PHYSICS

BOOKS - CENGAGE PHYSICS

STATICS

Worked Examples

1. A body is pivoted at a point. A force of 15 N is applied at a distance of 30 cm from the point. Calculate the moment of the force about the point.

View Text Solution

2. A mechanic can loosen a nut by applying a 150-N force using a spanner of length 40 cm. What is the length of the spanner if he wants to loosen the nut by applying a force of 50 N to produce the same turning effect?

View Text Solution

3. The following diagram shows two parallel, opposite forces, F_1 and F_2 each of magnitude 10

N, with their lines of action separated by a distance of 2 m. A point X lies midway between F_1 and F_2 while a point Flies on F_2. Calculate the total moment of the forces about (i) A'and (ii) Y. State the effect produced by the forces about the point X.

View Text Solution

4. Two children of weight 30 kgf and 50 kgf sit on the same side of a see-saw at distances 2 m and 3

m, respectively, from its mid-point. Where should a man of mass 75 kg sit to balance it?

View Text Solution

5. Two forces, each of magnitude 3 N, act vertically in opposite direction at the two ends of a uniform rod of length 1 m, pivoted at its centre. Draw a diagram of the arrangement and determine the resultant moment of the forces about the mid-point of the rod.

View Text Solution

6. A crowbar of length 135 cm has its fulcrum at a distance of 15 cm from the load. Calculate its mechanical advantage.

View Text Solution

7. A machine is used to lift a 100-kg stone through a vertical height 20 m in 80 s. Find the useful power of the machine. If the efficiency of the machine is 75%, find the electric power consumed by the machine. [Take g = $10ms^{-2}$]

View Text Solution

8. A block and tackle system of 5 pulleys is used to lift a body of weight 80 kgf using an effort of 20 kgf. Find its mechanical advantage, velocity ratio, and efficiency.

View Text Solution

9. Using a single fixed pulley, a load of 400 N is lifted by applying an effort of 500 N through a vertical height of 5min 10 s.

(i) What is VR of the machine?

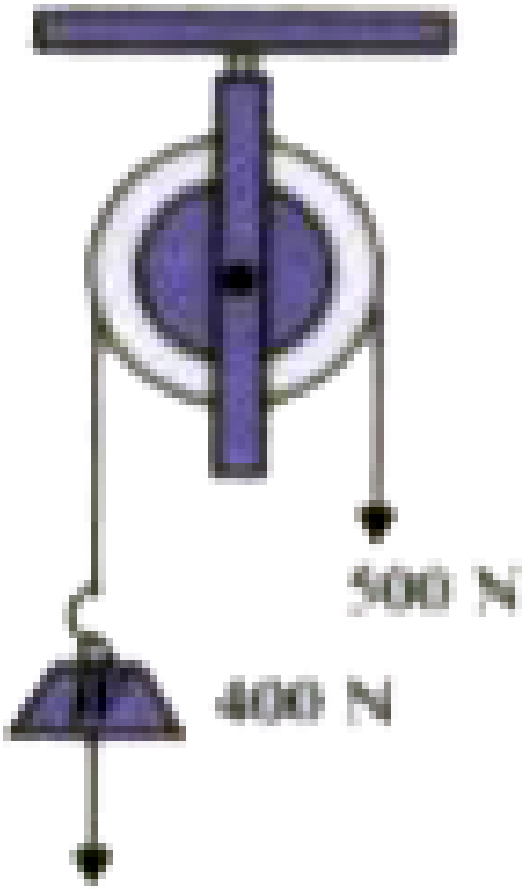
(ii) What is its MA?

(iii) Calculate its efficiency.

(iv) Why is the efficiency less than 100%?

(v) What is the energy gained by the load in 10 s?

(vi) How much power is developed by the effort?

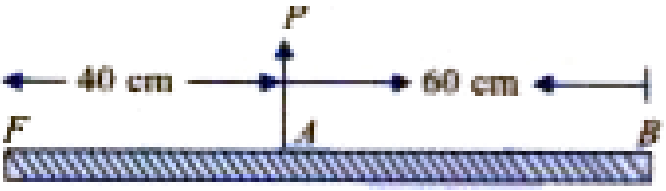


View Text Solution

10. (i) What is the order of the lever shown in the diagram?

(ii) If FA = 20 cm, AB = 60 cm, calculate the effort P.

(iii) Give one example for third-order lever.



View Text Solution

Mandatory Exercise Exercise Set I Short Answer Questions

1. Is moment of force a scalar or a vector?

View Text Solution

2. Give scientific reasons for the following:

(i) It is easier to open a door by applying a force farther from the hinges.

(ii) The handle of a domestic grinder is provided near its rim.

View Text Solution

3. The moment of a force about a given axis depends-

(a) only on the magnitude of the force.

