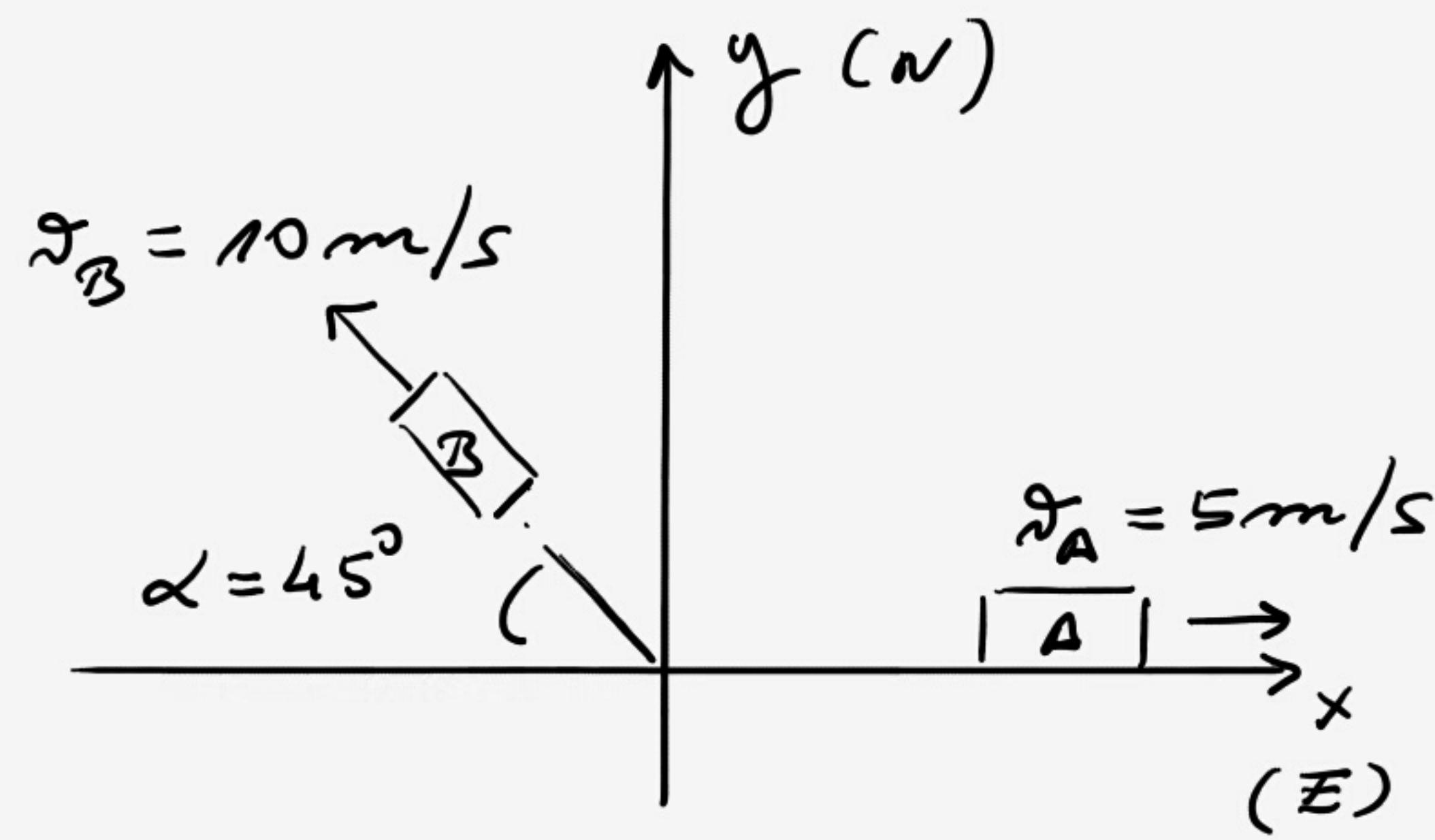


6.1



$$\vec{v}_{abs} = \vec{v}_{arr} + \vec{v}_{rel} ; \quad \vec{v}_{arr} = \vec{v}_0 + \vec{\omega} \times \vec{r}_{rel} = \vec{v}_0$$

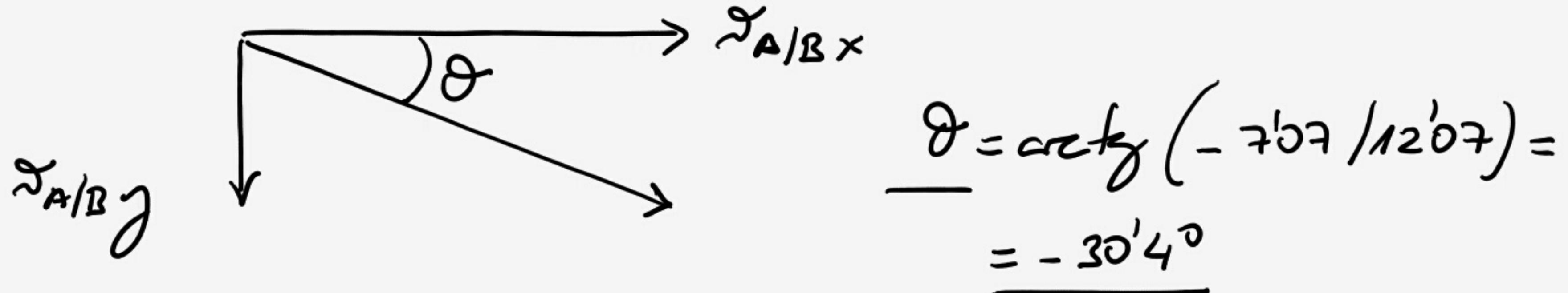
$\omega = 0$

$$\vec{v}_A = \vec{v}_B + \vec{v}_{A/B}$$

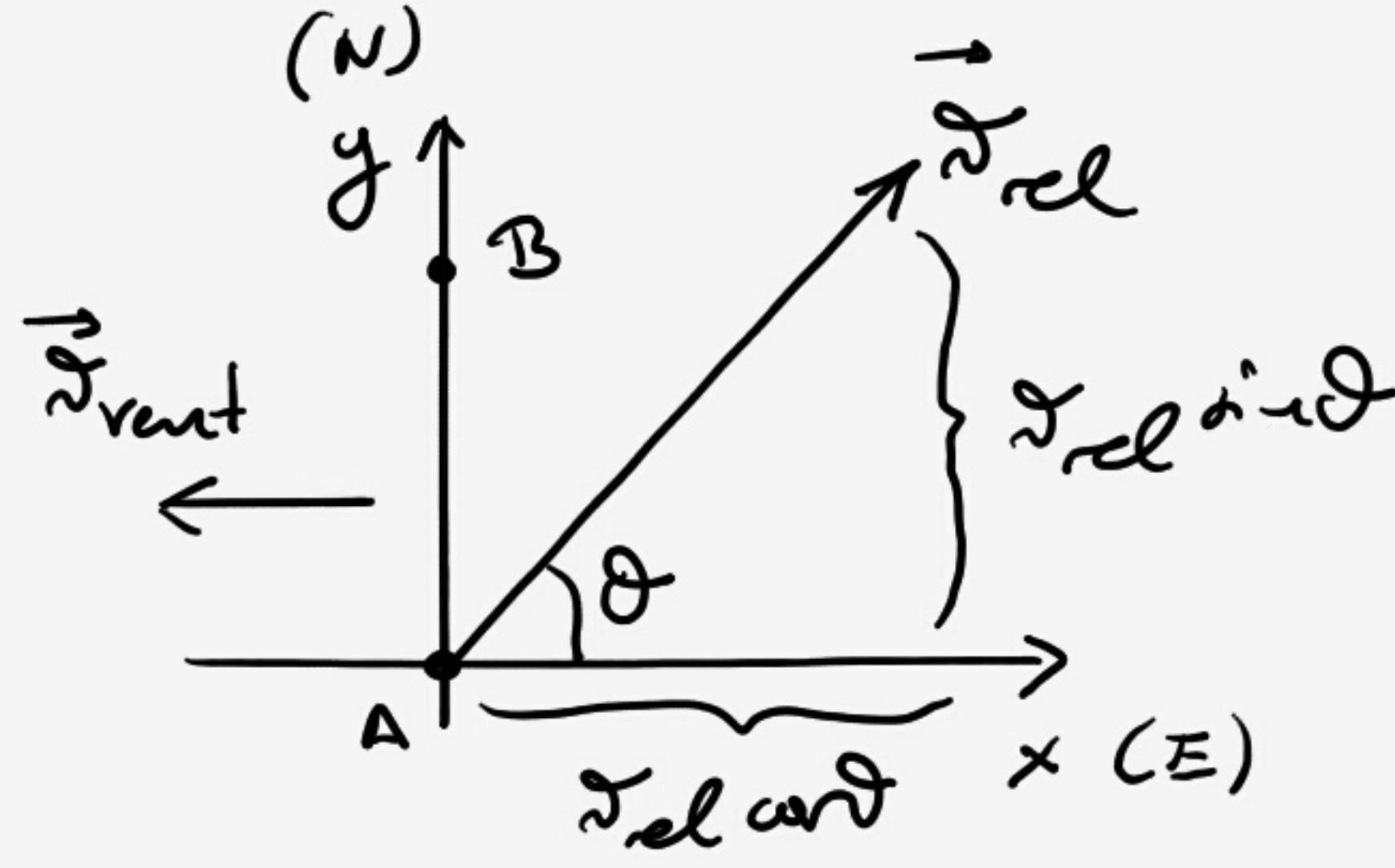
$$\vec{v}_A = 5 \vec{i} ; \quad \vec{v}_B = -10 \cos 45^\circ \vec{i} + 10 \sin 45^\circ \vec{j} = -7'07 \vec{i} + 7'07 \vec{j}$$

$$\vec{v}_{A/B} = \vec{v}_A - \vec{v}_B = 5 \vec{i} - (-7'07 \vec{i} + 7'07 \vec{j}) = 12'07 \vec{i} - 7'07 \vec{j} \text{ m/s}$$

$$v_{A/B} = \sqrt{12'07^2 + 7'07^2} = 14 \text{ m/s}$$



6.2



$$d = AB = 200 \text{ Km.}$$

$$v_{rel} = 290 \text{ Km/h}$$

$$v_{air} = v_{realt} = 50 \text{ Km/h}$$

$$\vec{v}_{abs} = \vec{v}_{rel} + \vec{v}_{air}; \quad \vec{v}_{air} = \vec{v}_0 + \vec{\omega} \times \vec{r}_{rel} = \vec{v}_0 = \vec{v}_{realt}$$

$\vec{\omega} = 0 \quad = -50 \vec{i} \text{ Km/h}$

$$v_{abs} \vec{j} = v_{rel} \cos \theta \vec{i} + v_{rel} \sin \theta \vec{j} - v_{realt} \vec{i} \Rightarrow$$

