Model (1) in Statics

First Question: Complete each of the following:

1) If $\overrightarrow{A} \times \overrightarrow{B} = \overrightarrow{0}$, then …….
2) If the limiting friction force equals 60 Newton and the coefficient of friction equals 0.75, then the resultant reaction equals = …….
3) If $\overrightarrow{F_1}$ // $\overrightarrow{F_2}$ and in opposite direction ,if their resultant is $\overrightarrow{R}$.
   If $F_1 = 3$ *Newton*, $R = 7$ *Newton*, then $F_2 =$ **.....**
4) If A and B are two points in the plane of the force $\overrightarrow{F}$, if $\overrightarrow{M_A} + \overrightarrow{M_B} = \overrightarrow{0}$, then ……
5) If $4\overrightarrow{F_1}, 3\overrightarrow{F_2}$ are two forces form a couple, and $\overrightarrow{F_1} = 6\hat{i} - 9j$, then $\overrightarrow{F_2}$ = **.....**
6) If a body is equilibrium under the action of some coplanar forces, then the sum of moment of these forces about any point = ……

Second Question:

a) If the two forces $\overrightarrow{F_1} = 2\hat{i} + m\hat{j}$, $\overrightarrow{F_2} = -6\hat{i} + 3\hat{j}$ are parallel. Find the value of m, and if the two forces act at the two points $(1,0)$, $(5,0)$ respectively. Find the intersection point of line of action of their resultant with X-axis.

b) ABCD is an isosceles trapezium where AD = BC = 10 cm, AB = 21 cm, CD = 9 cm , forces of magnitude $18, 20, 68, 20, 42$ *kg.wt* act along $\overrightarrow{CD}, \overrightarrow{DA}, \overrightarrow{AC}, \overrightarrow{CB}, \overrightarrow{BA}$ respectively. Prove that these forces equivalent to a couple, and find its moment norm.

Third Question:

a) ABCDHO is a regular hexagon of side length 6 cm. forces of magnitude $1, 3, 5, 2, 4, F$ *Newton* act along $\overrightarrow{AB}, \overrightarrow{BC}, \overrightarrow{DC}, \overrightarrow{HD}, \overrightarrow{OH}, \overrightarrow{OA}$ respectively. Find the value of F which makes the sum of moment of these forces about C vanishes.

a) AB is a non uniform rod, rests horizontally on two supports C, D . where $2AC = 2DB = CD$. If a weight W is suspended from A the rod is about to rotate, and if a weight K is suspended from B the rod is about rotate. Prove that the point of application of weight divides $\overline{AB}$ in ratio $(3w + k) : (w + 3k)$.

Fourth Question:

a) A body of weight **20** ***Newton*** placed on a rough inclined plane, the body is about to slide down when the plane inclined at angle $\mathbf{30^o}$ to the horizontal. If the angle increased to be $\mathbf{60^o}$. Find the least force act on the body parallel to the line of greatest slope to make it about to move.

b) AB is a uniform rod of length 240 cm, and weight **500** $\boldsymbol{kg.wt}$. Its end A rests on a rough horizontal plane and rests from point C on it on a smooth vertical wall of height 90 cm from the horizontal plane. When the rod is about to slide BC = 90 cm. find the reaction of the wall at C, then find the coefficient of friction between the rod and the horizontal plane.

Fifth Question:

a) If the force $\vec{F} = 4\hat{i} + 5\hat{j}$ acted at the point $A(1,2)$.

Find :

i) The moment of these force about point $B(3,2)$.

ii) The algebraic component of $\vec{F}$ in direction of $\overrightarrow{AB}$.

iii) The area of ΔABC where $C(3,5)$.

b) AB is a uniform rod of length 40 cm, and weight **3** $\boldsymbol{kg.wt}$. it hinged from A at a vertical wall. A couple of magnitude **30** $\boldsymbol{kg.wt.cm}$ acted on it until the rod inclines with angle θ to the vertical. Find in state of equilibrium the magnitude and the direction of the reaction at the hinged point and the measure of angle θ.

