Questions bank for 3ʳᵈ grade in mechanics.

Problems on moments

1 Answer the following questions:

(1) Force : $\vec{F} = 4\hat{i} - 3\hat{j}$ acts at A(2,1), find the moment of this force about B $(3, -1)$, then find the length of the perpendicular drawn from B to the line of action of the force.   (-4$\vec{k}$,1 length unit)

(2) If $\vec{F} = 3\hat{i} - 4\hat{j}$ acts at A(0,2), prove that the line of action of the force $\vec{F}$ passes through B $(3, -2)$, then find the length of the perpendicular drawn from $C(2,3)$ to the line of action of the force $\vec{F}$

$(\frac{11}{5} \, lenght \, unit)$

(3) The Force : $\vec{F} = 3\hat{i} - 3\hat{j}$ acts at A $= (0,3)$, find the moment of $\vec{F}$ about each of the two points , B $= (4,3)$, E $= (-2,1)$, then prove that the line of action of $\vec{F}$ bisects $\overline{BE}$

.(12$\vec{k}$, -12$\vec{k}$,)

(4) The force $\vec{F} = m\hat{i} - 5\hat{j}$ acts at point A(6,3). If its moment vector about point B$(8, -1)$ equals $-2\hat{k}$, find the value of the constant m , then find the length of the perpendicular drawn from the point B to the line of action of $\vec{F}$

$(3, \frac{\sqrt{34}}{17} \, lenght \, unit)$

(5) The Force $\vec{F} = l\hat{\imath} + m\hat{\jmath}$ acts at the origin (O). If the algebraic measures of the moments of the force $\vec{F}$ with respect to A(3,0), B(0,3) are 9,12 moment unit respectively. Determine the values of the constants ℓ and m, then find the length of the perpendicular drawn from B to the line of action of the force

(4, -3 , 2.4 length unit)

(6)Two Forces: $\vec{F_1} = 5\hat{\imath} - \hat{\jmath}, \vec{F_2} = \hat{\imath} + 9\hat{\jmath}$ act at the point A = (1,3). Find the moment of the resultant of the two forces about B = (5,0), then find the length of the perpendicular drawn from B to the line of action of the resultant

. ($-50\vec{k}$,5 length unit)

(7) The forces $\vec{F_1} = 2\hat{\imath} - \hat{\jmath}, \vec{F_2} = 5\hat{\imath} + 2\hat{\jmath}, \vec{F_3} = -3\hat{\imath} + 2\hat{\jmath}$ act at the point A(1,1). Prove by using moments that the line of action of the resultant is parallel to the straight line passing through the two points B(2,1), C(6,4) .

(8) The forces $\vec{F_1} = \hat{\imath} + 8\hat{\jmath}, \vec{F_2} = l\hat{\imath} + 5\hat{\jmath}, \vec{F_3} = \hat{\imath} - \hat{\jmath}$ act at A(2,3) If the sum of the moments of these forces about $B(-1,1)$ is $26\hat{k}$, then calculate the value of the constant l and find the length of the perpendicular drawn from B to the line of action of the resultant.

(2,3 length unit)

(9) If the forces : $\vec{F_1} = 3\hat{\imath} - 2\hat{\jmath}, \vec{F_2} = 6\hat{\imath} + 5\hat{\jmath}, \vec{F_3} = -5\hat{\imath}$ are intersecting at a point and the moment of their resultant with respect to the origin O(0,0) equals -8 k , find the point of intersection between the line of action of the resultant and the y-axis.

