# Homework No. 1 Vector Loop Closure Equation

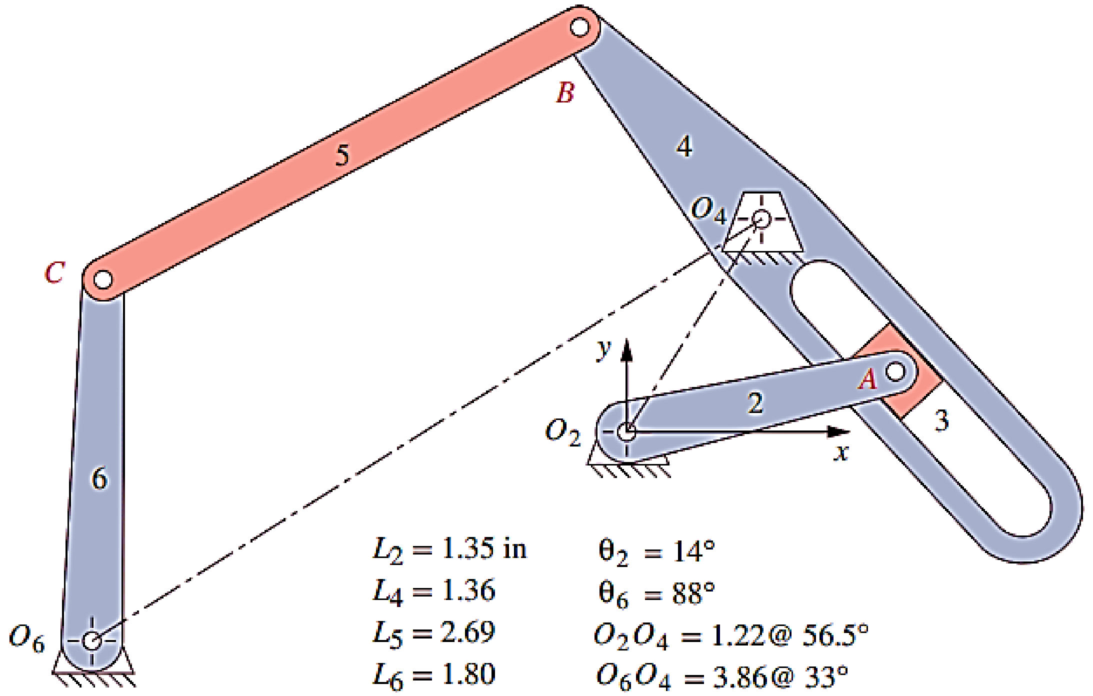
Your solution for each problem should include the following

1. What's given in the problem (FBD and numerical values)
2. What's required
3. Solution
4. Comments, recommendations.
5. You should use cover page with your name and your serial no.

**Due Monday 10/04/2023 (lecture time).**

P1. Use vector LCE method to calculate the accelerations of points A, B, and C for the position shown.
Problems 6-64 and 7-52 in the text book.

**An example similar to this problem was solved in the class.**

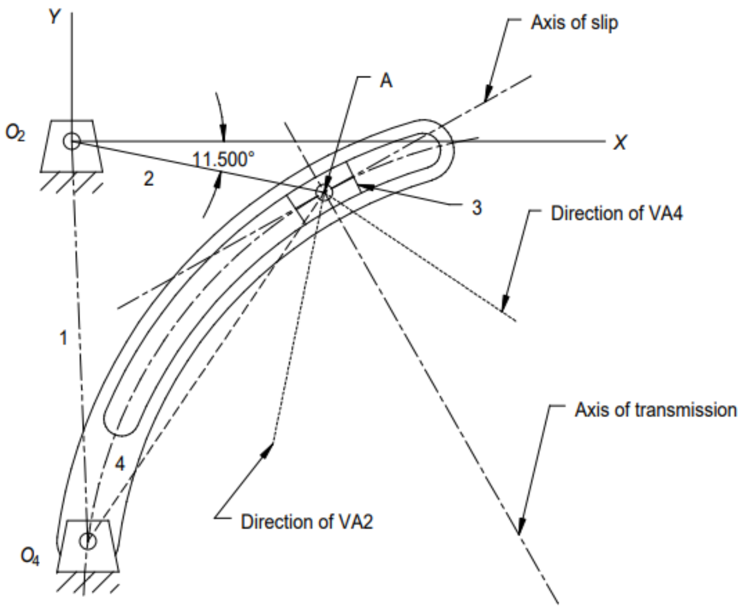


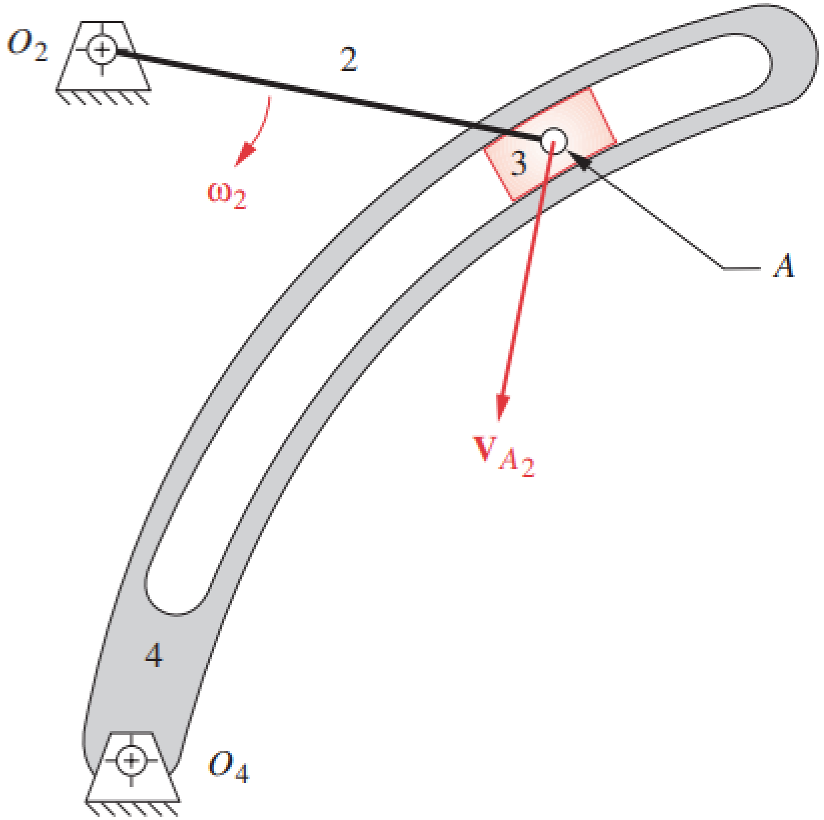

**Given:** Link lengths and angles:

| | | | |
|---|---|---|---|
| Link 1 ($O_2O_4$) | $d := 1.22 \cdot in$ | Angle $O_2O_4$ makes with $X$ axis | $\theta_1 := 56.5 \cdot deg$ |
| Link 2 ($O_2A$) | $a := 1.35 \cdot in$ | Angle $O_2A$ makes with $X$ axis | $\theta_2 := 14 \cdot deg$ |
| Link 4 ($O_4B$) | $e := 1.36 \cdot in$ | | |
| Link 5 ($BC$) | $f := 2.69 \cdot in$ | | |
| Link 6 ($CO_6$) | $g := 1.80 \cdot in$ | Angle $CO_6$ makes with $X$ axis | $\theta_6 := 88 \cdot deg$ |