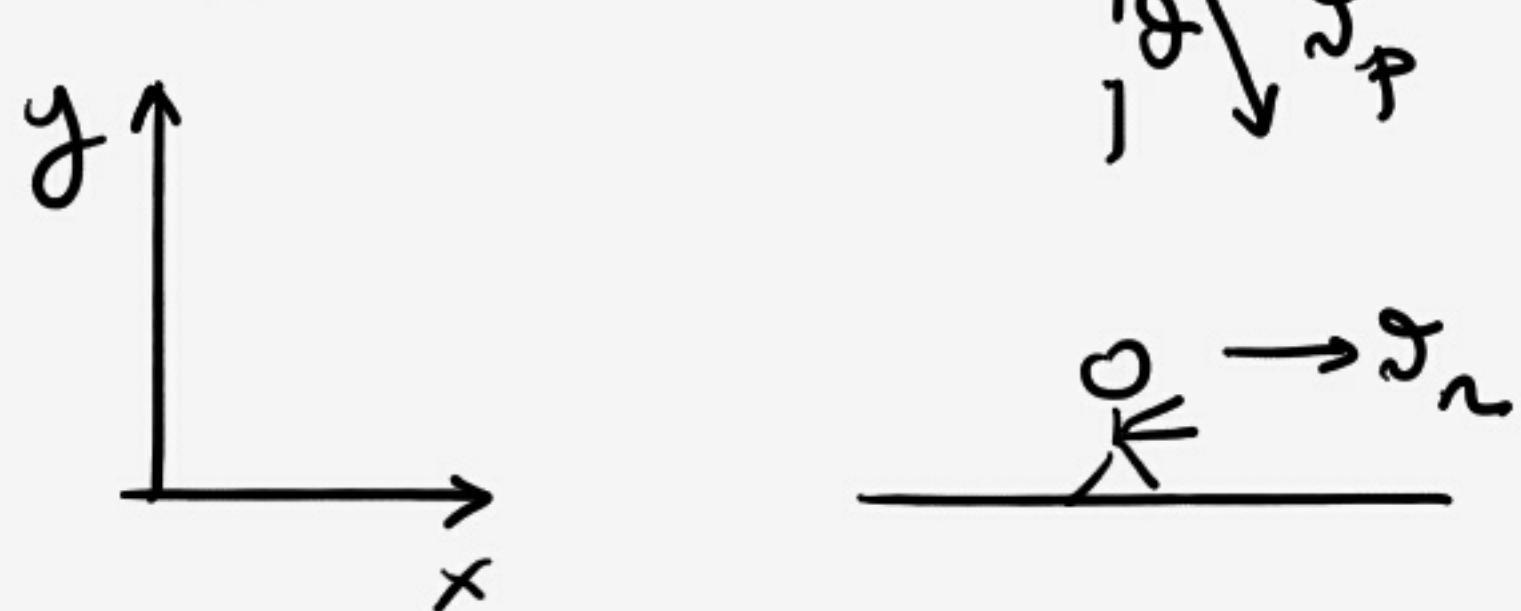
$$\left\{ \begin{array}{l} 0 = v_{rel} \cos \theta - v_{realt} \Rightarrow \theta = \arccos(v_{realt}/v_{rel}) = \\ = \arccos(50/290) = \\ = 80'07^\circ \\ v_{abs} = v_{rel} \sin \theta = 285'65 \text{ Km/h} \end{array} \right.$$



L'angle tanca el parametres
al N sent $\phi = 90 - 80'07 = 9'53^\circ$

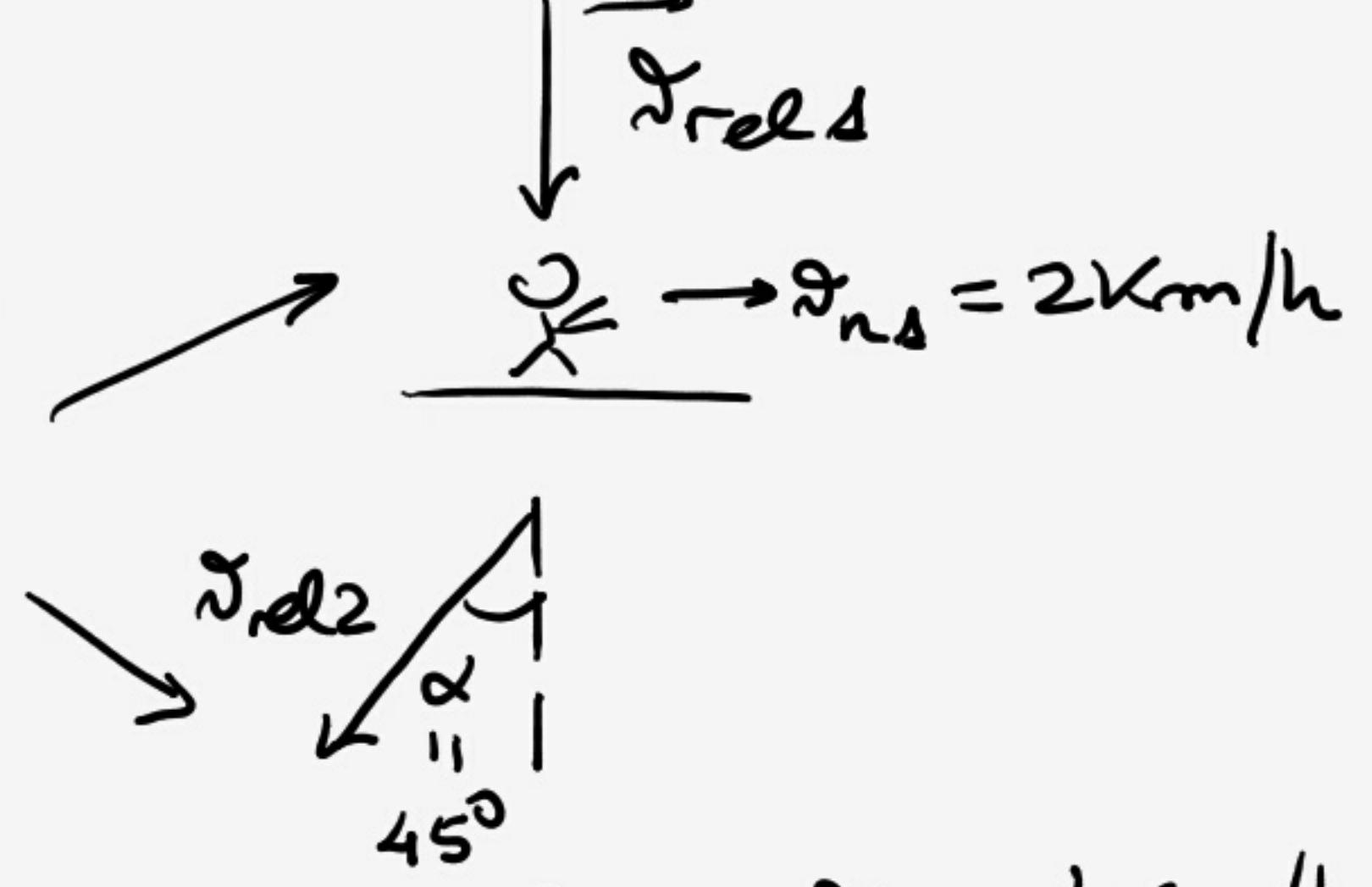
$$t = \frac{d}{v_{abs}} = \frac{200}{285'65} = 0'7 \text{ h} = \underline{42 \text{ min.}}$$

(6.3)



vist per la via

$\vec{v}_n \rightarrow v_{n1} = 2 \text{ km/h}$



$$\vec{v}_{abz} = \vec{v}_{avz} + \vec{v}_{rel} = \vec{v}_0 + \vec{v}_{rel}$$

$$\vec{v}_{avz} = \vec{v}_0 + \vec{\omega} \times \vec{v}_{rel} = \vec{v}_0$$

with $\omega = 0$

$$\vec{v}_{rel} = \vec{v}_{abz} - \vec{v}_0$$

$$\vec{v}_{rel} = \vec{v}_{n2} \hat{i}$$

$$\vec{v}_{n2} = v_{n2} \hat{i}$$

En el sentit dels \vec{v}_{abz} és la velocitat de la pluja, \vec{v}_0 la de la via i \vec{v}_{rel} la de la pluja respecte la via

CAS 1:

$$\vec{v}_{rel} = -\vec{v}_{rel1} \hat{j}; \vec{v}_{abz} = \vec{v}_p \sin \theta \hat{i} - \vec{v}_p \cos \theta \hat{j}; \vec{v}_0 = \vec{v}_{n1} \hat{i}$$

Aplicant $\vec{v}_{rel} = \vec{v}_{abz} - \vec{v}_0$ tenim:

$$-\vec{v}_{rel1} \hat{j} = \vec{v}_p \sin \theta \hat{i} - \vec{v}_p \cos \theta \hat{j} - \vec{v}_{n1} \hat{i} \Rightarrow \begin{cases} \vec{v}_p \sin \theta = \vec{v}_{n1} & (1) \\ \vec{v}_p \cos \theta = \vec{v}_{rel1} & (2) \end{cases}$$

CAS 2:

$$\vec{v}_{rel} = -\vec{v}_{rel2} \sin \alpha \hat{i} - \vec{v}_{rel2} \cos \alpha \hat{j}; \vec{v}_{abz} = \vec{v}_p \sin \theta \hat{i} - \vec{v}_p \cos \theta \hat{j};$$

$$\vec{v}_0 = \vec{v}_{n2} \hat{i}$$

Aplicant $\vec{v}_{rel} = \vec{v}_{abz} - \vec{v}_0$ tenim:

$$-\vec{v}_{rel2} \sin \alpha \hat{i} - \vec{v}_{rel2} \cos \alpha \hat{j} = \vec{v}_p \sin \theta \hat{i} - \vec{v}_p \cos \theta \hat{j} - \vec{v}_{n2} \hat{i} \Rightarrow$$

$$\Rightarrow \begin{cases} \vec{v}_{rel2} \sin \alpha = \vec{v}_{n2} - \vec{v}_p \sin \theta & (3) \\ \vec{v}_{rel2} \cos \alpha = \vec{v}_p \cos \theta & (4) \end{cases}$$

Combinant (1) i (3) tenim:

$$\vec{v}_{rel2} \sin \alpha = \vec{v}_{n2} - \vec{v}_p \sin \theta = \vec{v}_{n2} - \vec{v}_{n1} \Rightarrow$$

$$\Rightarrow \vec{v}_{rel2} = \frac{\vec{v}_{n2} - \vec{v}_{n1}}{\sin \alpha} = 2\sqrt{2} \text{ km/h}$$

Combinant (1) i (4) tenim:

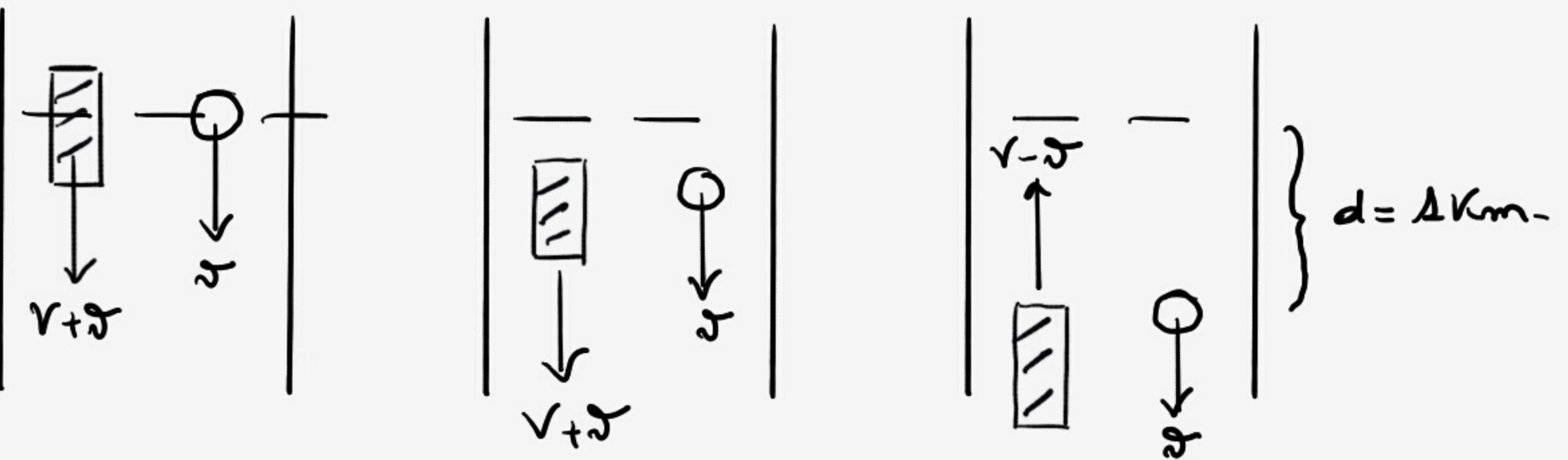
$$\operatorname{tg} \theta = \frac{\vartheta_p \sin \theta}{\vartheta_p \cos \theta} = \frac{\vartheta_m}{\vartheta_{rel2} \cos \alpha} = \frac{2}{2\sqrt{2} \frac{1}{\sqrt{2}}} = 1 \Rightarrow$$

$$\Rightarrow \underline{\theta = \arctg(1) = 45^\circ}$$

Apllicant (1) tenim:

$$\vartheta_p \sin \theta = \vartheta_m \Rightarrow \underline{\vartheta_p} = \frac{\vartheta_m}{\sin \theta} = \frac{2}{\sin 45^\circ} = 2\sqrt{2} = 2'828 \text{ km/h}$$