« (0,2) »

(10) The two forces: $\vec{F_1} = \hat{\imath} + 2\hat{\jmath}$ and $\vec{F_2} = m\hat{\imath} - 4\hat{\jmath}$ act at the two points $A(5,1), B(0,3)$ respectively. Determine the value of the constant m such that the sum of moments of the two forces about the origin point

vanishes, then find the length of the perpendicular drawn from the origin point to the line of action of the force $\overrightarrow{F_2}$

(11) Find the moment about the origin point of the force $\vec{F} = -2\hat{\imath} + 3\hat{\jmath} + 5\hat{k}$ which acts at the point A whose position vector with respect to the origin point is $\vec{r} = \hat{\imath} - \hat{\jmath} + \hat{k}$, then find the length of the perpendicular drawn from the origin point to the line of action of $\vec{F}$

(12) If $\vec{F} = 2\hat{\imath} + l\hat{\jmath} - \hat{k}$ acts at the point $A(4, -2,0)$ and the moment of the force $\vec{F}$ about the origin point is $\overrightarrow{M_O} = 2\hat{\imath} + 4\hat{\jmath} + 16\hat{k}$. Find the value of l

(13) If the force $\vec{F} = \hat{\imath} - b\hat{\jmath} + \hat{k}$ acts at point $A(-1,2,3)$ and the component of the moment of $\vec{F}$ about X-axis $= -4$ moment units. Find the value of b , hence find the length of the perpendicular segment drawn from the origin point to the line of action of the force.

(14) If the moment of the force $\vec{F} = 2\hat{\imath} + 3\hat{\jmath} - \hat{k}$ about the origin point O is equal to $\vec{M}_0 = 5\hat{\imath} - 3\hat{\jmath} + \hat{k}$ and if this force passes through a point whose y-coordinate is equal to 4 Find the coordinates χ and z for the point, hence find the length of the perpendicular segment drawn from the origin point to the line of action of the force.

(15) If the force $\vec{F} = a\hat{\imath} + 4\hat{\jmath} - \hat{k}$ acts at point A whose position vector with respect to the origin point is $\vec{r} = (1,2,2)$ and the component of the moment of the force $\vec{F}$ about y-axis is equal to 7 moment unit.

Find :
(1) The value of a
(2) The length of the perpendicular drawn from the origin point O on the line of action of $\vec{F}$

$(3, \dfrac{3\sqrt{442}}{26} \ length \ unit \ )$

(16) If the moment of the force $\vec{F} = 2\hat{\imath} + 3\hat{\jmath} - \hat{k}$ about the origin point (O) is $\overrightarrow{Mo} = -5\hat{\imath} + 3\hat{\jmath} - \hat{k}$ and the line of action of the force passes through the point $(m, 2, n)$. Find the value of each of m and n, then find the length of the perpendicular drawn from the origin point to the line of action of the force.

$(1, 1, \dfrac{\sqrt{10}}{2} \ length \ unit \ )$

Answer the following questions:

(1) ABCD is a rhombus, its side length 36 cm. , $m(\angle A) = 60°$ The forces 11,6,5,7 newton act along $\overrightarrow{BA}, \overrightarrow{BC}, \overrightarrow{DC}, \overrightarrow{DB}$ respectively. Find the algebraic sum of moments of these forces about A

$.(108\sqrt{3} unit \ length)$

(2) ABCD is a rectangle, $AB = 8$ cm, $BC = 6$ cm. , E is the midpoint of $\overline{AB}$, the forces with magnitude $2,3,4,5,5\sqrt{13}$ newton acted along $\overrightarrow{BC}, \overrightarrow{DC}, \overrightarrow{DA}, \overrightarrow{BD}, \overrightarrow{EC}$ respectively. Find the algebraic sum of the moments of these forces about each of the two points B and C .

(46,-8N.cm)

(3) ABC is an equilateral triangle, the height of the triangle is 12 cm . the forces 30,50,70 dyne act along $\overrightarrow{AB}, \overrightarrow{BC}, \overrightarrow{AC}$ respectively. Find the algebraic sum of the moments of these forces about the point of intersection of medians of the triangle

(-40dyne .cm)

(4) ABCD is a rectangle in which $AB = 5\sqrt{3}$ cm. , $BC = 5$ cm. The forces of magnitudes $10\sqrt{3}, 10,10$ newton act along $\overrightarrow{AB}, \overrightarrow{AC}, \overrightarrow{AD}$ respectively

<div align="right">Find:</div>

(1) The magnitude and direction of the resultant of these forces.

