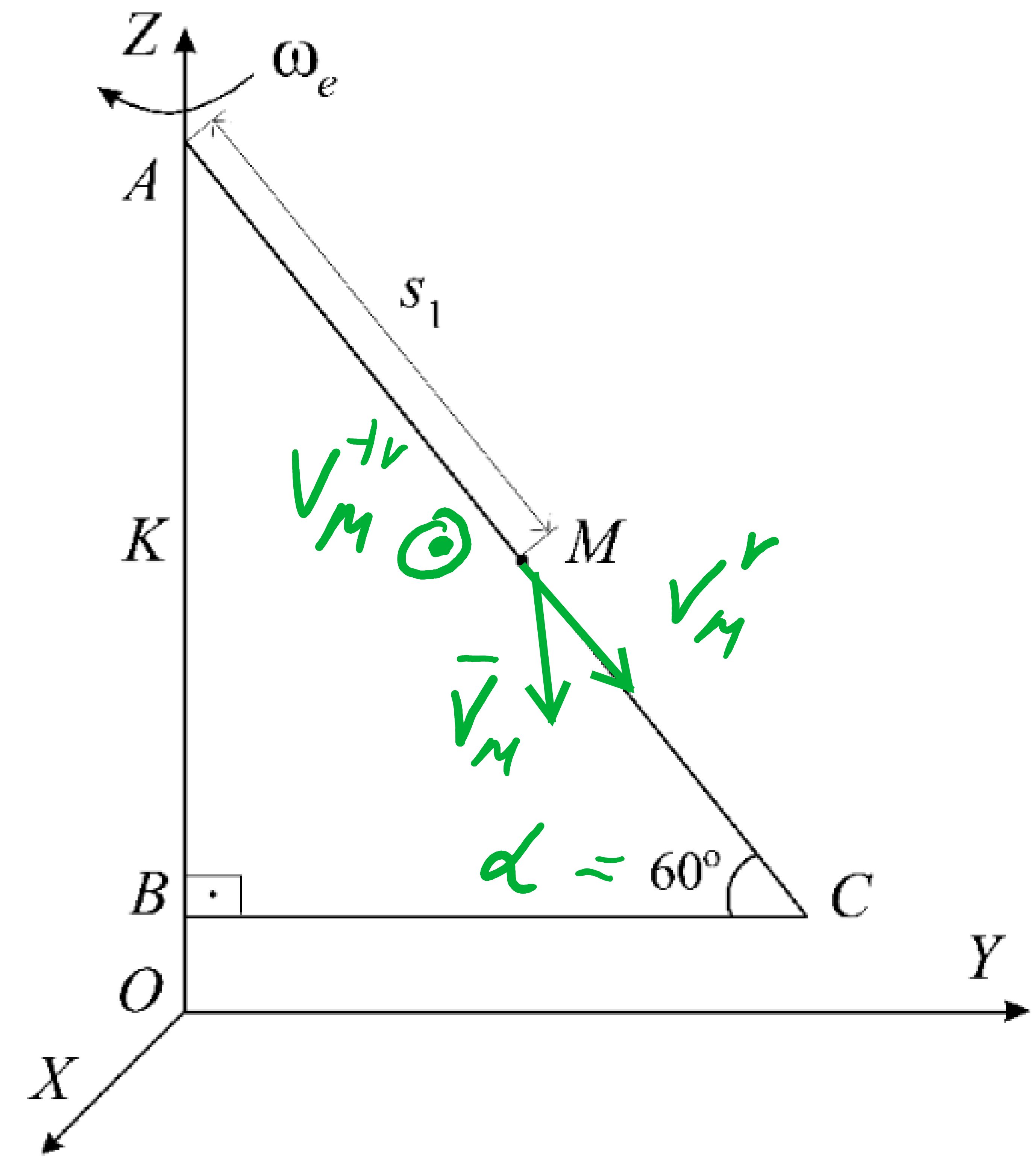
The plate ABC rotates around OZ axis with constant angular velocity $\omega_e = -10$. The point M moves along AC side. The motion law is the following $s = s(t) = AM(t) = 4t^3$.



The goal is to determine the velocity and acceleration of M, when $t = 0.5$.

