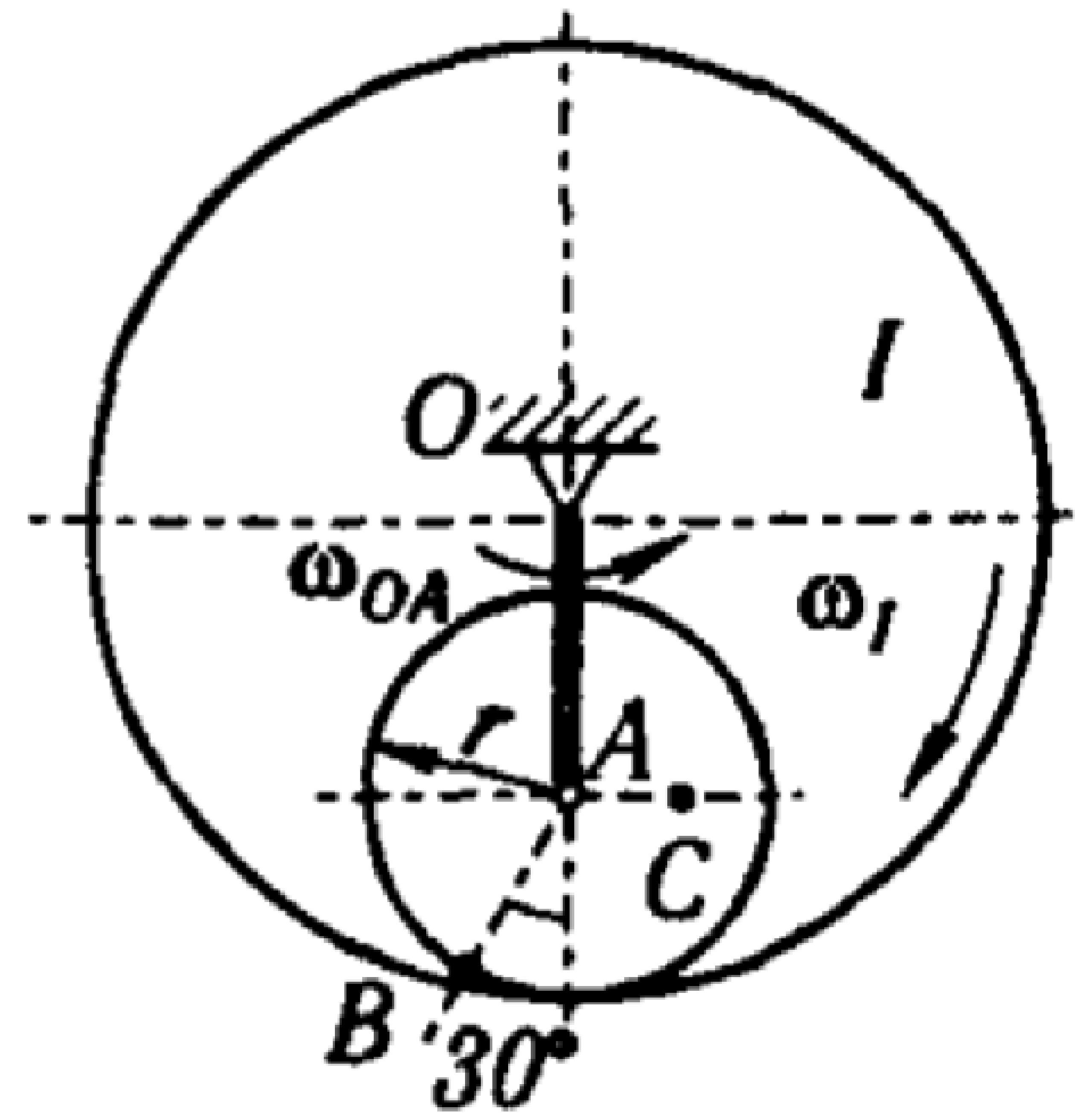
The goal is to find velocities and accelerations (both direction and magnitude) of $A,\ B,\ C$ if you know all dimensions of the mechanism, $\omega_{OA} = 2,\ \omega_1 = 1.2,\ \varepsilon_{OA} = 0.$



Lab 3, Task 3

High Level Algorithm
1) Imagine how the mechanism works
2) Choose the solution method:
   a) If code is needed -> analytical
   b) Code is not needed and only for 1 position -> IC
3) Start to write equations, starting from actuator
4) Determine amount of eqns and vars and solve it

HINTS:
1) Notation in vector form: $\bar{a}_o = \bar{a}_a + \bar{a}^n_{aD} + \bar{a}^\tau_{aD}$ 2 eqns, 3 vars are needed to find

2) We are finding IC only for a plane link!! Not the full mecanism
3) IC is suitable only if you have a plane motion link among all links.
4) For finding IC at least the directions for 2 points are needed!