Model (2) in Statics

First Question: Choose each of the following:

1) If λ is the measure of the angle between the limiting friction force and the resultant reaction. μ is the coefficient of friction then μ = ……

a) $Tan\lambda$ b) $Sin\lambda$ c) $Cos\lambda$ d) $Cot\lambda$

2) If $\overrightarrow{A}=(-2,3)$, $\overrightarrow{B}=(-1,4)$, then the area of parallelogram in which the vectors $\overrightarrow{A}, \overrightarrow{B}$ are represented by two adjacent sides equal ……. Unit of area

a) 11 b) 14 c) 5 d) – 5

3) The algebraic component of force $\overrightarrow{F}=4\hat{i}-\hat{j}$ in direction of $\overrightarrow{AB}$ where $A(-1,4)$, $B(2,0)$ equals ……

a) $\frac{12}{5}\hat{i}+\frac{4}{5}\hat{j}$ b) $-\frac{13}{5}$ c) $\frac{16}{\sqrt{13}}$ d) $\frac{16}{5}$

4) The force $\overrightarrow{F_1}=2\hat{i}-3\hat{j}$ acts on the point $A(2,3)$ and the force $\overrightarrow{F_2}=4\hat{i}-6\hat{j}$ acts on the point $B(-1,-3)$, then the resultant of these forces acts on the point …….

a) $(1,0)$ b) $(0,-1)$ c) $(3,-1)$ d) $(-1,0)$

5) If the two forces $\overrightarrow{F_1}=A\hat{i}+3\hat{j}$, $\overrightarrow{F_2}=5\hat{i}+B\hat{j}$ form a couple then $A+B=$ .....

a) zero b) 8 c) – 8 d) – 2

6) The necessary and sufficient condition to be a coplanar forces equilibrium is …….

a) the resultant vanishes
b) the moment about any point vanishes
c) the resultant and the moment at any point vanishes
d) to be parallel forces.

Second Question:

a) A body of weight W Newton is placed on a rough plane inclined to the horizontal at an angle of measure θ. If the angle of friction between the body and the plane equal λ where $\lambda < \theta$, a force acted on the body in direction of the greatest slope upward to prevent the body to slide downwards.

Prove that the least value of this force is $\left(\frac{Sin(\theta-\lambda)}{Cos\,\lambda}\right)W$.

b) The two forces $\overrightarrow{F_1} = k\hat{i} - 2\hat{j}$, $\overrightarrow{F_2} = \hat{i} + 3\hat{j}$ act at the a point $A(0,2)$. If the line of action of their resultant bisect $\overline{CD}$ where $C(3,-1)$, $D(1,3)$.

a) Find the value of k.

b) Prove that line of action of their resultant passes through $(6,-1)$

Third Question:

a) Two parallel forces in the same direction of magnitude F_1, F_2 Newton acted in two points A, B respectively. If the force F_1 moved parallel to it self a distance x in direction $\overrightarrow{BA}$. Prove that the resultant move in the same direction a distance $\left(\frac{F_1}{F_1+F_2}\right)x$.

c) AB is A uniform ladder of weight $20\,kg.wt$ rests with its lower end A on a smooth horizontal ground and its upper end B against a rough vertical wall. And the coefficient of friction between them equals $\frac{1}{\sqrt{3}}$. The ladder is being kept in a vertical plane and inclined at 60^o to the ground by joining the lower end A by a string to a point of the wall below the point B. And if the maximum tension in the string is $20\sqrt{3}\ kg.wt$. Prove that a man of weight $84\ kg.wt$ cannot ascended more than $\frac{5}{6}$ of the length of the ladder. without breaking the string .

Fourth Question:

a) $\overline{AB}$ is a uniform rod of length **20** ***cm*** , can rotate about a pin in the small hole at point $C \in \overline{AB}$, where AC = 5 cm. the rod is equilibrium horizontally under action of two equal forces each of magnitude **50** ***Newton*** act at its ends A and B in two opposite direction and each of them makes angle of measure 30^o with the rod. Find the weight of the rod and the reaction of the pin.

b) A force $\overrightarrow{F}$ in the plane of parallelogram ABCD where the algebraic sum of moment about points A, B, C equals 15, - 10, 15 Newton. C m respectively. Find the algebraic moment of force $\overrightarrow{F}$ about D.

Five Question:

a) $\overline{AB}$ is a non uniform rod rests on a horizontal position on two smooth supports at C, D where AC = 6 cm, BD = 7 cm, and the point of application of its weight divides the rod by ratio **2 : 3** from A, if a weight of magnitude **120** ***kg.wt*** is suspended from A or a weight of magnitude **180** ***kg.wt*** is suspended from B, the rod will be in the point of rotation. Find the weight of the rod and the distance between the two supports.

b) ABCD is a rectangle, where AB = 9 cm, BC = 24 cm. H and O are the mid-points of $\overline{BC}$, $\overline{AD}$ respectively. Forces of magnitudes **18, 48, 30, 24** ***kg.wt*** act in directions $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CO}$, $\overrightarrow{OA}$ respectively. Prove that the system equivalent to a couple and find its moment norm. then find two forces act at $\overrightarrow{HA}$, $\overrightarrow{OC}$ to be in equilibrium state.