6.4



$$t = \frac{1}{2} h$$

Per un observador inercial s'esperari reconeixre la barca i el flotador és:

$$d = \underbrace{(V + \Delta) t_1 + (-V + \Delta) t_2}_{\text{barca}} = \cancel{\Delta t_1} + \cancel{\Delta t_2}$$

flotador

Per tant:

$$V t_1 - V t_2 = 0 \Rightarrow t_1 = t_2 \Rightarrow t = t_1 + t_2 = 1h$$

Com en aquest temps el flotador s'ha mogut 1 Km, la velocitat de l'aigua és:

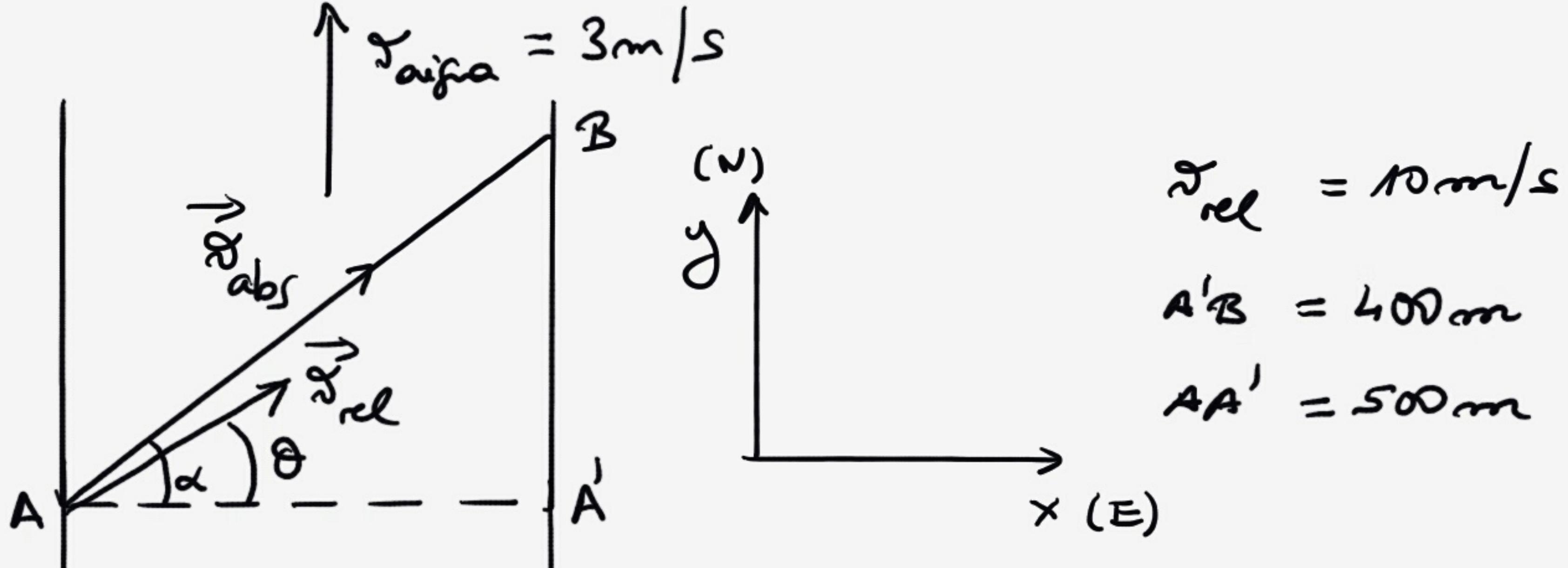
$$v_{\text{aigua}} = \frac{d}{t} = \frac{1 \text{ Km}}{1 \text{ h}} = 1 \text{ Km/h}$$

El raonament que faria un observador que no mogué amb el flotador seria igual, però s'esperari reconeixre una

$$d = 0 = V t_1 - V t_2 \Rightarrow t_1 = t_2$$

6.5

07



$$\vec{v}_{rel} = v_{rel} \cos \theta \vec{i} + v_{rel} \sin \theta \vec{j}; \vec{v}_{abs} = v_{abs} \cos \alpha \vec{i} + v_{abs} \sin \alpha \vec{j}$$

$$\vec{v}_{abs} = \vec{v}_{aer} + \vec{v}_{rel} \quad \text{ambis} \quad \vec{v}_{aer} = \vec{v}_0 + \vec{\omega} \times \vec{r}_{rel}$$

$$\text{Com } \omega = 0 \Rightarrow \vec{v}_{aer} = \vec{v}_0 = \vec{v}_{alpha} = 3 \vec{j}.$$

Per tant:

$$v_{abs} \cos \alpha \vec{i} + v_{abs} \sin \alpha \vec{j} = 3 \vec{j} + v_{rel} \cos \theta \vec{i} + v_{rel} \sin \theta \vec{j} \Rightarrow$$

$$v_{abs} \cos \alpha = v_{rel} \cos \theta = 10 \cos \theta \quad (1)$$

$$\Rightarrow v_{abs} \sin \alpha = 3 + v_{rel} \sin \theta = 3 + 10 \sin \theta \quad (2)$$

Dividim (2) entre (1) tenim:

$$\frac{v_{abs} \sin \alpha}{v_{abs} \cos \alpha} = \frac{3 + 10 \sin \theta}{10 \cos \theta} \quad \left. \begin{array}{l} \text{Com } \operatorname{tg} \alpha = \frac{A'B}{A'A} = \frac{400}{500} = 0.8 \\ \Rightarrow \operatorname{tg} \alpha = 0.8 \end{array} \right\} \Rightarrow \begin{aligned} \operatorname{tg} \alpha = 0.8 &= \frac{3 + 10 \sin \theta}{10 \cos \theta} \Rightarrow \\ 3 + 10 \sin \theta &= 8 \cos \theta \Rightarrow \\ \Rightarrow \cos \theta &= (3 + 10 \sin \theta) / 8 \end{aligned}$$

Aplicant l'identitat pitagòrica $\sin^2 \theta + \cos^2 \theta = 1$, tenim:

$$\sin^2 \theta + \frac{(3 + 10 \sin \theta)^2}{64} = 1 \Rightarrow 64 \sin^2 \theta + 9 + 60 \sin \theta + 100 \sin^2 \theta = 64$$

$$\Rightarrow 164 \sin^2 \theta + 60 \sin \theta - 55 = 0 \Rightarrow \sin \theta = \frac{-60 \pm 199}{328} \Rightarrow$$

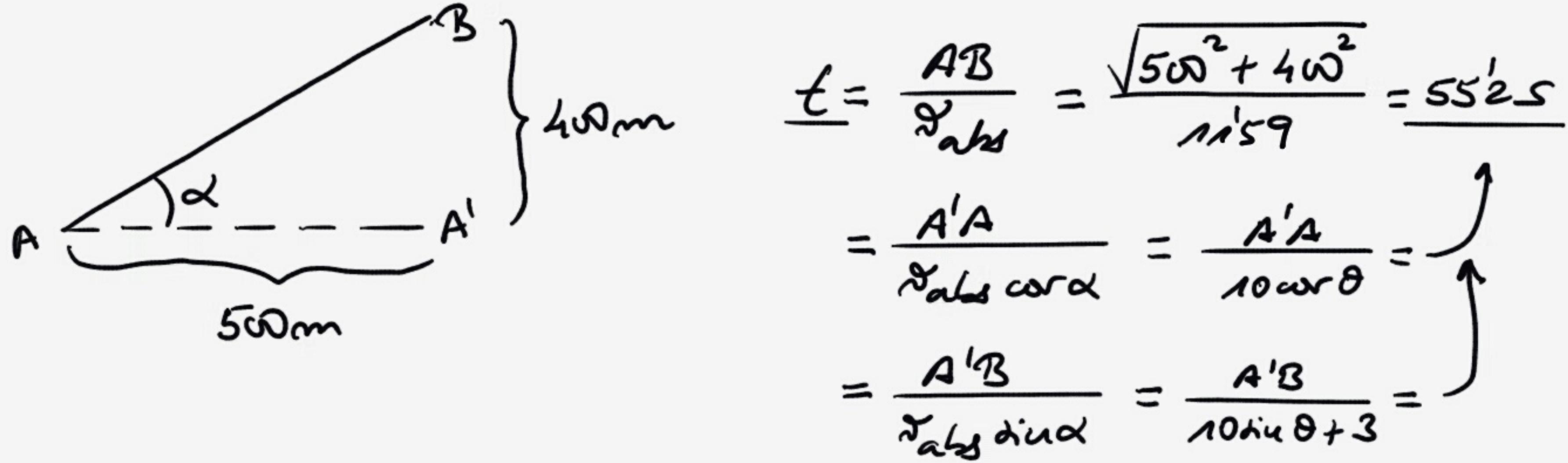
$$\Rightarrow \sin \theta = 0.4238 \Rightarrow \theta = 25.07^\circ \quad \left. \begin{array}{l} \text{A} \quad \text{B} \\ \text{A}' \quad \text{B}' \end{array} \right\} +$$

$$\Rightarrow \sin \theta = -0.7896 \Rightarrow \theta = -52.15^\circ \quad \left. \begin{array}{l} \text{A} \quad \text{B} \\ \text{A}' \quad \text{B}' \end{array} \right\} -$$

Utilitzant el valor positiu, element (1) i (2) al quadrat, sumant i fent arrel quadrada tenim:

$$\left. \begin{array}{l} \vartheta_{abs}^2 \cos^2 \alpha = 100 \cos^2 \theta \\ \vartheta_{abs}^2 \sin^2 \alpha = (3 + 10 \sin \theta)^2 \end{array} \right\} \vartheta_{abs} = \sqrt{100 \cos^2 \theta + (3 + 10 \sin \theta)^2}$$

Substituent tenim: $\vartheta_{abs} = 11'59 \text{ m/s i } \theta = 25'07^\circ$



$$6.6 \quad \vec{\omega} = 2t\vec{i} + 3t^2\vec{j} + (1-t)\vec{k} \text{ rad/s}$$

$$\vec{r}_{rel} = (t^2 - 1)\vec{i} + 3t\vec{j} - 2\vec{k} \text{ m; apagar para } t = 2s$$

$$a) \vec{v}_{abs} = \vec{v}_{arr} + \vec{v}_{rel}; \vec{v}_{arr} = \vec{v}_0 + \vec{\omega} \times \vec{r}_{rel}$$

$$\vec{v}_{rel} = \frac{d\vec{r}_{rel}}{dt} = 2t\vec{i} + 3\vec{j}; \vec{v}_{rel}(2) = 4\vec{i} + 3\vec{j} \text{ m/s}$$

$$\vec{r}_{rel}(2) = 3\vec{i} + 6\vec{j} - 2\vec{k} \text{ m}$$

$$\vec{v}_0 = 0$$

$$\vec{\omega}(2) = 4\vec{i} + 12\vec{j} - \vec{k} \text{ rad/s}$$

$$\vec{v}_{arr}(2) = \vec{v}_0 + \vec{\omega}(2) \times \vec{r}_{rel}(2) = 0 + \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 4 & 12 & -1 \\ 3 & 6 & -2 \end{vmatrix} =$$

$$= -18\vec{i} + 5\vec{j} - 12\vec{k} \text{ m/s}$$

$$\underline{\vec{v}_{abs}(2)} = \vec{v}_{arr}(2) + \vec{v}_{rel}(2) = -14\vec{i} + 8\vec{j} - 12\vec{k} \text{ m/s}$$

$$b) \vec{a}_{abs} = \vec{a}_{rel} + \vec{a}_{arr} + \vec{a}_{Coriolis}; \vec{a}_{arr} = 2\vec{\omega} \times \vec{v}_{rel}$$

$$\vec{a}_{arr} = \vec{a}_0 + \vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} + \vec{\alpha} \times \vec{v}_{rel} \quad \text{TANGENCIAL}$$

CENTRIPETA

$$\vec{a}_{rel} = \frac{d\vec{r}_{rel}}{dt} = 2\vec{i}; \vec{a}_0 = 0$$

$$\vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 4 & 12 & -1 \\ -18 & 5 & -12 \end{vmatrix} = -139\vec{i} + 66\vec{j} + 236\vec{k}$$

$$\vec{\alpha} = \frac{d\vec{\omega}}{dt} = 2\vec{i} + 6\vec{j} - \vec{k} \Rightarrow \vec{\alpha}(2) = 2\vec{i} + 12\vec{j} - \vec{k} \text{ rad/s}^2$$

