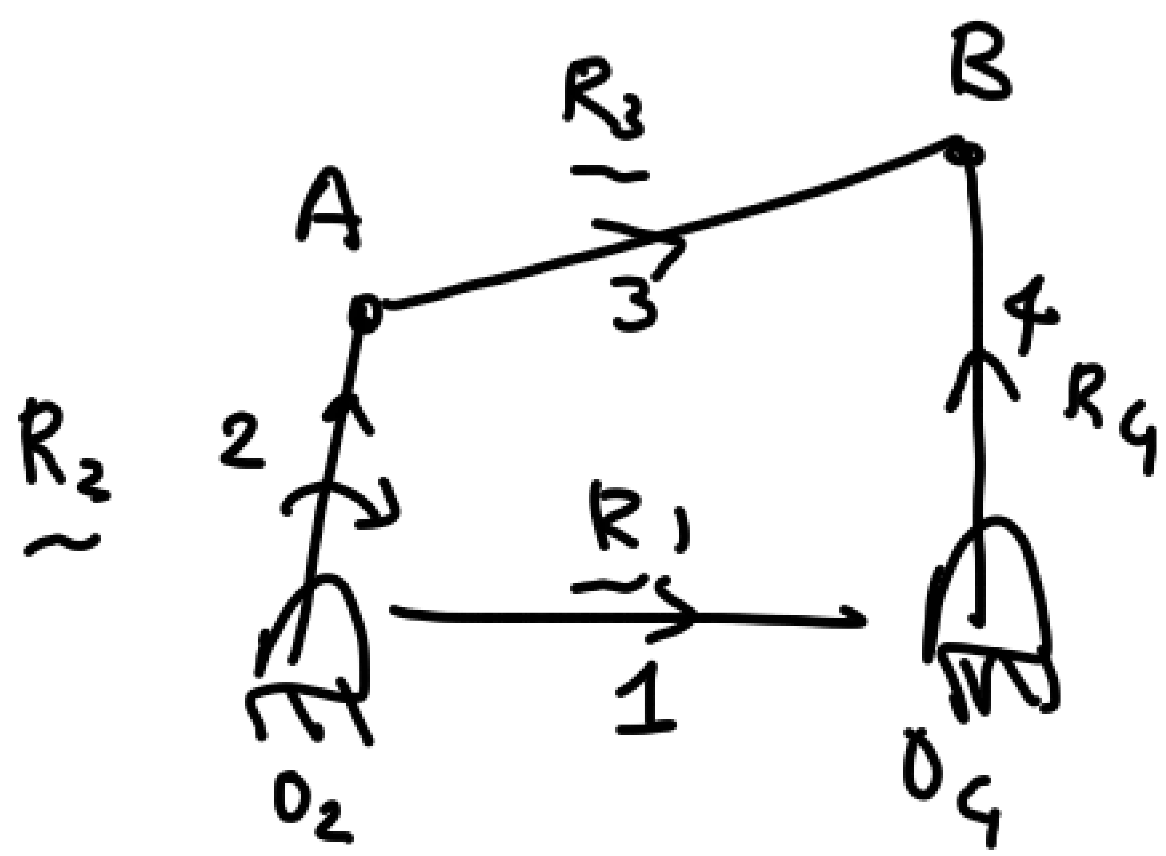
Position, Velocity and acceleration analysis :

