Moments & Equilibrium

U85-3 Two square cards OABC and CDEF of uniform density and negligible thickness are joined together as shown in Fig.U85-3. If their sides are respectively 8.00 cm and 6.00 cm, then the coordinates of the centre of gravity of the setup are __ (in cm).

E A. (5.00 ,4.00) B. (5.45 ,3.82)
C. (5.82 ,4.62) D. (6.00 ,3.64)
E. (6.52 3.64)

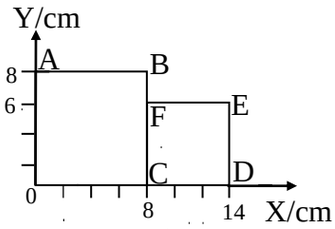

Fig.U85-3

U87-6 A non-uniform rod PQ has one end P thicker than the other end Q. C is a point between P and Q such that when the rod is suspended at C using a string, it balances horizontally. If the rod is cut into two at C, then _____.

A A. the portion PC would be heavier than the portion QC
B. the portion PC would be lighter than the portion QC
C. both the portions PC and QC are of equal weight
D. it is impossible to judge from the information given which of the two portions is heavier
E. N.O.T.A.

U89-6 A uniform wooden beam AB, 12 m long and weighing 160 N, is supported horizontally on two points which are 3 m and 2 m away from A and B respectively. How far from the centre of the beam can a boy weighing 400 N move towards A without causing the beam to topple over?

B A. 3.86 m B. 4.2 m C. 4.6 m D. 5.2 m E. 5.6 m

U96-11 If an object is at equilibrium, then _____.

D A. it must be at rest
B. only gravitational force acts on its body
C. it must move with constant velocity along a straight line
D. the algebraic sum of the moments of the object about any point is zero

U96-P3a Define **moment of force** and state **principle of moment**.

(b) Two opposing parallel forces 6 N and 10 N, acting at points P and Q respectively, as shown in Fig.96-P3b. If P and Q are 20 cm apart, find the magnitude and point of acting of their resultant force.

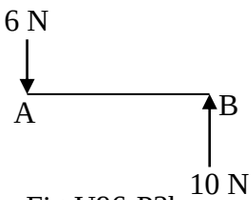

Fig.U96-P3b

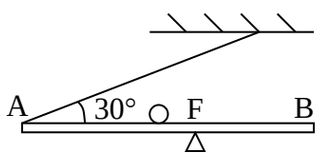

Fig.U96-P3c

(c) A uniform wooden plank of 5 m in length and 30 N in weight is set up as shown in Fig.U96-P3c where F is the point of pivot, AF: FB = 3: 2 and the supporting string makes an angle 30° with the plank. If the maximum tension in the string before it breaks is 50 N, and an iron ball of weight 25 N rolls along the plank, within what range as measured from A should the ball roll so that the plank will not topple?

U97-10 When a uniform metallic bar AB of length *l* is hung at its centre O, it maintains equilibrium, as shown in Fig.5. If OB is folded so that the end B coincides with O, which of the following expressions is **true**?

B A. The end A turns upwards.
B. The end A turns downwards.
C. The bar maintains equilibrium.
D. The bar moves up and down continuously

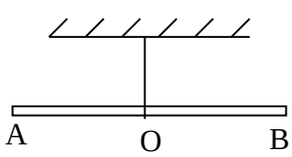

Fig.U97-10

U2k1-10 Two weights W_1 and W_2 are respectively hung at two ends of a uniform thick wooden stick which is pivoted at O as shown in Fig.U2k1-10. How many forces are acting on the stick in equilibrium?

B A. 3 B. 4 C. 5 D. 6

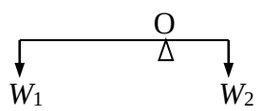

Fig.U2k1-10

U98-11 The weight of a rectangular board is *W* and the ratio of its length to its width is 4: 3. Two persons P and Q held the board at two ends A and B respectively and carried it upwards in the lift at a uniform speed. All the time they kept the diagonal of the board AC horizontally as shown in Fig.U98-11. The ratio of forces exerted by P and Q is ___.

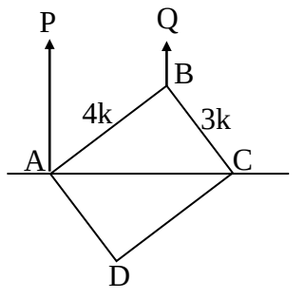

Fig.U98-11

D A. 1: 1
B. 4: 3
C. 5: 16
D. 7: 25

U2k2-7 The cross-sectional diagram of a cylinder is shown in Fig.U2k2-7. The cylinder is 26 cm in diameter and weighs 130 N. What is the **least** tangential force needed for the cylinder to roll onto a step of height 8 cm?