(b) only on the distance of the force from the axis

(c) on the force and the distance of the force from the axis

(d) on the force and its perpendicular distance from the axis

View Text Solution

4. Which of the following appliances works on the principle of moments?

A. spring balance

B. beam balance

C. pendulum clock

D. balance wheel

Answer: b

View Text Solution

5. If the forces applied at the two ends of a body are opposite in direction but unequal in magnitude

A. the body will not rotate

B. the body will only move in the direction of the larger force

C. the body will only rotate

D. the body rotates and moves in the direction of the larger force

Answer: d

View Text Solution

6. In order to rotate a body

A. a large force can be applied at any point on the body

B. a small force acting exactly at its center of gravity is required

C. forces at the two ends of the body acting in the same direction are required

D. two equal forces not acting in the same line and acting in opposite directions are required

Answer: d

View Text Solution

7. If the net force acting on a body is zero then the body is said to be in

A. unbalanced

B. balanced

C. equilibrium

D. none

Answer: c

View Text Solution

8. A body at rest or moving with a uniform velocity will have acceleration equals to

A. $1m/s^2$

B. $0m/s^2$

C. infinite

D. none

Answer: b

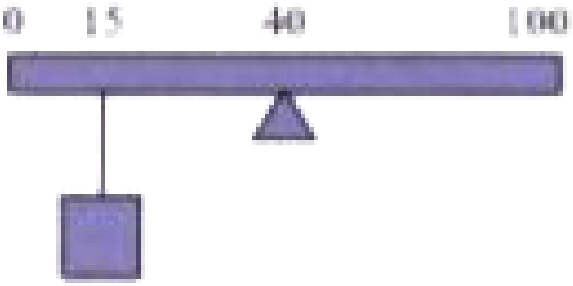
View Text Solution

Mandatory Exercise Numericals

1. A uniform plank of length 4.4 m weighing 200 N is placed horizontally and symmetrically on two supports which are 3.12 m apart. A man weighing 800 N stands on the plank over one of the supports. Draw a diagram of the arrangement.

View Text Solution

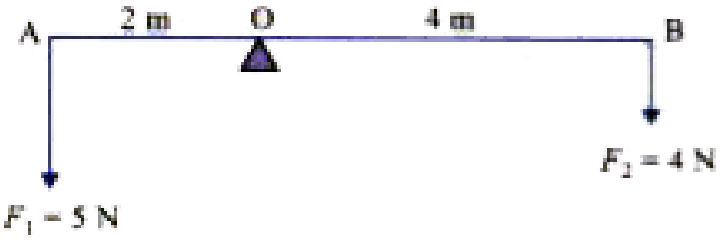
2. A meter rule is supported on a knife edge placed at the 40 cm graduation. It is found that the metre rule balances horizontally when a mass which has a weight of 0.45 N is suspended at the 15 cm graduation, as shown in the diagram.



Calculate the moment about the knife edge in this balanced condition, if the weight of the ruler is 0.90 N.

View Text Solution

3. The diagram shows two forces $F_1 = 5N$ and $F_2 = 4N$ acting at points A and B of a rod pivoted at a point O, such that OA = 2 m and OB = 4 m.



Calculate

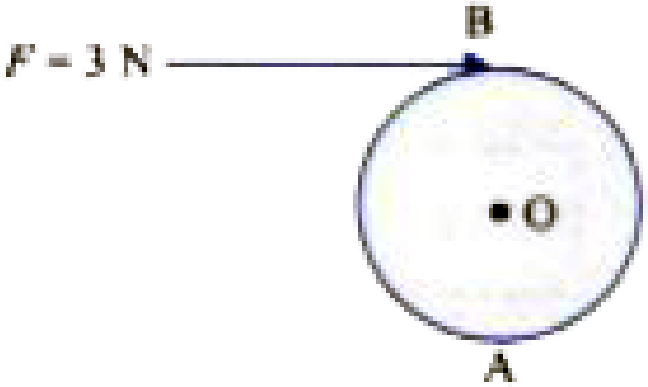
(i) Moment of force F_1 about O.

(ii) Moment of force F_2 about O.

(iii) Net moment of the two forces about O.

View Text Solution

4. A wheel of diameter 2 m mounted about an axle passing through its centre O is shown in the figure. A force of 3 N is applied at B in the direction shown in the figure. Calculate the moment of the force about (i) the centre O and (ii) the point A.



View Text Solution

View Text Solution

5. A man weighs 80 kg. He stands on a weighing scale in a lift which is moving upwards with a uniform acceleration of $5m/s^2$. What would be the reading on the scale? ($g = 10m/s^2$)