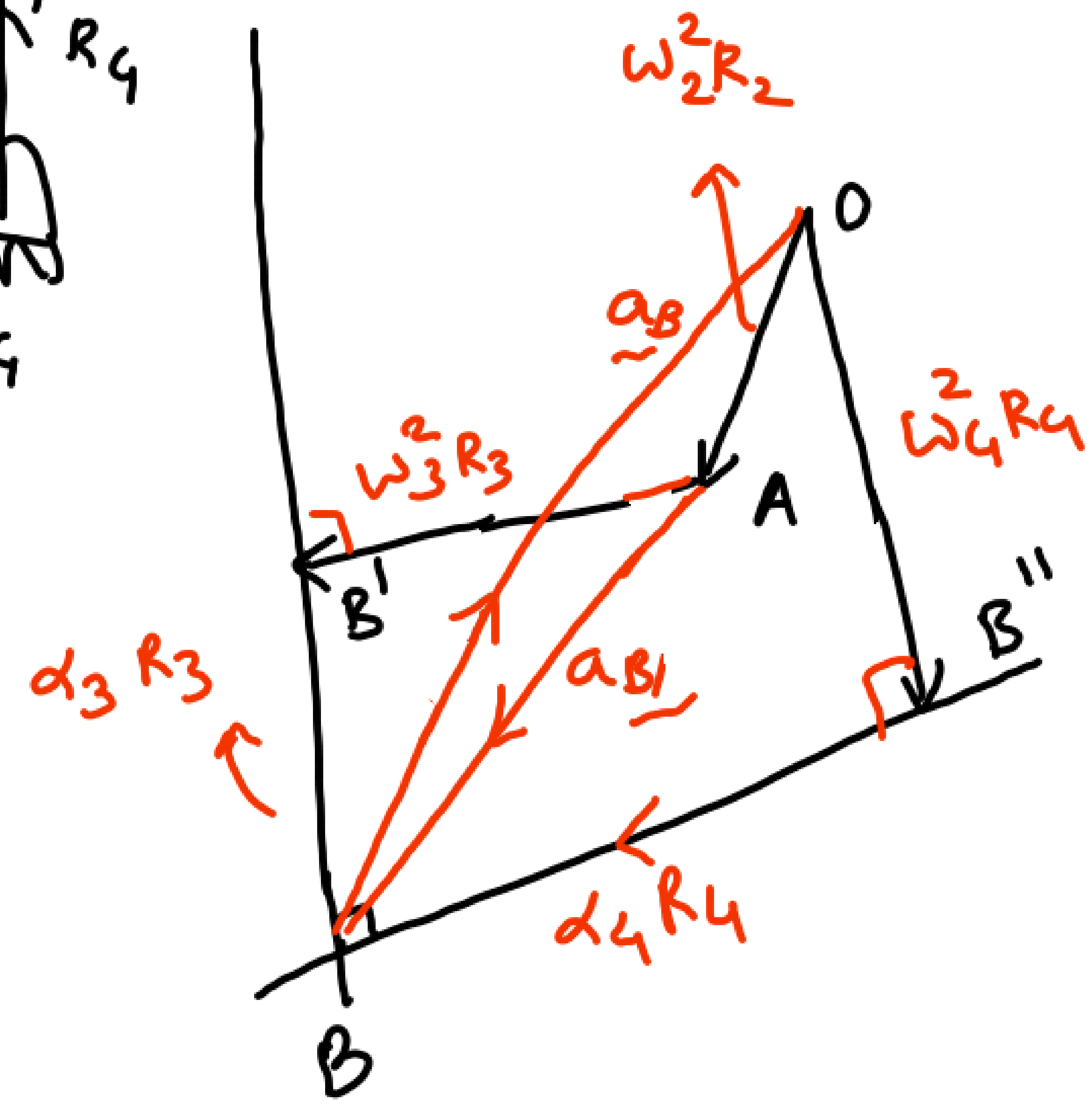


$$\underset{\sim}{V_B} = \underset{\sim}{V_A} + \underset{\sim}{V_{B/A}}$$

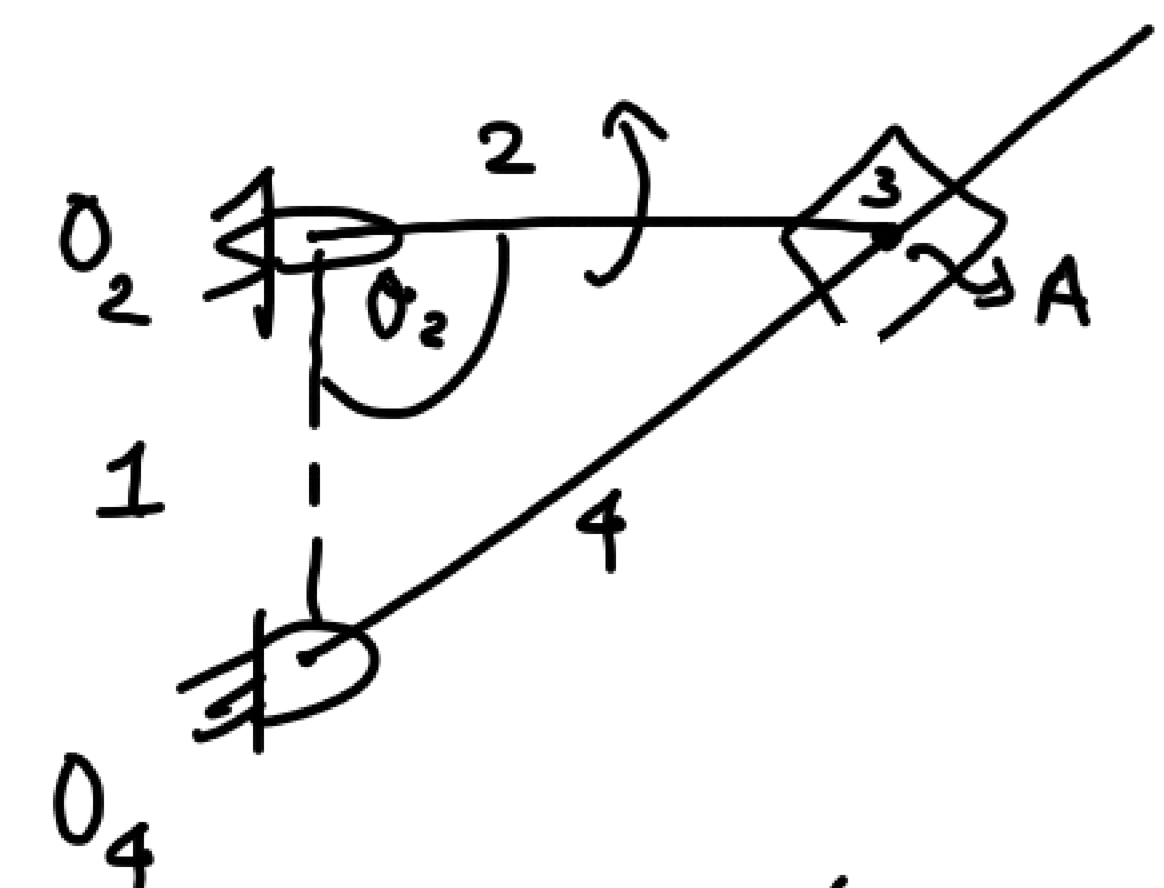
$$\underset{\sim}{a_B} = \underset{\sim}{a_A} + \underset{\sim}{a_{B/A}}$$

Each has normal and tangential acceleration

Acceleration diagram :



② Inversion of slider crank mechanism



To find : Velocity and acceleration of A.