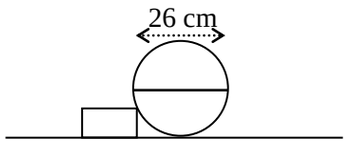

Fig.U2k2-7

B A. 87 N B. 60 N C. 40 N D. 30 N

U2k05-P3 (a) What conditions must be satisfied for a body to keep in balance when external forces act on it under a plane force system? [2%]

(b) As shown in Fig. U2k05-P3b, a light strut AB of length *L* is rotated freely at point B in a vertical plane, and an object of mass *m* is hung at point C. Connect point A with an inextensible string that passes over a smooth nail D (directly above point B) and joint it with a spring attached to the wall. The strut keeps its balance at horizontal position. Given that BC = ⅔ *L*, BD = ½ *L*, and the extension of the spring is just equal to BD. If *L* = 1 m, and *m* = 3 kg, determine the spring constant of the spring. [87.7 N m^{-1}] [4%]

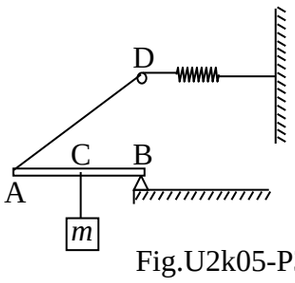

Fig.U2k05-P3b

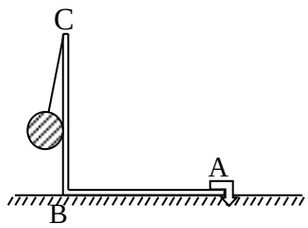

Fig.U2k05-P3c

(c) In Fig.U2k05-P3c, an L – shaped light right – angle frame ABC with both arms 2 m in length rests on a horizontal floor and is fixed at point A. When a ball of weight 50 N and 0.2 m in radius is hung by a light string of length 1 m at point C of the frame, find
(i) the reaction force at point A; [2%]
(ii) the reaction force on the ball by the frame. [5 N; 8.5 N] [2%]

U2k07-15 A uniform ladder leans against a smooth wall as shown in Fig. U2k07-15. What is the minimum value of the coefficient of static friction between the floor and ladder to prevent the ladder from slipping?

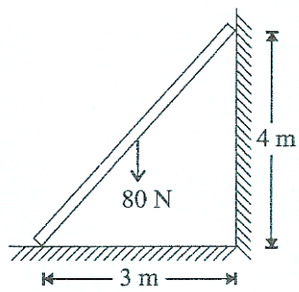

Fig.U2k07-15

C A. ¼
B. ¾
C. ⅜
D. 5/9

U2k09-7 As shown in Fig.U2k09-7, a heavy uniform plank of weight *W* and length *L* is supported by two forces F_1 and F_2 at points at distances ¼ *L* and ⅛ *L* from its two ends respectively. Determine the ratio of F_2: F_1.

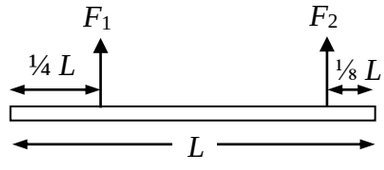

Fig.U2k09-7

B A. 1: 3 B. 2: 3
C. 3: 2 D. 3: 1

U2k08-10 As shown in Fig.U2k08-10, a rod of weight W is supported at a certain height by two springs A and B horizontally. The force constant of springs A and B are k_A and k_B respectively. The compression in spring A is x_A and the extension is spring B is x_B, determine the ratio x_A/x_B.

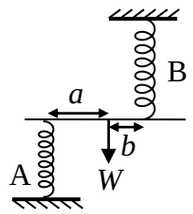

Fig.U2k08-10

C A. $\frac{b}{a}$ B. $\frac{k_A b}{k_B a}$

C. $\frac{k_B b}{k_A a}$ D. $\frac{k_B}{k_A}$

U2k10-9. Three balls with masses of 1 kg, 2 kg and 3 kg respectively are positioned along a light rod as shown in Fig.3. Find the distance between the centre of the system and the ball of mass 1 kg.

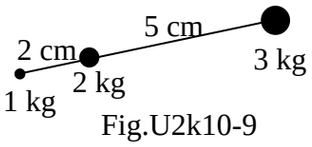

Fig.U2k10-9

C A. 2.62 cm B. 3.21 cm

C. 4.17 cm D. 4.62 cm

U2k10-P4a State the conditions for the equilibrium of a rigid body subjected by a number of forces.