(2) The algebraic sum of moments of these forces about the vertex B

($30N.$ and inclined at an angle of measure $30°$ with $\overrightarrow{AB}$, $-75\sqrt{3}$ $N.cm$)

(5) ABCD is a square. The diagonals of the square intersect at M . The forces of magnitudes $8,6,F,K$ newton act along $\overrightarrow{AB},\overrightarrow{CB},\overrightarrow{CD},\overrightarrow{AD}$ respectively. If the algebraic sum of the moments of these forces vanished about each of the two points A and M . Find the value of F and K .

<div align="right">*(6 , 8 newton)*</div>

(6) ABCD is a square with side length 10 cm ., the two points X and Y are midpoints of $\overline{AD}$ and $\overline{DC}$ respectively. The forces of magnitude F, K, 18gm. wt. act along $\overrightarrow{AB},\overrightarrow{CB},\overrightarrow{CD}$ respectively. If the line of action of the resultant of these forces is $\overleftrightarrow{XY}$. Find the values of F,K

<div align="right">*(6, 12gm.wt)*</div>

(7) ABC is an isosceles triangle, $m(\angle A) = 120°$ The forces of magnitudes $4,4,4\sqrt{3}$ kg.wt. act along $\overrightarrow{AB},\overrightarrow{AC},\overrightarrow{BC}$ respectively. Prove that the line of action of their resultant bisects $\overline{BC}$ and parallel to $\overleftrightarrow{AC}$

(8) ABC is a triangle, $m(\angle B) = 90°, m(\angle A) = 60°, BC = 6$ cm. The forces $6,4$ newton act along $\overrightarrow{BA},\overrightarrow{CA}$ respectively. Determine the point D where $D \in \overline{BC}$ such that the algebraic sum of moments of the two forces about D equals zero.

<div align="right">*(CD=4.5 cm)*</div>

Third Problems on parallel forces

Answer the following questions:

(1) If $\overrightarrow{F_1}, \overrightarrow{F_2}$ are two unlike parallel forces act at the two points A, B respectively such that $AB = 12.5$ cm. , $F_1 = 80$ dyne, $F_2 = 30$ dyne, find the resultant of the two forces.

(2) Two forces F_1, F_2 are parallel and act in opposite directions, the two forces act at A and B where $\overline{AB}$ is a light rod. If $F_1 > F_2$ and their resultant is 90 gm.wt. and acting at point $C \in \overline{AB}$ where $AB = 36$ cm., $AC = 16$ cm.
Find each of F_1, F_2

(3)The resultant of two parallel forces is 350 N . The magnitude of one of them is 500 N . and acts at a distance 51 cm . from the resultant. Find the magnitude of the second force and the distance between the lines of action of the two forces if the given force and the resultant acting in two opposite directions.

(4) $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are two parallel forces where $F_1 = 100$ newton and the magnitude of their resultant is R $= 150$ newton. The distance between the lines of action of first force and the resultant is 75 cm . If $\vec{F}_1$ and $\vec{R}$ are in the same direction, determine : the magnitude, the direction and the point of action of the force $\overrightarrow{F_2}$

(5) The two forces $\overrightarrow{F_1} = 9\hat{\imath} - 3\hat{\jmath}, \overrightarrow{F_2} = -6\hat{\imath} + 2\hat{\jmath}$ act at the two point A $(0,6), B(0,8)$ respectively. Find the point of intersection between the line of action of the resultant and the y-axis.

(6) If the two forces $\overrightarrow{F_1} = 3\hat{\imath} - \hat{\jmath}$ and $\overrightarrow{F_2} = -9\hat{\imath} + 3\hat{\jmath}$ act at the two points A$(-1,0)$ and B$(1,2)$ respectively, find the resultant of the two forces and its intersection point with $\overleftrightarrow{AB}$

(7) If the two forces $\vec{F}_1 = 6\hat{\imath} + 4\hat{\jmath}, \overrightarrow{F_2} = 3\hat{\imath} + 2\hat{\jmath}$, act at the two points

respectivly, and their resultant acts at the point $C(2,1) \in \overleftrightarrow{AB}, A(1,2), B$ then find the coordinates of the point B .

