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CONTENTS

MECHANICAL ENGINEERING

Objective Practice Sets

Engineering Mechanics

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1 CHAPTER
FBD, Equilibrium, Plane Trusses and Virtual Work

MCQ and NAT Questions

Q.1 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

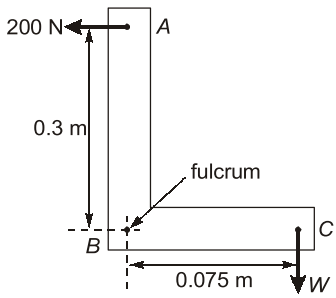
List-II

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.2 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.3 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) $\tan\alpha = \dfrac{P\sin\theta}{Q - P\cos\theta}$

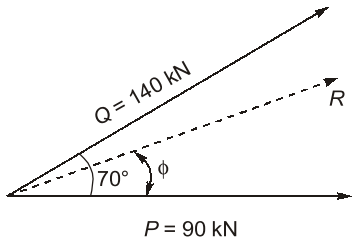
Q.4 The sum of the magnitudes of two forces acting at a point is 18 and the magnitude of their resultant is 12. If the resultant is 90° with the forces of smaller magnitude, the magnitude of forces are

(a) 10 and 8 (b) 9 and 9
(c) 5 and 13 (d) 6 and 12

Q.5 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.6 The resultant R and angle of resultant ϕ for the given system of force will be respectively:



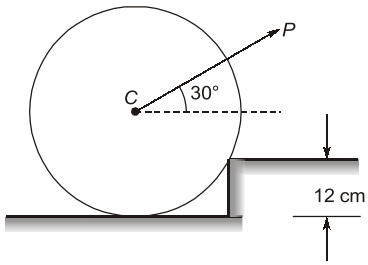
(a) 190.58 kN; 43° 39′ (b) 138.13 kN, 72°14′
(c) 166.43 kN; 47°51′ (d) 190.58 kN, 72°14′

Q.7 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

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

Multiple Select Questions (MSQ)

Q.48 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

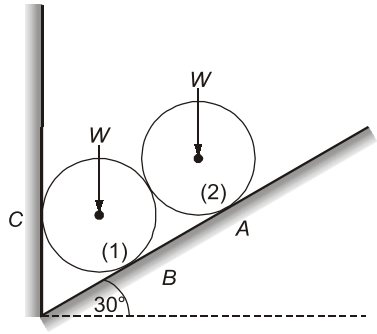
(b) For minimum value of P, it must be at 40.54° from the horizontal.

(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.49 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?



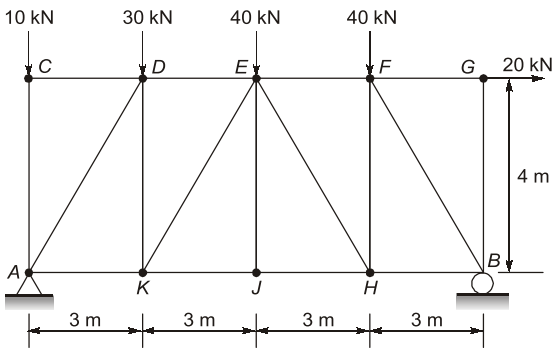
(a) Reaction at support *A* will be 385.38 N.

(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.50 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

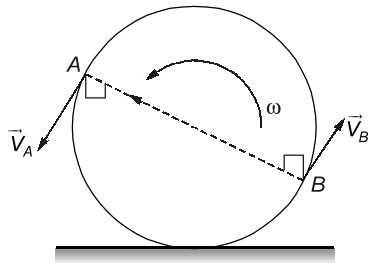
1. (a)	2. (d)	3. (c)	4. (c)	5. (a)	6. (a)	7. (b)	8. (c)	9. (346.4)	
10. (400)	11. (c)	12. (b)	13. (b)	14. (b)	15. (b)	16. (c)	17. (a)	18. (b)	19. (57.74)
20. (a)	21. (c)	22. (b)	23. (a)	24. (50)	25. (20)	26. (d)	27. (1.5)	28. (d)	29. (b)
30. (b)	31. (c)	32. (d)	33. (84.3)	34. (b)	35. (c)	36. (a)	37.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

5 CHAPTER

Plane Motion and Rotation

MCQ and NAT Questions

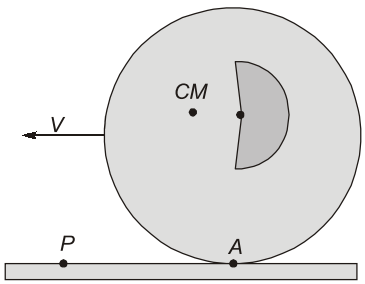
Q.1 *A* and *B* are the end points of a diameter of a disc rolling along a straight line with a counter clockwise angular velocity as shown in figure. Referring to the velocity vectors $\vec{V}_A$ and $\vec{V}_B$ shown in the figure



(a) $\vec{V}_A$ and $\vec{V}_B$ are both correct
(b) $\vec{V}_A$ is incorrect but $\vec{V}_B$ is correct
(c) $\vec{V}_A$ and $\vec{V}_B$ are both incorrect
(d) $\vec{V}_A$ is correct but $\vec{V}_B$ is incorrect

Q.2 Instantaneous centre of a body rolling without sliding on a stationary curved surface lies.
(a) at the point of contact
(b) on the common normal at the point of contact
(c) on the common tangent at the point of contact
(d) at the centre of curvature of the stationary surface

Q.3 The cylinder shown below rolls without slipping. Toward which of the following points is the acceleration of the point of contact *A* on the cylinder directed?