(b) A block P of mass 70 kg rests on a table, as in Fig.U2k10-P4b. The coefficient of static friction between block P ad table is 0.3, and the angle θ is 37°. Assume that the cord pulling block P is kept horizontal. Find the **maximum** weight of the block Q for which the system will still be stationary.
[155.08 N]

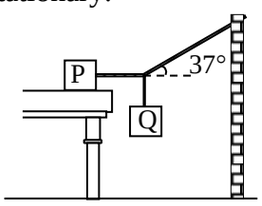

Fig.U2k10-P4b

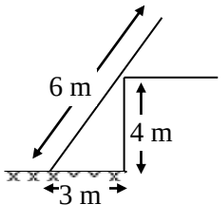

Fig.U2k10-P4c

(c) Fig.U2k10-P4c shows a uniform plank of length 6.0 m and weight 100 N leaning against a wall of height 4.0 m. The top of the wall is smooth. The distance of the lower end of the plank from the wall is 3.0 m, and the floor is rough. Calculate
(i) the reaction force on the plank at the top of the wall;
(ii) the frictional force at its lower end.
(Take g = 10 m s^{-2}) [36 N; 28.8 N]

U2k13-7 Fig.U2k13-7 shows a uniform rectangular block with height 30 cm, and a base of 20 cm × 20 cm each. The block is placed on an inclined at 30° with the horizontal. The coefficient of static friction between the block and the inclined plane is 0.8. The block will _____.

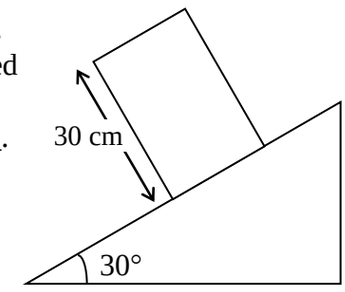

Fig.U2k13-7

B A. topple from the inclined plane
B. remain at rest on the inclined plane
C. slide down along the inclined plane with uniform speed
D. slide down along the inclined plane with uniform acceleration

U2k13-8 Fig.U2k13-8 shows a crank press machine, ON is the vertical plumb line. A horizontal force F applies at M to push the two points at O and N, with the help of rods MO and MN. The rods MO and MN have the same length. When the distance of ON is 200 cm, the distance of M to the plumb line ON is 10 cm. Assuming the weight of the pistons and the rods are negligible, what is the total compressive force acting on the object W?

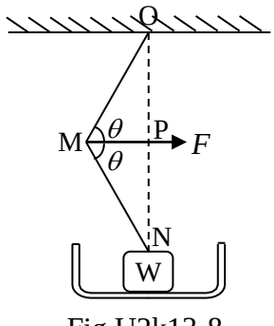

Fig.U2k13-8

C A. 3F B. 4F

C. 5F D. 6F

U2k11-10 As shown in Fig. U2k11-10, a thin metal disc is free to rotate about an axis at point O. Two forces, 12 N and 6 N act on point A and point B respectively. If OA = 30 cm and OB = 25 cm, the moment of inertia of the thin disc is 0.3 kgm^2, find the initial angular acceleration of the disc.

B A. 13.3 rad s^{-2} B. 15.4 rad s^{-2}
C. 16.8 rad s^{-2} D. 18.4 rad s^{-2}

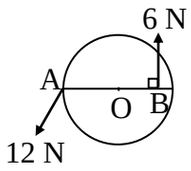

Fig.U2k11-10

U2k13-9 A 5 m long wooden pole PQ can be balanced horizontally if pivoted at a point 2 m from the end P, as shown in Fig.U2k13-9a. If pivoted at the point 2 m from the end Q, a weight of 500 N has to be hung at Q for the pole to remain balance horizontally, as shown in Fig.U2k13-9b. What is the weight of the wooden pole?

A A. 1000 N
B. 800 N
C. 670 N
D. 500 N

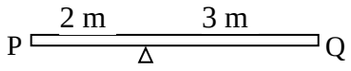

Fig.U2k13-9a

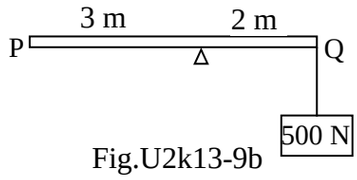

Fig.U2k13-9b

U2k15-8 As shown in Fig.U2k15-8, MN is a heavy uniform rod of length 120 cm, and its weight is 20 N. The end M is hinged at a vertical wall, and a light string is tied from the end N to point P on the wall. The system is in static equilibrium. Find the tension in the string.

B A. 7.1 N B. 12.2 N
C. 13.4 N D. 15.8 N

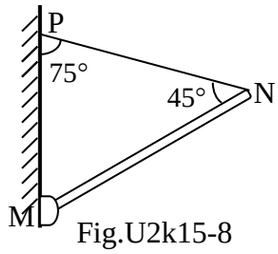

Fig.U2k15-8

U2k17-6 As shown in Fig.U2k17-6, a heavy pipe PQ is hinged at P on the wall. The end Q of the pipe is supported by a wire, which is tied to the point R on the wall above point P. If the weight of the pipe is *W* and the tension in the wire is *T*, then the direction of the reaction force at P is along _____.

B A. PQ B. PS
C. PR D. PX

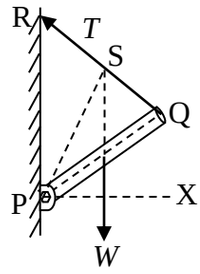

Fig.U2k17-6