QUESTION BANK

1. Instantaneous center of a body rolling with sliding on a stationary curved surface lies

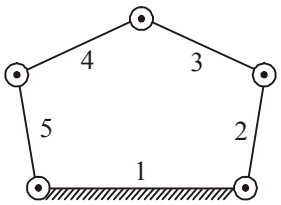
(a) At the point of contact

(b) On the common normal at the point of contact

(c) On the common tangent at the point of contact

(d) At the center of curvature of the stationary surface

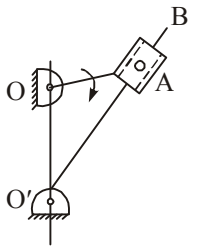
2. The number of degrees of freedom of a five link plane mechanism with five revolute pairs as shown in the figure is:



(a) 3 (b) 1

(c) 2 (b) 4

3. Figure shows a quick return mechanism. The crank OA rotates clockwise uniformly. OA 2 cm, OO′ = 4 cm. The ratio of time for forward motion to that for return motion is



(a) 0.5 (b) 2.0

(c) $\sqrt{2}$ (d) 1

4. ***Assertion (A):*** The elements of higher pairs must be force closed.

Reason (R): This is required in order to provide completely constrained motion.

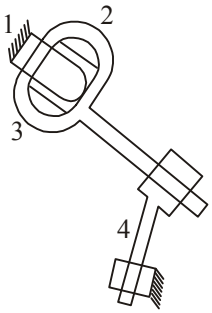
(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is not the correct explanation of A

(c) A is true but R is false

(d) A is false but R is true

5. For the planar mechanism shown in figure select the most appropriate choice for the motion of link 2 when link 4 is moved upwards.



(a) Link 2 rotates clockwise

(b) Link 2 rotates counter-clockwise

(c) Link 2 does not move

(d) Link 2 motion cannot be determined

6. The instantaneous centre of rotation of a rigid thin disc rolling on a plane rigid surface is located at

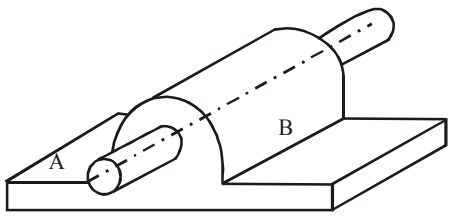
(a) The centre of the disc

(b) An infinite distance on the plane surface

(c) The point of contact

(d) The point on the circumference situated vertically opposite to the contact point

7. A round bar A passes through the cylindrical hole in B as shown in the given figure. Which one of the following statements is correct in this regard?



(a) The two links shown form a kinematic pair

(b) The pair is completely constrained

(c) The pair has incomplete constrained

(d) The pair is successfully constrained

8. ***Assertion (A)*****:** Hydraulic fluid is one form of link

Reason (R)**:** A link need not necessarily be a rigid body but it must be a resistant body.

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is not the correct explanation of A

(c) A is true but R is false

(d) A is false but R is true

9. The centre of gravity of the coupler link in a 4 bar mechanism would experience

(a) no acceleration

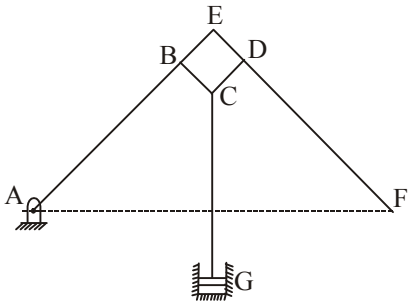
(b) only linear acceleration

(c) only angular acceleration

(d) both linear and angular acceleration

10. Consider the following statements:

Assertion (A)**:** The given line diagram of watt's indicator mechanism is a type of crank and lever mechanism.



Reason (R) **:** BCD acts as a lever.

Of these statements :

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is not the correct explanation of A

(c) A is true but R is false

(d) A is false but R is true

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

List-I

A. Quadratic cycle chain

B. Single slider crank chain

C. Double slider crank chain

D. Crossed slider crank chain

List-II

1. Rapson's slide

2. Oscillating cylinder engine mechanism

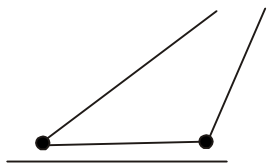
3. Ackermann steering mechanism

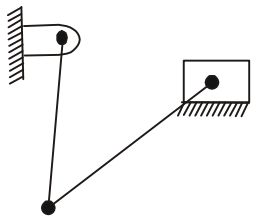
4. Oldham coupling

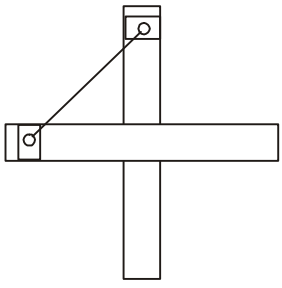
Codes :

	A	B	C	D
(a)	1	2	4	3
(b)	4	3	1	2
(c)	3	2	4	1
(d)	3	4	2	1

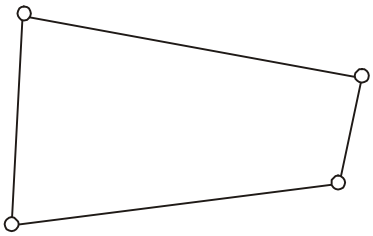
12. Which of the following are examples of a kinematic chain?

