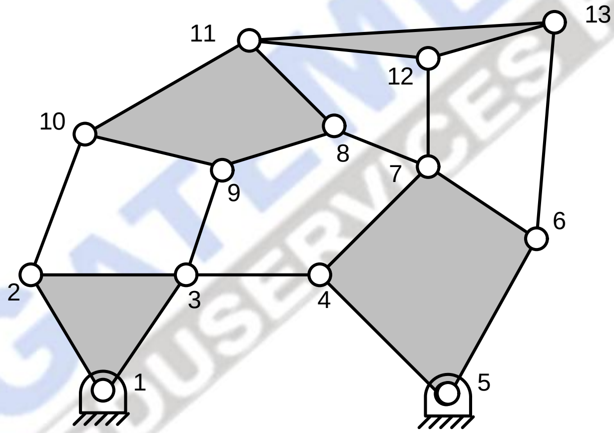
(A)NSWER SHEET (MOS,TOM,EM)											
1	(2)	13	(B)	25	(A)	37	(B)	49	(B)	61	(B)
2	(B)	14	(B)	26	(B)	38	(5.773)	50	(B)	62	(B)
3	(D)	15	(8)	27	(5)	39	(C)	51	(C)	63	(C)
4	(B)	16	(13.33)	28	(B)	40	(B)	52	(C)	64	(C)
5	(B)	17	(B)	29	(2.73)	41	(D)	53	(A)	65	(D)
6	(C)	18	(1)	30	(D)	42	(C)	54	(B)		
7	(B)	19	(A)	31	(B)	43	(1.71)	55	(C)		
8	(C)	20	(0.6)	32	(A)	44	(103.6)	56	(B)		
9	(A)	21	(A)	33	(B)	45	(B)	57	(B)		
10	(D)	22	(62.5)	34	(1)	46	(C)	58	(D)		
11	(A)	23	(B)	35	(A)	47	(B)	59	(A)		
12	(O)	24	(C)	36	(75)	48	(B)	60	(A)		

SOLUTION

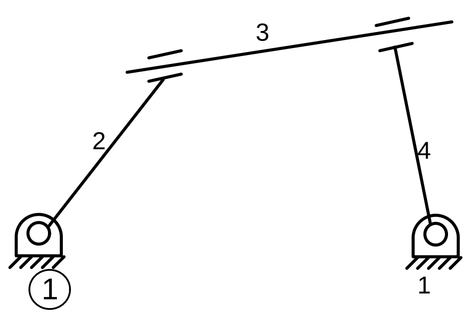
1. (2)



Joint 3, 7 are the joint which connects 3 links therefore joint 3 & 7 will be ternary joint.

Hence number of ternary joint = 2.

2. (B)



Number of link n = 4

Number of binary joint j = 4

Number of higher pair h = 0

The rod 3 of the mechanism can slide freely without causing any movement in rest of mechanism.

Hence number of reductant degree of freedom $F_r = 1$

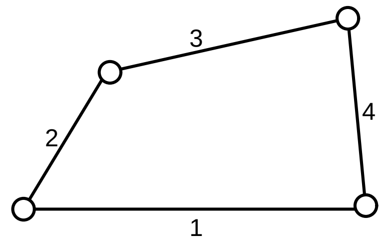
Hence, Degree of freedom,

$DOF = 3(n-1) - 2j - h - F_r$

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

$\boxed{DOF = 0}$

3. **(D)**



Number of link $n = 4$

Number of pair with 1 degree of freedom $J = 4$

Number of pair with 2 degree of freedom $h = 0$

Degree of freedom (DOF),

$\Rightarrow \quad \text{DOF} \quad = 3n - 2J - h$

$= 3(4) - 2(4) - 0$

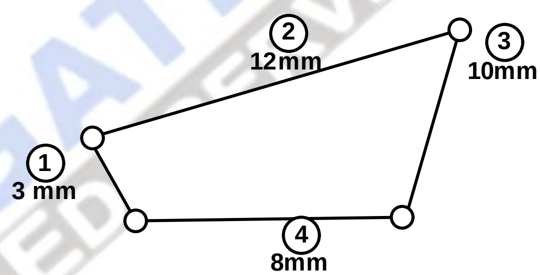
$= 12 - 8$

$\Rightarrow \quad \text{DOF} \quad = 4$

4. **(B)**

5. **(B)**

6. **(C)**



Length of longest link $l = 12mm$

Length of shortest link $s = 3mm$

Length of other two link,

$p = 8mm$

$q = 10mm$

$l + s = 12 + 3 = 15mm$

$p + q = 8 + 10 = 18mm$

$\therefore \qquad l + s < p + q$

Therefore above chain will be Greshof chain. For Greshof chain if link 3 will be fixed then the obtain mechanism will be Rocker–rocker mechanism.

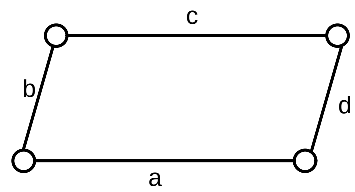
7. **(B)**

8. **(C)**

Transmition angle $\rightarrow$ angle between output link and connecting rod

9. **(A)**

10. (D)



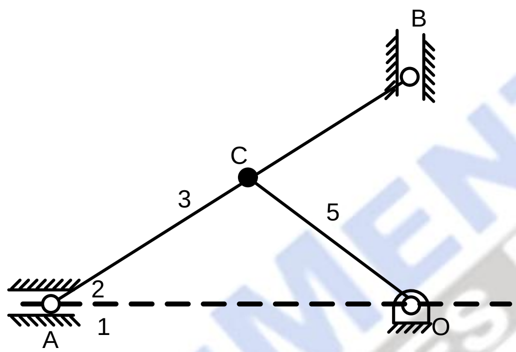
Given that length of parallel link are equal therefore above linkage is the example of parallel rank 4 bar chain in which by fixing any of the link the obtain mechanism will always be linkage double crank mechanism.

Therefore we cannot obtain crank – rocker mechanism from above chain.