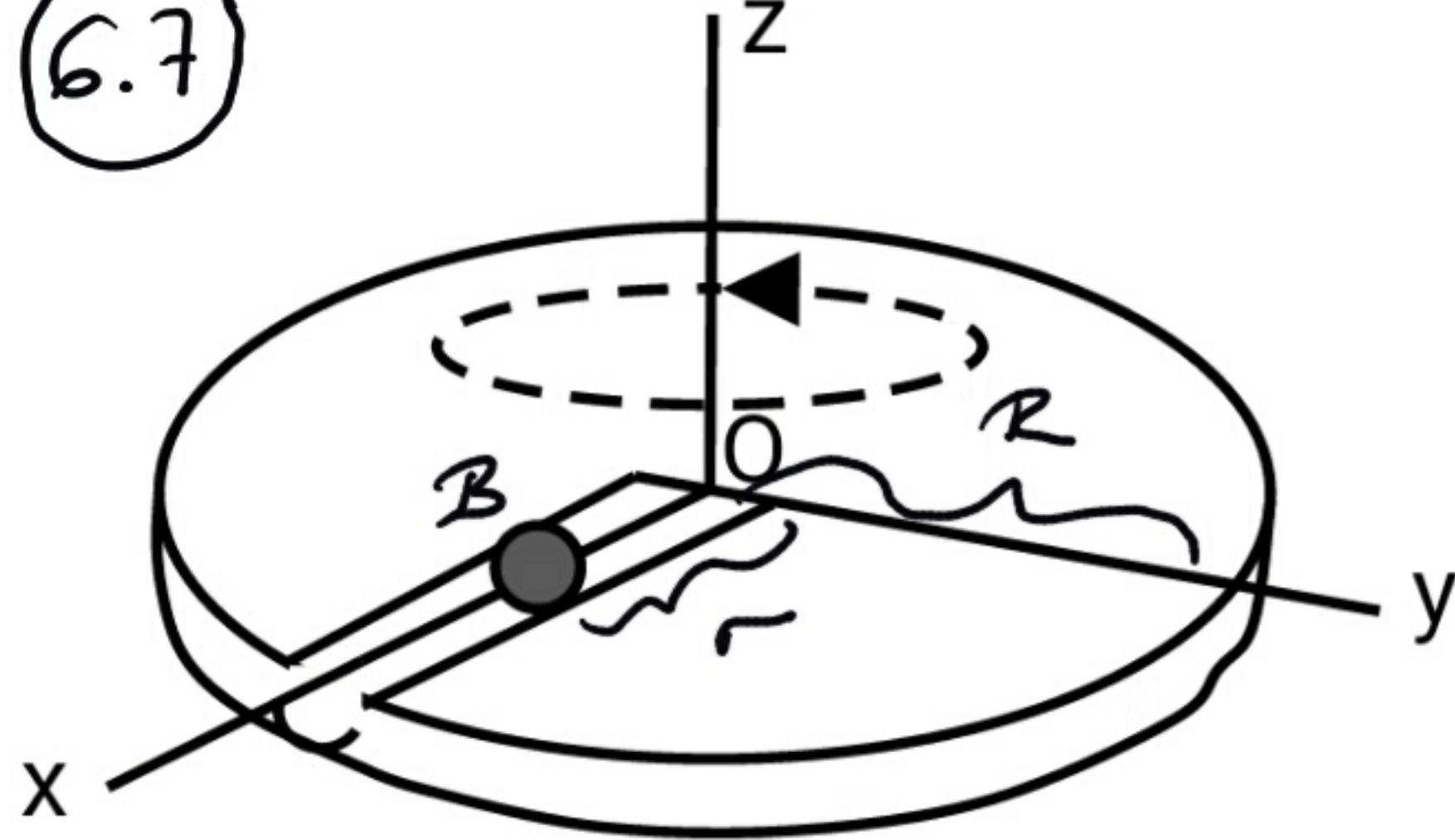
$$\vec{\alpha} \times \vec{v}_{rel} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 2 & 12 & -1 \\ 3 & 6 & -2 \end{vmatrix} = -18\vec{i} + \vec{j} - 24\vec{k}$$

$$\vec{a}_{Coriolis} = 2\vec{\omega} \times \vec{v}_{rel} = 2 \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 4 & 12 & -1 \\ 4 & 3 & 0 \end{vmatrix} = 6\vec{i} - 8\vec{j} - 72\vec{k}$$

$$\vec{a}_{arr} = \vec{a}_0 + \vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} + \vec{\alpha} \times \vec{v}_{rel} = -157\vec{i} + 67\vec{j} + 212\vec{k} \text{ m/s}^2$$

$$\underline{\vec{a}_{abs}} = \vec{a}_{rel} + \vec{a}_{arr} + \vec{a}_{Coriolis} = -149\vec{i} + 59\vec{j} + 140\vec{k} \text{ m/s}^2.$$

6.7



$$\omega = 6 \text{ rad/s}; \alpha = 3 \text{ rad/s}^2$$

$$R = 0.8 \text{ m}; r = 0.4 \text{ m}$$

$$\vec{r}_{\text{rel}} = 0.6 \text{ m/s}; \vec{a}_{\text{rel}} = 0.15 \text{ m/s}^2$$

L'origen del sistema de referència fixe i mòbil estan al punt O. El mòbil gira i el fixe està aturat. \vec{r}_{rel} és la posició de la partícula respecte al sistema mòbil

$$\vec{\omega} = 6 \vec{i} \text{ rad/s}; \alpha = 3 \vec{k} \text{ rad/s}^2; \vec{r}_{\text{rel}} = 0.4 \vec{i} \text{ m}; \vec{v}_{\text{rel}} = 0.6 \vec{i} \text{ m/s}; \vec{a}_{\text{rel}} = 0.15 \vec{i} \text{ m/s}^2$$

$$\vec{v}_{\text{abs}} = \vec{v}_{\text{rel}} + \vec{v}_{\text{arr}}; \vec{v}_{\text{arr}} = \vec{v}_0 + \vec{\omega} \times \vec{r}_{\text{rel}} = 0 + \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & 6 \\ 0.4 & 0 & 0 \end{vmatrix} = 2.4 \vec{j} \text{ m/s}$$

$$= 0.6 \vec{i} + 2.4 \vec{j} \text{ m/s}$$

$$\vec{a}_{\text{abs}} = \vec{a}_{\text{rel}} + \vec{a}_{\text{arr}} + \vec{a}_{\text{Coriolis}}; \vec{a}_{\text{arr}} = \vec{a}_0 + \vec{\omega} \times \vec{\omega} \times \vec{r}_{\text{rel}} + \vec{\alpha} \times \vec{r}_{\text{rel}}$$

$$\vec{\omega} \times \vec{\omega} \times \vec{r}_{\text{rel}} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & 6 \\ 0 & 2.4 & 0 \end{vmatrix} = -14.4 \vec{i} \text{ m/s}^2$$

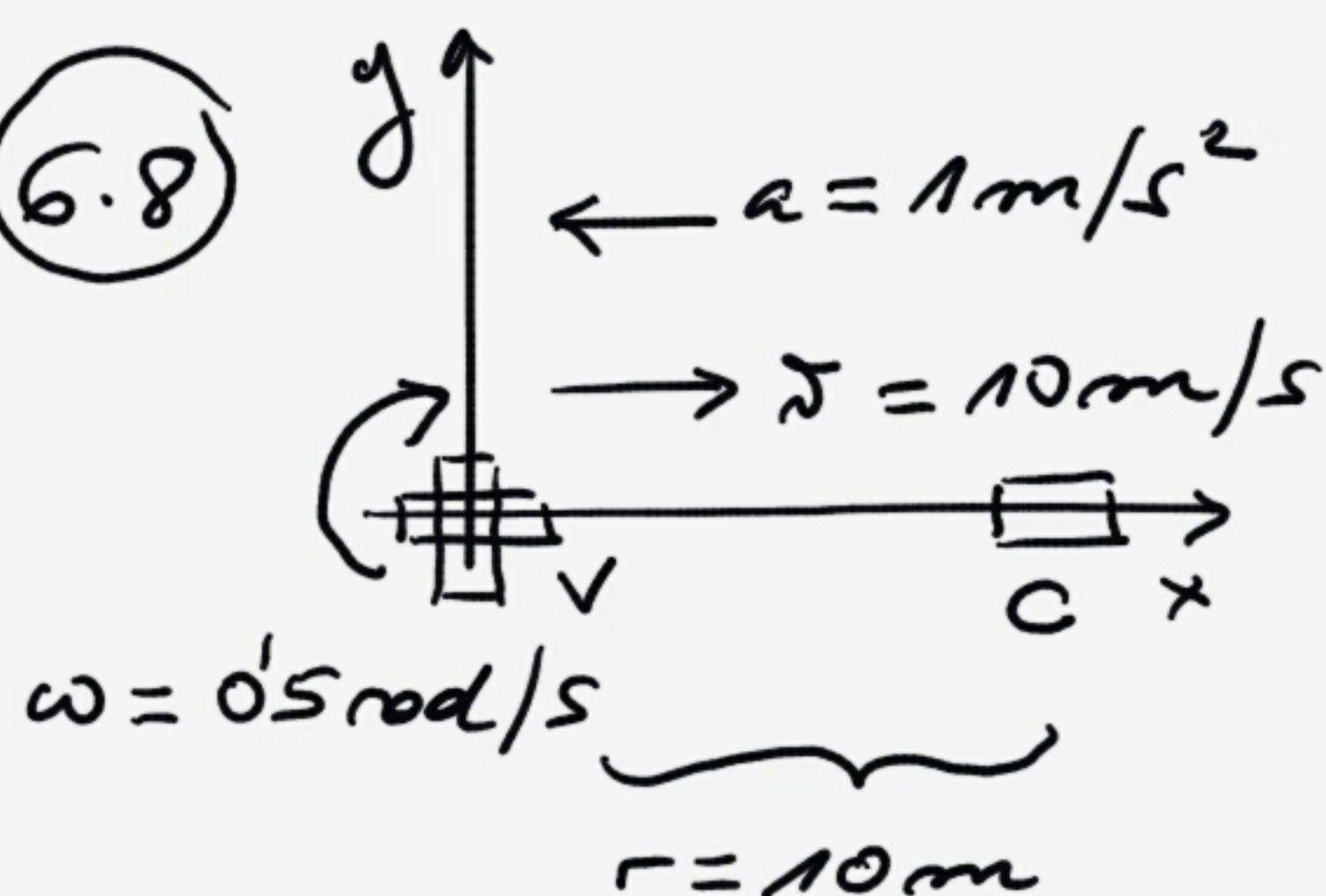
$$\vec{\alpha} \times \vec{r}_{\text{rel}} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & 3 \\ 0.4 & 0 & 0 \end{vmatrix} = 1.2 \vec{j} \text{ m/s}^2$$

$$\vec{a}_0 = 0 \rightarrow \vec{a}_{\text{arr}} = -14.4 \vec{i} + 1.2 \vec{j} \text{ m/s}^2$$

$$\vec{a}_{\text{Coriolis}} = 2 \vec{\omega} \times \vec{r}_{\text{rel}} = 2 \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & 6 \\ 0.6 & 0 & 0 \end{vmatrix} = 7.2 \vec{j} \text{ m/s}^2$$

$$\vec{a}_{\text{abs}} = 0.15 \vec{i} + (-14.4 \vec{i} + 1.2 \vec{j}) + 7.2 \vec{j} = -14.25 \vec{i} + 8.4 \vec{j} \text{ m/s}^2.$$