View Text Solution

Mandatory Exercise Set Ii

1. Can the centre of gravity of a body be situated outside its material? Justify with an example.

View Text Solution

2. Name the state of equilibrium in the following:

(i) A man lying on the ground

(ii) A man standing on one leg

(iii) A ball on the ground

(iv) A cone resting on its base

(v) A cone resting on its apex

View Text Solution

3. A bottle of glue lying on its base is in:

A. stable equilibrium

B. unstable equilibrium

C. neutral equilibrium

D. dynamic equilibrium

Answer: a

View Text Solution

4. If after a slight tilt the body does not return to its previous position, then it is said to be in

A. unstable equilibrium

B. stable equilibrium

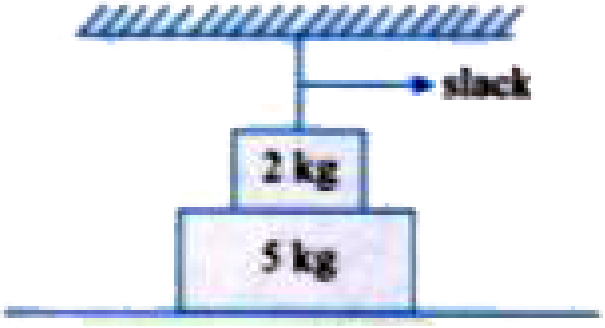
C. neutral equilibrium

D. none

Answer: a

View Text Solution

5. The tension in the string is:



A. 50 N

B. 70 N

C. 20 N

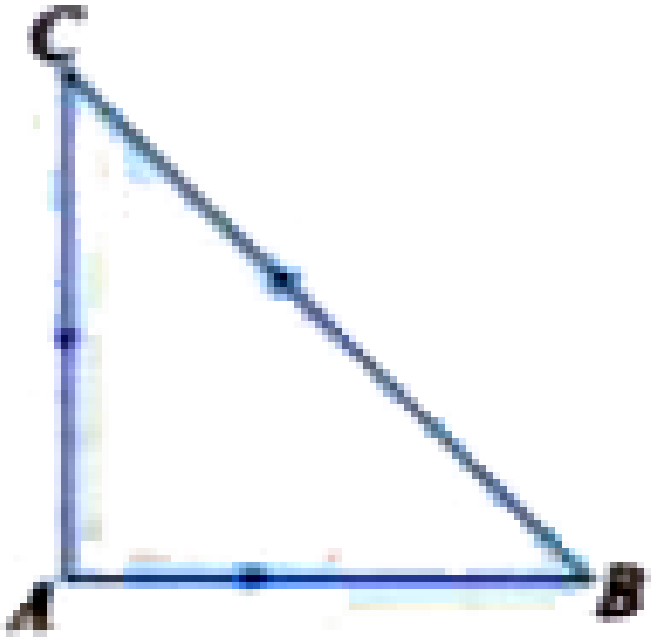
D. 0 N

Answer: d

View Text Solution

6. Three forces start acting simultaneously on a particle moving with velocity v. These forces are represented in magnitude and direction by the

three sides of a triangle ABC (as shown). The particle will now move with velocity:



A. $\overrightarrow{v}$ (remaining unchanged)

B. less than $\overrightarrow{v}$

C. greater than $\overrightarrow{v}$

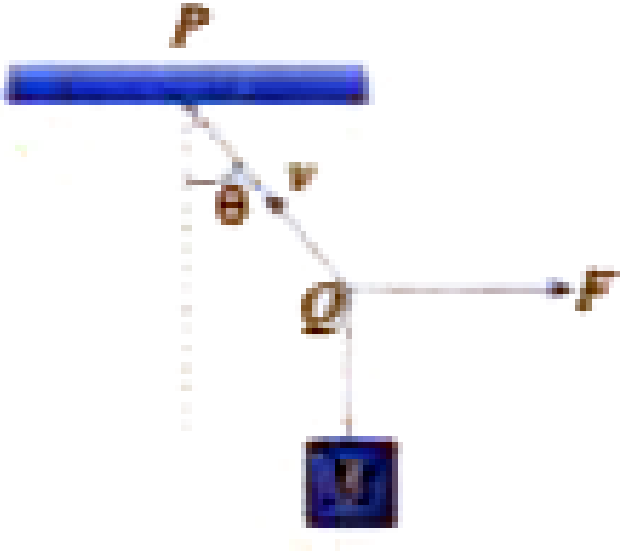
D. $\overrightarrow{v}$ in the direction of the largest force BC

Answer: a

View Text Solution

7. A mass M is suspended by a rope from a rigid support at P as shown in the figure. Another rope is tied at the end Q, and it is pulled horizontally with a force F. If the rope PQ makes angle θ with

the vertical then the tension in the string PQ is:



