



POSTAL BOOK PACKAGE 2024

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MECHANICAL ENGINEERING

Objective Practice Sets

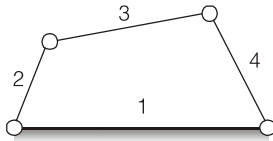
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Planer Mechanisms

MCQ and NAT Questions

Q.1 Refer to the figure given below



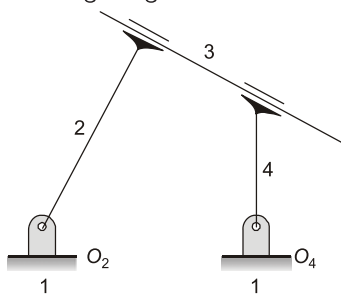
If 2 and 4 are given rotatory motion the motion of link 3 is

- (a) pure translation (b) pure rotation
(c) translation and rotation (d) Not defined

Q.2 A higher pair can be replaced by a

- (a) two revolute pair and two additional linkages
(b) two revolute pair and one additional linkage
(c) one revolute pair and one additional linkage
(d) None of these

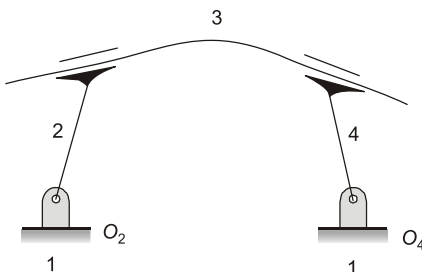
Q.3 Refer to the figure given below



The effective degree of freedom of the given figure is

- (a) one (b) zero
(c) three (d) indefinite

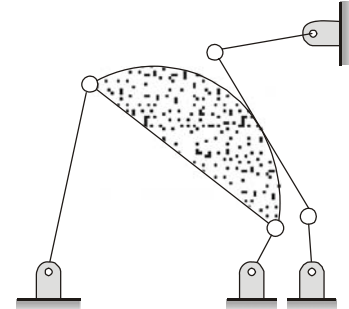
Q.4 Refer to the figure given below



The degree of freedom of the given figure is

- (a) one (b) two
(c) zero (d) three

Q.5 The degree of freedom of the given mechanism is



- (a) 1 (b) 2
(c) 3 (d) ∞

Q.6 In a kinematic chain, a quaternary joint is equivalent to

- (a) one binary joint (b) two binary joint
(c) three binary joint (d) four binary joints

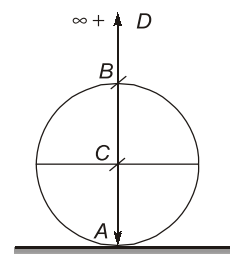
Q.7 Which of the following is an exact straight line mechanism?

- (a) Watt's Mechanism
(b) Grasshopper's Mechanism
(c) Peaucellier Mechanism
(d) Robert's Mechanism

Q.8 Which one of following is an Open Pair?

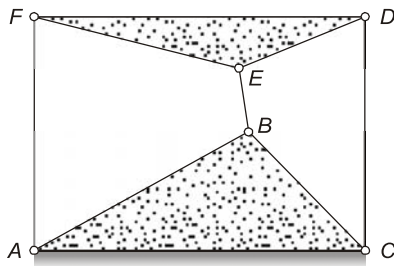
- (a) Ball and socket joint
(b) Journal bearing
(c) Lead screw and nut
(d) Cam and follower

Q.9 The instantaneous centre of motion of rigid-thin disc-wheel rolling on plane rigid surface shown in the figure, is located at the point



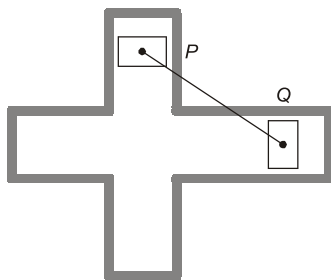
- (a) A (b) B
(c) C (d) D

- Q.10** A linkage is shown below in the figure in which links ABC and DEF are ternary links whereas AF , BE and CD are binary links