5) Cross product helps to get the direction $\begin{cases} \bar{a}^n_{BA} = \omega^2 \times R;\ R \parallel a^n_{BA} \\ \bar{a}^\tau_{BA} = \varepsilon \times R;\ a^\tau_{BA} \perp R \end{cases}$

$\bar{V}_{BA} = \omega \times R;\ V_{BA} \perp R$

6) Even in an actuator doesn't have angular acceleration, other links might have it
7) If you write equations fully, you can easily add other components to your solution

Solution: velocity, IC method
1) There are 3 links: "0" - rotation motion, "1" - plane motion, "2" - rotation motion
We can use IC effectively here.

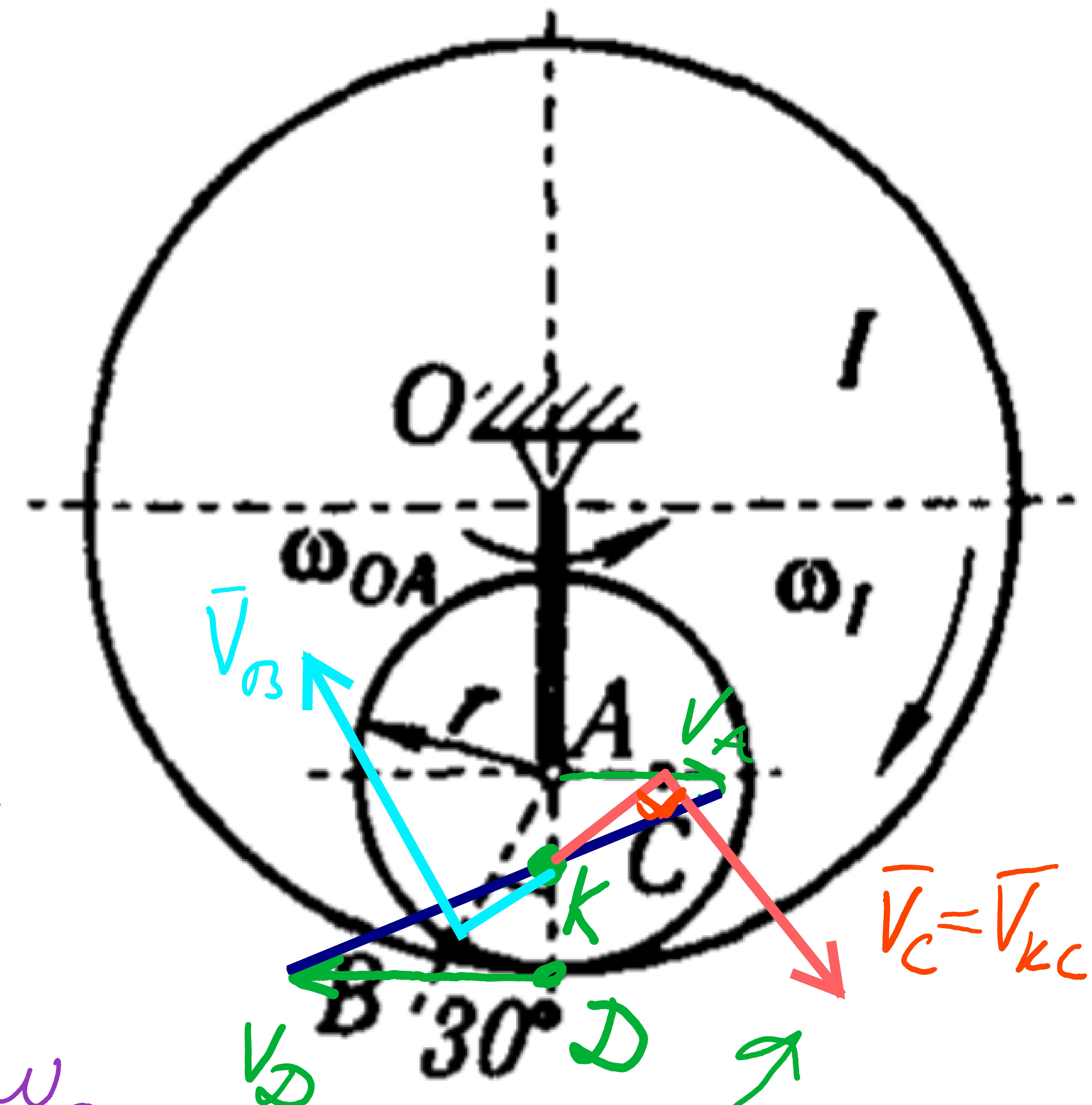
Because we know ω_0 -> find $V_A \Rightarrow \underline{\underline{V_A}} = \omega_0 l_{OA}$