Motion of link 2 $\quad \omega_2 := 20 \cdot rad \cdot sec^{-1}$ CW $\quad \alpha_2 := 0 \cdot rad \cdot sec^{-2}$

P2. Figure shows an inverted slider-crank mechanism. Given the dimensions below, use vector LCE method to find the acceleration of point A. Problem 6-61 in the text book.




Link lengths:

Link 2 ($O_2A$) $a := 2.5 \cdot in$ Link 4 ($O_4A$) $c := 4.1 \cdot in$ Link 1 ($O_2O_4$) $d := 3.9 \cdot in$

Measured angles:

$\theta_2 := 75.5 \cdot deg$ $\theta_{trans} := 26.5 \cdot deg$ $\theta_{slip} := 116.5 \cdot deg$

Velocity of point $A$ on links 2 and 3: $V_{A2} := 20 \cdot in \cdot sec^{-1}$ $V_{A3} := V_{A2}$

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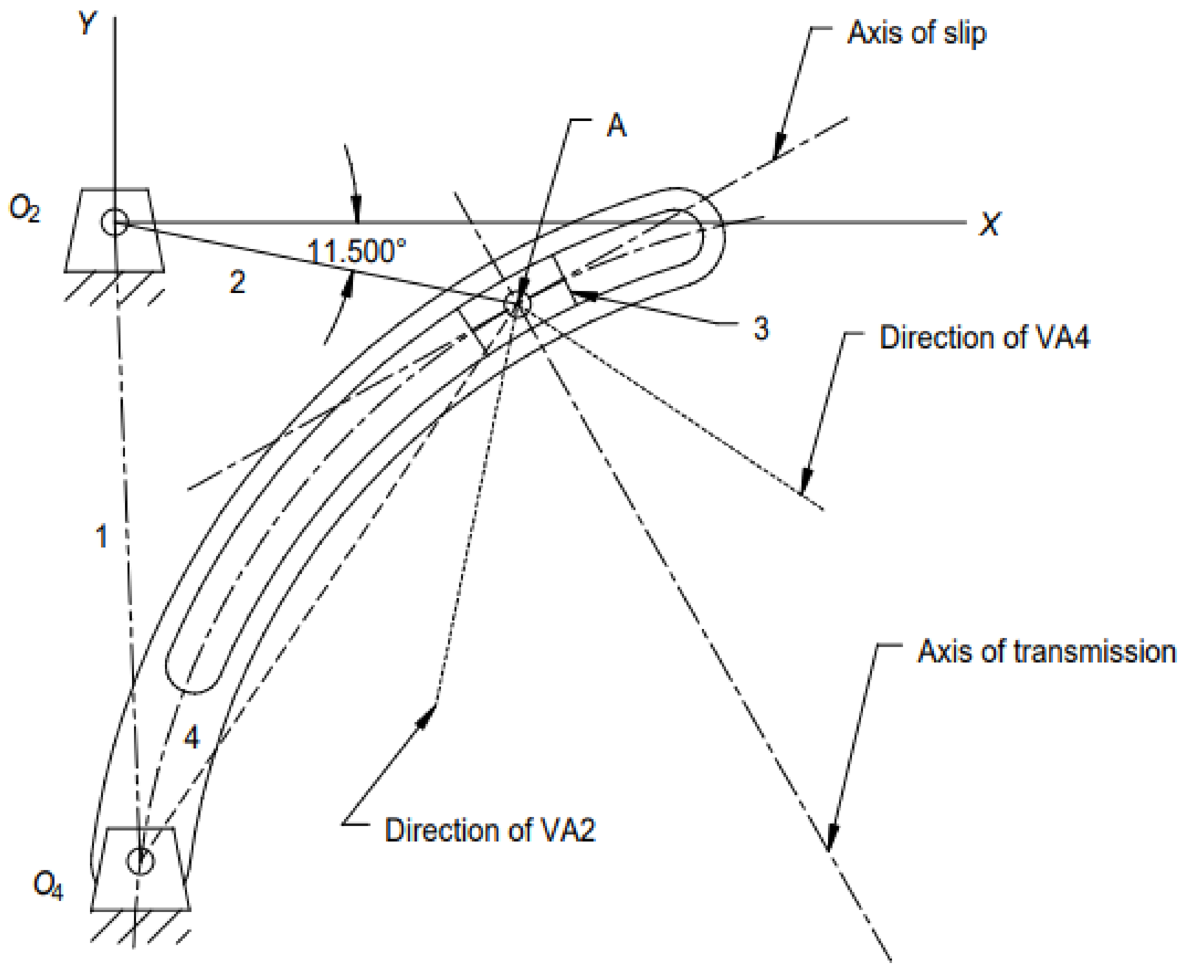
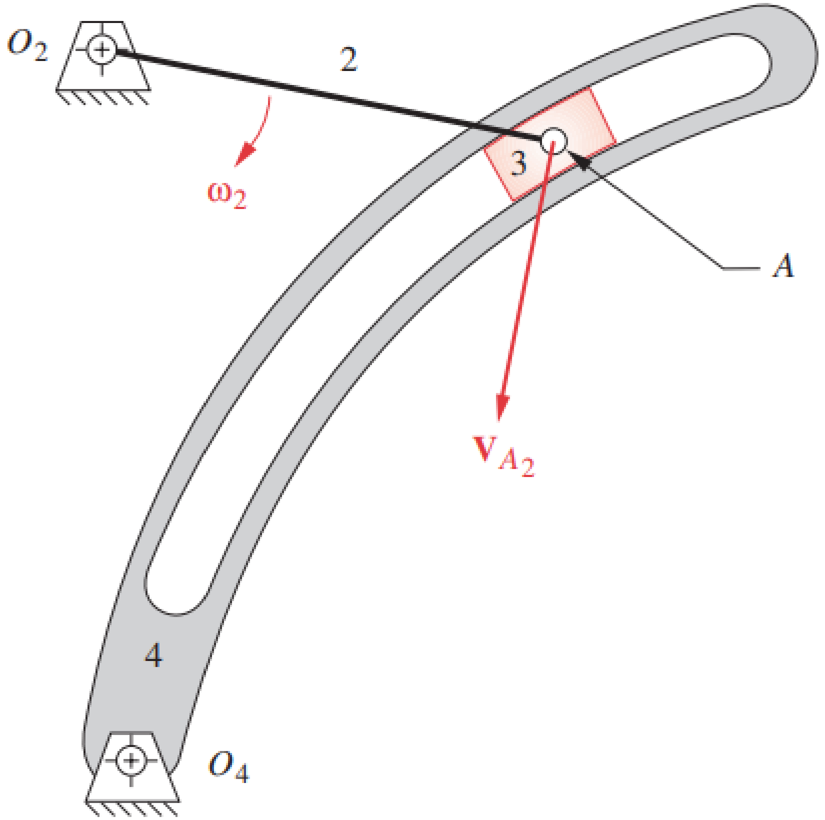
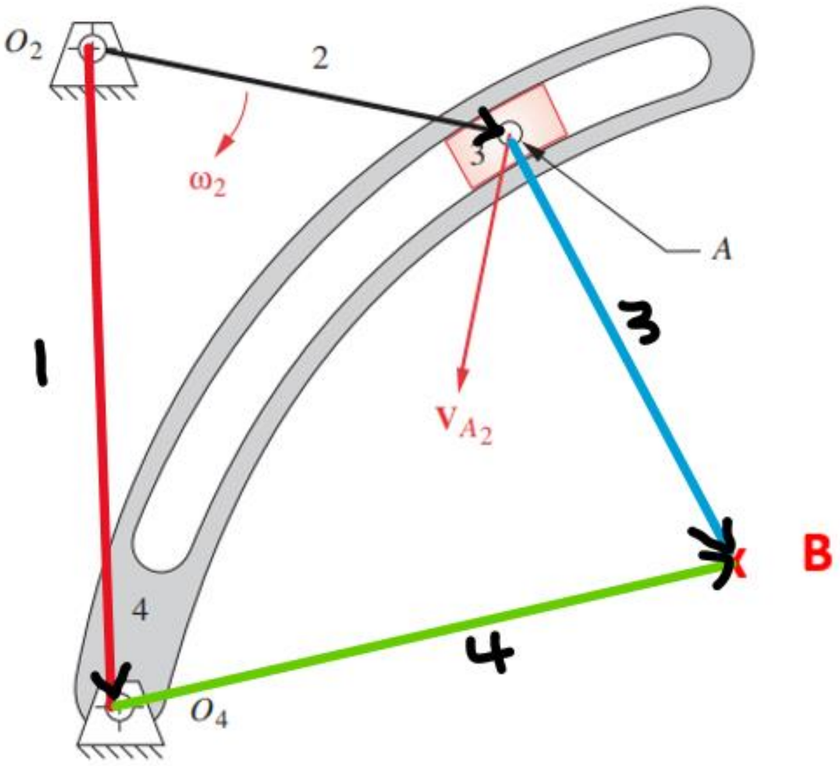