The degrees of freedom of the linkage when link ABC is fixed are

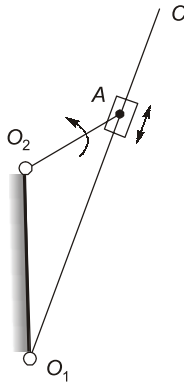
- (a) 0 (b) 1
(c) 2 (d) 3
- Q.11** $f = 3(n - 1) - 2j$. In the Grubler's equation for planar mechanisms given, j is the
- (a) Number of mobile links
(b) Number of links
(c) Number of lower pairs
(d) Length of the longest link
- Q.12** Which of the following plane mechanism represents the structure?
- (a) Three-bar mechanism
(b) Four-bar mechanism
(c) Five-bar mechanism
(d) Six bar mechanism
- Q.13** Consider the following statements
1. In a pure rolling contact of the two links, the I-centre lies at the point of contact
 2. Four-bar mechanism has 6 I centres
- Which of the following is correct?
- (a) Only 1 (b) Only 2
(c) Both 1 & 2 (d) Neither 1 nor 2
- Q.14** In one of the inversion of a double-slider crank mechanism, known as elliptical trammel, as shown in figure below:



The link connecting the two sides is PQ . The equation of the curve traced by the centre point of PQ is

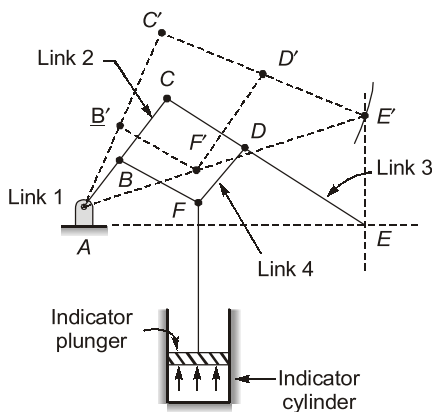
- (a) Straight line (b) Ellipse
(c) Hyperbola (d) Circle
- Q.15** Which is the correct expression for Grubler's criteria?
- (a) $3j - 3n + 4 = 0$
(b) $3j - 2n + 4 = 0$
(c) $2j - 3n + 3 = 0$
(d) $2j - 3n + 4 = 0$
- Q.16** According to Grashof's criteria
- (a) $l + s > p + q$ (b) $l + s < p + q$
(c) $l + s > q + s$ (d) $l + s > q + s$
- where, l = length of the longest link
 s = length of the shortest link
 p, q = length of the other two links
- Q.17** Which of the following is an inversion of single slider crank chain?
- (a) Beam engine
(b) Watt's indicator mechanism
(c) Elliptical Trammel
(d) Whitworth quick return motion mechanism
- Q.18** Which of the following is an inversion of double slider crank chain?
- (a) Elliptical Trammel
(b) Pendulum pump
(c) Coupling rod of a locomotive
(d) Oscillating cylinder engine
- Q.19** The number of links in Peaucellier mechanism are
- (a) 8 (b) 6
(c) 4 (d) 7
- Q.20** The number of links in Hart mechanism are
- (a) 8 (b) 6
(c) 4 (d) 7
- Q.21** The Ackermann steering gear mechanism is preferred to the Davis steering gear mechanism
- (a) The Ackermann steering is most economical
(b) Whole of the mechanism in the Ackermann steering gear is on the back of the front wheels
(c) The Ackermann steering gear consists of turning pairs
(d) both (b) and (c)

- Q.22** The crank and slotted lever quick-return motion mechanism is shown in figure. The length of links O_1O_2 , O_1C and O_2A are 10 cm, 20 cm and 5 cm respectively.



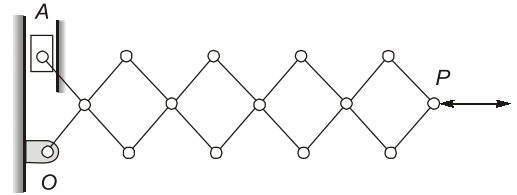
The quick return ratio of the mechanism is

- (a) 3.0 (b) 2.75
(c) 2.5 (d) 2.0
- Q.23** Watt's indicator mechanism which is an inversion of four bar chain, shown below. The links CE and BFD acts as

