POSTAL Book Package 2023

CIVIL ENGINEERING

Engineering Mechanics

Objective Practice Sets

Contents

MADE EASY Publications

1 CHAPTER
FBD, Equilibrium, Plane Trusses and Virtual Work

Q.1 Varignon's theorem is applicable only when the forces are:
(a) coplanar (b) concurrent
(c) non-concurrent (d) parallel

Q.2 Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I

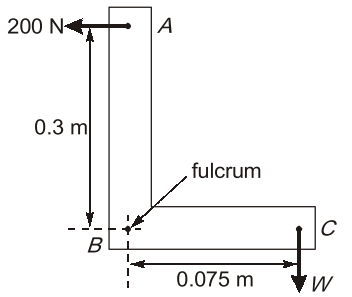
A. Lami's theorem
B. Varignon's theorem
C. Newton's first law of motion
D. Polygon law of forces

List-II

1. Determination of the position of resultant of parallel forces.
2. Definitions of the general condition of equilibrium.
3. Determination of resultant of non-parallel forces.
4. Estimation of the three forces on a body in equilibrium.

Codes:
(a) 4 1 2 3
(b) 1 4 3 2
(c) 1 4 2 3
(d) 4 1 3 2

Q.3 A horizontal force of 200 N is applied at A to lift the weight *W* at *C* as shown in the figure. The value of weight *W*, will be



(a) 200 N (b) 400 N
(c) 600 N (d) 800 N

Q.4 If two forces P and Q act at an angle θ the resultant of these two forces would make an angle α with P such that

(a) $\tan\alpha = \dfrac{Q\sin\theta}{P - Q\sin\theta}$

(b) $\tan\alpha = \dfrac{P\sin\theta}{P + Q\sin\theta}$

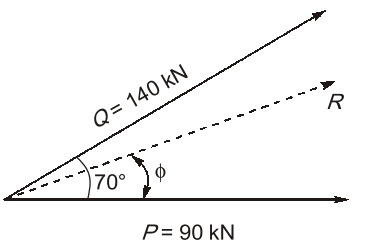
(c) $\tan\alpha = \dfrac{Q\sin\theta}{P + Q\cos\theta}$

(d) $\tan\alpha = \dfrac{P\sin\theta}{Q - P\cos\theta}$

Q.5 The sum of the magnitudes of two forces acting at a point is 18 and the magnitude of their resultant is 12. If the resultant is 90° with the forces of smaller magnitude, the magnitude of forces are
(a) 10 and 8 (b) 9 and 9
(c) 5 and 13 (d) 6 and 12

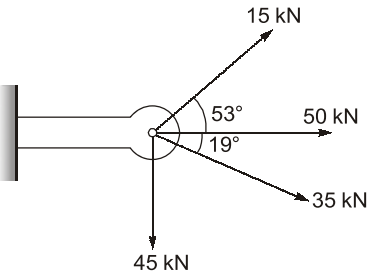
Q.6 If the magnitude of maximum and minimum resultant forces of the two forces acting on a particle are 40 kN and 10 kN respectively, then the two forces would be
(a) 25 kN and 15 kN
(b) 20 kN and 20 kN
(c) 20 kN and 10 kN
(d) 20 kN and 5 kN

Q.7 The resultant R and angle of resultant ϕ for the given system of force will be respectively:



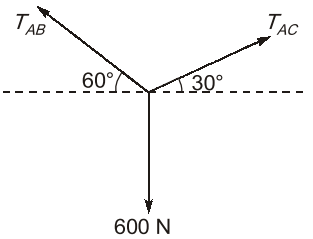
(a) 190.58 kN; 43° 39′ (b) 138.13 kN, 72°14′
(c) 166.43 kN; 47°51′ (d) 190.58 kN, 72°14′

Q.8 In the above figure, four cable exerts tension as indicated on the eyebolt. It is intended to replace these cables by a single cable. The tension on the single cable and angle at which it will be oriented w.r.t. the 50 kN (Assume coplanar force system).