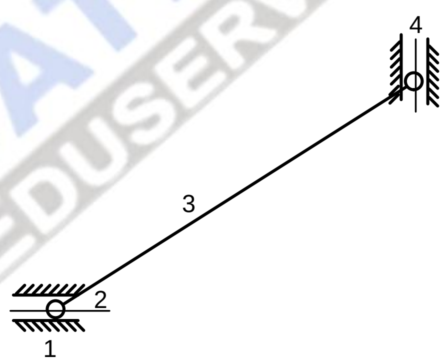
11. (A)

12. (0)

13. (B)



The locus of point C will be circle of radius equal to CD with or without link 5. Hence link 5 will not affect the motion of mechanism, therefore link 5 will be reductant link and we can remove it, to calculate the degree of freedom. After removing reductant link 5 , the mechanism becomes



Number of link = 4

Number of pair with 1 degree of freedom J = 4

Number of pair with 2 degree of freedom h = 0

Hence degree of freedom,

$$F = 3(n-1) - 2J - h$$

$$= 3(4-1) - 2(4) - 0$$

$$F = 1$$

14. (B)

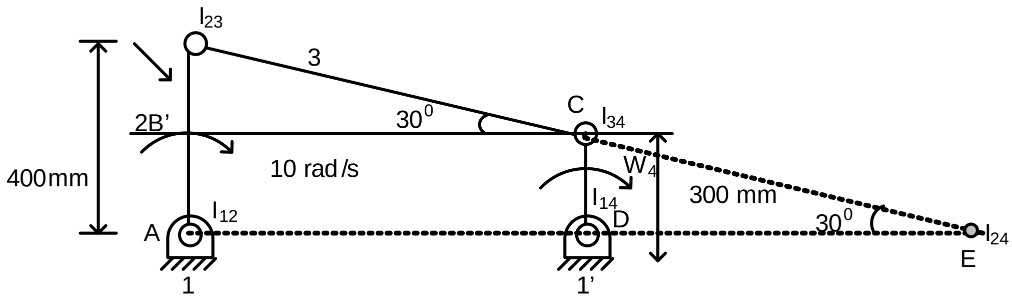
15. (8)

$$V_A = V_{AO} = \times length\, of\ link\, OA$$

$$= 20 \times 0.4$$

$\Rightarrow \quad V_A = 8\,m/s$

16. (13.33)



$$\tan 30 = \frac{400-300}{AD} \qquad [\Delta\ B\,C\,B']$$

$$\Rightarrow \quad AD = 173..205\,mm$$

$$\tan 30 = \frac{CD}{DE} = \frac{300}{DE} \Rightarrow DE = 519.615\,mm$$

$$AE = AD + DE = 173.205 + 519.613 = 692.82\,mm$$

$$V_{24} = W_2\left(I_{24} - I_{12}\right) = W_4\left(I_{24} - I_{14}\right)$$

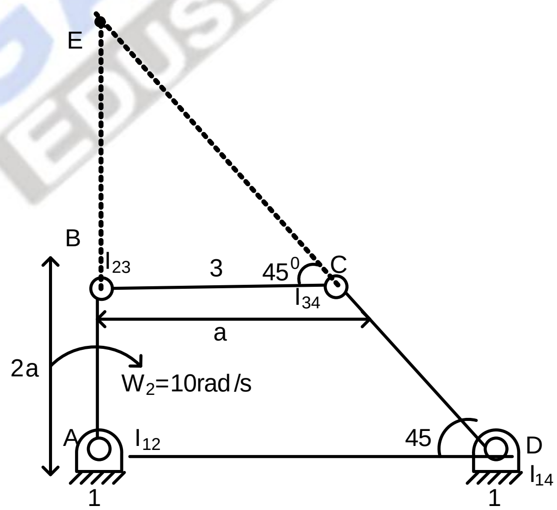
$$\Rightarrow \quad W_4 = \frac{W_2\left(I_{24} - I_{12}\right)}{\left(I_{24} - I_{14}\right)}$$

$$= \frac{10 \times AE}{DE}$$

$$= \frac{10 \times 692.82}{519.615}$$

$$\Rightarrow \quad W_4 = 13.33\,rad/s.$$

17. (B)



$$\tan 45° = \frac{BE}{BC} \qquad [\Delta\,EBC]$$

$$\Rightarrow \quad 1 = \frac{BE}{a}$$

$$\Rightarrow \quad BE = a$$

$V_{23} = \mu_3 (I_3 - I_{23}) = \mu_2 (I_{12} - I_{23})$

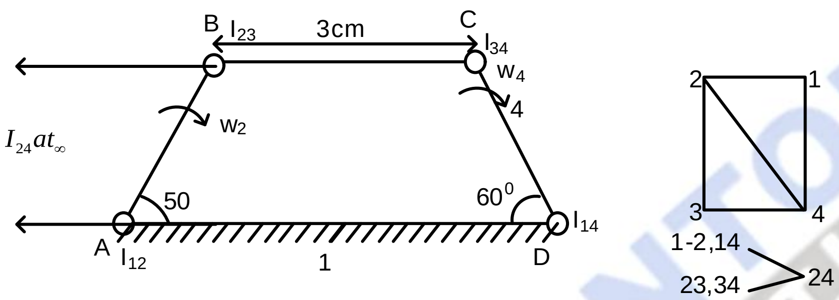
$\Rightarrow \qquad \mu_3 = \dfrac{\mu_2 (I_{12} - I_{23})}{I_{13} - I_{23}}$

$= \dfrac{\mu \times AB}{BE}$

$= \dfrac{10 \times 2a}{a}$

$\Rightarrow \qquad \mu_3 = 20 rad/s = \mu_{BC}$

18. (1)



Since I_{24} lies at ∞

Therefore, $I_{24} - I_{12} = I_{24} - I_{14}$

Hence, $\dfrac{W_4}{W_2} = 1$

Mechanism advantage,

$MA = \dfrac{W_2}{W_4}$

$= \dfrac{1}{W_4/W_2}$

$= \dfrac{1}{1}$

$M.A. = 1$

19. (A)