1. 

2. 

3. 

4.



Select the correct answer using the codes given below :

(a) 1, 3 and 4 (b) 2 and 4

(c) 1, 2 and 3 (d) 1, 2, 3, and 4

13. Which of the following pairs are correctly matched? Select the correct answer using the codes given below the pairs.

Mechanism

1. Whithworth quick return motion

2. Oldham's coupling

3. Scotch yoke

Chain from which derived

1. Single slider crank chain

2. Four bar chain

3. Double slider crank chain

(a) 1 and 2 (b) 1, 2 and 3

(c) 1 and 3 (d) 2 and 3

14. Match List-I with List-II and select the correct answer using the codes given below the lists

List-I	**List-II**
A. 4 link, 4 turning pairs	**1.** Complete constrained
B. 3 links, 3 turning pairs	**2.** Successfully constrained
C. 5 links, 5 turning pairs	**3.** Rigid frame
D. Footstep bearing	**4.** Incomplete constrained

Codes :

	A	**B**	**C**	**D**
(a)	3	1	4	2
(b)	1	3	2	4
(c)	3	1	2	4
(d)	1	3	4	2

15. In a single slider four-bar linkage when the slider is fixed, it form a mechanism of

(a) hand pump (b) reciprocating engine

(c) quick return (d) oscillating cylinder

16. Which one of the following pairs is correctly matched?

(a) Governor : Interference

(b) Gears : Hunting

(c) Klein's construction : Acceleration of piston

(d) Cam : Pinion

17. A four-bar chain has

(a) all turning pairs

(b) one turning pair and the others are sliding pairs

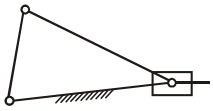
(c) one sliding pair and the others are turning pairs

(d) all sliding pairs

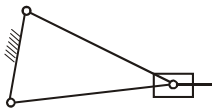
18. Match List-I (Kinematic inversions) List-II (Applications) and select the correct answer using the codes given below the lists

List-I

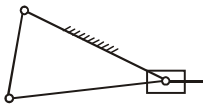
A.



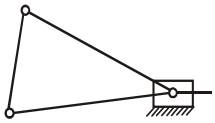
B.



C.



D.



List-II

1. Hand pump

2. Compressor

3. Whitworth quick return mechanism

4. Oscillating cylinder engine

Codes :

	A	B	C	D
(a)	1	3	4	2
(b)	2	4	3	1
(c)	2	3	4	1
(d)	1	4	3	2

19. Consider the following pairs of parts

1. Pair of gear in mesh

2. Belt and pulley

3. Cylinder and piston

4. Cam and follower

Among these, the higher pairs are

(a) 1 and 4 (b) 2 and 4

(c) 1, 2 and 3 (d) 1, 2 and 4

20. Consider the following statements

1. Round bar in a round hole forms a turning pair.

2. A square bar in a square hole forms a sliding pair.

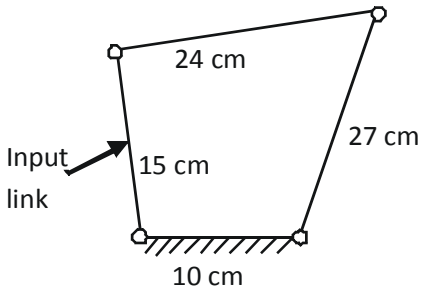
3. A vertical shaft in a footstep bearing forms a successful constrained.

Which of these statements are correct?

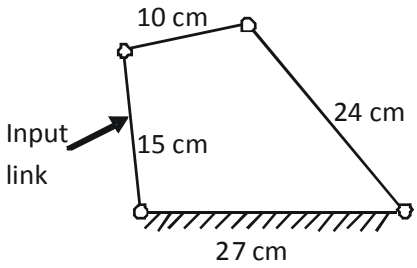
(a) 1 and 3 (b) 1 and 2

(c) 2 and 3 (d) 1, 2 and 3

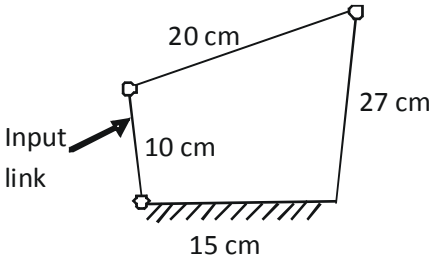
21. In which of the following cases the input link can make a complete rotation.