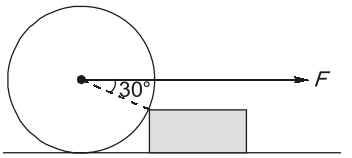
(a) 102.27 kN, 64.36° (clockwise)
(b) 102.27 kN, 25.74° (clockwise)
(c) 100.5 kN, 25.74° (clockwise)
(d) 100.5 kN, 64.26° (clockwise)

Q.9 If a point *A* is in equilibrium under the action of the applied forces, the value of tensions T_{AB} and T_{AC} are respectively



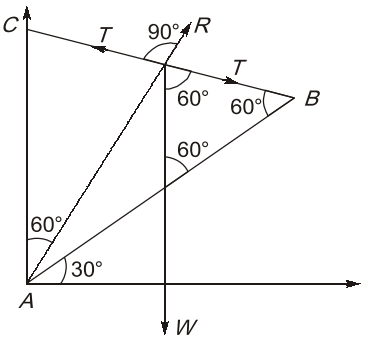
(a) 520 N and 300 N (b) 300 N and 520 N
(c) 450 N and 150 N (d) 150 N and 450 N

Q.10 A roller of weight *W* is rolled over the wooden block as shown in figure below. The pull *F* required to just cause the said motion is:

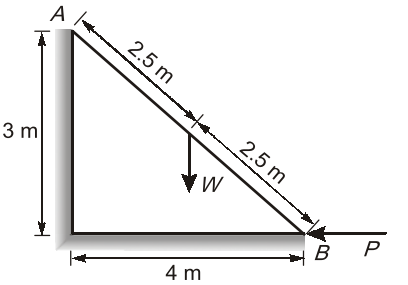


(a) $\frac{W}{2}$ (b) W
(c) $\sqrt{3}W$ (d) $2W$

Q.11 A uniform beam *AB* as shown in figure below is pinned at *A* and is held by a cable *BC* in the position shown. If the tension in the cable is 20 kgf, then the reaction of the pin at A on the beam will be _____ kgf.

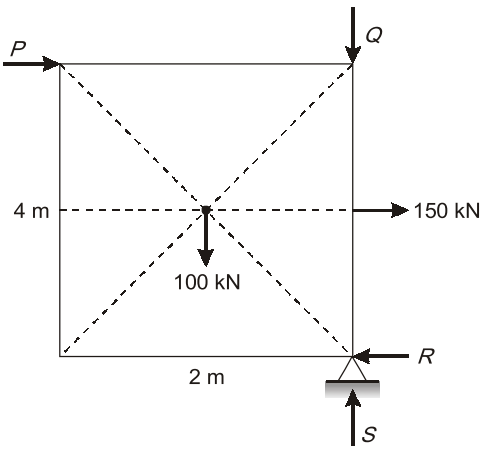


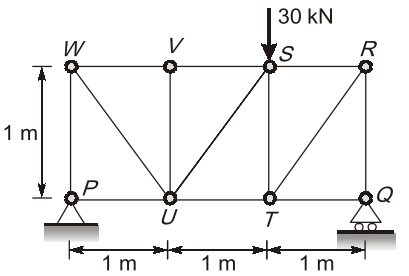
Q.12 A ladder *AB* of length 5 m and weight (W) = 600 N is resting against a wall. Assuming frictionless contact at the floor (B), and the wall (A), the magnitude of force P(in Newton) required to maintain equilibrium of ladder is _____.