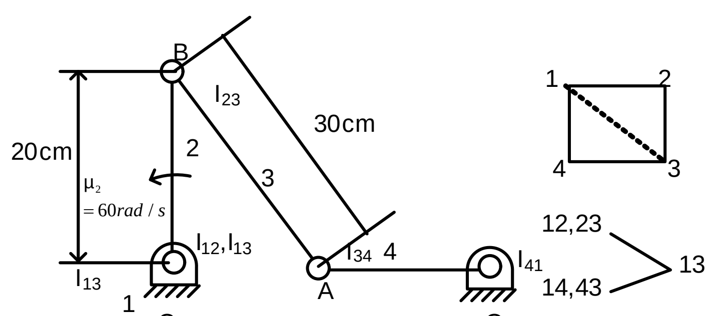
Number of Instantaneous centre,

$N = \dfrac{n(n-1)}{2}$

$= \dfrac{5(5-1)}{2}$

$N = 10$

20. (0.6)



$V_B = V_{BC} = W_2 \times BC$

$= 60 \times 0.2$

$V_B = 12\, m/s$

$V_{23} = W_3\left(I_{23} - I_{13}\right) = W_2\left(I_{23} - I_{12}\right)$

$\Rightarrow \qquad W_3 \times BC = W_2 \times BC$

$\Rightarrow \qquad W_3 = W_2 = 60\, rad/s$

Velocity of rubbing of pin B,

$V_{r_B} = r_B\left(W_2 + W_3\right)$

$= \dfrac{0.01}{2}(60 + 60)$

$V_{r_B} = 0.6\, m/s$

21. (A)

$a_B^t = a_{BA}^L = \sim \times AB$

$= 5 \times 0.1$

$a_B^t = 0.5\, m/s^2$

22. (62.5)

The acceleration along AR,

$a^C = f - w^2 r \qquad (f = 0)$

$= -5^2 \times 1.5$

$a^C = -37.5\, m/s^2$

The acceleration $\perp$ to AR,

$a^t = a^C_{corrilios} + \sim r \quad (\sim = 0)$

$\Rightarrow \qquad a^t = 2WV$

$= 2 \times 5 \times 5$

$\Rightarrow \qquad a^t = 50\, m/s^2$

Absolute acceleration of slider,

$a = \sqrt{\left(a^c\right)^2 + \left(a^t\right)^2}$

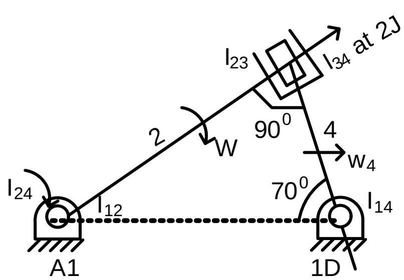
$= \sqrt{37.5^2 + 50^2}$

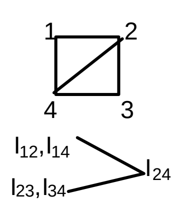
$a = 62.5\, m/s^2$

23. (B)

24. (C)

25. (A)





$$\frac{W_4}{W_2} = \frac{I_{24} - I_{12}}{I_{24} - I_{14}}$$

$$\frac{W_4}{W_2} = \frac{O}{AD}$$

$$\Rightarrow \qquad W_4 = O$$

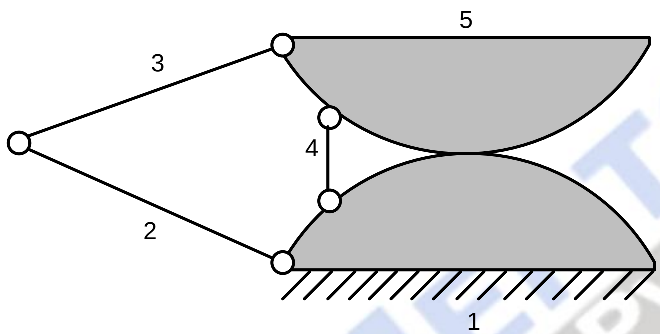
Corriolis component of acceleration,

$$a^C = 2W_4 \times V_{CB}$$

$$= 2 \times 0 \times V_{CB}$$

$$a^C = 0$$

26. (B)



Number of link n = 5

Number of lower pair J = 5

Number of higher pair h = 1

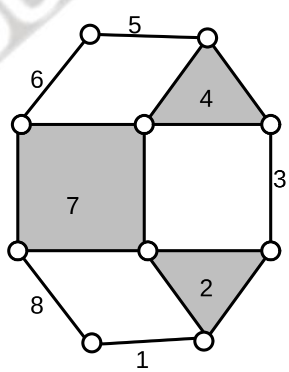
$\therefore$ Degree of freedom,

$$\text{DOF} = 3(n-1) - 2J - h$$

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

$$\boxed{DOF = 1}$$

27. (5)

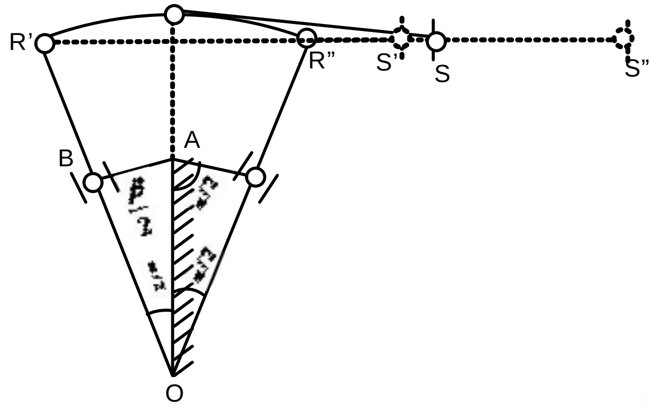


The above chain is symmetric about link 3 and 7.

Therefore identical inversion are obtained if either any one in 2, 1 and 8 or any one in 4, 5, 6 respectively is fixed. A Apart from above two more inversion can be possible by fixing 3 or 7.

Total number of inversion possible = 5.