(a) The mass centre
(b) The geometric centre
(c) The point *P* as marked
(d) None of the above

Q.4 If a thin trapezoidal plate of larger width '*p*' and smaller width '*q*' and height '*h*' is to hang horizontally, the point of support for its suspension shall have to pass through the point (along the axis of symmetry)

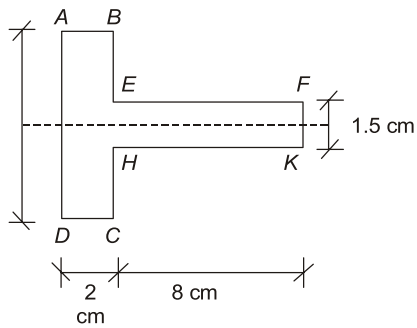
(a) $\left(\frac{2p+q}{p+q}\right)\frac{h}{3}$ from the larger edge

(b) $\frac{h}{2}$ from the smaller edge

(c) $\left(\frac{2p+q}{p+q}\right)\frac{h}{3}$ from the smaller edge

(d) $\frac{h}{2}$ from the larger edge

Q.5 In a thin uniform lamina having symmetrical central axis as shown above, the distance of centre of gravity from *AD* is



(a) 3 cm
(b) $\frac{22}{7}$ cm
(c) $\frac{23}{7}$ cm
(d) $\frac{24}{7}$ cm

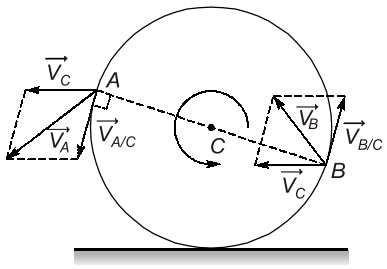
Q.6 The centroid of the hatched portion from the base shown in the given figure is

Answers Plane Motion and Rotation

1. (c) 2. (a) 3. (b) 4. (c) 5. (b) 6. (c) 7. (d) 8. (d) 9. (20.89)
10. (b) 11. (b) 12. (20) 13. (251.327) 14. (b) 15. (a) 16. (b, c) 17. (a, c)

Explanations Plane Motion and Rotation

1. (c)



$$\vec{V}_A = \vec{V}_C + \vec{V}_{A/C}$$

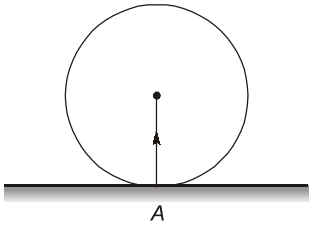
$$\vec{V}_B = \vec{V}_C + \vec{V}_{B/C}$$

2. (a)

Because for rolling without sliding, contact point has zero velocity.

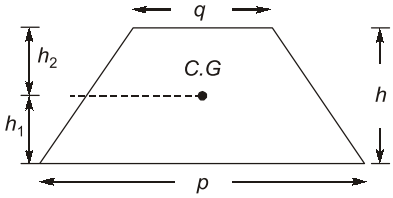
3. (b)

Acceleration of the point of contact *A* acts towards geometric centre.



$$\vec{a}_A = r\omega^2(+\hat{j})$$

4. (c)



The centre of gravity from larger edge '*p*'

$$h_1 = \frac{(p+2q)}{(p+q)}\frac{h}{3}$$

The centre of gravity from smaller edge '*q*'

$$h_2 = \frac{(2p+q)}{(p+q)}\frac{h}{3}$$

The support shall pass through centre of gravity (C.G.).

5. (b)

Rectangle *A B C D*

Area $(A_1) = 8 \times 2 = 16\ \text{cm}^2$

Centre of gravity $(x_1) = 1$ cm from *AD*

Rectangle *E F H K*

Area $(A_2) = 8 \times 1.5 = 12\ \text{cm}^2$

Centre of gravity $(x_2) = 2 + 4 = 6$ cm from *AD*

The centre of gravity of lamina from *AD*

$$\bar{x} = \frac{A_1x_1 + A_2x_2}{A_1 + A_2} = \frac{16\times1+12\times6}{16+12}$$

$$= \frac{22}{7}\ \text{cm}$$

6. (c)

Shape	Area	Centroid from base
Square	$A_1 = d^2$	$y_1 = d/2$
Half circle	$A_2 = \pi d^2/8$	$y_2 = 2d/3\pi$

The centroid of hatched position from base.

$$\bar{y} = \frac{A_1y_1 - A_2y_2}{A_1 - A_2}$$

$$= \frac{d^2\cdot\frac{d}{2} - \frac{\pi d^2}{8}\cdot\frac{2d}{3\pi}}{d^2 - \frac{\pi d^2}{8}} = \frac{10d}{3(8-\pi)}$$

7. (d)

Moment of inertia about $x_1 - x_1$ using parallel axis theorem

$$I_{x1x1} = I_{xx} + A \times (2)^2$$

$$\therefore \quad I_{xx} = 10 - 1 \times 4 - 6\ \text{m}^4$$

Moment of inertial about $x_2 - x_2$ using parallel axis theorem

$$I_{x2x2} = I_{xx} + A \times (3)^2$$

$$= 6 + 1 \times 9 = 15\ \text{m}^4$$