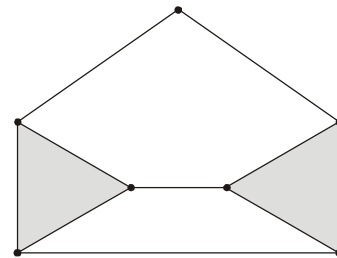


- (a) Two cranks
(b) CE as crank and BFD as lever
(c) CE as lever and BFD as crank
(d) CE and BFD both as levers
- Q.24** The relation between the number of links (l) and the number of binary joints (j) for a kinematic chain having constrained motion is given by $j + h/2 = 3l/2 - 2$. If the left hand side is greater than right hand side, then the chain is
- (a) locked chain
(b) completely constrained chain
(c) successfully constrained chain
(d) incompletely constrained chain

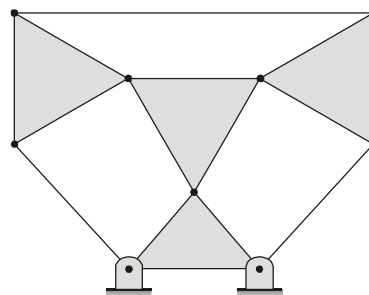
- Q.25** The given figure of lazy tong mechanism has the degree of freedom



- (a) 0 (b) 1
(c) 2 (d) 3
- Q.26** Which of the following pair is incorrect?
- (a) Peaucellier's Mechanism – exact straight line
(b) Grass-Hopper Mechanism – Modified Scott Russel Mechanism
(c) Lazy tong Mechanism – Parallel linkages
(d) Crosby indicator – Horizontal line
- Q.27** Which of the following pairs are correctly matched? Select the correct answer using the codes given below the pairs.
- Mechanism Chain from which it derived
- Whitworth quick return motion.... Single slider crank chain
 - Oldham's coupling Four bar chain
 - Scotch Yoke.... Double slider crank chain
- (a) 1 and 2 (b) 1, 2 and 3
(c) 1 and 3 (d) 2 and 3
- Q.28** The degree of freedom of the linkage shown in the figure below is



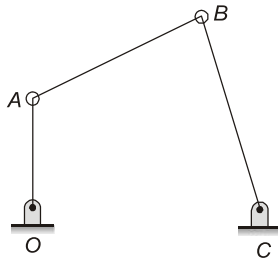
- (a) -1 (b) 0
(c) 1 (d) 2
- Q.29** Consider the following statements regarding the kinematic linkage shown below:



1. Number of binary links is 3
 2. Number of ternary links is 4
 3. Degree of freedom of this mechanism is 1
- Which of these statements are correct?

- (a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3

Q.30 The four bar mechanism shown in the figure (Given : $OA = 3$ cm, $AB = 5$ cm, $BC = 6$ cm, $OC = 7$ cm) is a



- (a) Double crank mechanism
(b) Double rocker mechanism
(c) Crank rocker mechanism
(d) Single slider mechanism

Q.31 The driving and driven shafts connected by a Hooke's joint will have equal speeds if

- (a) $\sin \theta = \pm \tan \alpha$
(b) $\tan \theta = \pm \sqrt{\cos \alpha}$
(c) $\tan \theta = \pm \sqrt{\sin \alpha}$
(d) $\cot \theta = \pm \sqrt{\cos \alpha}$

Q.32 In a Hooke's joint the maximum fluctuation of speed is approximately equal to

- (a) $\omega \alpha$ (b) $\frac{\omega}{\alpha}$
(c) $\omega \alpha^2$ (d) $\omega^2 \alpha$

Q.33 Angle between line of transmission with horizontal known as

- (a) Deviation angle
(b) Transmission angle
(c) Angle of action
(d) Angle of dwell

Q.34 In automobiles, Hooke's joint is used between which of the following

- (a) Clutch and gear box
(b) Gear box and differential
(c) Differential and wheels
(d) Flywheel and clutch