Q.13 Weight of 120 kN is being supported by a tripod whose each leg of length of 13 m. If the vertical height of the point of attachment of the load is 12 m, the force on the tripod leg would be
(a) 37.67 kN (b) 40 kN
(c) 43.3 kN (d) 46.6 kN

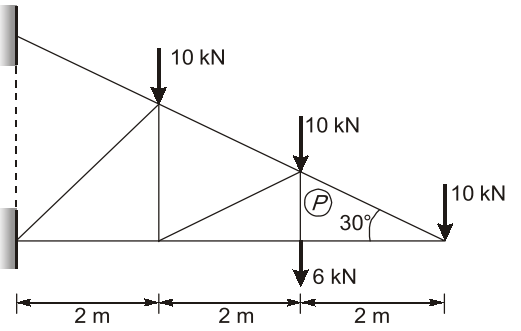
Q.14 A rectangular plate is held in equilibrium by then application of forces as shown in figure. What is the magnitude of the force *P*?





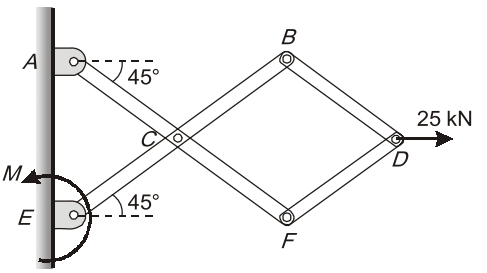
(a) 10 (b) 14.14
(c) 20 (d) 28.28

Q.54 The force in member *P* of the truss shown in figure below is



(a) 16 kN tensile (b) 16 kN compressive
(c) 4 kN tensile (d) 6 kN tensile

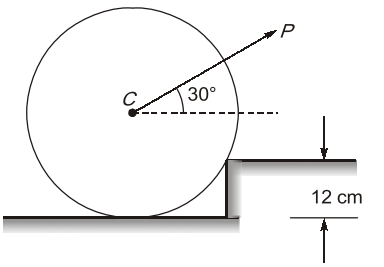
Q.55 The magnitude of the couple M required in kNm to maintain the equilibrium of the mechanism is:



Member	Length (cm)
AC	20
CF	20
CE	20
CB	20
BD	20
DF	20

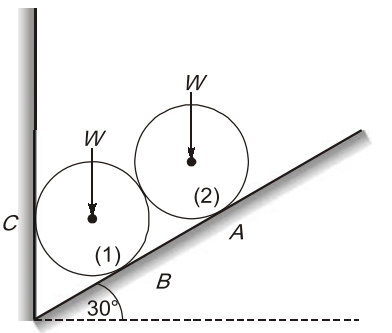
Multiple Select Questions (MSQ)

Q.56 The force P applied at 30° to the horizontal is just necessary to start a roller having radius 50 cm over a obstruction 12 cm high, the roller is of mass 100 kg.



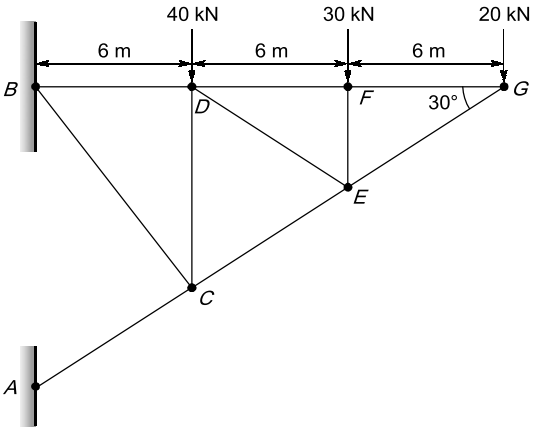
Which of the following statements is(are) correct?
(a) The magnitude of force P is 648.75 N
(b) For minimum value of P, it must be at 40.54° from the horizontal.
(c) The magnitude of required minimum force P is 621.24 N.
(d) The magnitude of required minimum force P is 579.31 N.

Q.57 Two identical rollers, each of weight, W = 445 N, are supported by an incline plane and a vertical wall as shown in figure.
Which of the following options is(are) correct, if the surfaces are smooth?