(1)



(2)



(3)

(a) 1 only (b) 1 and 3

(c) 1 and 2 (d) 1, 2 and 3

22. Match List-I with List-II and select the correct answer using the codes given below the lists

List-I (Type of Mechanism)

A. Scott-Russel mechanism

B. Geneva mechanism

C. Off-set slider-crank mechanism

D. Scotch Yoke mechanism

List-II (Motion achieved)

1. Intermittent motion

2. Quick return motion

3. Simple harmonic motion

4. Straight line motion

Codes :

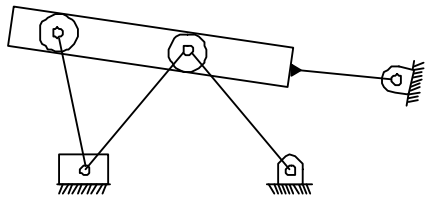
	A	B	C	D
(a)	2	3	1	4
(b)	3	2	4	1
(c)	4	1	2	3
(d)	4	3	1	2

23. If the length of the connecting rod (coupler) and the crank are 'r' units each, then the stroke length of the slider crank mechanism is

(a) r unit (b) 2r unit

(c) 3r unit (d) 4r unit

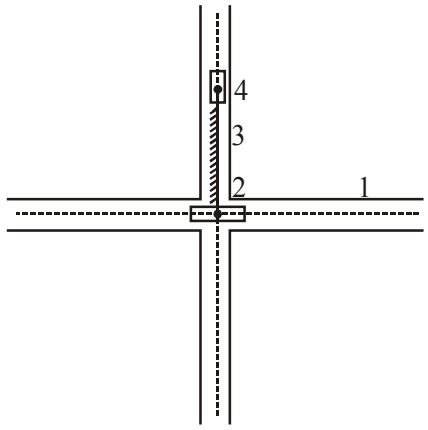
24. For the mechanism shown below. The number of degrees of freedom is



(a) 3 (b) 1

(c) 5 (d) 0

25. For the given inversion of the double-slider crank chain, link 3 is fixed which is of 5 cm in length. By rotating the slider (link 2) through 30^o in clock wise direction, the distance between the mid point of the link 1 and the center of rotation of link 4 for this instant is



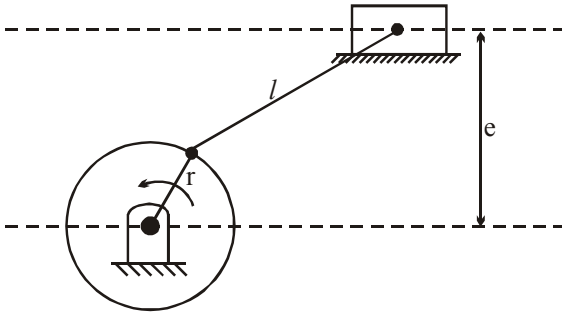
(a) 2.5 cm (b) 3.54 cm

(c) 4.33 cm (d) 5 cm

***Common Data Questions :* 26 and 27**

The figure shown an offset slider-crank mechanism that has an offset 'e'

