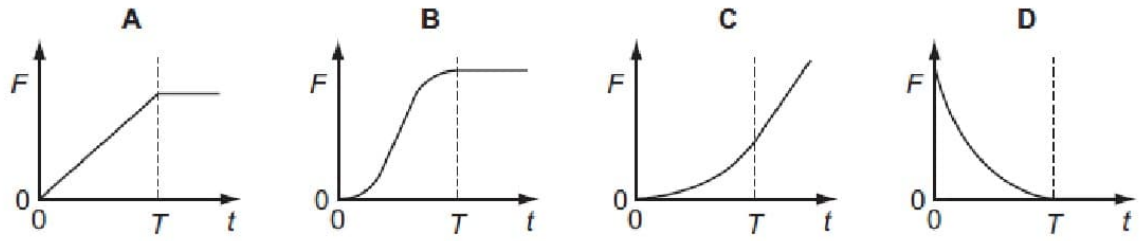


What is the ratio $\frac{wind\ resistance}{wheel\ friction}$ at a speed of 200 kmh^{-1}?

A 4 B 5 C 8 D 10

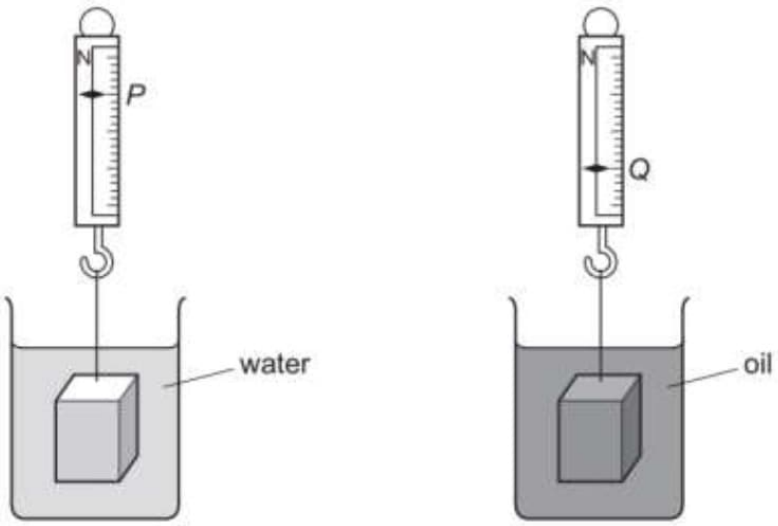
Q22 (6/M/J/13/12):

A sky diver falls vertically from a stationary balloon. She leaves the balloon at time t = 0. At time t = T, she reaches terminal velocity. Beyond the time shown in the graphs, she opens her parachute. Which graph shows the variation with time t and the force F due to air resistance?



Q23(11/O/N/19/11)

An object of weight *W* is suspended from a newton meter. When the object is completely immersed in water, the newton meter reads *P*. When the object is completely immersed in oil, the newton meter reads *Q*.



What is the ratio of $\frac{density\ of\ oil}{density\ of\ water}$

A $\frac{W-P}{Q-P}$ B $\frac{Q-P}{W-P}$ C $\frac{W-P}{W-Q}$ D $\frac{W-Q}{W-P}$

Moment of a force

1	B
2	A
3	B
4	A
5	B

Couple

1	A	7	B	13	C
2	D	8	B		
3	A	9	A		
4	B	10	A		
5	B	11	B		
6	D	12	D		

Equilibrium

1	C	17	C	33	C
2	C	18	B	34	C
3	D	19	B	35	A
4	D	20	C	36	A
5	C	21	B	37	B
6	A	22	B	38	C
7	D	23	D	39	B
8	B	24	C	40	A
9	A	25	C	41	D
10	C	26	B	42	B
11	A	27	C	43	B
12	D	28	B	44	D
13	D	29	D	45	C
14	B	30	C	46	B
15	A	31	D		
16	D	32	C		