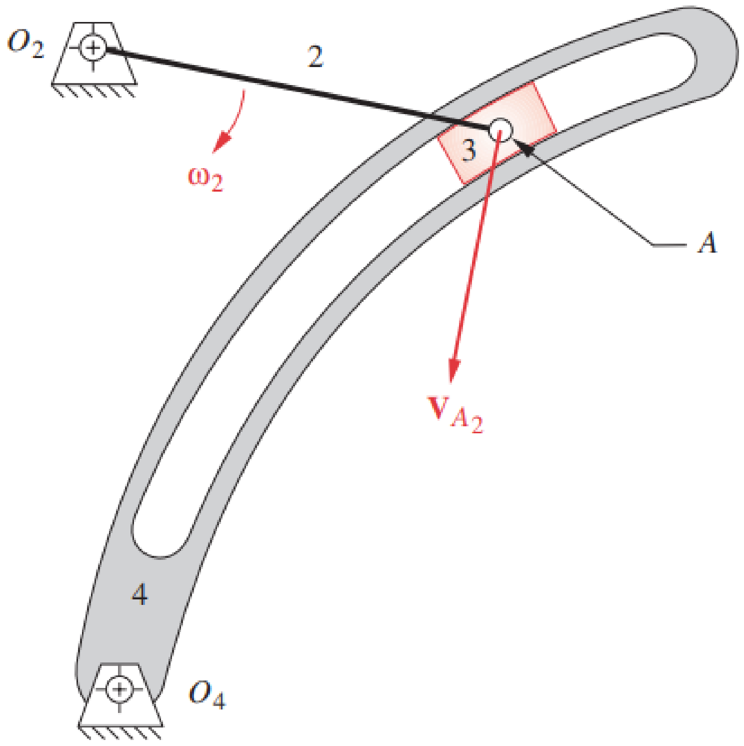



Assume you know the center of curvature of the curved guide.

Usually for such problems all data needed to solve the problem are given.

Assume the center of curvature is point B.