28. (B)



Given,

$OA = 250\,mm$

$AB = 100mm$

$OR = OR' = 450\,\text{mm}$

$\cos\frac{}{2} = \frac{AB}{OA}$

$\Rightarrow \qquad \cos\frac{}{2} = \frac{100}{250}$

$\Rightarrow \qquad \frac{}{2} = 66.42°$

$\frac{\sim}{2} = 180 - 90 - \frac{}{2}$

$\Rightarrow \qquad \frac{\sim}{2} = 180 - 90 - \frac{}{2}$

$\Rightarrow \qquad \frac{\sim}{2} = 23.58°$

Stroke length $\quad = S'S''$

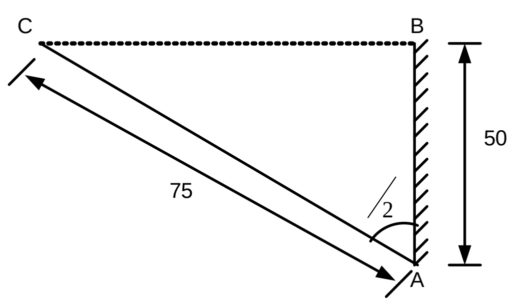
$= R'R''$

$= 2OR'\sin\frac{\sim}{2}$

$= 2 \times 450 \sin(23.58)$

Stroke length $\quad = 360.3\,mm$

29. (2.73)

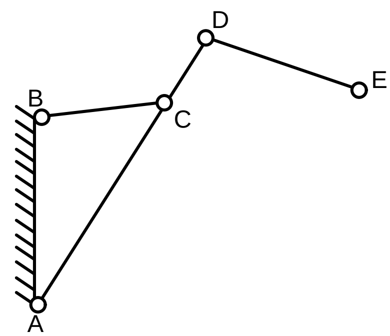


$$\cos\frac{}{2}=\frac{50}{75}$$

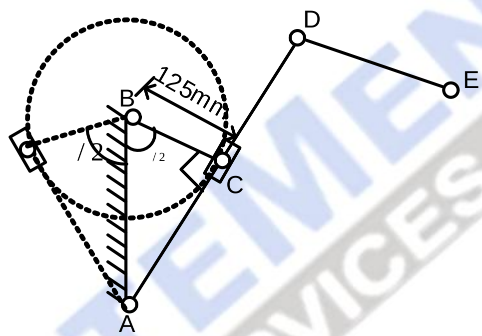
$$\Rightarrow \quad = 9638^0$$

$$QRR=\frac{360^0-}{}=2.73$$

30. (D)



Given, $BC = 125mm$



Given, $\frac{\text{Time to forward strok}}{\text{Time to return stroke}}=2$

$\Rightarrow \quad \frac{360°-}{}=2$

$\Rightarrow \quad 360- \quad =2$

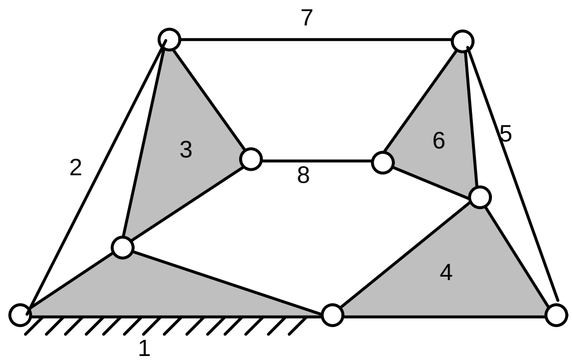
$\Rightarrow \quad =120°$

$\Rightarrow \quad \cos\frac{}{2}=\frac{BC}{AB}$

$\Rightarrow \quad AB=\frac{125}{\cos(60°)}$

$\Rightarrow \quad AB=250mm$

31. (B)



Number of link $n = 8$

Number of binary joint $J_2 = 7$

Number of ternary joint $J_3 = 2$

Degree of freedom $= 3(n-1) - 2(J_2 + 2J_3)$

$= 3(8-1) - 2[7 + 2(2)]$

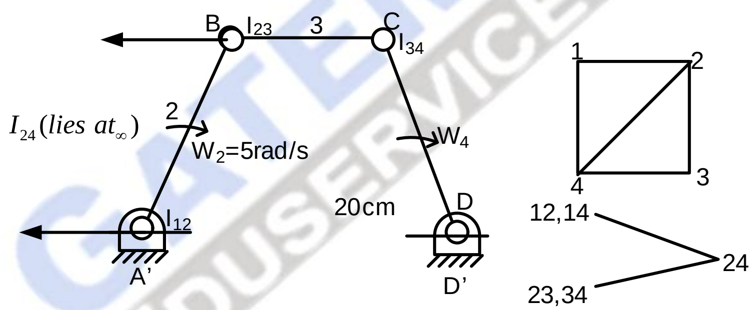
$= 21 - 22$

$\Rightarrow \quad DOF \quad = -1$

$DOF < 0$

Hence the above mechanism will be super structure.

32. (A)



$$\Rightarrow \quad \frac{W_4}{W_2} = \frac{I_{24} - I_{12}}{I_{24} - I_{14}}$$

Since I_{24} lies at ∞ therefore,

$I_{24} - I_{12} \approx I_{24} - I_{14}$

Hence,

$$\Rightarrow \quad \frac{W_4}{W_2} = 1$$

$\Rightarrow \quad W_4 = W_2$

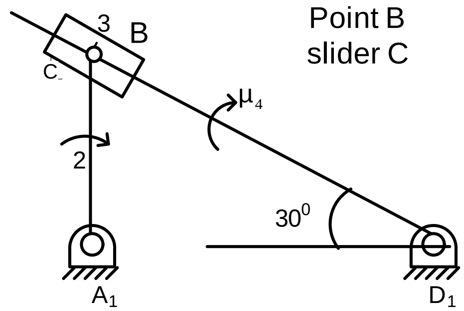
$\Rightarrow \quad W_4 = 5\,rad/s$

$V_E = V_{ED} = \mu_4 \times ED$

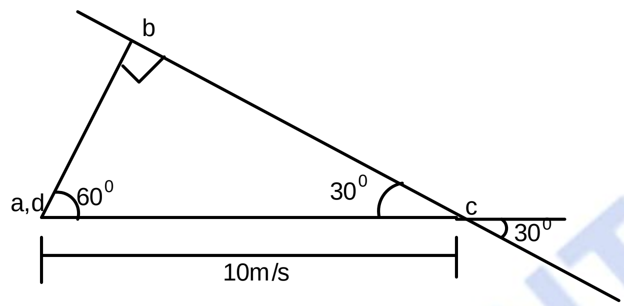
$= 5 \times 0.2$

$V_E = 1\,m/s$

33. (B)