A. $F \sin \theta$

B. $F / \sin \theta$

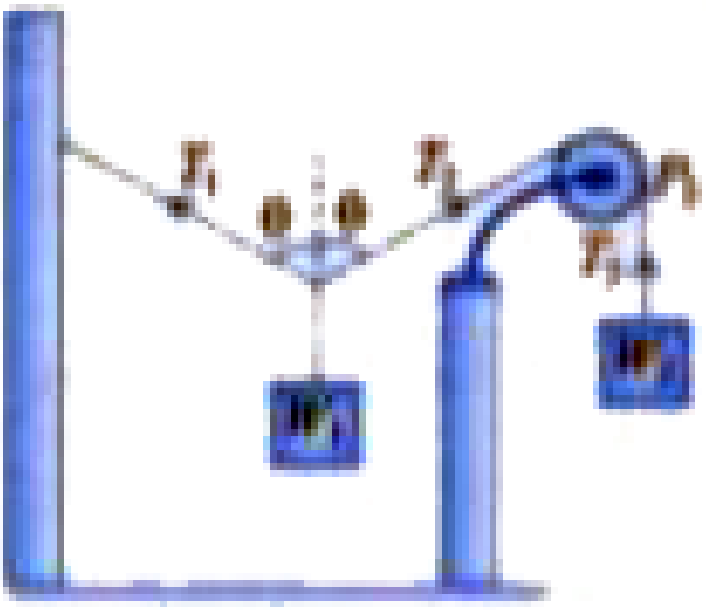
C. $F \cos \theta$

D. $F / \cos \theta$

Answer: b

View Text Solution

8. In the figure, the pulley is massless and frictionless. The relation between T_1, T_2 and T_3 will be:



A. $T_1 = T_2 \neq T_3$

B. $T_1 \neq T_2 = T_3$

C. $T_1 \neq T_2 \neq T_3$

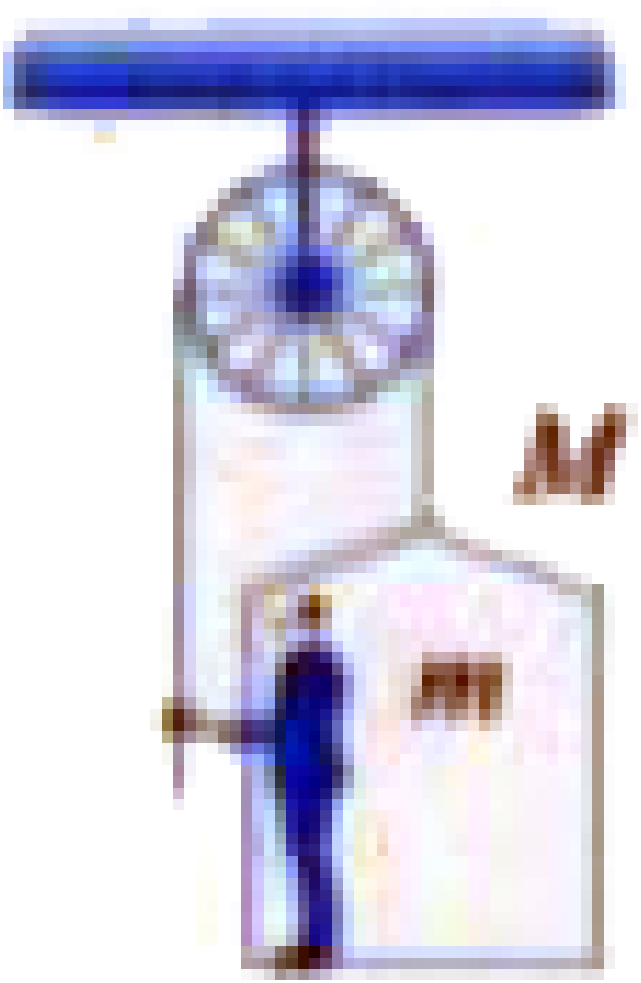
D. $T_1 = T_2 = T_3$

Answer: d

View Text Solution

9. A man of mass m stands on a crate of mass M. He pulls on a light rope passing over a smooth light pulley. The other end of the rope is attached to the crate. For the system to be in equilibrium,

the force exerted by the men on the rope will be:



A. $(M+m)g$

B. $\frac{1}{2}(M+m)g$

C. Mg

D. mg

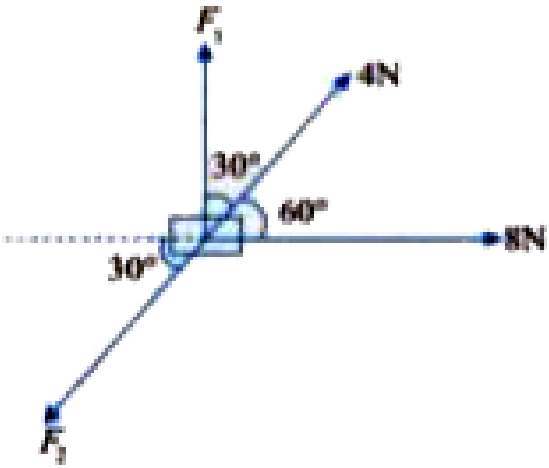
Answer: b

View Text Solution

Mandatory Exercise Set Iii

1. An object is in equilibrium under the action of multiple forces as shown in the figure. Find the

magnitude of F_1 and F_2.