A_2, A_3, A_4

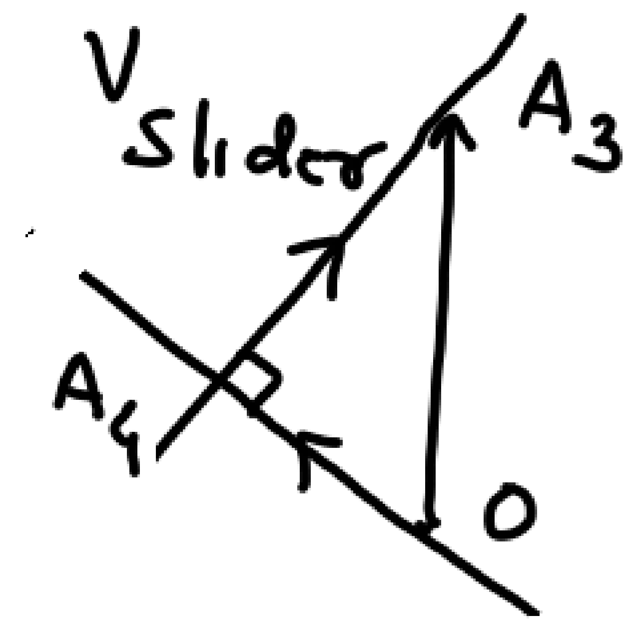
A_2 and A_3 are always going to coincide.

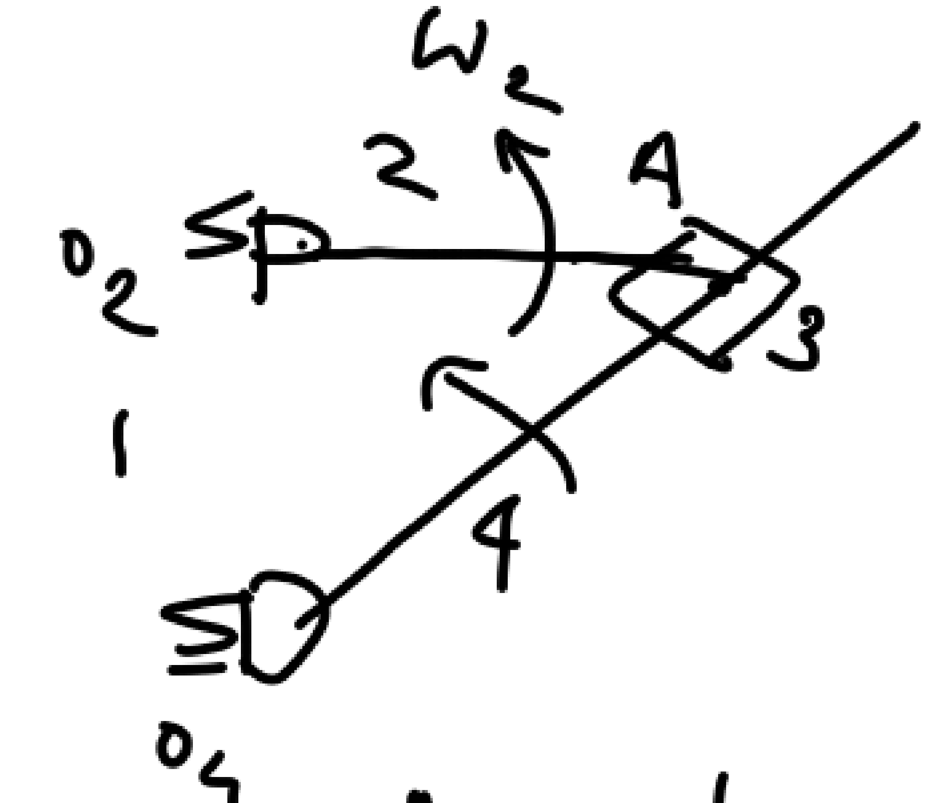
$$\underset{\sim}{V_{A_2}} = \underset{\sim}{V_{A_3}}$$

$$\underset{\sim}{a_{A_2}} = \underset{\sim}{a_{A_3}}$$

$$\underset{\sim}{V_{A_3}} = \underset{\sim}{V_{A_4}} + \underbrace{\underset{\sim}{V_{rel}}}_{\text{Velocity of slider on link 4}}$$