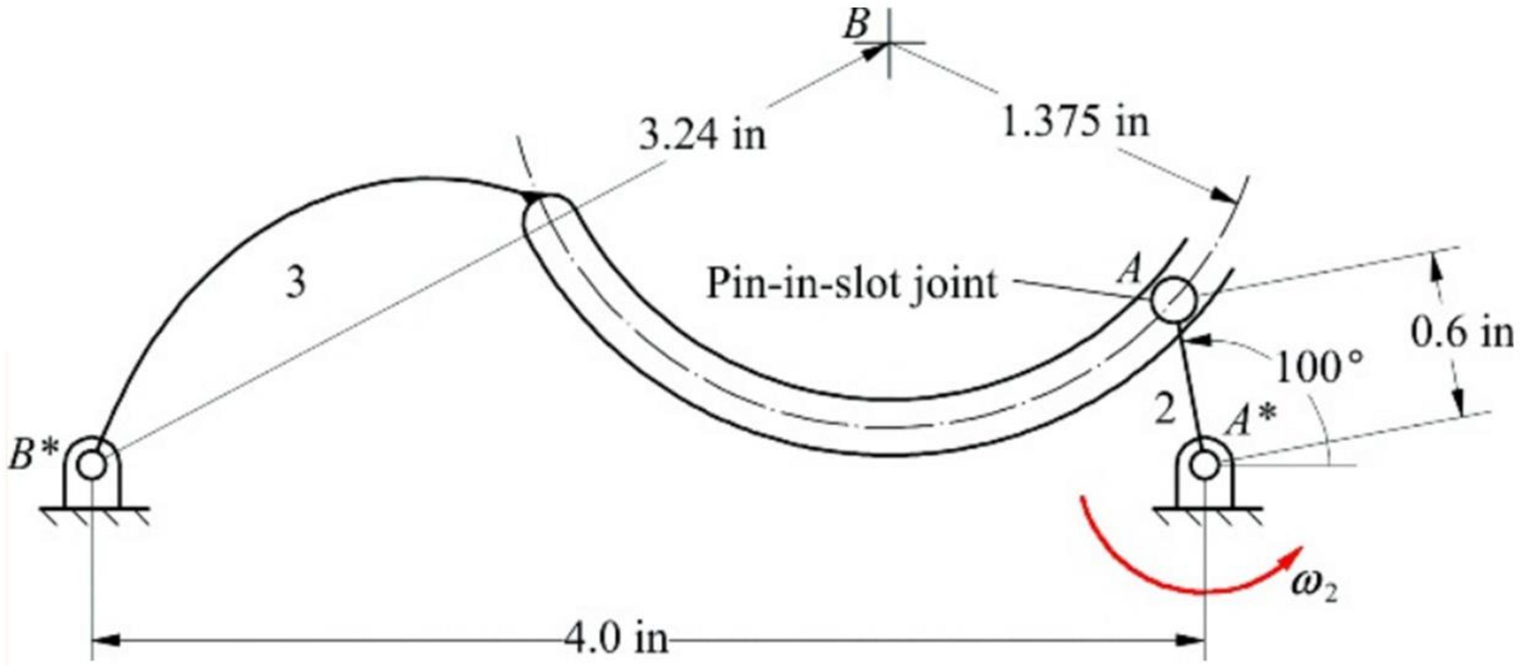
Based on Figure, the vector closure equation for this mechanism is

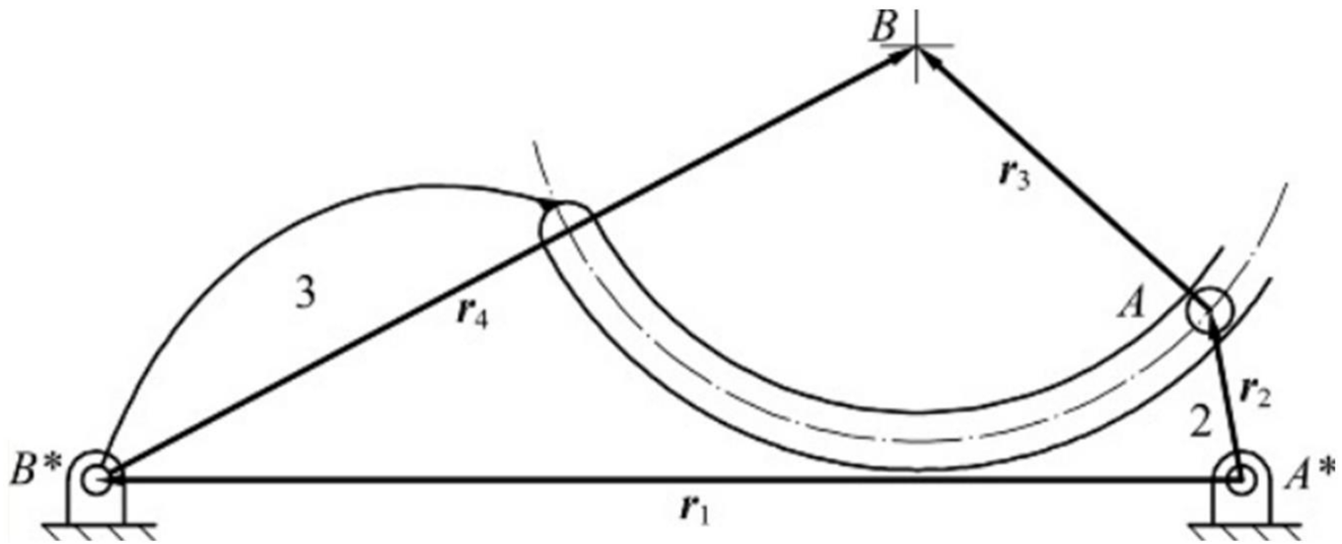


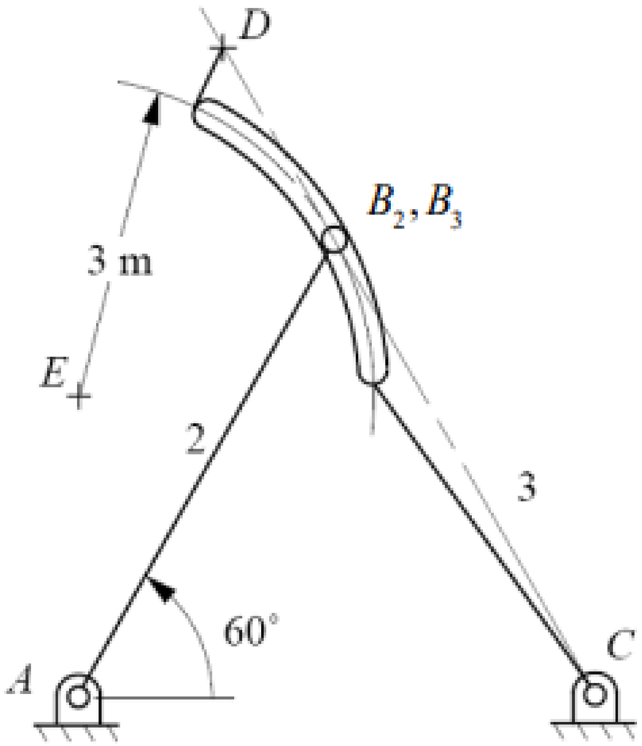

$$\mathbf{r}_2 + \mathbf{r}_3 = \mathbf{r}_1 + \mathbf{r}_4$$

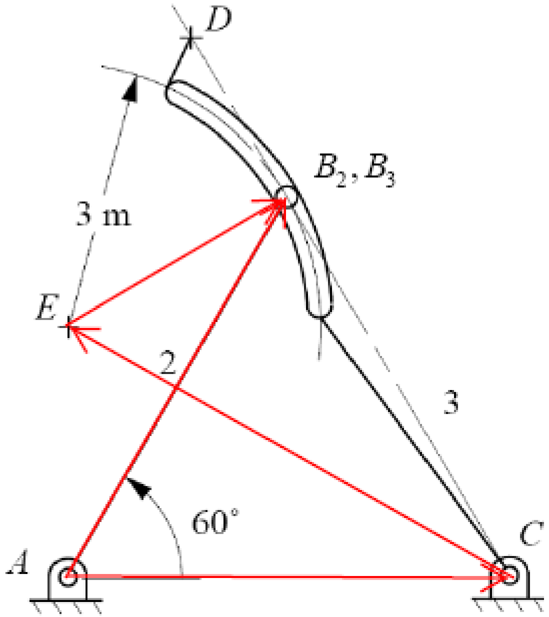
This equation is exactly the same as that for a four-bar linkage. Therefore, the equations developed for a four-bar linkage can be applied directly to this problem.