Velocity diagram,



$\cos 60 = \frac{bd}{dc}$

$\Rightarrow \quad bd = 10 \times \cos 60$

$\Rightarrow \quad bd = 5\, m/s$

$V_{BD} = bd = 5\, m/s$

$= W_4 = W_{BD}$

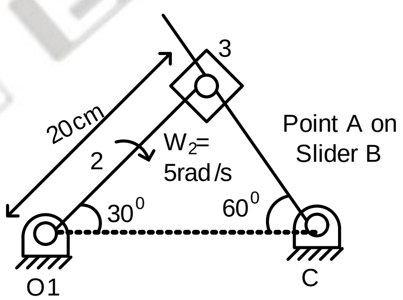
$= \frac{V_{BD}}{BD}$

$= \frac{5}{0.5}$

$W_4 = 10 rad/s$

34. (1)

NOTATIONS

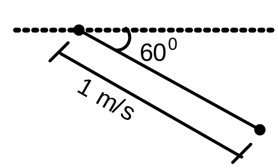


$V_{BO} = W_2 \times BO$

$= 5 \times 0.2$

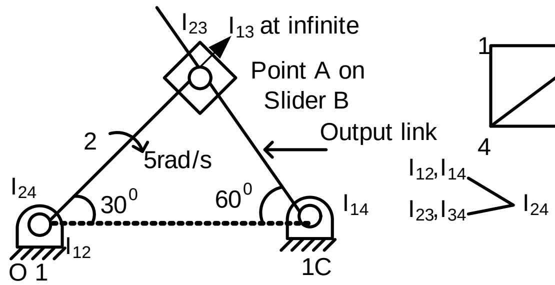
$V_{BO} = 1 m/s$

Velocity diagram o,c,a



$V_{BA} = ab = ob = 1\, m/s$

35. (A)

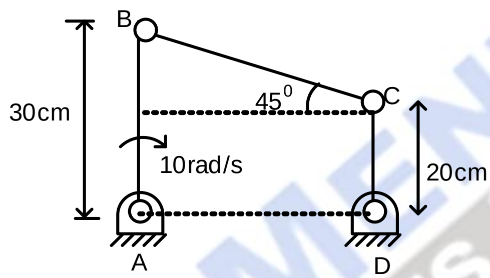


$$\frac{W_4}{W_2} = \frac{I_{24} - I_{12}}{I_{24} - I_{14}}$$

$$\Rightarrow \qquad \frac{W_4}{W_2} = \frac{0}{OC}$$

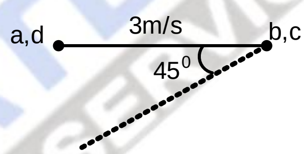
$$\Rightarrow \qquad W_4 = 0\, rad/s$$

36. (75)



$V_{BA} = ab = 10 \times 0.3 = 3\, m/s$

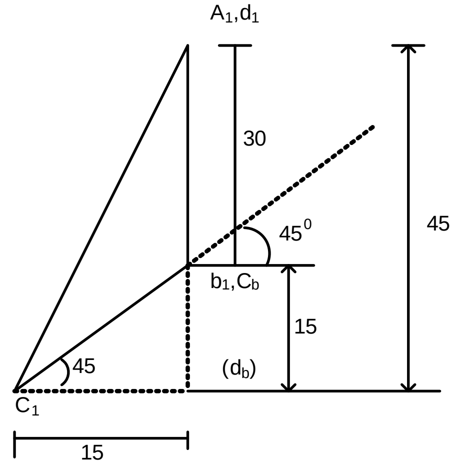
Velocity diagram,



$V_{BA} = ab = 3\, m/s$, $V_{BC} = 0$, $V_{CD} = 3\, m/s$

Acc. Vector	**Magnitude** (m/s^2)	**Direction**	**Sense**
$a_{ba}^{c}\left(a_1\, b_1\right)$	$\frac{V_B A^2}{AB} = 30\, m/s^2$	11 AB	$\rightarrow A$
a_{BC}^{C}	$\frac{V_{BC}{}^2}{BC} = 0$	11 BC	$\rightarrow B$
$a_{BC}^{b}\left(c_1\, c_1\right)$	–	$\perp BC$	–
$a_{CD}^{C}\left(d_1\, d_b\right)$	$\frac{V_{CD}{}^2}{CD} = 45$	11 CD	$\rightarrow$
a_{CD}^{t}	–	$\perp CD$	–

Acceleration diagram,



$\tan 45° = \frac{15}{C_1\, d_b}$

$\Rightarrow \qquad 1 = \frac{15}{C_1\, d_b}$

$\Rightarrow \qquad C_1\, d_b = 15\, m/s^2$

$C_1\, d_1 = \sqrt{15^2 + 45^2}$

$C_1\, d_1 = 47.43\, m/s^2$

$a^t_{CD} = C_1\, d_b$

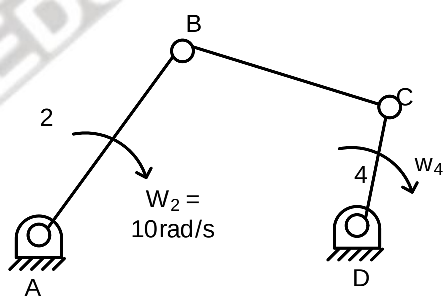
$a^t_{CD} = 15\, m/s^2$

$\sim_{CD} = \frac{a^t_{CD}}{CD}$

$= \frac{15}{0.2}$

$\sim_{CD} = 75\, rad/s^2$

37. (B)