A. $\frac{20}{\sqrt{3}}N, \frac{4}{\sqrt{3}}N$

B. $\frac{4}{\sqrt{3}}N, \frac{20}{\sqrt{3}}N$

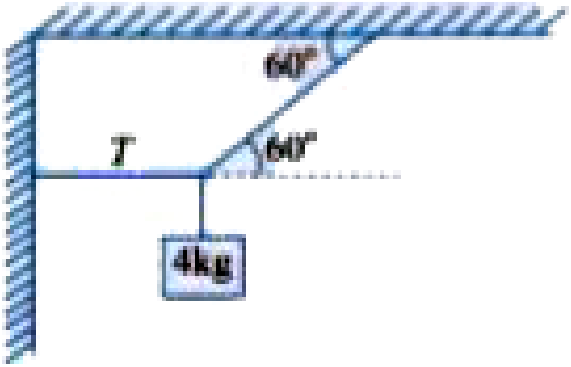
C. 4 N, 20N

D. none

Answer: b

View Text Solution

2. The value of tension T in the given figure is:



A. 45 N

B. 23 N

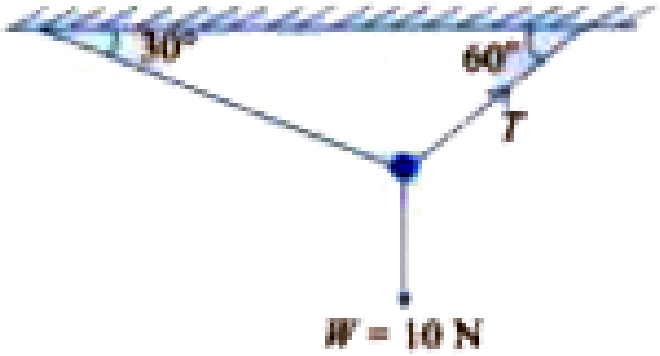
C. 33 N

D. none

Answer: b

View Text Solution

3. A ball of mass 1 kg hangs in equilibrium as shown in the figure. What is the value of tension T in the given figure?



A. $5\sqrt{3}$

B. $1/2$

C. 5

D. none

Answer: a

View Text Solution

4. The value of tension T_1 and T_2 respectively in the given figure is:

A. 70, 70 N

B. 70, 50 N

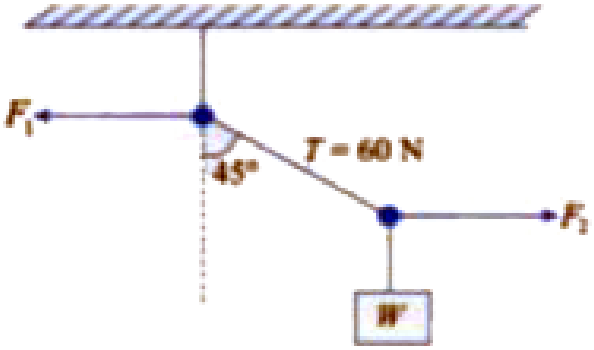
C. 50, 50 N

D. 50, 70 N

Answer: b

View Text Solution

5. In the given figure the tension in the diagonal string is 60 N. The magnitude of force F_1 and F_2 is:



A. $30\sqrt{2}, 30\sqrt{2}$

B. 30,30

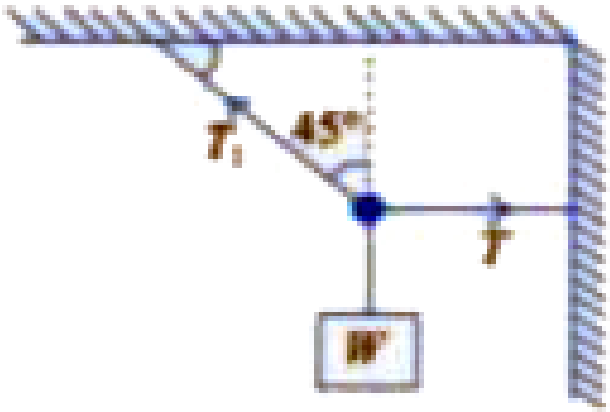
C. $30, 30\sqrt{2}$

D. $30\sqrt{2}, 30$

Answer: a

View Text Solution

6. Tension in the horizontal string is 30 N. The weight W shown is:



A. $30\sqrt{2}N$

B. $30/\sqrt{2}$

C. 30 N

D. None

Answer: c

View Text Solution

7. A spherical ball of weight 100 N is kept stationary on a rough horizontal surface with

$\mu = 0.2$ The maximum value of F for which the ball will not move is:

A. 200 N

B. 20 N

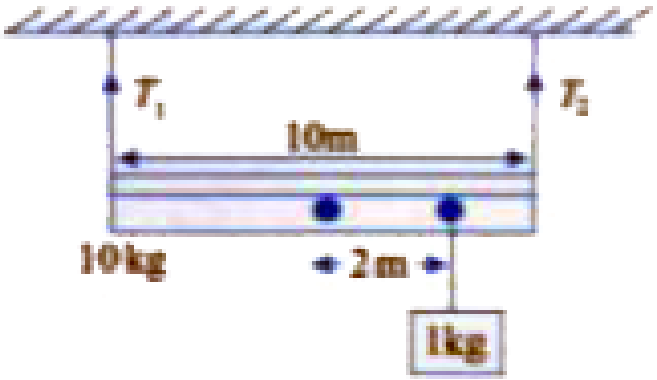
C. 40 N

D. None

Answer: b

View Text Solution

8. The tension in the strings T_1 and T_2 is:



A. 55,55

B. 53, 57

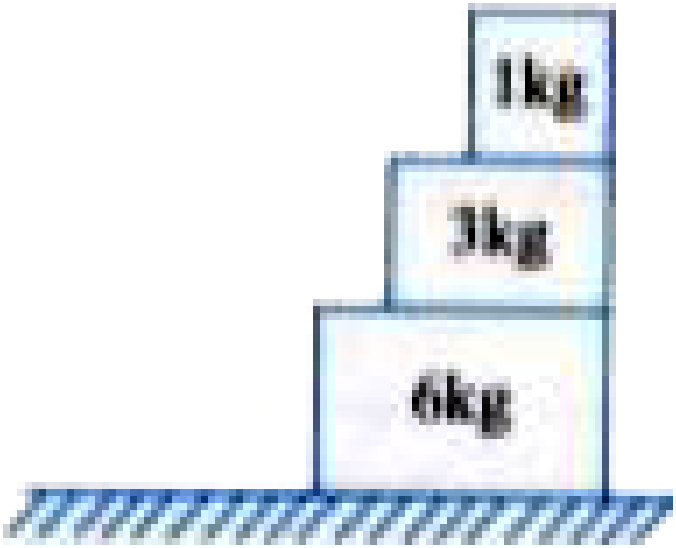
C. 57, 53

D. None

Answer: b

View Text Solution

9. The normal reaction between the 3 kg and 6 kg block



A. 40 N

B. 10 N

C. 30 N

D. 60 N

Answer: a

View Text Solution

10. The normal reaction between the 1 kg and 2 kg block is:

A. 15 N

B. 10 N

C. 5 N

D. none

Answer: c

View Text Solution

11. The value of F so that the block will remain in equilibrium is:

A. 20 N

B. 30 N

C. 40 N

D. none

Answer: d

View Text Solution

12. Two forces, with equal magnitude F, act on a body and the magnitude of the resultant force is $\frac{F}{3}$. The angle between the two forces is:

A. $\cos^{-1}\left(-\frac{17}{18}\right)$

B. $\cos^{-1}\left(-\frac{1}{3}\right)$

C. $\cos^{-1}\left(\frac{2}{3}\right)$

D. $\cos^{-1}\left(\frac{8}{9}\right)$

Answer: a

View Text Solution

Mandatory Exercise

1. Classify the following levers:

(i) A nutcracker (ii) An oar used to row a boat (iii) A human arm (iv) A see-saw

(v) Coal tongs (vi) A physical balance (vii) A crowbar (viii) A wheelbarrow

Also draw diagrams showing the fulcrum, points of application of the load, and the effort.