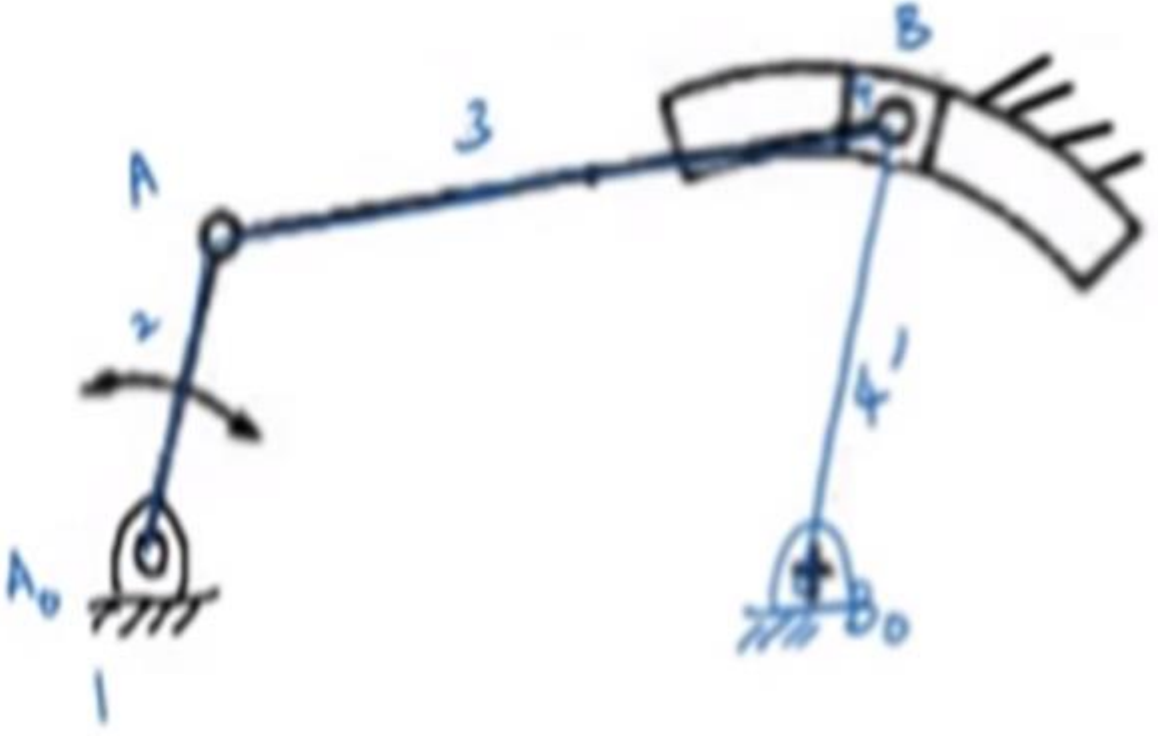
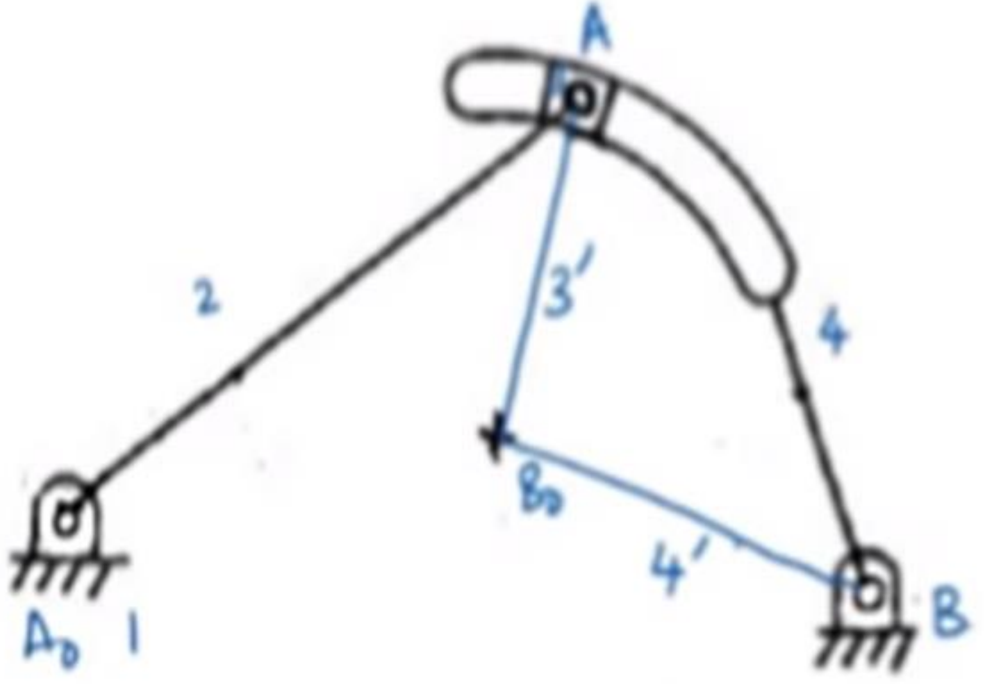
# Another similar examples