$M.A = \frac{W_2}{W_4}$

$\Rightarrow \qquad 2 = \frac{W_2}{W_4}$

$\Rightarrow \qquad W_4 = \frac{W_2}{2} = \frac{10}{2} = 5\, rad/s$

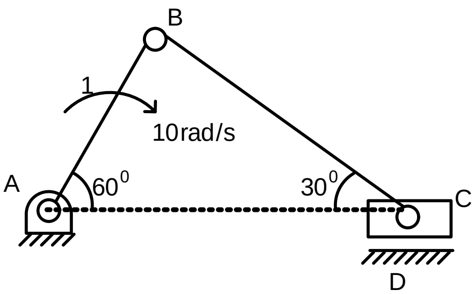
Centripetal acceleration of point C with respect to point D,

$a^C_{CD} = W_4^2 \times CD$

$= 5^2 \times 0.5$

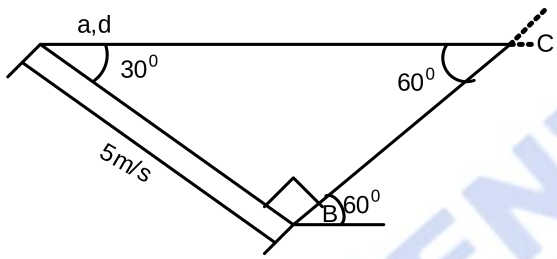
$a_{CD}^{C} = 12.5\, m/s^2$

38. (5.773)



$AB = 50\, cm$

Velocity diagram,



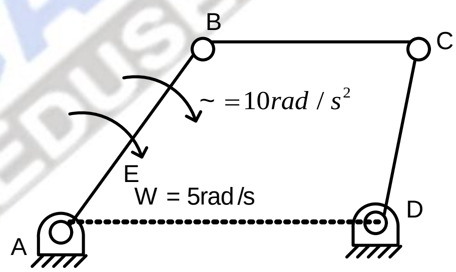
$\cos 30° = \frac{ab}{dc}$

$\Rightarrow \quad \frac{\sqrt{3}}{2} = \frac{5}{dc}$

$\Rightarrow \quad dc = 5.773\, m/s$

Velocity of slider $V_c = dc = 5.773\, m/s$

39. (C)



$AB = 1\, m$

$AE = 0.7\, m$

$a_{AE} = W^2 \times AE$

$= 5^2 \times 0.7$

$a_{AE}^{C} = 17.5\, m/s^2$

$a_{AE}^{t} = \sim \times AE$

$= 10 \times 0.7$

$a_{AE}^{t} = 7\, m/s^2$

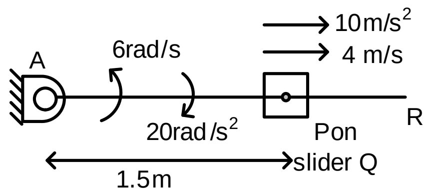
Absolute acceleration of E with respect to A

$a_{AE} = \sqrt{\left(a_{AE}^{C}\right)^2 + \left(a_{AE}^{t}\right)^2}$

$= \sqrt{17.5^2 + 7^2}$

$a_{AE} = 18.85\, m/s^2$

40. (B)



$V = 4\, m/s$

$f = 10\, m/s^2$

$\sim\ = 20\, rad/s^2$

$w = -6\, rad/s$

$r = 1.5\, m$

Acceleration along AR,

$a^C = f - w^2 r$

$= 10 - \left[(-6)^2 \times 1.5\right]$

$a^C = -44\, m/s^2$

Acceleration $\perp ar$ to AR,

$a^t = a_{corriolis} + \sim .r$

$a^t = (2wv) + \sim r$

$= [(2)(-6)(4)] + [20 \times 1.5]$

$a^t = -18\, m/s^2$

Absolute acceleration of slider,

$a = \sqrt{(a^c)^2 + (a^t)^2}$

$= \sqrt{(-44)^2 + (-18)^2}$

$a = 47.54\, m/s^2$

41. (D)

We know that,

Angular velocity of slider $= W_4 = 0$

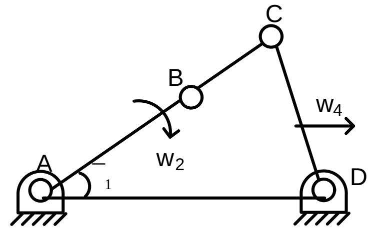
Hence mechanism advantage,

$MA = \frac{W_1}{W_4}$

$= \frac{W_1}{0}$

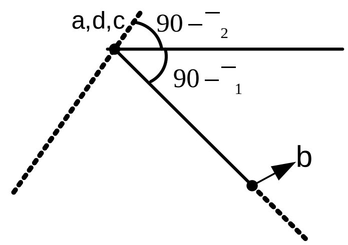
$MA = \infty$

42. (D)



Velocity diagram,

Let, $V_{BA} = x$



$V_{CD} = CD = 0$

$W_4 = \frac{V_{CD}}{CD} = 0$

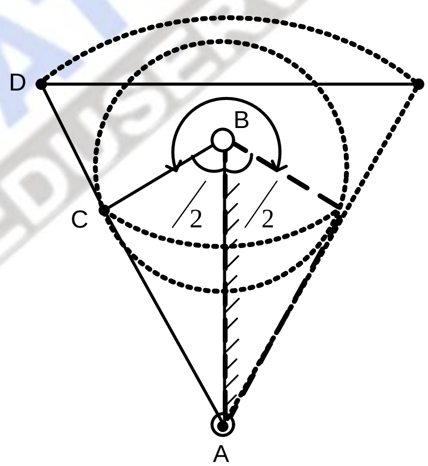
Mechanical advantage,

$MA = \frac{W_2}{W_4}$

$= \frac{W_2}{0}$

$MA = \infty$

43. (1.71)