View Text Solution

2. In an actual machine VR is always more than MA. The efficiency of a practical machine is less

than 100%. Justify the above with reason.

View Text Solution

3. The correct relationship between the mechanical advantage (MA), the velocity ratio (VR), and the efficiency (η) is:

A. $MA = \eta \times VR$

B. $VR = \eta \times MA$

C. $\eta = MA \times VR$

D. $\eta = VR - MA$

Answer: A

View Text Solution

4. For an ideal machine the ratio of mechanical advantage (MA) to the velocity ratio (VR) is:

A. greater than one

B. less than one

C. equal to one

D. dependent on the value of load

Answer: C

View Text Solution

5. The relationship between the velocity ratio (VR). distance moved by load (dL), and distance moved by effort (dE) of a machine is:

A. $VR = dL + dE$

B. $VR = \frac{d_L}{d_E}$

C. $VR = \frac{d_E}{d_L}$

D. $VR = dE \times dL$

Answer: B

View Text Solution

6. The lever for which mechanical advantage is less than one has

A. the fulcrum between the load and the effort

B. load between the effort and the fulcrum

C. effort between the fulcrum and the load

D. load and the effort acting at the same point

Answer: C

View Text Solution

7. A fixed pulley is driven by a 100-kg mass descending at a rate of 8 m in 4 s. Calculate the power input to the pulley taking $g = 10ms^{-2}$

View Text Solution

8. In a block and tackle system consisting of 3 pulleys, a load of 75 kgf is raised. Find the effort applied, if the efficiency of the system is 50%.

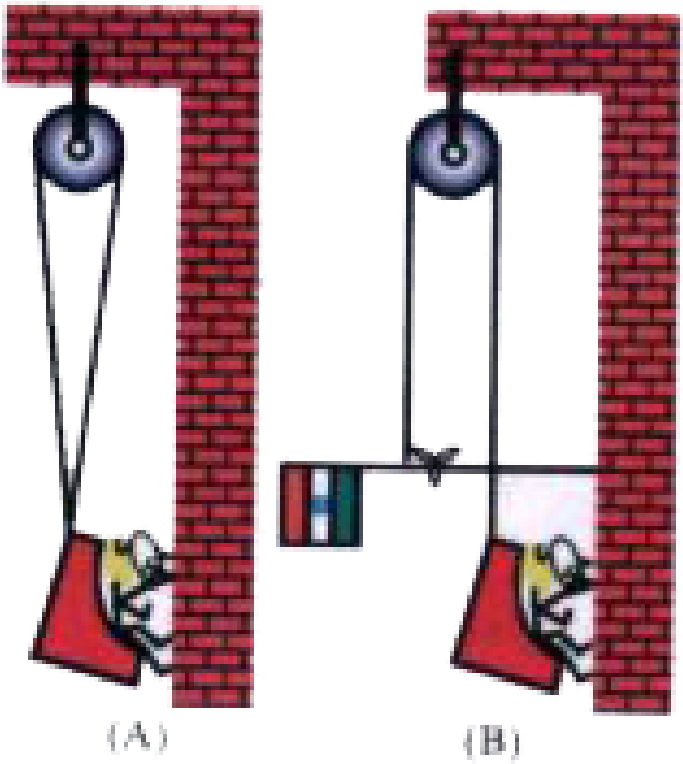
View Text Solution

Consolidated Exercise

1. Read the following passage and answer the questions:

Harry the painter swings year after year from his bosun's chair. His weight is 500 N and the rope, unknown to him, has a breaking point of 300 N. All these years he painted supporting himself as shown in figure (A). One day while painting near a flagpole, for a change,

he ties the free end of the rope to the flagpole instead of his chair, as shown in figure (B). He ended up taking his vacation early.



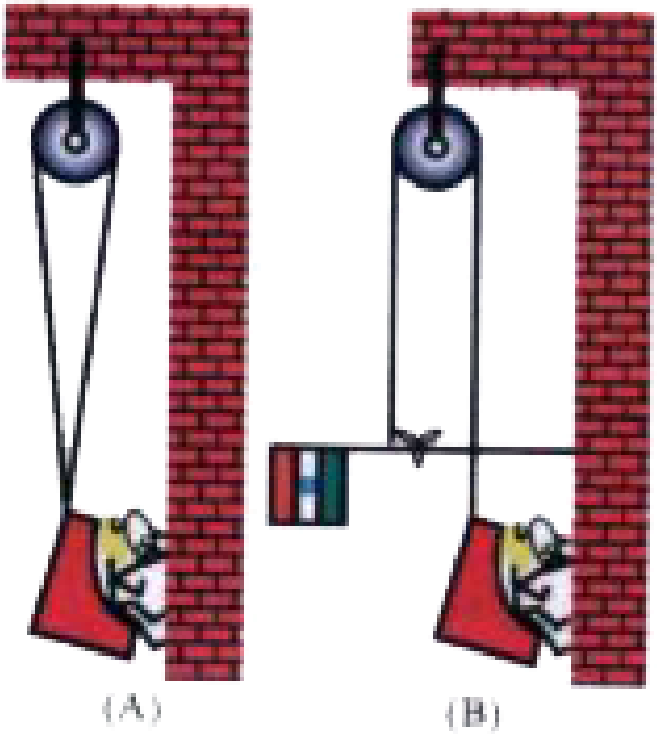
In which of the two cases, (A) or (B) does the rope break and why?