We need to know velocity directions for 2 points, for using IC. And we already know it

For "D" - there is no slippering, and "A" - we found recently $V_D = \omega_1 OD$

Because of coincidence b/w two velocities, IC will be point K.
It used to be found by geometry rules

$\begin{cases} AK + KD = \underline{\underline{r}} \\ \dfrac{\underline{\underline{V_A}}}{\underline{\underline{V_D}}} = \dfrac{AK}{KD} \end{cases} \Rightarrow$ 2 eqns, 2 vars



For finding other velocities, it's better to find angular velocity of 2nd body (ω_2)

$\underline{\underline{V_D}} = \omega_2 \underline{\underline{KD}} \Rightarrow \underline{\underline{\omega_2}}$

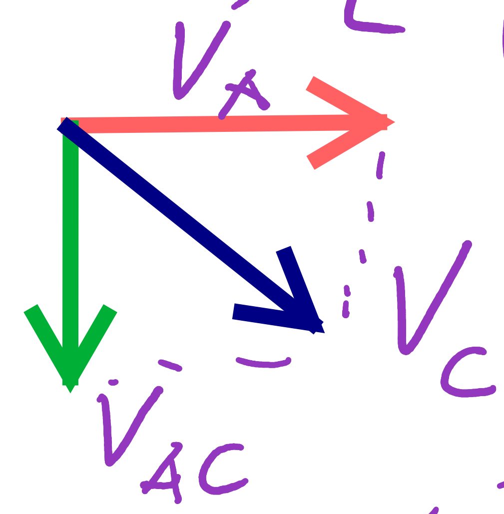
$\underline{\underline{\bar V_C}} = \omega_2 KC$ We can find a line, but not a direction (from equation). Despite it, we can find direction if imagine how mechanism works $\omega_1 \parallel \omega_2$

$\underline{\underline{\bar V_B}} = \omega_2 BK$ BK can be found using cosine rule

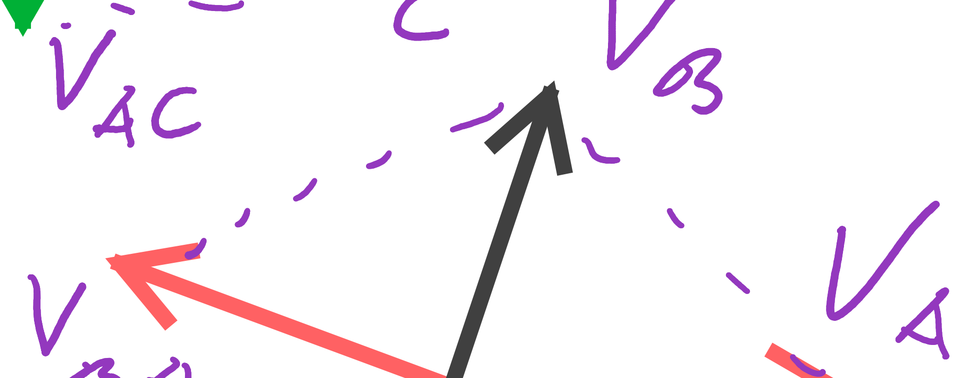
$\Delta ABK;\ BA = r;\ AK;\ \beta \Rightarrow BK^2 = AK^2 + BA^2 + AK\, BK \cos\beta$

Solution: velocity, analytical method
Start from $V_A = \omega_0 OA$
Also it is needed to find $\omega_2 \Rightarrow \begin{cases} \bar V_D = \underline{\underline{\bar V_A}} + \underline{\omega_2} \underline{\underline{AD}} \\ V_D = \underline{\underline{\omega_1}}\, \underline{\underline{OD}} \end{cases} \Rightarrow \underline{\underline{\omega_2}}$

$\underline{\bar V_C} = \underline{\underline{\bar V_A}} + \underline{\underline{\omega_2 AC}}$