Q.35 The condition for correct steering of a Davis steering gear is

- (a) $\sin \alpha = b/c$ (b) $\cos \alpha = c/b$
(c) $\cot \alpha = c/2b$ (d) $\tan \alpha = c/2b$

where,

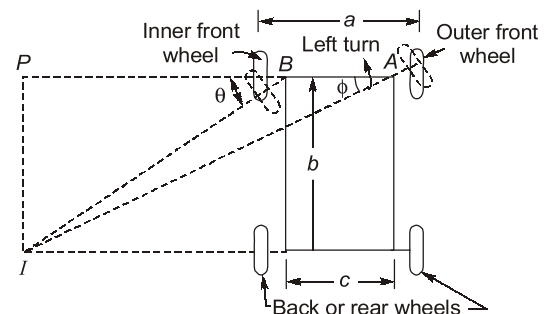
α = Angle of inclination of the links to the vertical
 b = wheel base and

c = Distance between the pivots of the front axle

Q.36 The conditions for correct steering mechanism is

- (a) The front two wheel must turn about same instantaneous centre
(b) The back two wheel and front two wheel must turn about same instantaneous centre
(c) The span of back two wheels must be greater than the front two wheels
(d) The back two wheel must turn about same instantaneous centre

Q.37 Consider the figure given below and choose the correct alternative as per the condition for correct steering mechanism:



(a) $\cot \phi - \cot \theta = \frac{c}{b}$

(b) $\tan \phi - \tan \theta = \frac{c}{b}$

(c) $\cot \phi - \cot \theta = \frac{2c}{b}$

(d) $\cot \phi - \cot \theta = b/c$

Q.38 In fundamental equation of correct gearing, the term $(\cot \phi - \cot \theta)$ for a vehicle

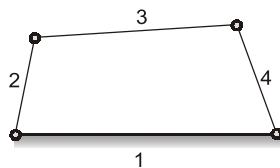
- (a) remains same
(b) always increases on right turn
(c) always decreases on left turn
(d) always increases rather it is right side turn or left side turn.

Answers Planer Mechanisms

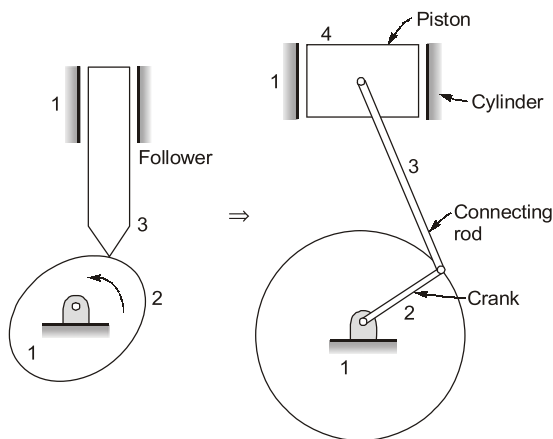
1. (c) 2. (b) 3. (b) 4. (a) 5. (a) 6. (c) 7. (c) 8. (d) 9. (a)
 10. (a) 11. (c) 12. (a) 13. (c) 14. (d) 15. (d) 16. (b) 17. (d) 18. (a)
 19. (a) 20. (b) 21. (c) 22. (d) 23. (d) 24. (a) 25. (b) 26. (d) 27. (c)
 28. (c) 29. (a) 30. (c) 31. (b) 32. (c) 33. (a) 34. (b) 35. (d) 36. (b)
 37. (a) 38. (a) 39. (d) 40. (d) 41. (c) 42. (d) 43. (a) 44. (d) 45. (a)
 46. (d) 47. (c) 48. (a) 49. (c) 50. (c) 51. (c) 52. (b) 53. (c) 54. (d)
 55. (d) 56. (c) 57. (a) 58. (39.06) 59. (1) 60. (4) 61. (99.594) 62. (1.71)
 63. (360) 64. (421.8) 65. (533.3) 66. (120) 67. (34.92) 68. (b, c, d) 69. (a, c, d) 70. (a, c, d)

Explanations Planer Mechanisms**1. (c)**

If link 2 and 4 are given rotatory motion, then the motion of link 3 in the mechanism is neither purely translatory nor purely rotatory. It is a combination of translation and rotation which we normally say the link is in general motion.