r = 20 cm, l = 80 cm, e = 60 cm



26. The time ratio of the mechanism is

(a) 1 (b) 1.74

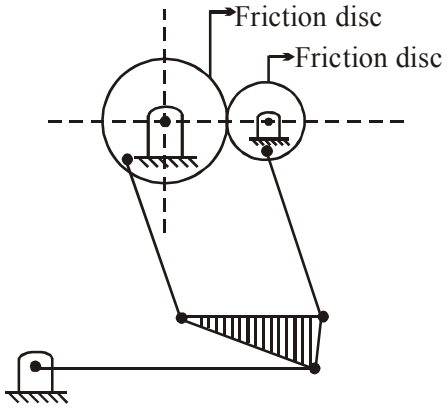
(c) 1.84 (d) 5.76

27. Stroke length of the slider is

(a) 20 cm (b) 40 cm

(c) 60 cm (d) 80 cm

28. The degree of freedom for the mechanism is



(a) 0 (b) 1

(c) 2 (d) 3

29. The relative motion in higher pair is

(a) sliding

(b) turning

(c) combination of sliding and turning

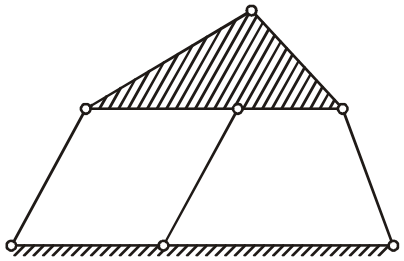
(d) rotary

30. If the fixed link is changed in a kinematic chain, what will be the relative motion of other links?

(a) Will change (b) Will remain same

(c) Will not occur (d) None

31. The number of degrees of freedom for below mentioned arrangement is

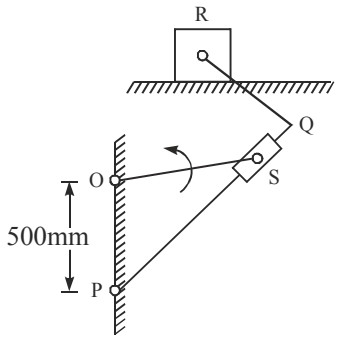


(a) 0 (b) 1

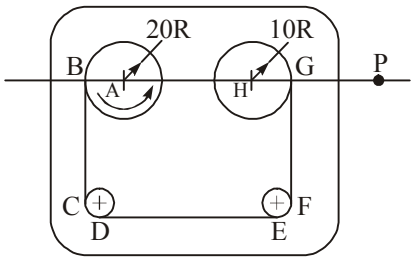
(c) 2 (d) 3

***Statement Linked Questions* 32 and 33**

A quick return mechanism is shown below. The crank OS is drive at 2 rev/s in counter clockwise direction.



32. For the audio cassette mechanism shown in figure given below. Where is the instantaneous centre of rotation (point) of the two spools?



(a) Point P lies to the left of both the spools but at infinity along the line joining A and H

(b) Point P lies in between the two spools on the line joining A and H, such that PH = 2AP

(c) Point P lies to the right of both the spools on the line joining A and H, such that AH = HP

(d) Point P lies at the intersection of the line joining B and C and the line joining G and F

33. Match the following with respect to special mechanisms.

Type of Joint	**Motion constraint**
P. Revolute	**1.** Three
Q. Cylindrical	**2.** Five
R. Spherical	**3.** Four
	4. Two
	5. Zero

Codes :

	P	**Q**	**R**
(a)	1	3	1
(b)	5	4	3
(c)	2	3	1
(d)	4	5	3

34. Which of the following statement is true for links

(a) Tensile loads, belts, ropes, chains are as links only when they are in tension

(b) Liquids are treated as links when they transfer compressive force

(c) Springs are not treated as links in kinematic analysis

(d) All of the above

35. A universal joint is case of

(a) Turning pair (b) Sliding pair

(c) Rolling pair (d) Lower pair

36. Which among the following is a lower pair?

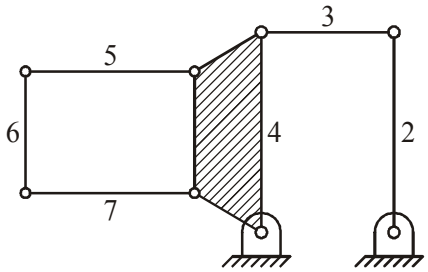
(a) Pair of friction disc

(b) Ball and roller bearing

(c) Piston and cylinder

(d) Gear

37. The number of degrees of freedom for the below mentioned mechanism is



(a) 0 (b) 1

(c) –1 (d) 2

38. For kinematic chains $\frac{2(j+2)}{3}$ applied to higher pair

(a) Each higher pair must be taken equivalent to two lower pairs

(b) Each higher pair equivalent to one additional link

(c) Each higher pair must be taken equivalent to two lower pairs and one additional link

(d) Each higher pair is equivalent to one lower pair and two additional links

39. Minimum requirement of kinematic chain are

(a) 3 links and 2 turning pairs

(b) 4 links and 4 turning pairs

(c) 3 links and 3 turning pairs

(d) 2 links and 3 turning pairs

40. Grubler's criterion for determining the degrees of freedom (n) having plane motion is

(a) $n = 3(l - 1) - 2j$

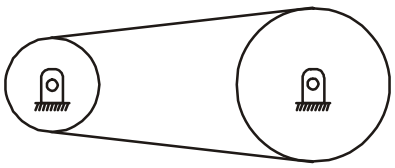
(b) $n = \frac{2}{3}(l - 1) - 2j$

(c) $n = 4(l - 1) - 2j$

(d) None of the above

where $n = 1$

41. The number of degrees of freedom for below mentioned belt and pulley drive is



(a) 0 (b) 2

(c) 1 (d) 3

42. If l = number of links and P = number of pair which constitute a kinematic chain, then there is a relation between number of joints and number of links which is given by the expression

