

- b) ABC is an equilateral triangle of side a : D, E, F divide the sides BC, CA, AB respectively in the ratio 2: 1. Three forces each equal to P act at D, E, F perpendicularly to the sides and outward from the triangle. Prove that they are equivalent to a couple of moment $\frac{1}{2}Pa$.
- 14.a) If three coplanar forces acting on a rigid body keep it in equilibrium, then prove that they must either be concurrent or be all parallel.
- (OR)**
- b) Forces 3, 2, 4, 5 kg weight act respectively along the sides AB, BC, CD and DA of a square. Find the magnitude of their resultant.
- 15.a) State the laws of Friction.
- (OR)**
- b) AB and BC are two uniform rods of length $2a$ and $2b$ respectively. If $\angle BAC = \theta$, then prove that the distance from A of the centre of gravity of the two rods is
$$\frac{(a^4 + 2a^2b^2 \cos \theta + b^4)^{1/2}}{a+b}$$
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SECTION – C (5 X 5 = 25 MARKS)

ANSWER EITHER (a) or (b) IN EACH OF THE FOLLOWING QUESTIONS. K4 & K5

16. a) State and prove Lami's Theorem.
- (OR)**
- b) OA, OB, OC are lines of action of two forces P and Q and their resultant be R . Any transversal meets the lines in L, M and N respectively. Prove that $\frac{P}{OL} + \frac{Q}{OM} = \frac{R}{ON}$.
17. a) State and prove Varignon's theorem of moments.
- (OR)**
- b) Three like parallel forces, acting at the vertices of a triangle, have magnitudes proportional to the opposite sides. Show that their resultant passes through the incentre of the triangle.
- 18.a) If two couples, whose moments are equal and opposite, act in the same plane upon a rigid body, then prove that they balance one another.
- (OR)**
- b) Five equal forces act along the sides AB, BC, CD, DE, EF of a regular hexagon. Find the sum of the moments of these forces about a point Q on AF at a distance x from A.
- 19.a) A beam of weight w hinged at one end is supported at the other end by a string so that the beam and the string are in a vertical plane and make the same angle θ with the horizon. Show that the reaction at the hinge is $\frac{W}{4}\sqrt{8 + \operatorname{cosec}^2\theta}$.
- (OR)**
- b) Three forces each equal to P act along the sides of a triangle ABC in order. Prove that the resultant is $P\left(1 - 8 \sin \frac{A}{2} \sin \frac{B}{2} \sin \frac{C}{2}\right)^{1/2}$ and that its line of action divides BC externally in the ratio $c : b$.
- 20.a) A weight can be supported on a rough inclined plane by a force P acting along the plane or by a force Q acting horizontally. Show that the weight is $\frac{PQ}{\sqrt{Q^2 \sec^2 \lambda - P^2}}$, where λ is the angle of friction.
- (OR)**
- b) A wire of length $5a$ is bent so as to form the five sides of a regular hexagon. Show that the distance of its centre of gravity from either end of the wire is $\frac{a}{10}\sqrt{133}$.