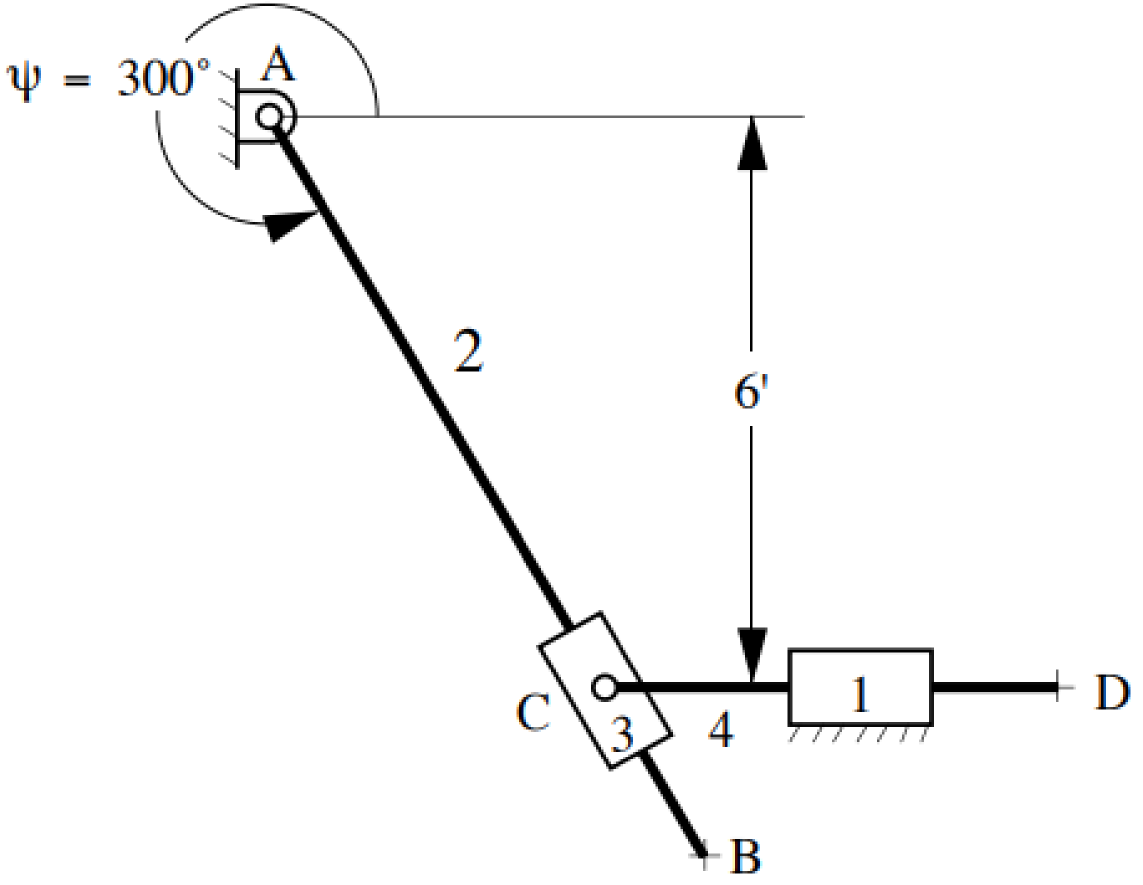



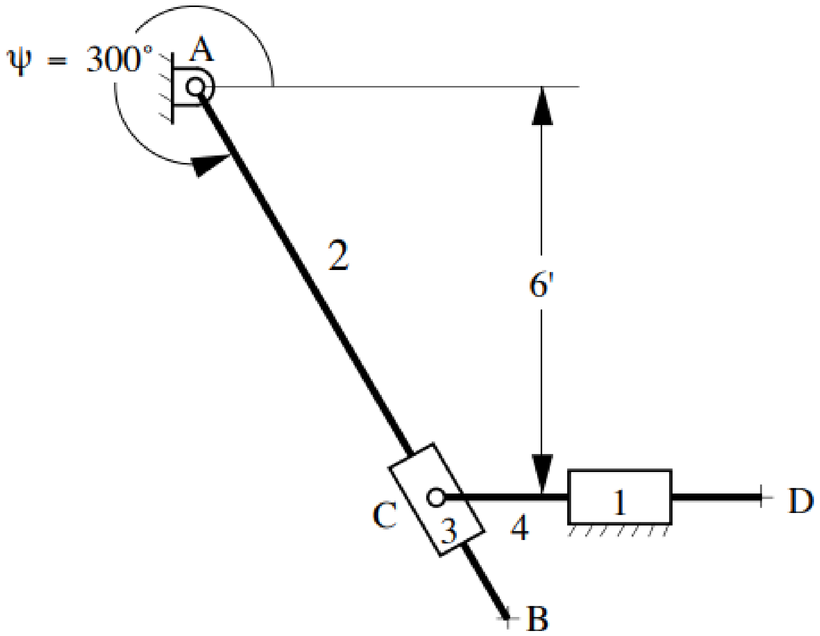

D
$B_2, B_3$
3 m
E
2
3
60°
A
C

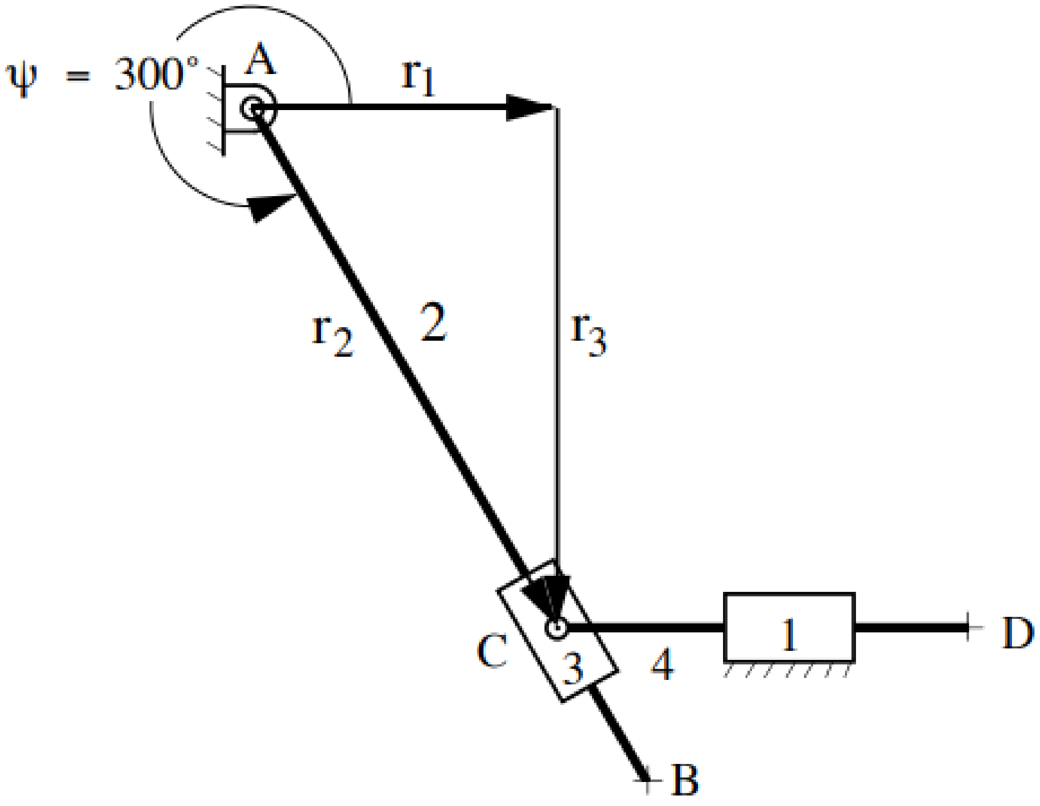

D
$B_2, B_3$
3 m
E
2
3
60°
A
C


B
3
A
2
4'
A0
B0
1

A
2
3'
4
B0
4'
A0
1
B

P3. For the mechanism shown, the velocity of rod CD is a constant 10 in/min to the right, use the loop closure equation to determine the angular acceleration of link 2.