Given,

Length of fixed link $AB = 250mm$

Length of crank $BC = 100mm$

$\cos\frac{\ }{2} = \frac{BC}{AB}$

$\Rightarrow \quad Cos\frac{\ }{2} = \frac{100}{250}$

$\Rightarrow \quad \frac{\ }{2} = 66.42°$

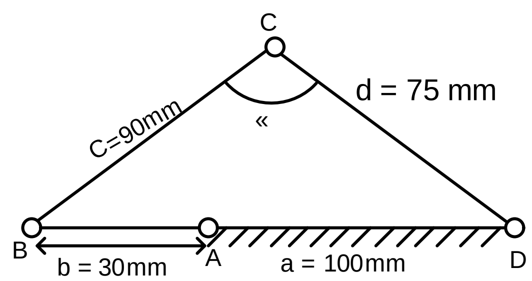
$\Rightarrow \qquad = 132.84^\circ$

$\dfrac{\text{Time to cutting storke}}{\text{Time to return stork}} = \dfrac{360^\circ -}{}$

$= \dfrac{360^\circ - 132.84^\circ}{132.84}$

$= 1.71$

44. (103.6⁰)



By the above figure

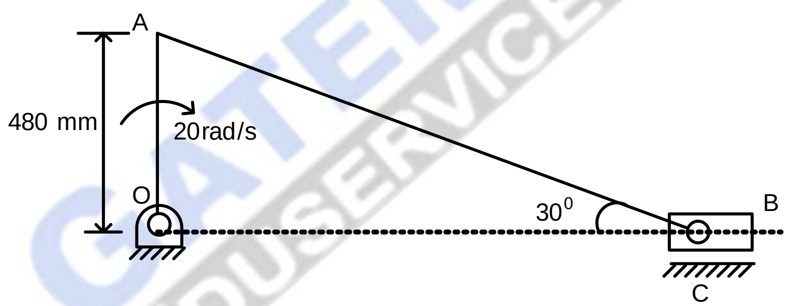
$(a+b)^2 = c^2 + d^2 - 2cd\cos «$

$\Rightarrow \qquad (100+30)^2 = 90^2 + 75^2 - (2\times 90\times 75)\cos «$

$\Rightarrow \qquad \cos « = -0.235$

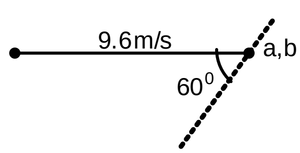
$\Rightarrow \qquad « = 103.6$

45. (B)



$V_{OA} = 20\times 0.48 = 9.6\, m/s$

Velocity diagram,



Velocity O slider $= V_{BC} = bc$

$= 9.6\, m/s$

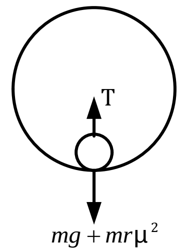
46. (C)

Range $= \dfrac{u^2 \sin 2¯}{g}$

$\Rightarrow \quad 25 = \dfrac{u^2 \sin 60}{9.81}$

$\Rightarrow \quad \boxed{u = 16.83\, m/\text{sec}}$

47. (B)



At bottom point

$T_{\max} = mg + mr\mu^2$

$\Rightarrow \quad 20 = 0.5 \times 9.81 + 0.5 \times 0.5 \times \mu^2$

$\Rightarrow \quad \sqrt{\dfrac{20 - 0.5 \times 9.81}{0.25}} = \mu$

$\Rightarrow \quad \mu = 7.75\, rad / \sec$

48. (B)

To avoid skidding

$\dfrac{mv^2}{r} \le F_A + F_B$

$\Rightarrow \quad \dfrac{mv^2}{r} \le « \left(R_A + R_B\right)$

$\Rightarrow \quad \dfrac{mv^2}{r} \le « w$

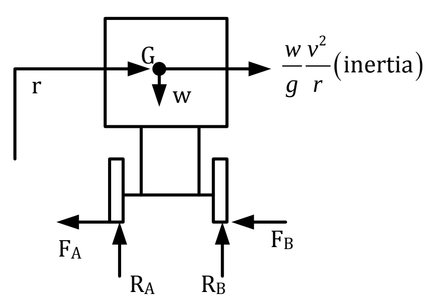
$\Rightarrow \quad \dfrac{w}{g}\dfrac{v^2}{r} \le « w$

$\Rightarrow \quad v \le \sqrt{« gr}$

$\Rightarrow \quad 10 \le \sqrt{0.5 \times 9.81 \times r}$

$\Rightarrow \quad \dfrac{10^2}{0.5 \times 9.81} = r$

$\boxed{r = 20.38m}$



49. (B)

$x = 2t^2 + 5t$

$y = 4.9t^2$

$v_x = 4t + 5$

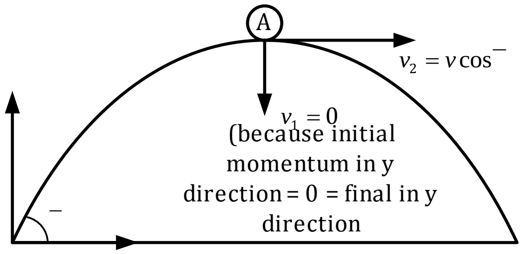
$v_y = 9.8t$

$a_x = 4$

$a_y = 9.8$

$a = \sqrt{a_x^2 + a_y^2} = 10.58\, m/s^2$

50. (B)



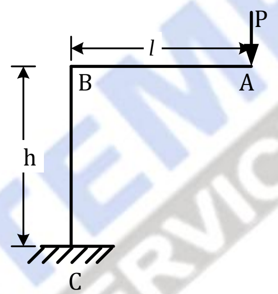
Initial momentum without explosion.