(a) $P = l - 2$ (b) $l - 4P - 2$

(c) $P = 2l - 3$ (d) $l = 2P - 4$

43. Which one is a spherical pair?

(a) Ball bearing and roller bearing

(b) Ball and socket joint

(c) Bolt and nut

(d) Crank shaft is in journal of engine

44. The lower pair is a

(a) Turning pair (b) Closed pair

(c) Open pair (d) Sliding pair

45. An example of turning pair is

(a) Piston and cylinder

(b) Ball and socket joint

(c) Shaft with collars at both ends fitted in a circular hole

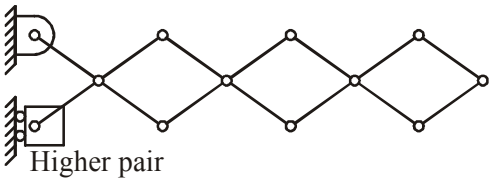
(d) Bolt and nut

46. Motion between two elements having surface in contact is

(a) Sliding pair (b) Rolling pair

(c) Lower pair (d) Higher pair

47. The number of degrees of freedom for below mentioned arrangement is



(a) 0 (b) 2

(c) 1 (d) –1

48. If there are l number of links in a mechanism then number of possible inversions is equal to

(a) l (b) $l - l$

(c) $l + 3$ (d) $l - 2$

49. A piston and cylinder in a slider crank mechanism form a

(a) Cylindrical pair (b) Spherical pair

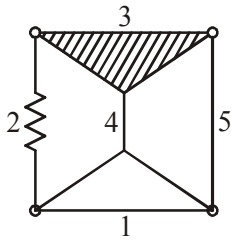
(c) Higher pair (d) Sliding pair

50. A shaft in a bearing is a

(a) Lower pair (b) Higher pair

(c) Rolling pair (d) Spherical pair

51. In the below mentioned arrangement, the removal of spring (without affecting the degree of freedom), can be replaced by



(a) Single link (b) Binary link

(c) Ternary link (d) None of these

52. For kinematics chains constituted by lower pair the relation between the number of link l and the number of joint j is

(a) $l = \frac{2}{3}(j+2)$ (b) $l = \frac{2}{3}(j+2)^2$

(c) $l = \frac{3}{2}(j+2)$ (d) $l = \frac{5}{2}(j+2)$

53. A quartenary joint is equivalent to

(a) Two binary joints

(b) Three binary joints

(c) Four binary joints

(d) All of above

54. Which of the following is inversion of slider crank mechanism?

(a) Reciprocating internal combustion engine

(b) Crank and slotted lever mechanism

(c) Whitworth quick return mechanism

(d) (a), (b) and (c)

55. As per equation $l = \frac{2}{3}(j + 2)$ to determine whether the given chain is kinematic or not, higher pair is treated equivalent to

(a) Two lower pairs and two additional links

(b) One lower pair and two additional links

(c) Two lower pairs and one additional link

(d) Three lower pairs and two additional links

56. A quartenary joint is comparable to

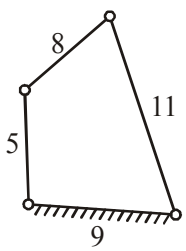
(a) Two binary joints

(b) Three binary joints

(c) Four binary joints

(d) None of the above

57. The arrangement shown below represents



(a) Double rocker mechanism

(b) Double crank mechanism

(c) Crank-rocker mechanism

(d) None of these

58. Double slider crank chain traces a

(a) Elliptical path (b) Straight line path

(c) Parabolic path (d) Circular path

59. When does a kinematic chain becomes a mechanism?

(a) If the first two links fixed

(b) If all links are fixed

(c) If any one link is fixed

(d) None of the links are fixed

60. Kinematic pairs are those which have two elements which

(a) Permit relative motion

(b) Act as support

(c) Have line contact

(d) Are held together

61. A simple mechanism has

(a) 2 links (b) 4 links

(c) 5 links (d) 6 links

62. In case of lower pairs

(a) There is surface contact between the two elements while in the motion

(b) There is line contact between the two elements while in the motion

(c) Contact is at upper end

(d) None of the above

63. Cross head and guides is an example of

(a) Lower pair (b) Turning pair

(c) Sliding pair (d) Surface pair

64. In case of higher pairs

(a) There is contact only at higher point of the two elements while in motion

(b) There is surface contact between the two elements

(c) There is no contact between two elements

(d) There is only line or point contact between the two elements while in motion

65. For 6 links in a mechanism number of pairs would be

(a) 12 (b) 6

(c) 3 (d) 5

66. ***Assertion (A)*:** The Ackermann Steering gear is commonly used in all automobiles.