**2. (b)**

A higher pair can be replaced by a two revolute pair and one additional linkage
 Example:

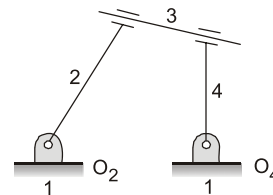


Here H.P. between link 2 and 3 is replaced by 2 L.P. (revolute pair) with one additional linkage.

3. (b)

Degree of freedom,

$$F = 3(l - 1) - 2j - h - F_r$$



where, l = number of links; j = number of lower pair (binary joints); h = number of higher pair
 F_r = number of those motions which are not the part of mechanism (redundant motions)

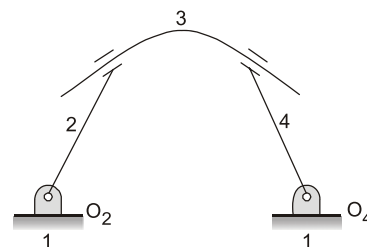
$$F = 3(4 - 1) - 2 \times 4 - 0 - 1 = 0$$

So, the effective degree of freedom is zero.

4. (a)

Here $F_r = 0$
 i.e. no. redundant motion

$$\text{So, } F = 3(l - 1) - 2j - h - F_r = 3(4 - 1) - 2 \times 4 = 1$$



Note: The degree of freedom of given figure is 1, but still it is structure.

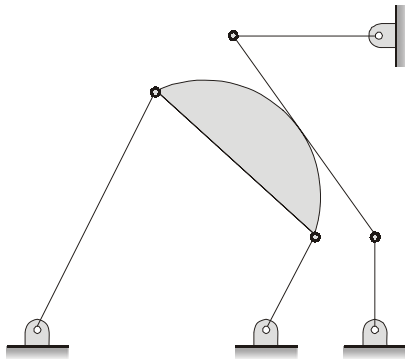
5. (a)

The mechanism has a cam pair. Therefore, its degree of freedom must be found from Gruebler's criterion.

Total number of links (l) = 7

Number of lower pairs (j) = 8

Number of higher pairs (h) = 1



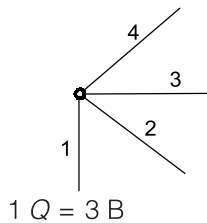
$$F = 3(l - 1) - 2j - h$$

$$= 3(7 - 1) - 2 \times 8 - 1 = 1$$

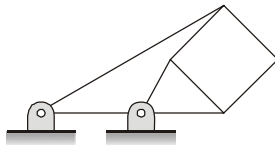
Thus, it is a mechanism with one degree of freedom.

6. (c)

In a kinematic chain, a quaternary joint is equivalent to three binary joints.



7. (c)



An exact straight line mechanism guides a reciprocating part in an exact straight line. On the other hand, an approximate straight-line mechanism is designed in such a way that the middle and the two extreme positions of the guided point are in a straight line and the intermediate positions deviate as little as possible from the line. Peaucellier Mechanism is an exact straight line mechanism.

8. (d)

When two links of a pair are in contact either due to force of gravity or some spring action, they constitute an unclosed (or open) or forced closed pair. In this, the links are not held together mechanically, e.g. cam and follower pair.

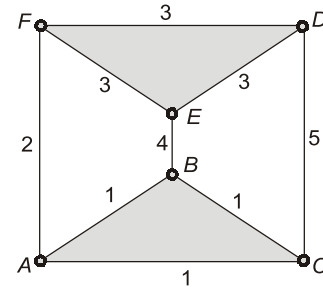
9. (a)

The instantaneous centre of rotation of a rigid thin

disc wheel rolling without slip on a plane rigid surface is located at the point of contact i.e. at point A.

10. (a)

In the given linkage,



no. of links (l) = 5

no. of lower pairs (j) = 6

$$\therefore F = 3(l - 1) - 2j - h$$

$$= 3(5 - 1) - 2 \times 6 = 0$$

Thus, the degree of freedom of the linkage is zero.

11. (c)

Grubler's equation for a planar mechanism,

$$F = 3(n - 1) - 2j$$

where,

n = no. of links

j = no. of lower pairs

12. (a)

3-bar mechanism has zero DOF which forms a structure.