$a = mv\cos$ —

$mv\cos$ — $p + \frac{m}{2}v_2$

$\Rightarrow$ $\boxed{v_2 = 2v\cos\text{—}}$

51. (C)

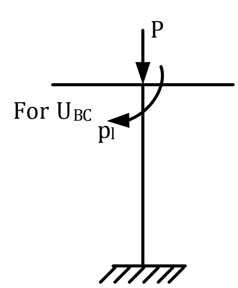


$U_{AB} = \int_0^l \frac{(px)^2\, dx}{2EI}$

$= \frac{p^2}{2EI}\int_0^l x^2 dx$

$= \frac{p^2}{2EI}\left[\frac{x^3}{3}\right]_o^l$

$= \frac{p^2 l^3}{6EI}$



$= \int_o^h \frac{(pl)^2\, dx}{2EI}$

$$= \frac{p^2 l^2 h}{2EI}$$

$$U = U_{AB} + U_{BC}$$

$$= \frac{P^2 l^3}{6EI} + \frac{p^2 l^2 h}{2EI}$$

Now

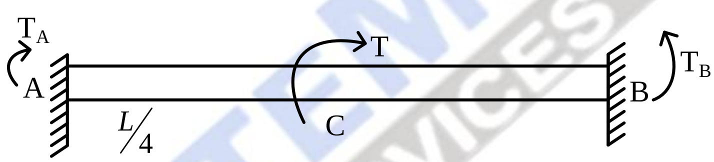
$$¢_A = \frac{\partial U}{\partial P}$$

$$= \frac{pl^3}{3EI} + \frac{pl^2 h}{EI}$$

$$= \frac{pl^2}{EI}\left[\frac{l}{3} + h\right]$$

$$¢_A = \frac{pl^2}{3EI}\left[l + 3h\right]$$

52. (C)



$$T_A - T_B = T \qquad ----(i)$$

$$-_A = -_B$$

$$\frac{T_A \cdot l/4}{Gd_4} = \frac{T_B \cdot 3l}{4 \times Gd_4}$$

$$T_A = 3T_B \; ----(ii)$$

From (i) and (ii)

$$3T_B - T_B = T$$

$$T_B = \frac{T}{2} \qquad \Bigg| \; T_A = \frac{3T}{2}$$

$$\tau = \frac{Tr}{J}$$

$$\frac{\tau_{Ac}}{\tau_{CB}} = \frac{T_A}{T_B} = \frac{3T/2}{T/2} = 3$$

$$\boxed{\frac{\tau_{AC}}{\tau_{CB}} = \frac{3}{1}}$$

53. (A)

$$K_{eq} = \frac{2S \times S}{2S + S} = \frac{2}{3}S$$

$$\delta = \frac{F}{K_{eq}} = \frac{W}{\frac{2}{3}S} = \frac{3W}{2S}$$

54. (B)

$$-_1 = \text{ due to torque } T_1 = \frac{T_1}{J}.\frac{\ell}{C}$$

$$-_1 = \frac{T_1}{C}\left[\frac{2.4}{\frac{®}{32}\times(0.1)^4} + \frac{2.6}{\frac{®}{32}\times(0.05)^2}\right],$$

$$-_2 = \frac{T_2}{C}\frac{2.4}{\frac{®}{32}\times(0.1)^4}$$

Given $-_1 - -_2 = .065$ and $\frac{T_2}{T_1} = 3 \Rightarrow T_2 = 3T$

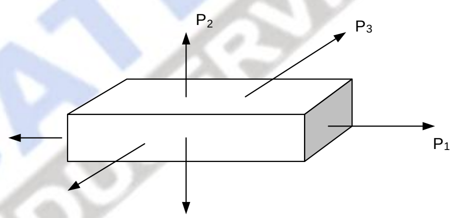
$$\frac{T_1}{C}\left[\frac{2.4\times32}{®\times(0.10)^4} + \frac{2.5\times32}{®\times(0.05)^4}\right] - \frac{3T_1}{C}\frac{2.4\times32}{(0.1)^4\times®} = .065$$

$$\frac{T_1}{C}\left[\frac{2.5\times32}{®\times(0.05)^4} - \frac{2\times2.4\times32}{®\times(0.10)^4}\right] = 0.065$$

$T_1 = 3.263KNm, T_2 = 9.789\text{KNm}$

55. (C)

Volumetric strain



$$\frac{\Delta V}{V} = £_V = (P_1 + P_2 + P_3)\left(\frac{1-2«}{E}\right)$$

$$\Rightarrow 0 = (P_1 + P_2 + P_3)\left(\frac{1-2«}{E}\right)$$

$$\therefore P_1 + P_2 + P_3 = 0$$

56. Let d be the distance the cyclist covers, s be his usual speed and t be the time he usually takes, Then, from the given information;

$\frac{d}{s+2} = t - \frac{1}{6}(eq1) and \frac{d}{s-4} = t + \frac{1}{2}(eq2)$. We also know that $\frac{d}{s} = t$. Solving the equations, we get s = 16 km/hr

57. (B)

58. (D)

59. (A)

60. (A)

61. The second word is the highest point of the first word. While a crest is the highest point of a wave, a peak is the highest point of a mountain.,

62. Let us consider statement I first. If n be the large number, $n^2 - n = 90$ => n = 10 and -9. But since n is a natural number, it has to be 10. Hence we get the product of n and n-1 as 90. Hence we can definitely answer the question using statement I. Let us now ignore statement I and consider statement II alone. If m be the smaller number, then m + x^2 = 13, where x is an even integer. Now the only value of x^2 which will satisfy this equation is 4. Therefore, the only value of m is 9, which means the product is 90. Again using statement II alone, we can definitely conclude whether the product is greater than 90 or not. Thus this question can be answered using either statement alone hence option B

63. **(C)**

64. Let c be the capital or fixed amount that the contractor has , W be the weekly subsidy, ie the amount the contractor receives per week and s be the weekly wage for each man. Then , from the first condition , c + 52w = 42 x 52s (eq 1). From the second condition , c + 13w = 13 x 60s (eq 2.) Solving we get 39w = 1404s or w = 36s and 3c = 936s or c = 312s. Now., If n men can be maintained for 26 weeks, c + 26w = 26 x n x s => 312s + 26 xn x s => n = 48 men.

65. If the studies are considered adequate it is believed that there is a clear difference in psychological capacities of the two, which refutes the finding.