***Reason (R)*:** It has the correct inner turning angle θ for all positions.

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is not the correct explanation of A

(c) A is true but R is false

(d) A is false but R is true

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ANSWERS AND EXPLANATION

1. ***Ans. (b)***

In a pure rolling the I-centre lies at the point of contact at the given instant.

In sliding motion, the I-centre lies at infinity in a direction perpendicular to the path of motion of slider. As for three centers in line theorem, in both rolling and sliding motion the I-center lies in between point of contact and in the direction of the centre of sliding i.e. perpendicular to the sliding direction.

2. ***Ans. (c)***

Grubler's equation

$$F = 3(N - 1) - 2P_1 - 1P_2$$

F = degrees of freedom

N = total number of links in a mechanism

P_1 = number of pairs having one degree of freedom

P_2 = number of pairs having two degree of freedom (Higher pairs)

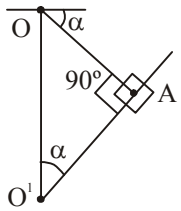
Above mechanism have 5 joint pairs which have one degree of freedom = $(P_1) = 5$.

There is No class II pairs $(P_2) = 0$, Number of links N = 5.

$\therefore \quad F = 3(5 - 1) - 2 \times 5 = 2$

3. ***Ans. (b)***

$$\sin \alpha = \frac{OA}{OO^1}$$



$\Rightarrow \quad \alpha = 30^\circ$

$$QRR = \frac{180 + 2\alpha}{180 - 2\alpha}$$

$\Rightarrow \quad QRR = 2$

4. ***Ans. (d)***

5. ***Ans. (b)***

Link 2 rotates counter-clockwise. Identify the I centre 24 direction of the velocity of I_{24} gives the direction of rotation of link 2.

6. ***Ans. (c)***

If the two links form a higher kinematic pair with pure rolling. Then their instantaneous center lies at the point of contact itself.

7. ***Ans. (c)***

8. ***Ans. (a)***

Link need not necessarily be a rigid body but it must be a resistant body so that it is capable of transmitting motion from one member to another without appreciable deformation in it. For eg: in hydraulic lifts it transmits motion.

9. ***Ans. (d)***

The centre of gravity of the coupler link in a 4-bar mechanism would experience both linear and angular acceleration.

10. ***Ans. (a)***

11. ***Ans. (c)***

Quadratic cycle chain → Ackermann steering.

Single slider crank chain → Oscillating cylinder engine mechanism.

Double slider cranks chain → Oldham coupling.

Crossed slider crank chain → Rapson's slide.

12. ***Ans. (d)***

For kinematic chain, $l = 2p - 4$

Where, l = No. of link

p = No. of pair

Here p = 4

$\therefore \quad l = 4$

13. ***Ans. (c)***

Oldham's coupling → Double slider crank chain.

14. ***Ans. (d)***

If $l = (2p - 4)$ Complete constrained

$l > (2p - 4)$ Rigid frame

$l < (2p - 4)$ Incomplete constrained

15. ***Ans. (a)***

16. ***Ans. (c)***

Governor	Hunting
Gear	Interference
Klein's construction	Acceleration of piston
Cam	Follower

17. ***Ans. (a)***

18. ***Ans. (c)***

Kinematic inversion	**Application**
1. Frame is fixed	Compressor
2. Crank is fixed	Whitworth quick return mechanism
3. Connecting rod is fixed	Oscillating cylinder engine
4. Slider is fixed	Hand pump

19. ***Ans. (d)***

Higher Pair : When a pair has a point or line contact between the links, it is known as a higher pair. The contact surfaces of the two links are dissimilar.

Wheel rolling on a surface, cam-follower, tooth gear, ball and roller bearing etc.

20. ***Ans. (d)***

21. ***Ans. (a)***

According to the Grashof's criterion for a planar four bar linkage, the sum of the shortest and longest link length cannot be greater than the sum of the remaining two link length if there is to be continuous relative rotation between two members.

$\Rightarrow \quad \ell + s \le p + q$

Where, ℓ = length of the largest link

s = length of the shortest link

p, q = length of the other two links

If this inequality is not satisfied, no link will make a complete revolution relative to another. Again if this inequality is satisfied, this will leads three different kinds of mechanisms.

(a) A double-crank mechanism where 's' in frame (fixed link).

(b) Two different crank rocker mechanism when 's' is the crank and any one of the adjacent links is the frame (fixed link).

(c) One double rocker mechanism when 's' is the coupler [i.e. opposite to the frame (fixed link)].

As in figure 1

$10 + 27 < 24 + 15$

And the smallest link is fixed, it will give rise to a double-crank mechanism i.e. both the links adjacent to the fixed link can full rotation with respect to the fixed link.