6.8



$$\left. \begin{array}{l} \vec{r}_v = 0 \text{ (esta atrazat)} \\ \vec{v}_v = 10 \vec{i} \\ \vec{r}_{c/v} = 10 \vec{i} \\ \vec{\omega} = -0.5 \vec{k} \end{array} \right\}$$

$$\vec{v}_{abs} = \underbrace{\vec{v}_0 + \vec{\omega} \times \vec{r}_{rel}}_{\vec{v}_{am}} + \vec{v}_{rel} \Rightarrow$$

$$\Rightarrow \vec{v}_{rel} = \vec{v}_{abs} - \vec{v}_0 - \vec{\omega} \times \vec{r}_{rel}$$

$$\vec{v}_{c/v} \quad \vec{v}_c \quad \vec{v}_v \quad \vec{r}_{c/v}$$

$$\vec{\omega} \times \vec{r}_{rel} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & -0.5 \\ 10 & 0 & 0 \end{vmatrix} = -5 \vec{j}$$

$$\underline{\vec{v}_{c/v} = 0 - 10 \vec{i} - (-5 \vec{j}) = -10 \vec{i} + 5 \vec{j} \text{ m/s.}}$$

$$\vec{a}_{abs} = \underbrace{\vec{a}_0 + \vec{\omega} \times \vec{\omega} \times \vec{r}_{rel}}_{\vec{a}_{am}} + \vec{\alpha} \times \vec{r}_{rel} + \vec{a}_{rel} + \underbrace{2 \vec{\omega} \times \vec{v}_{rel}}_{\vec{a}_{Coriolis}} \Rightarrow$$

$$\Rightarrow \vec{a}_{rel} = \vec{a}_{abs} - \vec{a}_0 - \vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} - \vec{\alpha} \times \vec{r}_{rel} - 2 \vec{\omega} \times \vec{v}_{rel}$$

$$\vec{a}_{c/v} \quad \vec{a}_c \quad \vec{a}_v \quad \vec{v}_{c/v}$$

$$\vec{a}_c = 0 \text{ (esta atrazat)}, \quad \vec{a}_v = -\vec{i};$$

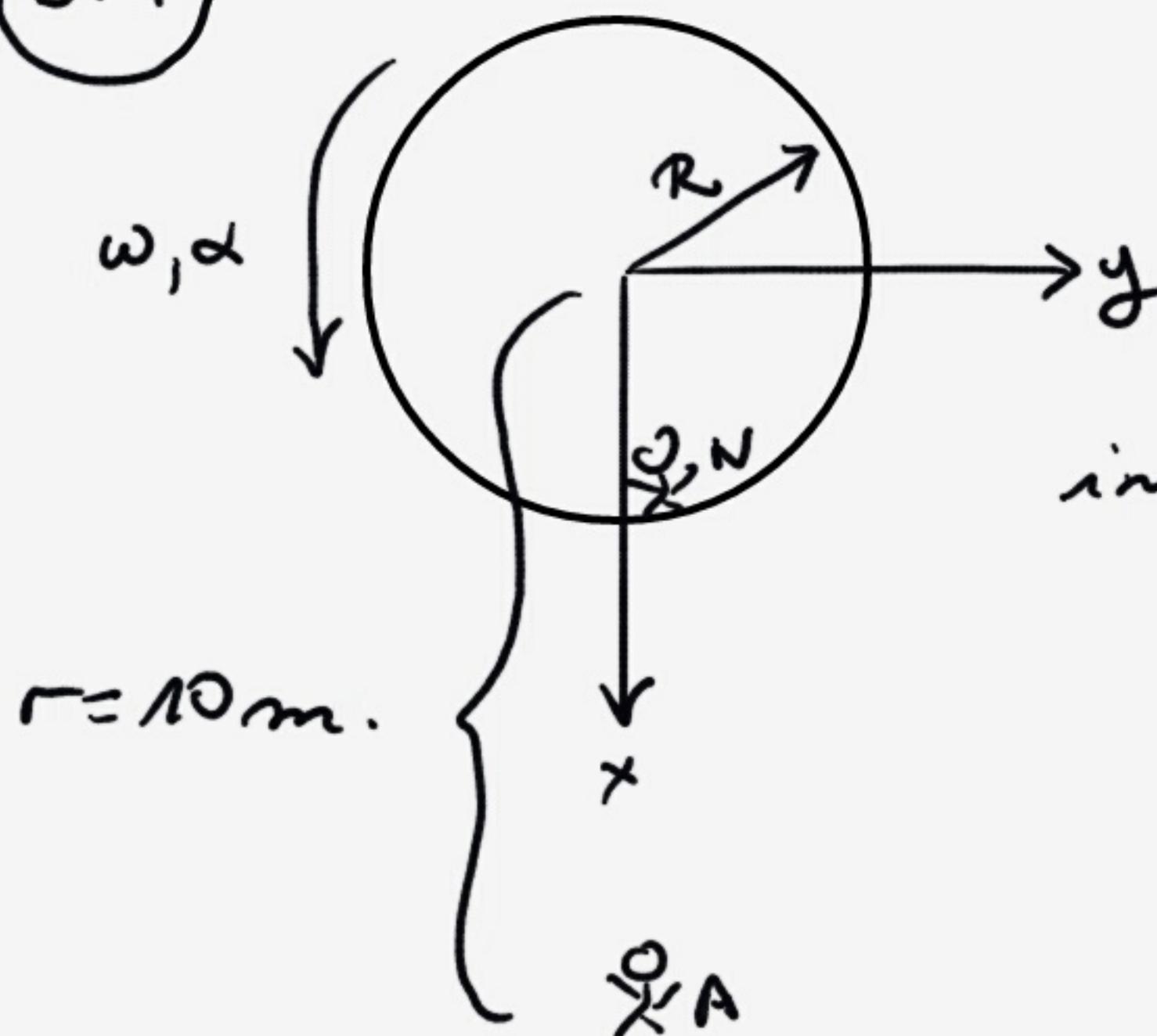
$$\vec{\alpha} = 0$$

$$\vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & -0.5 \\ 0 & -5 & 0 \end{vmatrix} = -2.5 \vec{i}$$

$$2 \vec{\omega} \times \vec{v}_{rel} = 2 \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & -0.5 \\ -10 & 5 & 0 \end{vmatrix} = 5 \vec{i} + 10 \vec{j}$$

$$\underline{\vec{a}_{c/v} = 0 - (-\vec{i}) - (-2.5 \vec{i}) - 0 - (5 \vec{i} + 10 \vec{j}) = -15 \vec{i} - 10 \vec{j} \text{ m/s}^2}$$

6.9



$$R = 3 \text{ m}; \omega = 1 \text{ rad/s}; \alpha = 0.5 \text{ rad/s}^2$$

a) Com s'ha estat aturat s'ha un sistema
inicial

$$\vec{v}_{N/A} = \vec{v}_{abs} = \omega R \vec{j} = 3 \vec{j} \text{ m/s}$$

$$\vec{a}_{N/A} = \vec{a}_{abs} = -\omega^2 R \vec{i} + \alpha R \vec{j} \rightarrow \begin{array}{l} \text{centrífuga} \\ \text{tangencial} \end{array}$$

$$= -3 \vec{i} + 1.5 \vec{j} \text{ m/s}^2$$

b) Si el referencial s'ha el seu

$$\vec{v}_{abs} = \vec{v}_0 + \vec{\omega} \times \vec{r}_{rel} + \vec{v}_{rel} \Rightarrow \vec{v}_{rel} = \vec{v}_{abs} - \vec{v}_0 - \vec{\omega} \times \vec{r}_{rel}$$

$$\vec{v}_{A/N} = \vec{v}_A - \vec{v}_N - \vec{\omega} \times \vec{r}_{A/N}$$

$$\vec{v}_A = 0; \vec{v}_N = \omega R \vec{j}$$

$$\vec{\omega} \times \vec{r}_{A/N} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & \omega \\ (r-R) & 0 & 0 \end{vmatrix} = \omega(r-R) \vec{j}$$

$$\vec{v}_{A/N} = 0 - \omega R \vec{j} - \omega(r-R) \vec{j} = -\omega r \vec{j} = -10 \vec{j} \text{ m/s}$$

$$\vec{a}_{abs} = \underbrace{\vec{a}_0 + \vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} + \vec{\alpha} \times \vec{r}_{rel}}_{\vec{a}_{am}} + \vec{a}_{rel} + 2 \underbrace{\vec{\omega} \times \vec{v}_{rel}}_{\vec{a}_{coriolis}} \Rightarrow$$

$$\Rightarrow \vec{a}_{rel} = \vec{a}_{abs} - \vec{a}_0 - \vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} - \vec{\alpha} \times \vec{r}_{rel} - 2 \vec{\omega} \times \vec{v}_{rel} \Rightarrow$$

$$\Rightarrow \vec{a}_{A/N} = \vec{a}_A - \vec{a}_N - \vec{\omega} \times \vec{\omega} \times \vec{r}_{A/N} - \vec{\alpha} \times \vec{r}_{A/N} - 2 \vec{\omega} \times \vec{v}_{A/N}$$

$$\vec{a}_A = 0; \vec{a}_N = -\omega^2 R \vec{i} + \alpha R \vec{j};$$

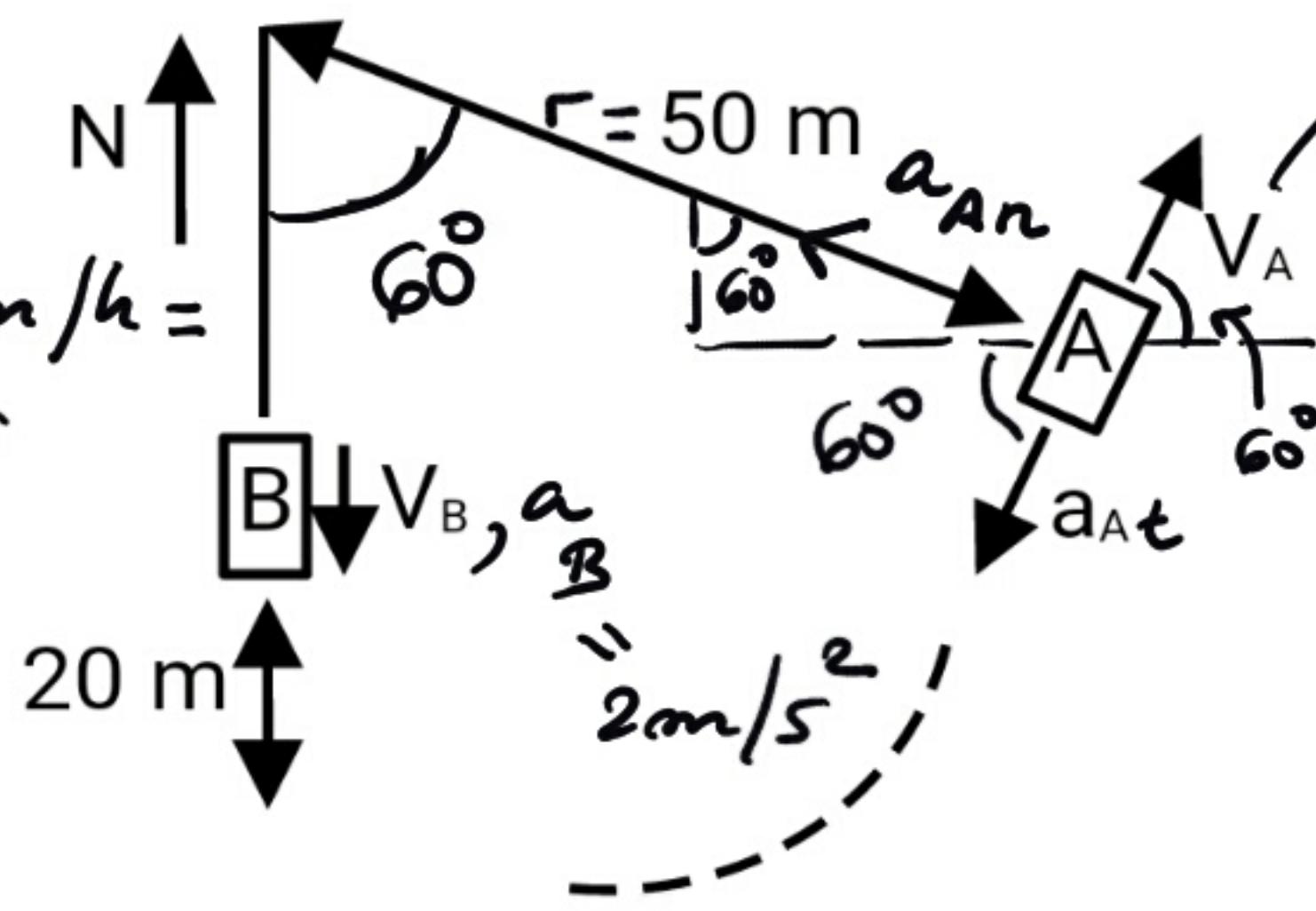
$$\vec{\omega} \times \vec{\omega} \times \vec{r}_{A/N} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & \omega \\ 0 & \omega(r-R) & 0 \end{vmatrix} = -\omega^2(r-R) \vec{i}$$

$$2 \vec{\omega} \times \vec{v}_{A/N} = 2 \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & \omega \\ 0 & -\omega r & 0 \end{vmatrix} = 2\omega^2 r \vec{i}$$