(8) Three vertical like forces of magnitudes 10,14,18 newton act at the points A, B, C respectively such that $B \in \overline{AC}, AB = 60$ cm., $BC = 80$ cm. Find the resultant of this system of forces.

<p align="right" style="color:red">*(42newton,80cm for from A)*</p>

Answer the following questions:

(1) A uniform rod of length 4 meters and weight 50 kg. wt. rests horizontally on two supports at its ends. If a weight of magnitude 20 kg .wt. is fixed at 1 metre apart from one of its ends, find the reaction of the two supports.
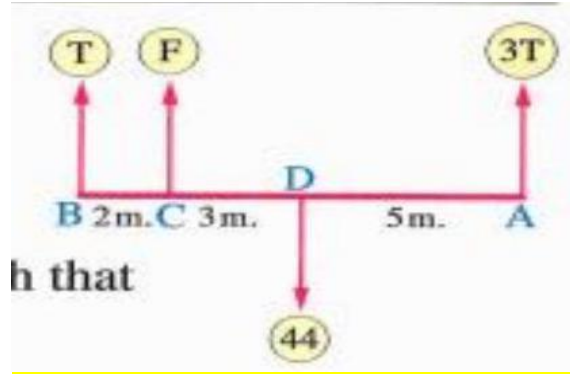
<p align="right" style="color:red">*(40,30 kg.wt)*</p>

(2) $\overline{AB}$ is a uniform rod of length 4 metres and weight 10 kg .wt. rests horizontally on two supports the first at A and the second is at a distant 1 metre from B Identify at which point on the rod a weight of magnitude 50 kg . wt. should be suspended in order that the magnitudes of the pressure on the two supports are equal.

(3) $\overline{AB}$ is a uniform rod of length 100 cm . and its weight is 20 newton. The rod rests horizontally on two supports, one of them is 30 cm . distant from A and the other is 20 cm . distant from B. Find the magnitude of the pressure on each support. Find also the magnitude of the weight that should be suspended at B so that the rod is about to rotate.

(4) In the given figure :
 is a uniform rod of length 10 meters and of weight 44 kg .wt. If the $\overline{AB}$ rod is suspened from its two ends A, B by two vertical strings, then find the vertical force F which acts at the point C such that the tension at A is three times the tension at B

T F   3T

D

B 2m. C 3m.   5m.   A

h that

44

Choose the correct answer:

1- Which of the following best describes Newton's First Law?
A) An object will accelerate when a force is applied to it.
B) Every action has an equal and opposite reaction.
C) An object in motion will stay in motion unless acted upon by an unbalanced force.
D) The rate of change of momentum is directly proportional to the applied force.

Answer: C) An object in motion will stay in motion unless acted upon by an unbalanced force.

2- If the tension in a pulley system is 20 N, what is the pressure on the pulley in a system where the

tension is acting on both sides
of the pulley equally?
A) 20 N
B) 40 N
C) 2T
D) 2T cos(θ)

Answer: B) 40 N

3- In a pulley system, two bodies
with masses m1=5kg and m2
=3kg are hanging at the ends of
an inelastic string. If the tension
in the string is 36.75 N, what is
the pressure on the pulley?
A) 36.75 N
B) 73.5 N
C) 50 N
D) 112.5 N

Answer: B) 73.5 N

4- In a pulley system where two
masses m1=125kg and m2
=120kg hang at the ends of an
inelastic string, what is the
acceleration of the system?
A) 0.36 m/s²
B) 0.2 m/s²
C) 2.45 m/s²
D) 4.9 m/s²

Answer: B) 0.2 m/s²

5- Which of the following statements is true according to Newton's Second Law?
A) The force on an object is directly proportional to its mass.
B) The force on an object is inversely proportional to its velocity.
C) The acceleration of an object is directly proportional to the force acting on it and inversely proportional to its mass.
D) The acceleration of an object is inversely proportional to the time it takes to accelerate.