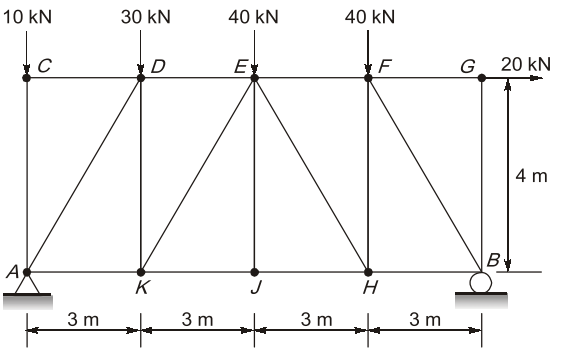
(a) Reaction at support *A* will be 385.38 N.
(b) Reaction at support *B* will be 642.3 N.
(c) Reaction at support *B* will be 385.38 N.
(d) Reaction at point of contact of two rollers is 222.5 N.

Q.58 A plane with loading is shown in figure below: Members are pin joints.



(a) Force in member EG is 40 kN (Compressive).
(b) Force in member GF is 34.64 kN (Tensile).
(c) Force in member DF is 34.6 kN (Tensile).
(d) Force in member EF is 30 kN (Compressive).

Q.59 A truss is loaded as shown in figure. All members are pin jointed.



(a) Force in member AC is 10 kN (Compressive).
(b) Force in member CD is 0.
(c) Force in member BG is 0.
(d) Force in member JE is 0.

■■■■

Answers FBD, Equilibrium, Plane Trusses and Virtual Work

1. (b)	2. (a)	3. (d)	4. (c)	5. (c)	6. (a)	7. (a)	8. (b)	9. (a)	10. (c)
11. 346.4	12. 400	13. (c)	14. (b)	15. (b)	16. (a)	17. (b)	18. (b)	19. (b)	20. (c)
21. (a)	22. (b)	23. 57.74	24. (a)	25. 100	26. (c)	27. (b)	28. (a)	29. 50	30. 20
31. (d)	32. (d)	33. 1.5	34. (d)	35. (a)	36. (b)	37. (b)	38. (c)	39. (d)	40. 84.3
41. (b)	42. (c)	43. (a)	44. (c)	45. 70.71	46. (d)	47. (a)	48. 0	49. 5	50. 20
51. (a)	52. (c)	53. (c)	54. (d)	55. 10.606		56. (a, b)		57. (a, b, d)	
58. (a, b, c, d)		59. (a, b, c, d)							

Explanations FBD, Equilibrium, Plane Trusses and Virtual Work

2. (a)

Lami's theorem: In statics, lami's theorem is an equation relating the magnitudes of three coplanar, concurrent and non-collinear forces which keeps an object in static equilibrium, with the angles directly opposite to the corresponding forces,

$$\frac{A}{\sin\alpha} = \frac{B}{\sin\beta} = \frac{C}{\sin\gamma}$$

Where,

A, B, C are the magnitude of three coplanar, concurrent and non-collinear forces which keeps the object in static equilibrium, and α, β and γ are the angles directly opposite to the forces A, B and C respectively.

Polygon Law's of forces: If a number of forces acting simultaneously on a particle be represented in magnitude and direction by the sides of a polygon taken in order, their resultant may be represented in magnitude and direction by the closing side of the polygon taken in opposite order.

Newton's first Law of Motion: When viewed in an inertial reference frame, an object either remains at rest or moves with constant velocity, unless acted upon by an external force.

Varignon's Theorem: The moment about any point of the resultant of several concurrent forces is equal to the sum of the moments of the particular forces about the same point.