22. ***Ans. (c)***

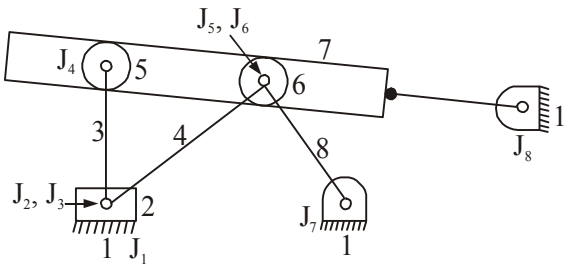
Straight line motions (Exact)

Approximate straight line motions

- Paucellier mechanism
- The watt mechanism
- Hart mechanism
- The Grasshopper mechanism
- Scott–Russel mechanism
- The Tchebicheff straight mechanism
- The Robot's straight mechanism

23. ***Ans. (b)***

24. ***Ans. (b)***



l = no. of links = 8

j = no. of simple hinges = no. of joints having one degree of freedom = 8

h = no. of higher pairs = no. of joints having two degrees of freedom = 2

F_r = no. of reductant degrees of freedom = 2

Both the links 5 and 6 have a reductant degree of freedom. As they can rotate without causing

any movement in the rest of the mechanism.

So F_e = Effective degrees of freedom

$= 3(l - 1) - 2j - h - F_r$ .... (Kutzbach Equation)

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

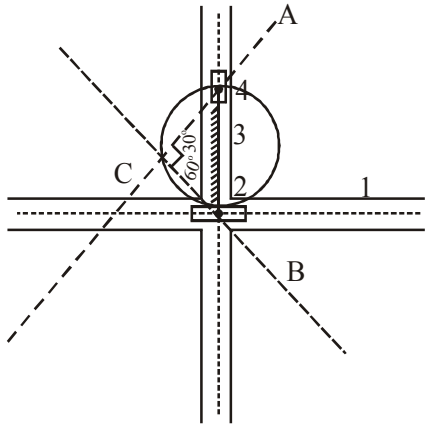
$= 21 - 16 - 4 = 1$

25. ***Ans. (c)***

The mid point of link 1 rotates in a circle with the length of link '3' on diameter.

Length of link

$3 = AB = 5$ cm



As points A and B are on the diameter of a circle.

$\angle ACB = 90°$

Also $\angle CAB = 30°$

and $\angle CBA = 60°$

Now from ΔABC, $\sin 60^o = \dfrac{AC}{AB}$

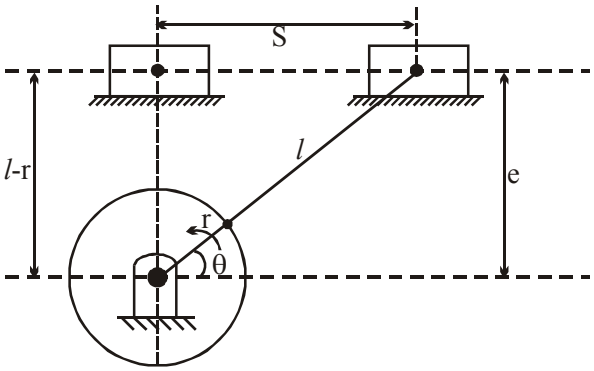
$\Rightarrow$ $AC = AB \sin 60^o$

$= 4.33$ cm

26. ***Ans. (c)***

27. ***Ans. (d)***

The given figure shows the slider crank mechanism in its limiting position.



From geometry,

$$\sin\theta = \frac{e}{r+l} = \frac{60}{20+80} = \frac{60}{100}$$

$\Rightarrow$ $\theta = 36.87°$

Now time ratio

$$= \frac{360^o - (90^o + 36.87^o)}{(90^o + 36.87^o)}$$

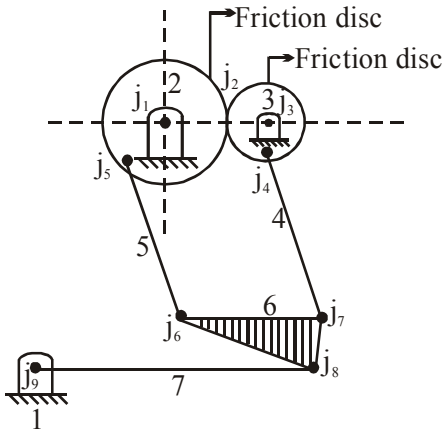
$\simeq 1.84$

Also from geometry

$$S = \sqrt{(r+l)^2 - (l-r)^2} = \sqrt{4.r.l}$$

$$S = \sqrt{4 \times 20 \times 80} = 80 \text{ cm}$$

28. ***Ans. (a)***



n = 7

j = 9 (since the discs are rolls without slipping, the higher pair is replaced by a lower pair joint)