Answer: C) The acceleration of an object is directly proportional to the force acting on it and inversely proportional to its mass.

6- A stone of mass 5 kg is falling freely under gravity. If the velocity of the stone just before hitting the ground is 20 m/s, what is the change in momentum?
A) 50 kg·m/s
B) 100 kg·m/s
C) 150 kg·m/s
D) 200 kg·m/s

Answer: A) 50 kg·m/s

7- In a situation where a body is subjected to two forces, F1

=15N acting to the right and F2 =10N acting to the left, what is the net force acting on the body?

A) 5 N to the right
B) 5 N to the left
C) 25 N to the right
D) 25 N to the left

Answer: A) 5 N to the right

8- Two blocks are connected by a rope over a frictionless pulley. Block A has a mass of 10 kg and block B has a mass of 5 kg. If block A is hanging vertically and block B is on a horizontal surface, what is the tension in the rope?

A) 25 N
B) 50 N
C) 30 N
D) 70 N

Answer: A) 25 N

9- A force of 50 N is applied to a box, causing it to move a distance of 5 meters. What is the work done on the box?

A) 25 J
B) 50 J
C) 250 J
D) 100 J

Answer: C) 250 J

10- A particle moves in a circular path with a radius of 2 meters and a speed of 4 m/s. What is the centripetal force acting on the particle if its mass is 2 kg?
A) 4 N
B) 8 N
C) 16 N
D) 32 N

Answer: B) 8 N

11- A body of mass 10 kg is dropped from a height of 20 meters. What is the velocity of the body just before hitting the ground, assuming no air resistance?
A) 10 m/s
B) 20 m/s
C) 40 m/s
D) 19.8 m/s

Answer: B) 20 m/s

12- An object accelerates from rest at a constant rate of 2 m/s². What is its velocity after 5 seconds?
A) 5 m/s
B) 10 m/s
C) 15 m/s
D) 25 m/s

13- Which of the following describes the concept of inertia?
A) The ability of an object to remain at rest unless acted upon by an unbalanced force.
B) The resistance of an object to changes in its state of motion.
C) The force required to change the direction of an object's motion.
D) The ability of an object to exert force on another object.

Answer: B) The resistance of an object to changes in its state of motion.

Essay problems:

1) A particle moves in a straight line its velocity given by the relation
V=$2t + t^3$ m/s. Find the acceleration of the particle after 2 seconds from beginning of the motion equals.

2) A particle moves in a straight line such that
.Evaluate the initial velocity of the $S = t^3 + 3t^2 - 30t + 16$ m particle.

3) If $S = 5t^2 - 40t - 21\ m$ .when the particle reverses its motion?

4) A particle moves in a straight line starting from rest and at a distance 10 meter to the right from a fixed point on the straight line, if a = 12t + 6 m/s^2 . Find the relation between the displacement and the time.

5) A car started its motion from the rest in a straight line from a fixed point on the straight line and the algebraic measure of its velocity vector after (t) seconds given by the relation: V=$5t - 3t^2\ m/s$. Find the displacement of the car at t = 2.

6) A particle moves in a straight line from the rest from a fixed point (o) where a = 2t - 4 m/s^2, Find the time elapsed before the particle reverses its motion direction.

7) A stone of mass 5 kg. Fell from a height 18 m. Find the momentum when it reaches to the surface of the ground equals.

8) A body of weight 8 kg moves in a straight line where) $\vec{e}$ m where $\vec{e}$ is the unit vector in the $\vec{S} = (12t^2 + 6t - 10$ direction of motion of the body. Find the momentum of the body after 4 seconds from starting the motion.