Velocity diagram





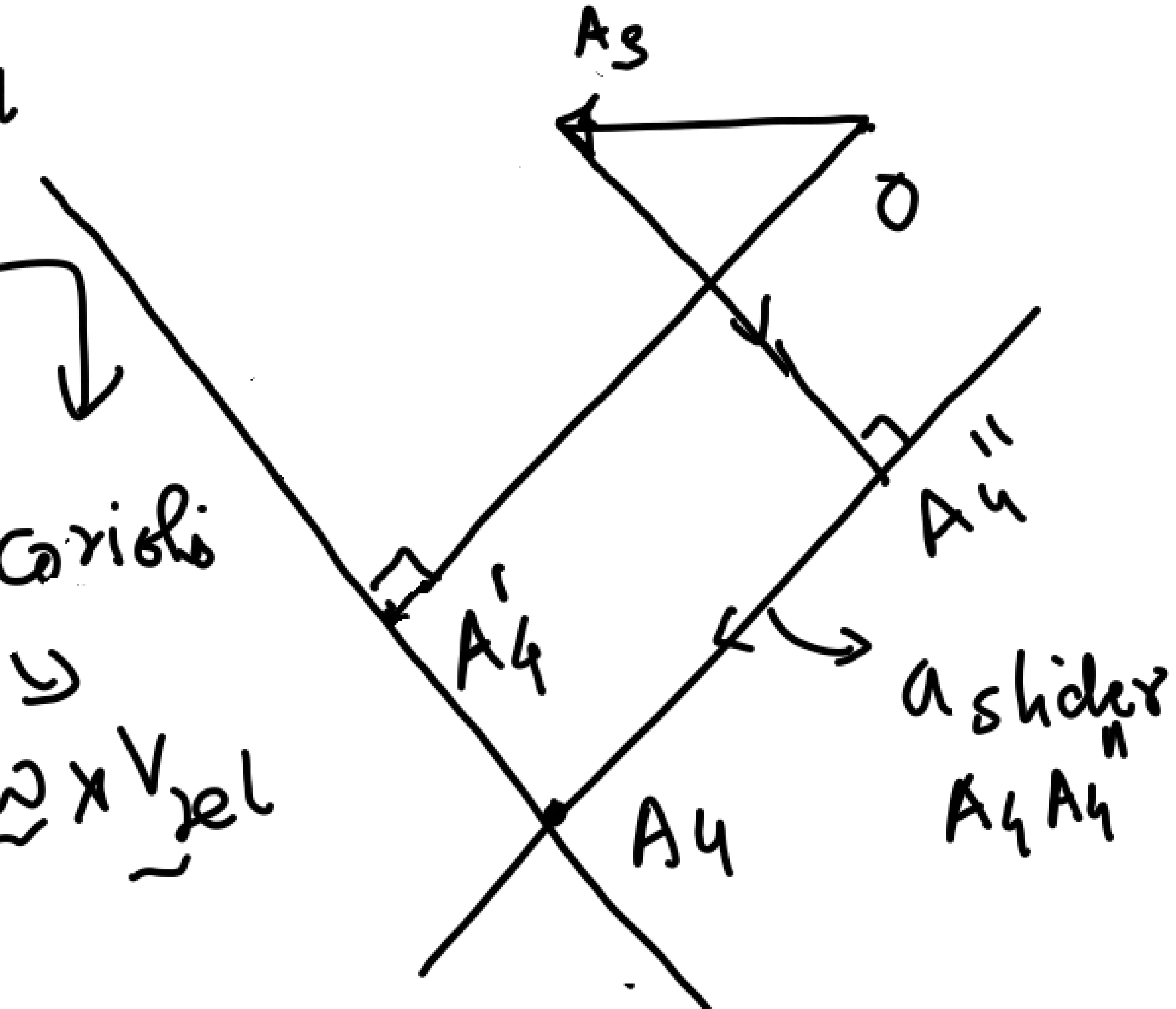
Acceleration:

$$\underset{\sim}{a_{A_3}} = \underset{\sim}{a_{A_4}} + \underset{\sim}{a_{rel}}$$

$$\underset{\sim}{a_{rel}} \rightarrow \underset{\sim}{a_{slider}} + \underset{\sim}{a_{coriolis}}$$

$$\underset{\sim}{a_{coriolis}} \rightarrow 2\,\underset{\sim}{\omega} \times \underset{\sim}{V_{rel}}$$