$F = 3(7 - 1) - 2 \times 9 = 0$

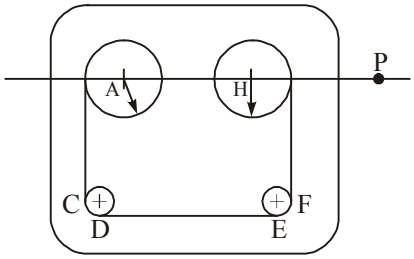
29. ***Ans. (c)***

30. ***Ans. (b)***

31. ***Ans. (a)***

32. ***Ans. (c)***

Consider the three bodies the bigger spool (Radius 20), smaller spool (Radius 10) and the frame. They together have three I centers, I centre of big spool with respect to the frame is at its centre A. that of the small spool with respect to the frame is at its centre H. The I centre for the two spools P is to be located.



As for the three centers in line theorem all the three centers should lie on a straight line implies on the line joining of A and H more over as both the spools are rotating in the same direction, P should lie on the same side of A and H. Also it should be close to the spool running at higher angular velocity. Implies close to H and it is to be on the right of H. Whether P belongs to bigger spool or smaller spool its velocity must be same. As for the radii of the spools and noting that the velocity of the tape is same on both the spools

$$\omega_H = 2\omega_A$$

$$\therefore \quad AP \cdot \omega_A = HP\omega_H$$

and $$AP = AH + HP$$

$$\Rightarrow \quad HP = AH$$

33. ***Ans. (c)***

For revolute joint, degree of freedom is 1 and constrained DOF = 5.

For cylindrical joint, degree of freedom is 2 and constrained DOF = 4.

For spherical joint, degree of freedom is 3 and constrained DOF = 3.

[Degree of constraints = 6 – Degree of freedom]

34. ***Ans. (d)***

35. ***Ans. (d)***

36. ***Ans. (c)***

37. ***Ans. (d)***

Number of links = 7

Number of lower pair = 8

$$D.O.F = 3(7 - 1) - 2(8)$$

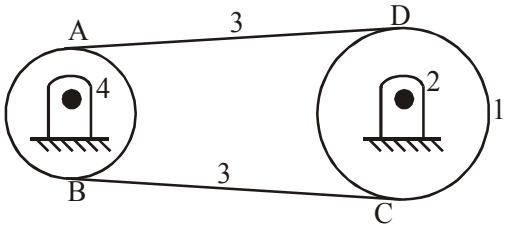
$$= 18 - 16 = 2$$

38. ***Ans. (c)***

39. ***Ans. (b)***

40. ***Ans. (a)***

41. ***Ans. (c)***



Four links are marked as shown. We have two turning pairs at 2 and 4. Points of contact A, B, C and D form 4 higher pairs.

$$D.O.F = 3(n - 1) - 2p_1 - p_2$$

$$= 3(4 - 1) - 2(2) - 4 = 1$$

42. ***Ans. (d)***

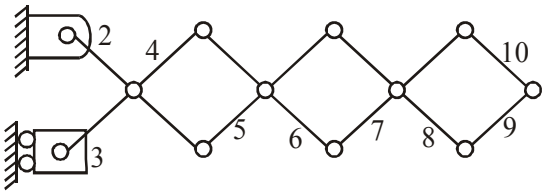
43. ***Ans. (b)***

44. ***Ans. (d)***

45. ***Ans. (c)***

46. ***Ans. (c)***

47. ***Ans. (c)***



No. of loops = 4

No of links = 10

$$F = n - (2(\text{no of loops}) + 1)$$

$$= 10 - 9 = 1$$

48. ***Ans. (a)***

49. ***Ans. (d)***

50. ***Ans. (a)***

51. ***Ans. (b)***

52. ***Ans. (a)***

53. ***Ans. (b)***

54. ***Ans. (d)***

55. ***Ans. (c)***

56. ***Ans. (b)***

57. ***Ans. (c)***

Since $5 + 11 < 8 + 9$

So it is class-I mechanism. Also link adjacent to shortest link is fixed, so becomes a crank-rocker mechanism.

58. ***Ans. (a)***

59. ***Ans. (c)***

60. ***Ans. (a)***

61. ***Ans. (b)***

62. ***Ans. (a)***

63. ***Ans. (c)***

64. ***Ans. (d)***

65. ***Ans. (d)***

$$l = 2p - 4$$

66. ***Ans. (c)***

Ackermann steering fullfils fundamental equation for gearing at middle and two extreme positions not in all positions.

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