9) The displacement vector of a moving body is $\vec{S} = 3t\ \vec{i} - 2\vec{j}$ m, if its momentum = 15 kg.m/s. Find the mass of the body.

10) A man is tied to parachute descends vertically down, if it is known that the air resistance is directly proportion with the square of the velocity, and the air resistance = half the weight of the man and the parachute when the velocity is 20 km /h.
Find the uniform velocity by which the man descends.

11) A ball falls in a viscous liquid if the resistance of the liquid to the motion of the ball is directly proportion with velocity of the ball inside the liquid, if the liquid resistance = quarter of the weight of the ball when its velocity is 10 cm /s, Find the descending uniform velocity of the ball .

12) A particle moves in a straight line under the effect of three forces:
Newton, $\vec{f_2} = -2\vec{i} + 3\vec{k}$ Newton and $\vec{f_3}$, $\vec{f_1} = 3\vec{i} + 2\vec{j} - 5\vec{k}$ such that the displacement vector is given by the relation: $\vec{S} = 3\vec{i} + 10\vec{j}$ m. Evaluate the norm of $\vec{f_3}$.

13) A force F acts on a body at a rest of mass 3 tons moving it in its direction a distance of magnitude 200 m within 10 seconds from starting the motion , find the magnitude of the force F .

14) A balloon of mass 600 kg. ascends vertically up with uniform velocity, an object of mass 80 kg. fall from it, find the magnitude of the acceleration by which the balloon moves after fall of the object.

15) A particle of unity mass moves under effect of the forces:

N, $\vec{f_2} = -2\,\vec{\imath} + 3\vec{k}$ N, find magnitude of the $\vec{f_1} = 2\vec{\jmath} - 4\vec{k}$

acceleration

16) A body is hold to a spring balance in a ceiling of a lift moving vertically, the reading of the balance during ascending with uniform acceleration 250 cm/s^2 is 48 kg.wt, if the lift descends with the same acceleration; find the reading of the balance.

17) A body of mass 100 kg holding in a spring balance in a ceiling of a lift moves vertically, if the pointer of the balance points to 80 kg.wt then find the magnitude of the acceleration of the lift and its direction.

8) A body of mass 120 kg .placed inside a box of mass 28 kg .and the box tied by a robe moves it vertically ,if the magnitude of the tension in the robe is 160 kg.wt ,then find the pressure of the body on floor of the box.

19) A body of mass 5 kg ,placed on a smooth inclined plane to the horizontal by an angle 30^0 , a force of magnitude 80 newton acts on it in the line of the greatest slope upwards , find the time which the body gains till its velocity reaches 120 m/sec.

20) A body of mass 10 kg placed on a smooth inclined plane, then it slides under the effect of its weight only a distance 50 m within 6 seconds from the beginning, if a force F acts upon in the line of

the greatest slope upwards makes it moves upwards with a
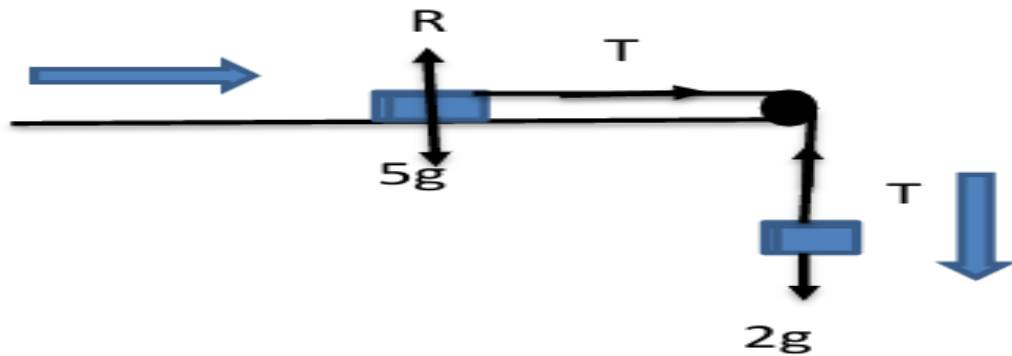uniform acceleration of magnitude 98 cm/s^2 .find F .