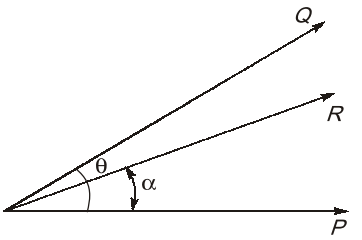
3. (d)

Taking moment about fulcrum B,

$200 \times 0.3 = W \times 0.075$

$$W = \frac{200\times0.3}{0.075} = 800 \text{ N}$$

4. (c)



$$R\sin\alpha = Q\sin\theta$$
$$R\cos\alpha = Q\cos\theta + P$$
$$\Rightarrow \quad \tan\alpha = \frac{Q\sin\theta}{Q\cos\theta + P}$$

5. (c)

Let P be the smaller force,

$$P + Q = 18 \quad ...(1)$$
$$R = (P^2 + Q^2 + 2PQ\cos\theta)^{1/2} = 12 \quad ...(2)$$

Also,

$$\frac{Q\sin\theta}{P+Q\cos\theta} = \tan\alpha = \tan90° = \infty$$

$$\Rightarrow \quad P + Q\cos\theta = 0 \quad ...(3)$$

Subtracting eq. (3) eq. (1)

$$P + Q\cos\theta - P - Q = 0 - 18$$
$$Q(1 - \cos\theta) = 18 \quad ...(4)$$

Now, operating square of eq. (2- eq. (1)

$$18^2 - (12)^2 = 2PQ(1 - \cos\theta)$$
$$180 = 2PQ(1 - \cos\theta) \quad ...(5)$$

Operate eq. (4) subtract eq. (5)

$$\frac{Q(1-\cos\theta)}{2PQ(1-\cos\theta)} = \frac{18}{180}$$
$$2P = 10$$
$$P = 5$$

From eq. (1); Q = 18 – 5 = 13

So, magnitude of forces are 5 and 13.

6. (a)

Resultant of two forces,

$$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$$

R will be maximum when, $\cos\theta = 1$

$$R_{max} = \sqrt{P^2 + Q^2 + 2PQ} = \sqrt{(P+Q)^2} = P + Q$$

R will be minimum when, $\cos\theta = -1$

$$R_{min} = \sqrt{P^2 + Q^2 - 2PQ} = \sqrt{(P-Q)^2} = P - Q$$

$P + Q = 40$

$P - Q = 10$

$2P = 50$

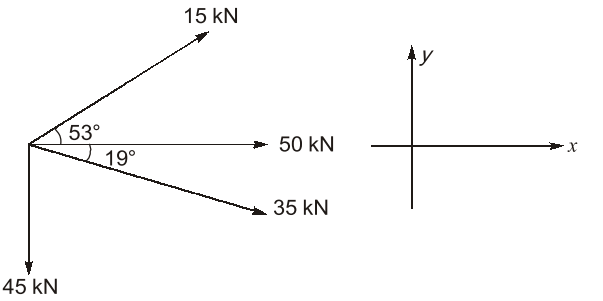
$P = 25$ kN; $Q = 15$ kN

7. (a)

$$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$$
$$= \sqrt{(90)^2 + (140)^2 + 2\times140\times90\times(\cos70°)}$$
$$= 190.58 \text{ kN}$$
$$\tan\phi = \frac{Q\sin\theta}{P+Q\cos\theta}$$
$$= \frac{140\sin70°}{90+140\cos70°} = 0.594$$
$$\phi = 43°39'$$

8. (b)

Figure can be idealized as:



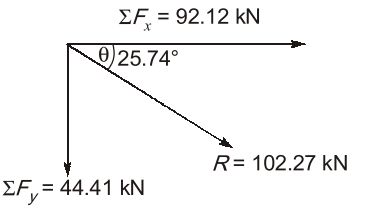
$\Sigma F_x = 50 + 15\cos53° + 35\cos19° = 92.12$ kN

$\Sigma F_y = 15\sin53° - 45 - 35\sin19° = -44.41$ kN

Resultant,

$$F_R = \sqrt{(92.12)^2 + (-44.41)^2} = 102.26 \text{ kN}$$

$$\tan\theta = \left(\frac{\Sigma F_y}{\Sigma F_x}\right)$$



$$\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right) = \tan^{-1}\left(\frac{44.41}{92.12}\right) = 25.74°$$