View Text Solution

2. Read the following passage and answer the questions:

Harry the painter swings year after year from his bosun's chair. His weight is 500 N and the rope, unknown to him, has a breaking point of 300 N. All these years he painted supporting himself as shown in figure (A). One day while painting near a flagpole, for a change,

he ties the free end of the rope to the flagpole instead of his chair, as shown in figure (B). He ended up taking his vacation early.



Suppose a spring balance is tied in the middle of the rope in each case, how would the reading on the scale compare with Harry's weight in each case?

View Text Solution

3. Read the following passage and answer the questions:

Harry the painter swings year after year from his bosun's chair. His weight is 500 N and the rope, unknown to him, has a breaking point of 300 N. All these years he painted supporting himself as shown in figure (A). One day while painting near a flagpole, for a change,

he ties the free end of the rope to the flagpole instead of his chair, as shown in figure (B). He ended up taking his vacation early.

Give reasons for each of the following:

(i) Players keep their feet wide apart while playing a game of football.

(ii) Tumblers are often placed inverted when not in use.

(iii) A tight rope walker often holds a long pole in his hands while walking on the rope.

(iv) One leans forward while climbing up a hill.

View Text Solution

Challenging Exercise

1. A ladder of mass 10 kg is resting with its top end touching a vertical wall and the bottom end on the floor. If the angle between the ground and the ladder is 45^{o}, find the horizontal force required at the bottom to prevent the ladder from sliding. Neglect friction and take $g = 10ms^{-2}$.

View Text Solution

2. A boy pulls a friend sitting in a home-made trolley by means of a rope inclined at 30 to the

horizontal. If the tension T in the rope is 300 N, find (i) the effective force pulling the trolley and (ii) the force tending to lift the trolley off the ground.

View Text Solution

3. A magnetic compass needle is subjected to a force of 0.02 N acting due north and a force of 0.04 N acting due west. Calculate the resultant force on the needle and the direction in which it rests.

View Text Solution

4. A uniform metre rule is pivoted at its mid-point. A weight of 50 gf is suspended at one end. Where should be a weight of 100 gf suspended to keep the rule horizontal?

View Text Solution

5. The iron gate of a building is 3 m broad. It can be opened by applying a 100-N force at the middle of the gate. Calculate the least force which can

open the gate. Where should the force be applied?

View Text Solution

Olympiad And Ntse Level Exercises

1. Which of the following sets of concurrent forces may be in equilibrium?

A. $F_1 = 3N, F_2 = 5N, F_3 = 9N$

B. $F_1 = 3N, F_2 = 5N, F_3 = 1N$

C. $F_1 = 3N, F_2 = 5N, F_3 = 15N$

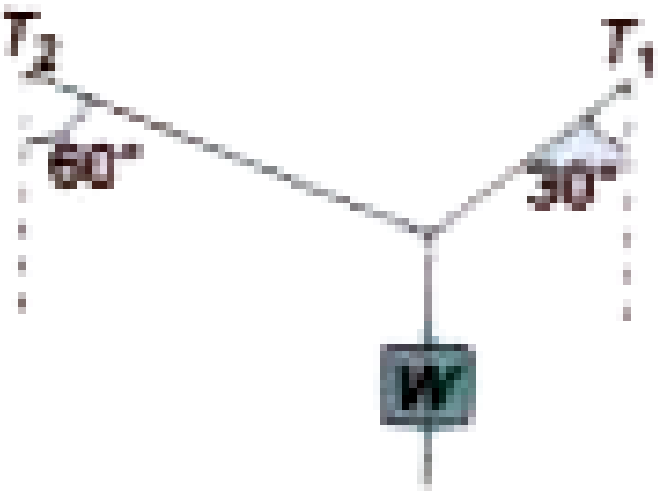
D. $F_1 = 3N, F_2 = 5N, F_3 = 6N$

Answer: D

View Text Solution

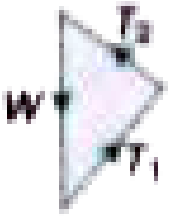
2. A weight W is supported by two strings inclined at 60° and 30° to the vertical. The tensions in the strings are T_1 , and T_2 , as shown. If these tensions are to be determined in terms of W using a triangle of forces, which of these triangles

should you draw? (block is in equilibrium)



A. 

B. 

C. 

D. 