21) Two bodies their masses 5kg, 8 kg are tied by inelastic
light string passes over a small smooth pulley where the two
branches of the string are vertical, find the acceleration of
the set.

22) Two bodies their masses 4 kg , 3 kg are tied by inelastic
light string passes over a small smooth pulley where the two
branches of the string are vertical ,find the pressure on the
pulley.

23) Two bodies their masses 8 kg , 5 kg are tied by inelastic
light string passes over a small smooth pulley where the two
branches of the string are vertical ,find the tension in the
string .

24) Two bodies 12 kg, 15 kg hanged at the ends of inelastic
light string passes over a small smooth pulley, if the set starts
the motion from the rest and the two bodies in one
horizontal plane, find the vertical distance between them
after one second from beginning the motion.

25) In the opposite figure:
If the horizontal plane is a smooth and
the set moves from the rest

R

T

5g

T

T

2g

.

Find each of:

- The acceleration of the set.
- The tension in the string.
- The pressure on the pulley.
- The velocity of the set after 3 sec.

26) A body of mass 100 kg. placed on a smooth inclined plane makes with the horizontal an angle of measure 30^0 and tied by one of the two ends of a string passes over a small smooth pulley at the top of the plane and hanging from the other end of the string a body of mas 80 kg. if the set moves from the rest .find the acceleration of the set.

Answers:

1. a = 2 + $3t^2$ After 2 sec. a = 2 + 3 x4 = 14 m/s^2

2. $v = 3t^2 + 6t - 30 \; m/s$ then $v_0 = -30 \; m/s$

3. $v = 10t - 40 \; m/s$ let $v = 0$ then $t = 4 \; s$

4. $S = 2t^3 + 3t^2 + 10 \; m$

5. $S = 2 \; m$

6. $t = 4 \; s$

7. $H = 93.9 \; Kg.\,m/s$

8. $\vec{H} = 144 \; \vec{e}$

9. m=5 kg

10.   28.3

11.   20

12.   3

13.   12

14.   1.5

15.   3

16.   28.5

17. $moving \; down \; with \; a = 1.96 \; m/s^2$

18.   30.3

19.   38.7

20.   56

21.   2.26

22.   67.2

23.   60.3

24.   1.1

25.   2.8 - 14- 14 $\sqrt{2}$ -8.4

26. -1.63

1) the force $\vec{F} = -3\vec{i} + k\vec{J}$ acts at the point A (3 ,1) if the moment of f about the point B(-2 , 4) is $7\vec{k}$

find value of m   (k = 3)

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2) the force $\vec{F} = \vec{\imath} + \vec{\jmath}$ acts at the point A (2 ,2) prove that the moment vector of $\vec{F}$ about the origin point is the zero vector ,explain the answer ?

(the line of action of passes by the origin point)

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3) The two forces $\vec{F_1} = \vec{\imath} - \vec{\jmath}$, $\vec{F_2} = m\vec{\imath} + 2\vec{\jmath}$ act at the two points A(3 ,0), B (0 ,3) respectively, determine the value of the constant m such that the sum of moments of the two forces about the origin point vanishes.?

(-1)

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4) The force $\vec{F} = 2\vec{\imath} - \vec{\jmath} + 3\vec{k}$ act at the point

A (-3,1,2) find the moment of the force $\vec{F}$ about the point B (2,2,-1) ,then find the length of perpendicular from B to the line of action of the force ?   ($\sqrt{35}$)

5) The force $\vec{F} = m\vec{\imath} + 4\vec{\jmath} - \vec{k}$ acts at the point A its position vector with respect to the origin point is

(1 , 2 ,2)and the component of the moment $\vec{F}$ about Y axis is 7 moment unit ,find the value of m ,then find the length of perpendicular from (O) to the action line of $\vec{F}$

(2.4)