The vector equation is: **r2 = r1+ r3**

The known input information is: θ1 = 0, θ3 = -90°

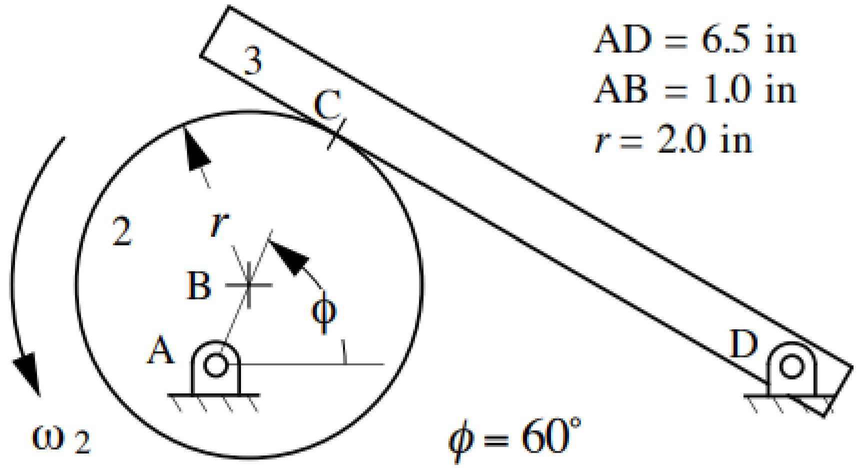
$\ddot{\psi} = -2.165 \text{ rad/min}^2$ CCW.

$\psi = 300°$; $r_3 = 6'$; $\dot{r}_1 = 10$ in/min; $\ddot{r}_1 = 0$;

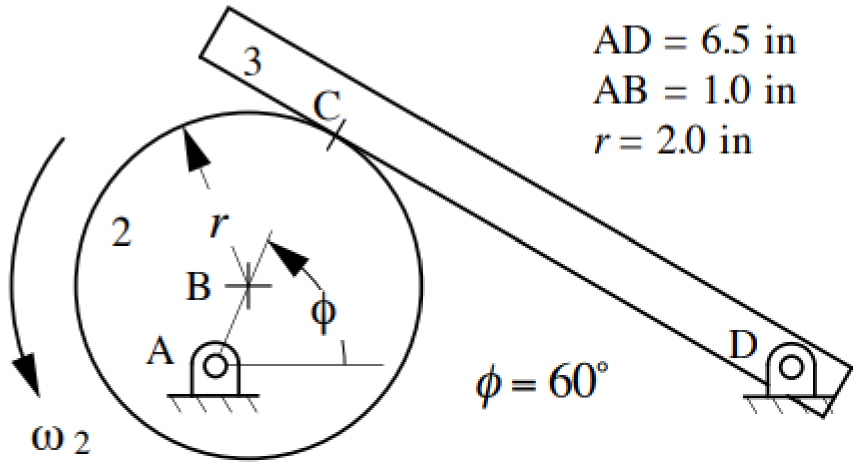
$\ddot{r}_2 = 10.826$

$$\begin{Bmatrix} \dot{r}_2 \\ \dot{\psi} \end{Bmatrix} = \begin{Bmatrix} 6 \\ 1.25 \end{Bmatrix} \begin{matrix} \text{in/min} \\ \text{rad/min} \end{matrix}$$

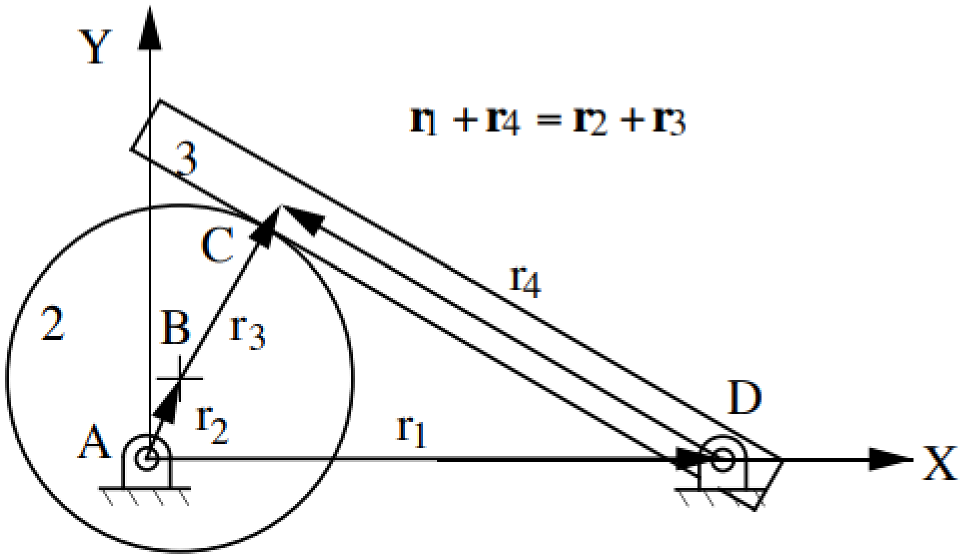
P4. For the mechanism shown, link 2 rotates with an angular velocity of 200 rad/s. use the loop closure equation to determine the angular velocity and acceleration of link 3. link 3 is of negligible thickness, treat it as line.




the cam (link 2)
follower (link 3)




the cam (link 2)
follower (link 3)




$r_1 = 6.5 \quad r_2 = 1.0 \quad r_3 = 2.0 \quad \phi = 60^\circ \quad \dot{\phi} = 200$