Acceleration diagram



$$O_3A = \omega_2^2 (O_2A)$$

$$O_4A' = \omega_4^2 (O_4A)$$

$$A_3A_4'' = 2(V_{slider}\,\omega_4)$$

$$\underset{\sim}{a}_{A_4} = \underset{\sim}{\omega}_4 \times (\underset{\sim}{\omega}_4 \times \underset{\sim}{R}_4) + \underset{\sim}{\alpha}_4 \times \underset{\sim}{R}_4$$

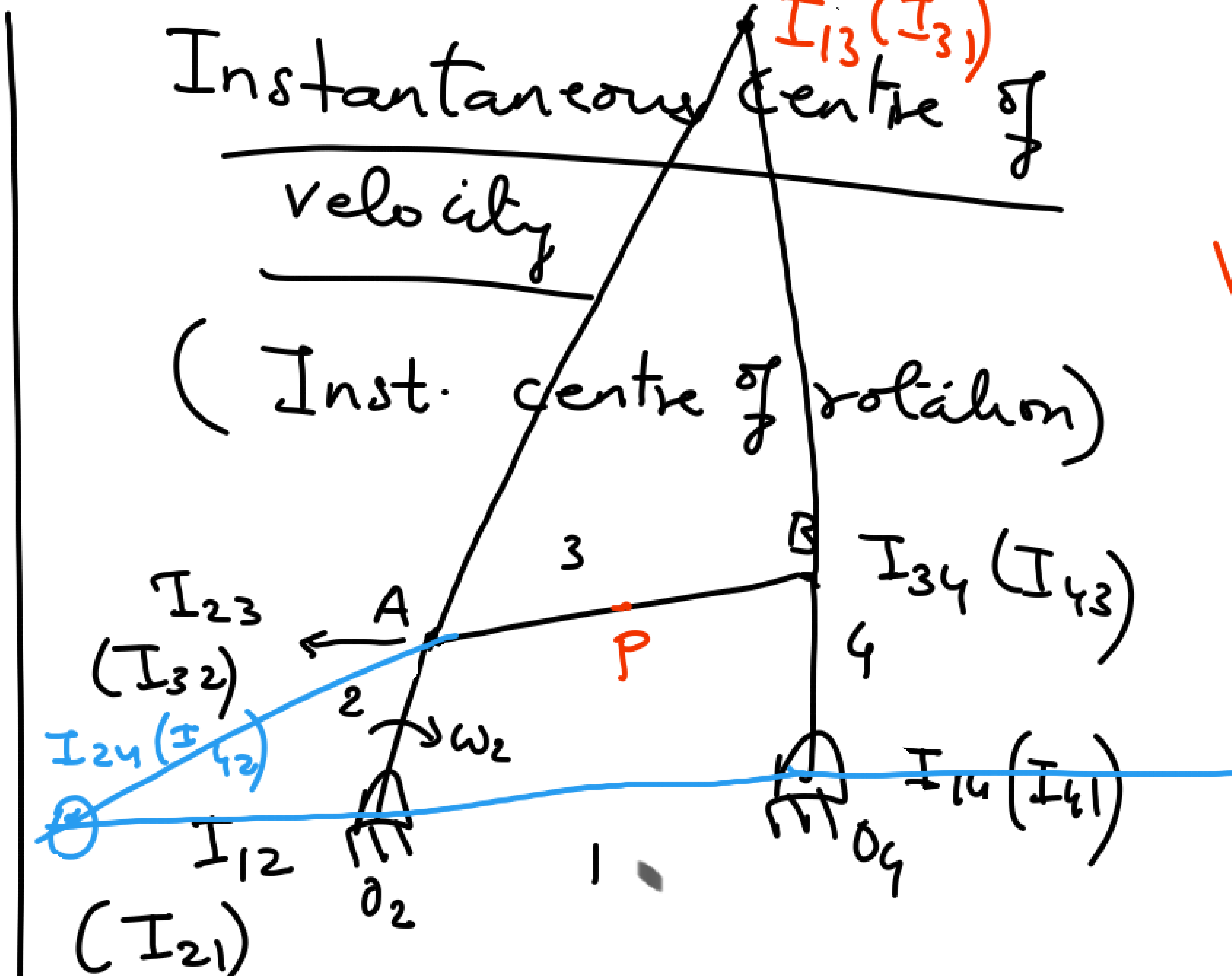
$$\underset{\sim}{a}_{rel} = \underline{\underset{\sim}{a}_{slider}} + 2\underset{\sim}{\omega}_4 \times \underset{\sim}{V}_{rel}$$