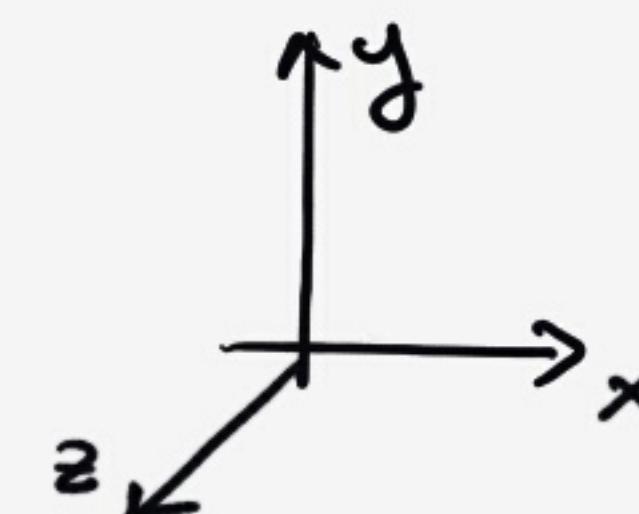
$$\vec{\alpha} \times \vec{r}_{A/N} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & \alpha \\ r-R & 0 & 0 \end{vmatrix} = \alpha(r-R) \vec{j}$$

$$\vec{a}_{A/N} = 0 - (-\omega^2 R \vec{i} + \alpha R \vec{j}) - (-\omega^2(r-R) \vec{i}) - \alpha(r-R) \vec{j} - 2\omega^2 r \vec{i} = -\omega^2 r \vec{i} - \alpha r \vec{j} = -10 \vec{i} - 5 \vec{j} \text{ m/s}^2.$$

6.10



$$= 50 \text{ Km/h} = \\ = 13.89 \text{ m/s}$$



$$\vec{v}_A = \vec{v}_A \cos 60^\circ \vec{i} + \vec{v}_A \sin 60^\circ \vec{j} = \\ = 6.94 \vec{i} + 12.03 \vec{j} \text{ m/s}$$

$$\vec{v}_B = -5 \vec{j} \text{ m/s}$$

$$\vec{a}_A = \vec{a}_{An} + \vec{a}_{At}; \quad \vec{a}_{An} = -\frac{\vec{v}_A^2}{r} \sin 60^\circ \vec{i} + \frac{\vec{v}_A^2}{r} \cos 60^\circ \vec{j} = -3.84 \vec{i} + 1.06 \vec{j} \text{ m/s}^2$$

$$\vec{a}_{At} = -a_{At} \cos 60^\circ \vec{i} - a_{At} \sin 60^\circ \vec{j} = -0.5 \vec{i} - 0.866 \vec{j}$$

$$\vec{a}_A = -3.84 \vec{i} + 1.06 \vec{j} \text{ m/s}^2; \quad \vec{a}_B = -2 \vec{j} \text{ m/s}^2$$

$$a) \vec{v}_{abs} = \vec{v}_0 + \vec{\omega} \times \vec{r}_{rel} + \vec{v}_{rel} \Rightarrow \vec{v}_{rel} = \vec{v}_{abs} - \vec{v}_0 - \vec{\omega} \times \vec{r}_{rel}.$$

Ets demanat la velocitat relativa de A respecte de B.
d'acord $\vec{v}_{abs} = \vec{v}_A$; $\vec{v}_0 = \vec{v}_B$; $\vec{\omega} = 0$ (B no gira); $\vec{v}_{rel} = \vec{v}_{A/B}$.
Per tant:

$$\underline{\vec{v}_{A/B}} = \vec{v}_A - \vec{v}_B = (6.94 \vec{i} + 12.03 \vec{j}) - (-5 \vec{j}) = \underline{6.94 \vec{i} + 17.03 \vec{j} \text{ m/s}}$$

Pel cas de l'acceleració tenim que $\vec{a}_{abs} = \vec{a}_0 + \vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} + \vec{\alpha} \times \vec{r}_{rel} +$
+ $\vec{a}_{rel} + \vec{a}_{coriolis} \Rightarrow \vec{a}_{rel} = \vec{a}_{abs} - \vec{a}_0 - \vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} - \vec{\alpha} \times \vec{r}_{rel} - \vec{a}_{coriolis}$
Com B NO GIRA $\Rightarrow \omega = \alpha = 0 \Rightarrow \vec{a}_{coriolis} = 2 \vec{\omega} \times \vec{r}_{rel} = 0$. A
més $\vec{a}_{abs} = \vec{a}_A$; $\vec{a}_0 = \vec{a}_B$ i $\vec{a}_{rel} = \vec{a}_{A/B}$. Per tant:

$$\underline{\vec{a}_{A/B}} = \vec{a}_A - \vec{a}_B = (-3.84 \vec{i} + 1.06 \vec{j}) - (-2 \vec{j}) = \underline{-3.84 \vec{i} + 3.06 \vec{j} \text{ m/s}^2}.$$

b) En aquest cas e'sserva que A gira amb una velocitat
i acceleració angulars ω_A i α_A , que valen: $\omega_A = \vec{\omega}_A / r =$
 $= 13.89 / 50 = 0.278 \text{ rad/s}$ i $\alpha_A = a_{At} / r = 1 / 50 = 0.02 \text{ rad/s}^2$.

D'acord amb els eixos de la figura i els resultats de \vec{v}_A i \vec{a}_A
tenim que: $\vec{\omega}_A = 0.278 \vec{i} \text{ rad/s}$ i $\vec{\alpha}_A = -0.02 \vec{i} \text{ rad/s}^2$. En
aquest cas $\vec{v}_{rel} = \vec{v}_{B/A}$; $\vec{v}_{abs} = \vec{v}_B$; $\vec{v}_0 = \vec{v}_A$; $\omega = \omega_A$ i
 $\vec{r}_{rel} = \vec{r}_{B/A} = \vec{r}_B - \vec{r}_A = -30 \vec{j} - (50 \sin 60^\circ \vec{i} - 50 \cos 60^\circ \vec{j}) =$
 $= -30 \vec{j} - (43.3 \vec{i} - 25 \vec{j}) = -43.3 \vec{i} - 5 \vec{j} \text{ m}$. Per tant:

$$\vec{v}_{B/A} = \vec{v}_B - (\vec{v}_A + \vec{\omega}_A \times \vec{r}_{B/A})$$

$$\vec{\omega}_A \times \vec{r}_{B/A} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & 0'278 \\ -43'3 & -5 & 0 \end{vmatrix} = 1'39\vec{i} - 12'03\vec{j}$$

Per tant: $\underline{\vec{v}_{B/A}} = -5\vec{j} - (6'94\vec{i} + 12'03\vec{j} + 1'39\vec{i} - 12'03\vec{j}) =$
 $= -8'33\vec{i} - 5\vec{j} \text{ m/s.}$

Per que ja a l'acceleració, ara tenim que $a_{rel} = \vec{a}_{B/A}$;
 $\vec{a}_{abs} = \vec{a}_B$; $\vec{a}_o = \vec{a}_A$; $\omega = \omega_A$; $\alpha = \alpha_A$ i $\vec{v}_{rel} = \vec{v}_{B/A}$. Per tant

$$\vec{a}_{B/A} = \vec{a}_B - (\vec{a}_A + \vec{\omega}_A \times \vec{\omega}_A \times \vec{r}_{B/A} + \vec{\alpha}_A \times \vec{r}_{B/A} + 2\vec{\omega}_A \times \vec{v}_{B/A})$$

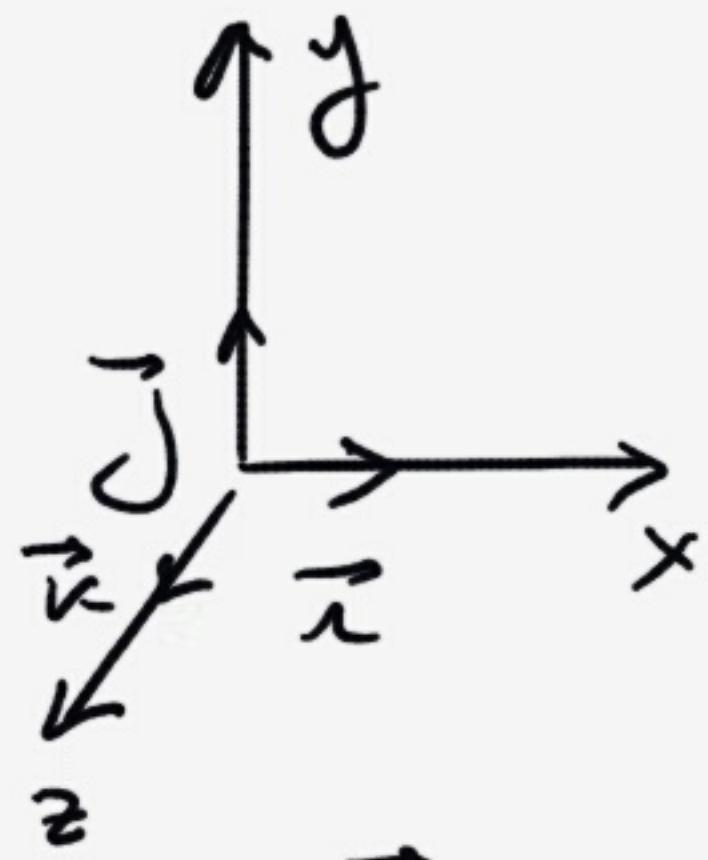
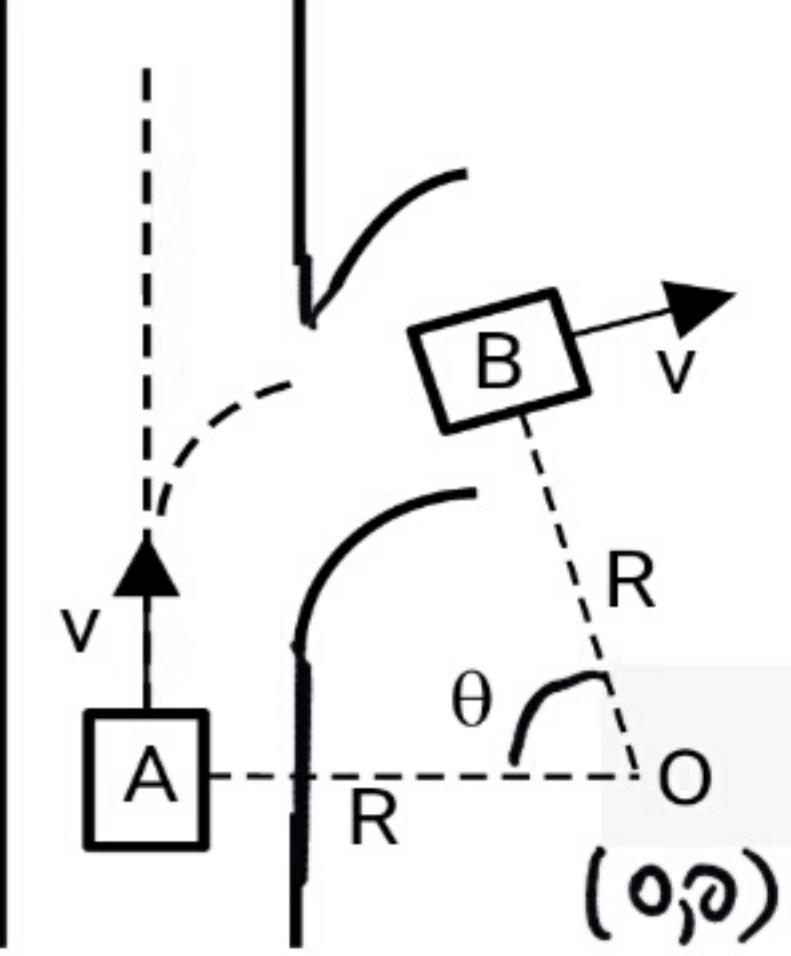
$$\vec{\omega}_A \times \vec{\omega}_A \times \vec{r}_{B/A} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & 0'278 \\ 1'39 - 12'03 & 0 & 0 \end{vmatrix} = 3'34\vec{i} + 0'39\vec{j}$$

$$\vec{\alpha}_A \times \vec{r}_{B/A} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & -0'02 \\ -43'3 & -5 & 0 \end{vmatrix} = -0'1\vec{i} + 0'866\vec{j}$$

$$2\vec{\omega}_A \times \vec{v}_{B/A} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & 0'278 \\ -83'3 & -5 & 0 \end{vmatrix} = 2'78\vec{i} - 4'63\vec{j}$$