13. (c)

Both statements are correct

Number of I -centres (N) can be given by for n is number of links

$$N = \frac{n(n-1)}{2} = n_{c_2}$$

$$\text{if } n = 4, N = \frac{4(4-1)}{2} = 6$$

14. (d)

Let the coordinate of centre point be (x, y)

$$x = \frac{L}{2} \cos \theta$$

$$y = \frac{L}{2} \sin \theta$$

We know, $\sin^2 \theta + \cos^2 \theta = 1$

$$\Rightarrow \frac{y^2}{(L/2)^2} + \frac{x^2}{(L/2)^2} = 1$$

$$\Rightarrow x^2 + y^2 = \left(\frac{L}{2}\right)^2$$

Also, $F = N - (2L + 1)$
where, $N = \text{number of links}$
 $L = \text{number of loops}$
 $\therefore F = 12 - (2 \times 5 + 1) = 1$

26. (d)

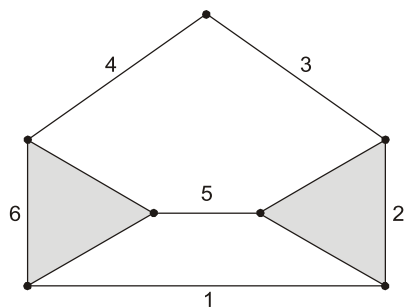
- Peaucellier's mechanism is an exact straight-line mechanism.
- Grass-Hopper Mechanism is a derivation of the modified Scott-Russel mechanism.
- Lazytong Mechanism is parallel linkage mechanism in which linkage will always form a parallelogram.
- Crosby indicator, employs a modified form of the pantograph, used to keep the graphical record of pressure inside the cylinder during the piston stroke.

27. (c)

Oldham's coupling is an inversion of Double slider crank chain, not of four bar chain.

28. (c)

Total number of links, $l = 6$
Number of binary joints, $j = 7$
Number of higher pairs, $h = 0$



$$\text{DOF, } F = 3(l - 1) - 2j - h \\ = 3(6 - 1) - 2 \times 7 = 1$$

29. (a)

Number of binary links = 3
Number of ternary links = 4
Total number of links, $l = 7$
Number of binary joints, $j = 9$
Number of higher pairs, $h = 0$
 $\therefore \text{Degree of freedom, } F = 3(l - 1) - 2j - h \\ = 3(7 - 1) - 2 \times 9 - 0 = 0$

30. (c)

Shortest link $OA = 3 \text{ cm}$

Longest link $OC = 7 \text{ cm}$
Sum of shortest and longest link = 10 cm
Sum of other two = $5 + 6 = 11 \text{ cm}$
since $s + l \leq p + q$ and s is adjacent to fixed
hence crank rocker mechanism.

31. (b)

A Hooke's joint is used to connect two non-parallel and intersecting shafts. The driving and driven shafts connected by a Hooke's joint will have equal speeds when the following condition is satisfied.

$$\tan \theta = \pm \sqrt{\cos \alpha}$$

This is possible once in all the four quadrants for particular values of θ if α is constant.

32. (c)

In a Hooke's joint, maximum variation of velocity of the driven shaft of its mean velocity

$$= \frac{\omega_{2\max} - \omega_{2\min}}{\omega_{\text{mean}}}$$

Maximum variation

$$= \frac{\frac{\omega_1}{\cos \alpha} - \omega_1 \cos \alpha}{\omega_1} \\ = \frac{1 - \cos^2 \alpha}{\cos \alpha} = \frac{\sin^2 \alpha}{\cos \alpha} \\ = \tan \alpha \cdot \sin \alpha$$

If α is small, i.e. the angle between the axes of the two shafts is small,

$$\sin \alpha \simeq \tan \alpha \simeq \alpha$$

$\therefore \text{Maximum variation} \simeq \alpha^2$

So, maximum fluctuation of speed $\simeq \alpha^2 \omega$

33. (a)

Angle between line of transmission with horizontal is known as deviation angle while 90° - deviation angle (δ) is transmission angle (γ)
 $\therefore \delta + \gamma = 90^\circ$

34. (b)

In automobile Hooke's joint is used between gear box and differential. It is provided on propeller shaft.

35. (d)

For correct steering action,

$$\cot \phi - \cot \theta = \frac{c}{b}$$