$$\underset{\sim}{a}_{A_3} - \underset{\sim}{a}_{rel} = \underset{\sim}{a}_{A_4}$$

$$A_4A_4' = \alpha_4 (O_4A)$$

Instantaneous Centre of velocity

(Inst. centre of rotation)



Inst. centre of rotation is the centre between the moving body and ground.

$I_{13}(I_{31})$

$$V_p = I_{13} \times \omega_3$$

Finding angular velocities;

$$V_A = \omega_2 (O_2A) = \omega_3 (I_{13})$$

$$\boxed{\omega_3 = \frac{\omega_2 (O_2A)}{I_{13}}}$$

At pt. B:

$$V_B = \omega_3 (I_{13}B)$$
$$= \omega_4 (O_4B)$$
$$\therefore \omega_4 = \frac{\omega_3 (I_{13}B)}{(O_4B)}$$

Angular velo. ratio

$$\frac{\omega_4}{\omega_2} = \frac{\cancel{\omega_2}(O_2A)}{I_{13}} \frac{(I_{13}B)}{(O_4B)} \frac{1}{\cancel{\omega_2}}$$

At I_{24}: $V_2 = V_4$

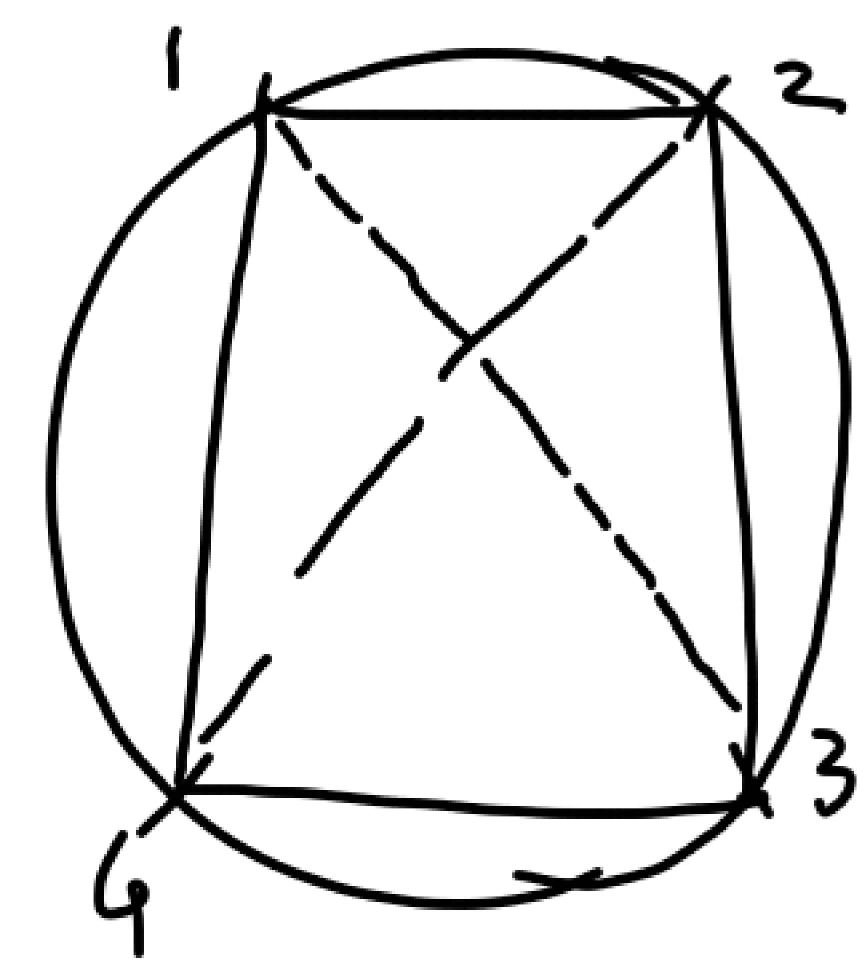
(*) Instantaneous centre of velocity for two moving links is the point w.r.t whom, either of the body undergoes pure rotation.