HINTS:

1) $a_B = a_a + \underbrace{\varepsilon_{tr} \times \rho_{BA} + \omega_{tr} \times (\omega_{tr} \times \rho_{BA})}_{\text{Transport}} + \underbrace{2\omega_{tr} \times V_B^{rel}}_{\text{Coriolis}} + \underbrace{(\ddot{x} i' + \ddot{y} j' + \ddot{z} k')}_{\text{Relative}}$ Lab 5, Task 1

For finding each component you should make a mind experiment:

a) Fix a needed point on a body and activate a mechanism. Find what you need.

b) Fix a body and imagine how a point moves. Find necessary data.

Afterwards, put all received data together for obtaining the real velocities and accelerations of a point.

2) I used to write equations in vector form. It should help with directions.

3) Relative part most of the time is given in natural form. You should just differentiate it for obtaining velocities and accelerations.

Solution:

1) We need to find the precise position of point M $\Rightarrow S_1 = 4t_1^3 = 0.5$

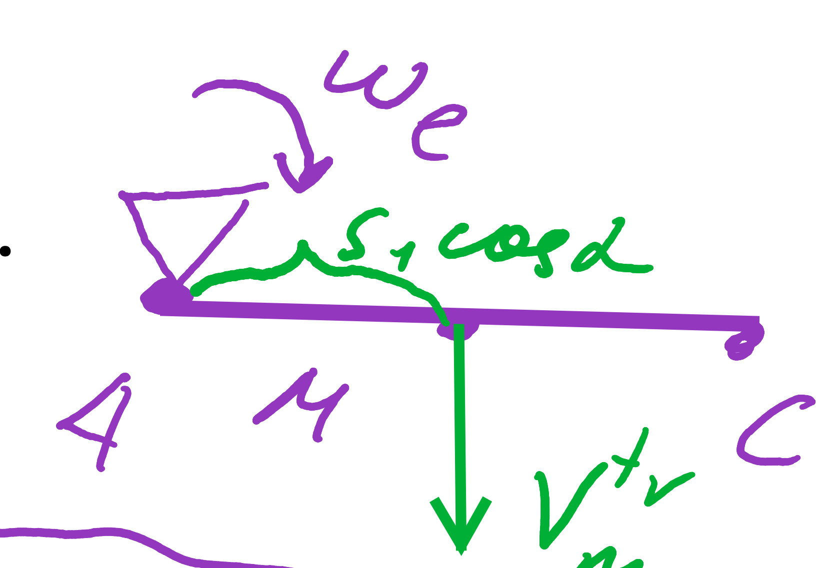
2) For finding relative components - let's differeciate it.

$V_M^r = \frac{ds}{dt} = 12t^2; \quad V_{M_1}^r = 3 > 0; \quad a_M^r = \ddot{s} = 24t; \quad a_{M_1}^r = 12 > 0$

Both are positive -> both vectors look at C

3) Let's find transport component. Let's fix the point M.

Body ABC - rotation motion. As a hint we draw it in top view.



$V_M^{tr} = \omega_e S_1 \cos\alpha; \quad \bar{V}_M^{Full} = \bar{V}_M^{tr} + \bar{V}_M^r = \sqrt{(V_M^{tr})^2 + (V_M^r)^2} = 3.9$

4) Let's find accelerations

$\bar{a}_M^{full} = \bar{a}_M^{tr} + \bar{a}_M^{cor} + \bar{a}_M^{r}$

Because we have angular velocity of a body and linear velocity of a Point -> coriolis acceleration appears

$\Downarrow$

$\cancel{\bar{a}_A}^{0} + \cancel{\bar{a}_{MA}^{\tau}}^{0} + \bar{a}_{MA}^{n} = \omega_e^2 s_1 \cos\alpha$

$a_M^{cor} = 2(\omega_e \times V_M^r) = 2|\omega_e||V_M^r|\sin(90-\alpha) = 30$

$\omega_e = const$

$x: a_{Mx} = a_M^{cor}$

$y: a_{My} = a_M^r \cos\alpha - a_M^{tr}$

$z: a_{Mz} = -a_M^r \sin\alpha$

$a_M^{full} = \sqrt{a_{Mx}^2 + a_{My}^2 + a_{Mz}^2} = 37$