The vector equation is: **r1 +r4 = r2 +r3**

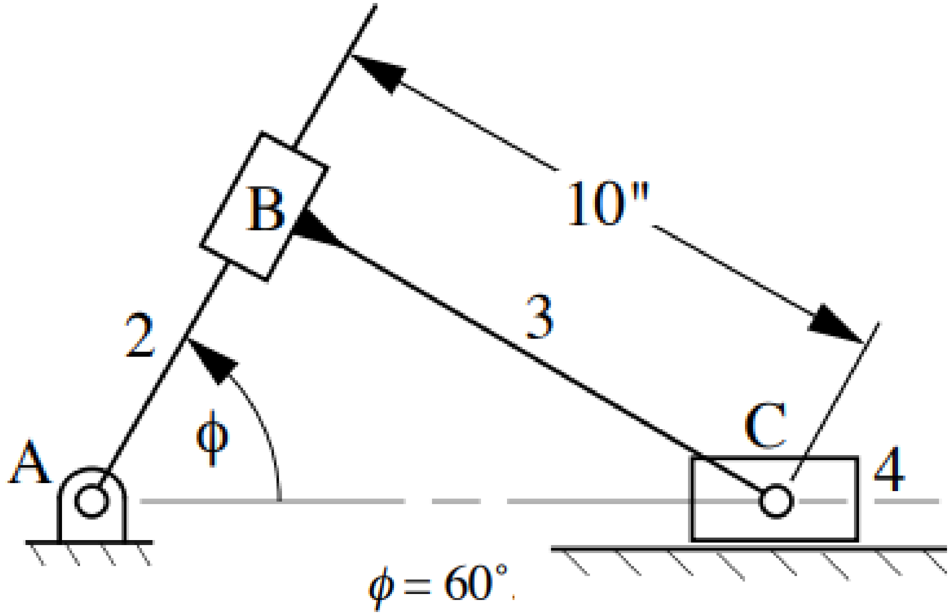
r1, r2 , r3 , and θ 1 = 0 are constants, and $\theta_4 = 90^\circ + \theta_3$

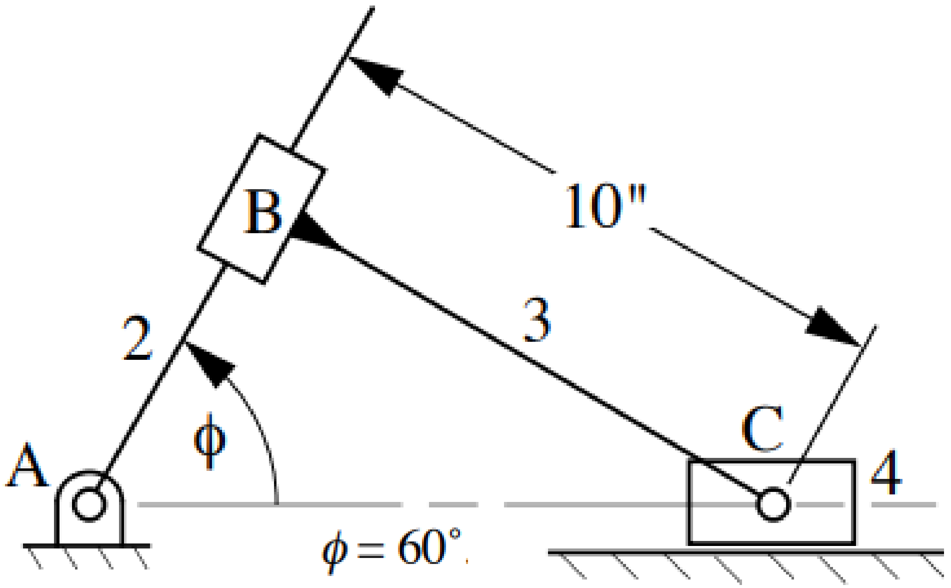
$$\dot{\theta}_3 = \dot{\theta}_4 \, , \ \dot{\theta}_2 = \dot{\phi}$$

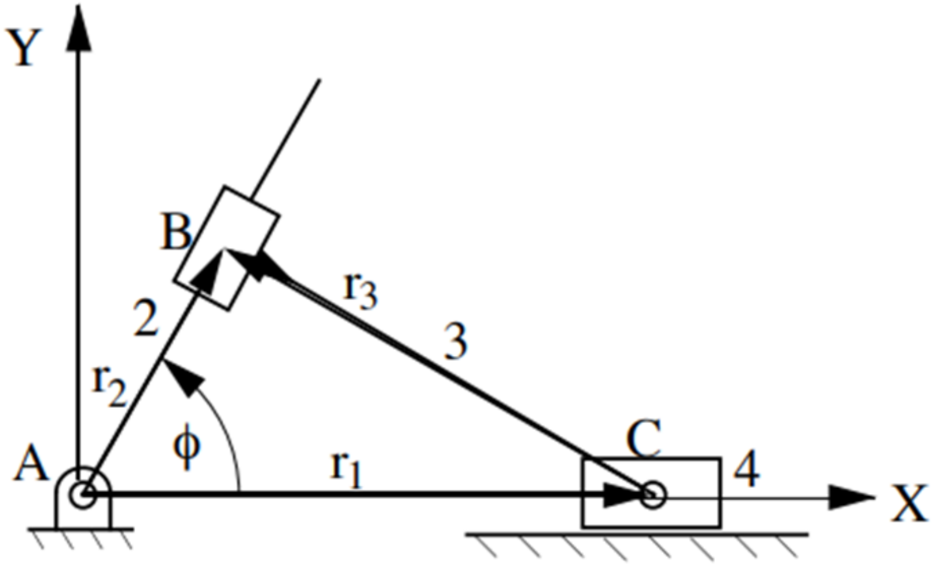
$$\begin{Bmatrix} \dot{r}_4 \\ \dot{\theta}_4 \end{Bmatrix} = \begin{Bmatrix} 196.39 \\ -1.69 \end{Bmatrix} \quad \text{rad/sec CW}$$

$$\begin{Bmatrix} \ddot{r}_4 \\ \ddot{\theta}_4 \end{Bmatrix} = \begin{Bmatrix} 1.615 \times 10^4 \\ 7.10 \times 10^3 \end{Bmatrix} \text{rad / sec}^2 \ \text{CCW.}$$

P5. In the mechanism shown, link 3 is perpendicular to link 2. Use the loop closure equation to find the acceleration of point C. The angular velocity of link 2 is constant and equal 100 rad/s CCW.






The basic loop equations is: **r2 = r1+ r3**

When $\theta_2 = 60$, $r_2 = 10 \cdot \cos 60° / \sin 60° = 5.774$ and

$r_1 = r_2 \cos\theta_2 + r_3 \sin\theta_2 = 5.774 \cdot \cos 60° + 10 \sin 60° = 11.547$

$\dot{r}_2 = -1333.40$

$\mathbf{v}_{C_4} = \dot{r}_1 = -666.70$ in/sec.