(*) At this point, both bodies have SAME ABSOLUTE VELOCITY

No. of instantaneous centres for 4-bar.

$$^4C_2 = \frac{\lfloor 4}{\lfloor 2 \lfloor 2} = \frac{3\times\cancel{2}}{\cancel{2}} = 6$$

Kinematic diagram



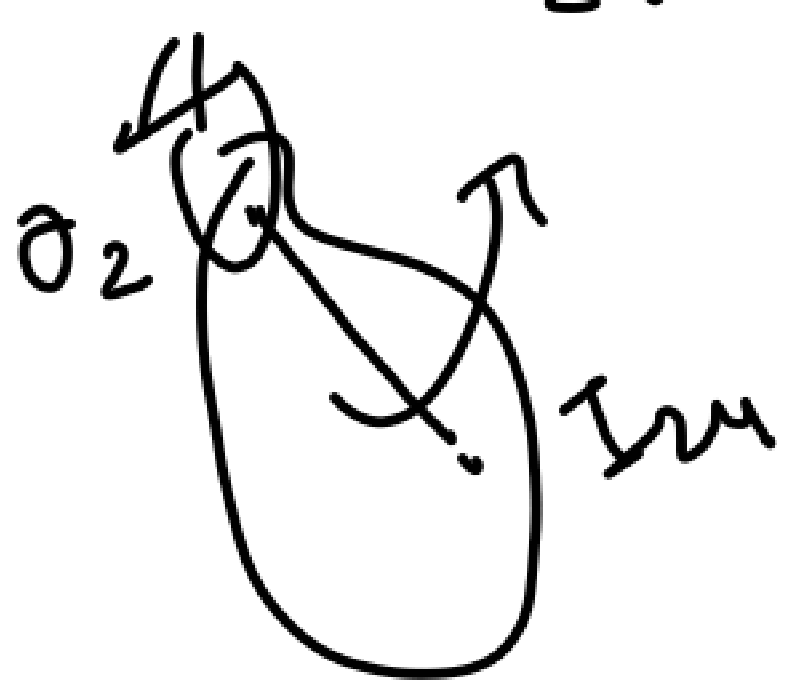
I_{12}
I_{14}
I_{24}

I_{24}
I_{34}
I_{23}

At $\underline{I_{24}}$

V of link 2 = V of link 4

$$\omega_2 (O_2 I_{24}) = \omega_4 (I_{24} O_4)$$



so $$\boxed{\frac{\omega_4}{\omega_2} = \left(\frac{O_2 I_{24}}{O_4 I_{24}}\right)}$$