$\vec{a}_{B/A} = -2\vec{j} - (-3'84\vec{i} + 1'66\vec{j} + 3'34\vec{i} + 0'39\vec{j} - 0'1\vec{i} + 0'87\vec{j} + 2'78\vec{i} - 4'63\vec{j})$
 $= -2'18\vec{i} + 0'31\vec{j} \text{ m/s}^2.$

6.11



Les posicions de A i B referides a l'origen i el sistema d'eixos indicat són:

$$\vec{r}_A = -R\vec{i}$$

$$\vec{r}_B = -R\cos\theta\vec{i} + R\sin\theta\vec{j}$$

La distància relativa de A referida a B és:

$$\vec{r}_{A/B} = \vec{r}_A - \vec{r}_B = -R(1-\cos\theta)\vec{i} - R\sin\theta\vec{j}$$

La velocitat relativa és: $\vec{v}_{A/B} = \vec{v}_A - \vec{v}_B - \vec{\omega} \times \vec{r}_{A/B}$

$$\vec{v}_A = \ddot{x}_A\vec{j}; \quad \vec{v}_B = \ddot{x}_B\sin\theta\vec{i} + \ddot{x}_B\cos\theta\vec{j};$$

$$\vec{\omega} = -\frac{\ddot{x}_B}{R}\vec{k}$$



$$\vec{\omega} \times \vec{r}_{A/B} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & -\ddot{x}_B/R \\ -R(1-\cos\theta) & -R\sin\theta & 0 \end{vmatrix} = -\ddot{x}_B\sin\theta\vec{i} + \ddot{x}_B(1-\cos\theta)\vec{j}$$

Així doncs:

$$\begin{aligned} \vec{v}_{A/B} &= \ddot{x}_B\vec{j} - \left\{ \ddot{x}_B\sin\theta\vec{i} + \ddot{x}_B\cos\theta\vec{j} \right\} - \left\{ -\ddot{x}_B\sin\theta\vec{i} + \ddot{x}_B(1-\cos\theta)\vec{j} \right\} = \\ &= (\ddot{x}_A - \ddot{x}_B)\vec{j} = \underline{0} \quad (\text{ja que } \ddot{x}_A = \ddot{x}_B = \ddot{x}). \end{aligned}$$

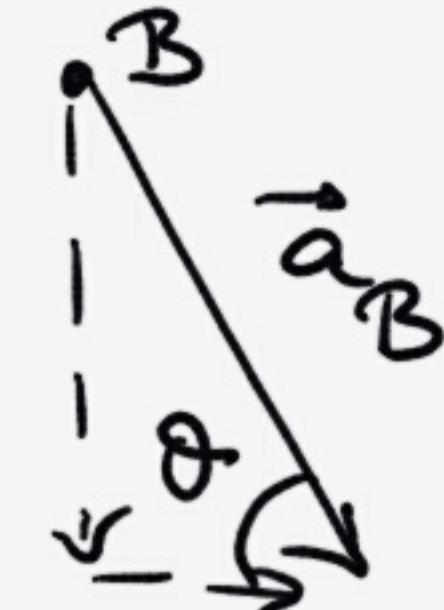
L'acceleració relativa és:

$$\vec{a}_{A/B} = \vec{a}_A - \vec{a}_B - \vec{\omega} \times \vec{\omega} \times \vec{r}_{A/B} - \vec{\alpha} \times \vec{r}_{A/B} - 2\vec{\omega} \times \vec{v}_{A/B}$$

$$\text{Ara } \vec{a}_A = 0; \quad \vec{a}_B = \frac{\ddot{x}_B^2}{R}\cos\theta\vec{i} - \frac{\ddot{x}_B^2}{R}\sin\theta\vec{j}$$

$$\vec{\alpha} = 0 \Rightarrow \vec{\alpha} \times \vec{r}_{A/B} = 0$$

$$\vec{a}_{\text{coriolis}} = 2\vec{\omega} \times \vec{v}_{A/B} = 2 \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & -\ddot{x}_B/R \\ 0 & (\ddot{x}_A - \ddot{x}_B) & 0 \end{vmatrix} = 2 \frac{\ddot{x}_B}{R}(\ddot{x}_A - \ddot{x}_B)\vec{i}.$$

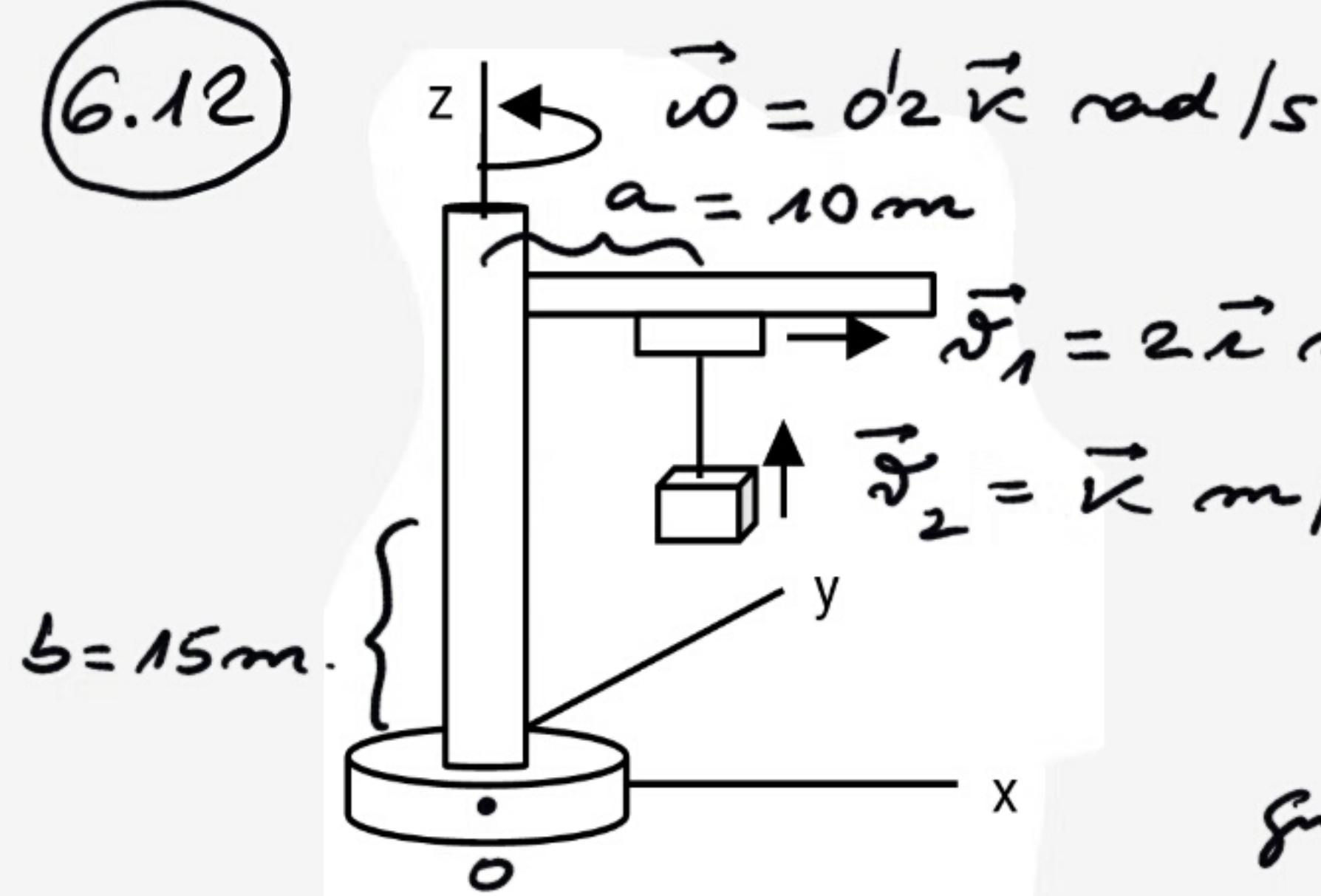


$$\vec{\omega} \times \vec{\omega} \times \vec{r}_{A/B} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & -\ddot{x}_B/R \\ -\ddot{x}_B\sin\theta & \ddot{x}_B(1-\cos\theta) & 0 \end{vmatrix} = \frac{\ddot{x}_B^2}{R}(1-\cos\theta)\vec{i} + \frac{\ddot{x}_B^2}{R}\sin\theta\vec{j}$$

Per tant:

$$\begin{aligned} \vec{a}_{A/B} &= 0 - \frac{\ddot{x}_B^2}{R}\cos\theta\vec{i} + \frac{\ddot{x}_B^2}{R}\sin\theta\vec{j} - \frac{\ddot{x}_B^2}{R}(1-\cos\theta)\vec{i} - \frac{\ddot{x}_B^2}{R}\sin\theta\vec{j} - 2 \frac{\ddot{x}_B}{R}(\ddot{x}_A - \ddot{x}_B)\vec{i} = \\ &= \frac{\ddot{x}_B}{R}(\ddot{x}_B - 2\ddot{x}_A)\vec{i} = -\frac{\ddot{x}^2}{R}\vec{i} \quad (\text{ja que } \ddot{x}_A = \ddot{x}_B = \ddot{x}). \end{aligned}$$

6.12



Com a sistema de referència mòbil pren un gire t' l'origen a 0 i que fa una velocitat angular ω , de manera que la velocitat relativa en aquest sistema és desigual a les velocitats \vec{v}_1 i \vec{v}_2 . Així doncs:

$$\vec{v}_{abs} = \vec{v}_0 + \vec{\omega} \times \vec{r}_{rel} + \vec{v}_{rel}; \quad \vec{v}_0 = 0, \text{ ja que el sistema mòbil no es troba rotant}$$

$$\vec{v}_{rel} = 2\hat{i} + \hat{k}$$

$$\vec{r}_{rel} = a\hat{i} + b\hat{k} = 10\hat{i} + 15\hat{k}$$

$$\vec{v}_{abs} = 0 + \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 0.2 \\ 10 & 0 & 15 \end{vmatrix} + 2\hat{i} + \hat{k} = 2\hat{i} + 2\hat{j} + \hat{k} \text{ m/s.}$$

$\hat{z}\hat{j}$

Anòlisi ↴

$$\vec{a}_{abs} = \vec{a}_0 + \vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} + \vec{\alpha} \times \vec{r}_{rel} + \vec{a}_{rel} + 2\vec{\omega} \times \vec{v}_{rel}$$