Answer: C

View Text Solution

3. The pulleys and strings sho vn in the figure are smooth and of negligible mass. For the system to remain in equilibrium, the angle θ should be:

A. 0°

B. 30°

C. 45°

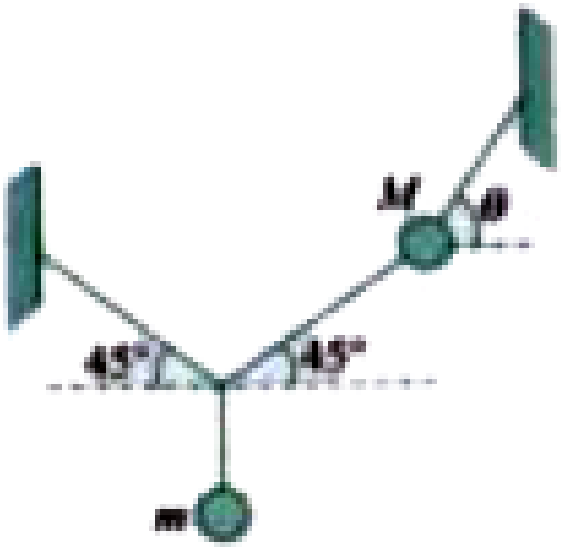
D. 60°

Answer: C

View Text Solution

4. Two masses m and M are ttached with strings as shown. For the system to be in equilibrium we

have:



A. $\tan\theta = 1 + \dfrac{2M}{m}$

B. $\tan\theta = 1 + \dfrac{2m}{M}$

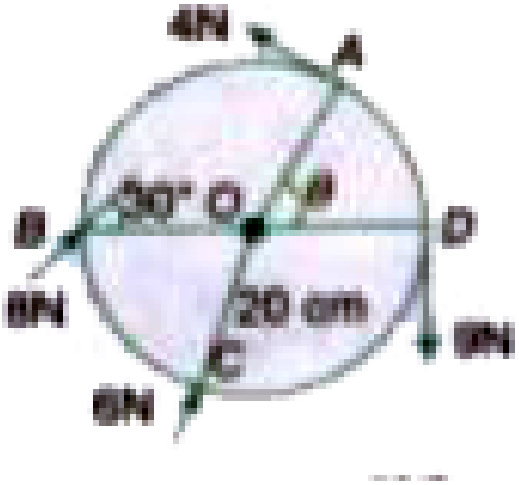
C. $\tan\theta = 1 + \dfrac{M}{2m}$

D. $\tan\theta = 1 + \dfrac{m}{2M}$

Answer: A

View Text Solution

5. A wheel of radius 20 cm has four forces applied to it as shown in fig. Then, the torque produced by these forces about O is:



A. 5.4 Nm anticlockwise

B. 1.8 Nm clockwise

C. 1.8 Nm anticlockwise

D. 5.4 Nm clockwise

Answer: B

View Text Solution

6. A metre stick is balanced on a knife edge at its centre. When two coins, each of mass 5 g are put one on of the other at the 12 cm mark, the stick is found to balanced at 45 cm. The mass of the metre stick is:

A. 56 g

B. 66 g

C. 76 g

D. 36 g

Answer: B

View Text Solution

7. A car weighs 1800 kg. The distance between its front and back axles is 1.8 m. Its centre of gravity is 1 m behind the front axle. The force exerted by

the level ground on each front wheel and each back wheel is (Take $g: 10ms^{-1}$)

A. 4000 N on each front wheel, 5000 N on each back wheel

B. 5000 N on each front wheel, 4000 N an each back wheel

C. 4500N on each front wheel, 4500 N on each back wheel

D. 3000 N on each front wheel, 6000 N on each back wheel

Answer: A

View Text Solution

8. The system shown in the figure is in equilibrium. The maximum value of W, so that the maximum value of static factional force on 100 kg body is 450 N, will be:

A. 100 N

B. 250 N

C. 450 N

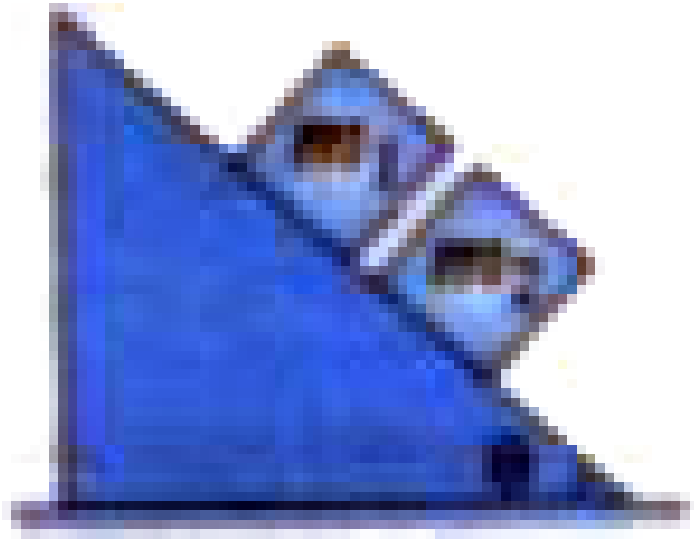
D. 1000 N

Answer: C

View Text Solution

9. A block of mass m, = 1 kg and another mass $m_2 = 2$ kg are placed together (see figure) on an inclined plane with angle of inclination θ. Various values of 0are given in List I. The coefficient of friction between the block m_1 and the plane is always zero. The coefficient of static and dynamic friction between the block /w, and the plane are

equal to $\mu = 0.3$. In List II expressions for the friction on the block are given. Match the correct expression of the friction in List II with the angles given in List I, and choose the correct option. The acceleration due to gravity is denoted by g.



[Useful information:

$\tan(5.5^\circ) = 0.1 \tan(11.5^\circ) = 0.2, \tan(16.5^\circ) = 0.3$

]

A. p-1, q-1, r-1, s-3

B. p-2, q-2, r-2, s-3

C. p-2, q-2, r-2, s-4

D. p-2, q-2, r-3, s-3

Answer: D

View Text Solution