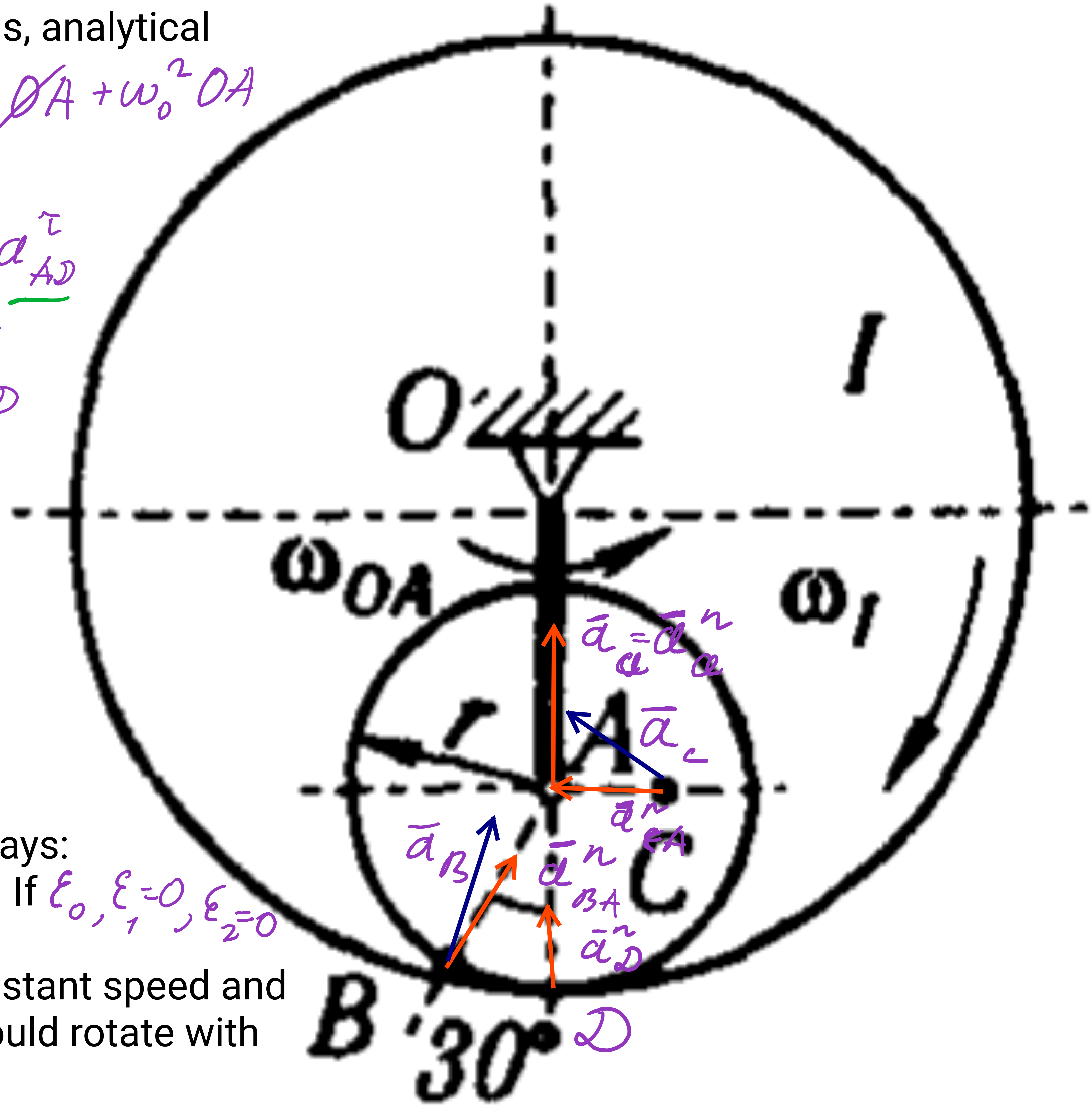
$\underline{\bar V_B} = \underline{\underline{\bar V_A}} + \underline{\underline{\omega_2 AB}}$



Solution: accelerations, analytical

$$\bar a_A = \bar a^\tau_{OA} + \bar a^n_{OA} = \underbrace{\varepsilon_0 OA}_{0} + \omega_0^2 OA$$

$$\begin{cases} \bar a_D = \bar a_A + \bar a^n_{AD} + a^\tau_{AD} \\ \bar a_D = \underbrace{\bar a^n_{OD}}_{\omega_1^2 OD} + \bar a^\tau_{OD} \end{cases} \Rightarrow \varepsilon_2$$



It can be found in 2 ways:
1) As provided above. If $\varepsilon_0, \varepsilon_1 = 0, \varepsilon_2 = 0$
2) Using dedication:
if OA rotates with constant speed and OD too -> AD also should rotate with constant speed.

$$\bar a_C = \bar a_A + \bar a^n_{AC} + \bar a^\tau_{AC}$$

$$\bar a_B = \bar a_A + \bar a^n_{BA} + \bar a^\tau_{BA}$$