En aquest cas: $\vec{a}_0 = 0$; $\vec{a}_{rel} = 0$ (les velocitats són constants);

$$\vec{\alpha} = 0$$

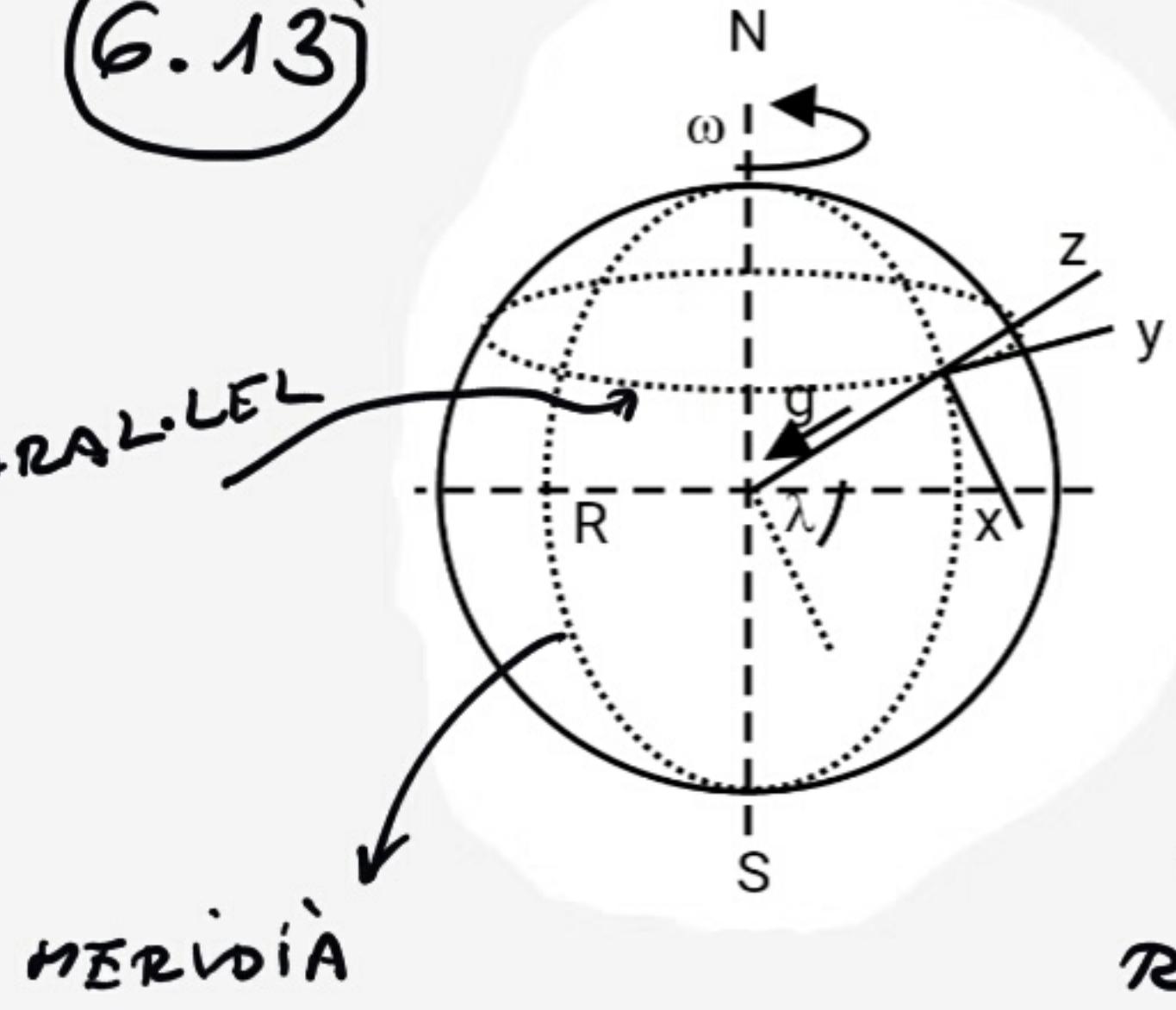
$$\vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 0.2 \\ 0 & 2 & 0 \end{vmatrix} = -0.4\hat{i}$$

$$2\vec{\omega} \times \vec{v}_{rel} = 2 \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 0.2 \\ 2 & 0 & 1 \end{vmatrix} = 0.8\hat{j}$$

Per tant:

$$\vec{a}_{abs} = 0 + (-0.4\hat{i}) + 0 + 0 + 0.8\hat{j} = -0.4\hat{i} + 0.8\hat{j} \text{ m/s}^2.$$

6.13)



MERIDIÀ

Així doncs:

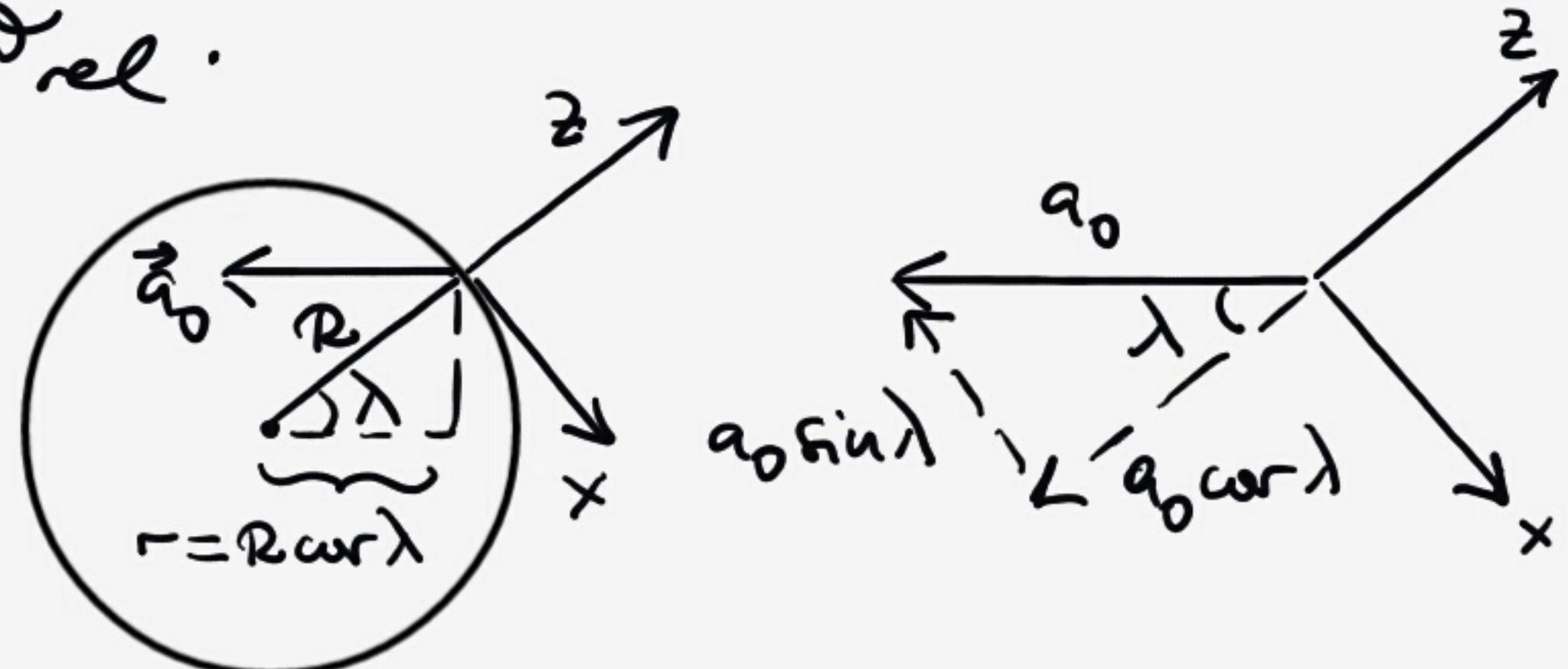
Es tracta d'expressar l'acceleració d'un objecte per un sistema de referència situat en un punt de la superfície. Obviament no és inercial ja que es mou (ACCELERAT) degut a la ROTACIÓ de la terra amb velocitat angular ω . Així doncs:

$$\vec{a}_{abs} = \vec{a}_0 + \vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} + \vec{\alpha} \times \vec{r}_{rel} + \vec{a}_{rel} + 2\vec{\omega} \times \vec{\dot{r}}_{rel} \Rightarrow$$

$$\Rightarrow \vec{a}_{rel} = \vec{a}_{abs} - \vec{a}_0 - \vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} - \vec{\alpha} \times \vec{r}_{rel} - 2\vec{\omega} \times \vec{\dot{r}}_{rel}$$

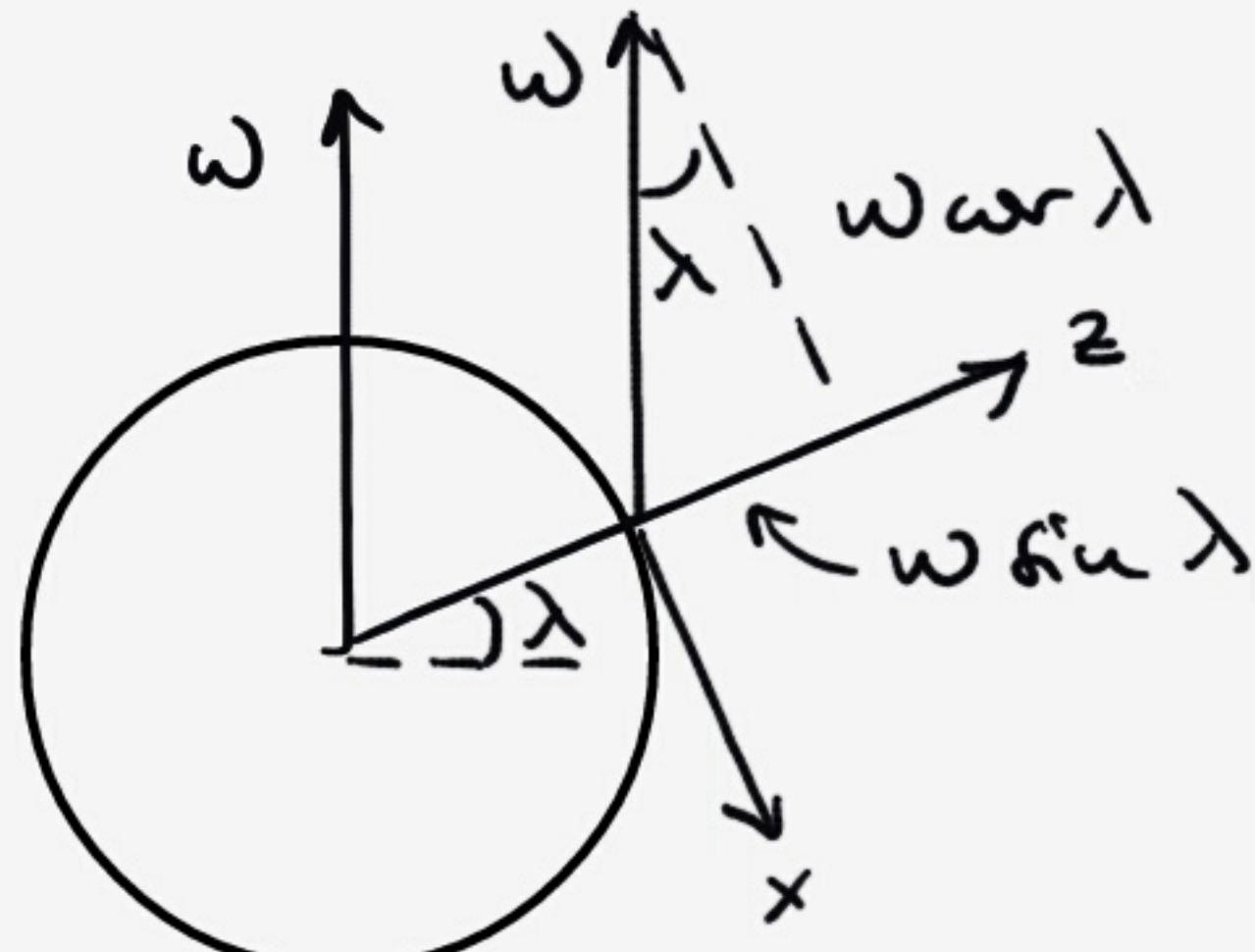
En el nostre cas: $\vec{a}_{abs} = -g \vec{k}$; $\vec{\alpha} = 0$; $\vec{r}_{rel} \approx 0$; ja que $r_{rel} \ll R \Rightarrow \vec{\omega} \times \vec{\omega} \times \vec{r}_{rel} = 0$. Així doncs tenim dues contribucions: \vec{a}_0 i $2\vec{\omega} \times \vec{\dot{r}}_{rel}$.

\vec{a}_0 és l'acceleració antípoda de P degut a la ROTACIÓ a la latitud λ



$$\text{Pertant: } \vec{a}_0 = -\omega^2 R \cos \lambda (\sin \lambda \vec{i} + \cos \lambda \vec{k})$$

la velocitat de rotació $\vec{\omega}$ respecte aquells eixos és:



$$\vec{\omega} = -\omega \cos \lambda \vec{i} + \omega \sin \lambda \vec{k}$$

El terme de Coriolis pel cas més general en que la velocitat relativa té components $(\dot{x}_x, \dot{x}_y, \dot{x}_z)$ és:

$$2\vec{\omega} \times \vec{\dot{r}}_{rel} = 2 \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ -\omega \cos \lambda & 0 & \omega \sin \lambda \\ \dot{x}_x & \dot{x}_y & \dot{x}_z \end{vmatrix} = 2\omega \left\{ -\dot{x}_y \sin \lambda \vec{i} + (\dot{x}_x \sin \lambda + \dot{x}_z \cos \lambda) \vec{j} - \dot{x}_y \cos \lambda \vec{k} \right\}$$

Així doncs:

$$\vec{a}_{rel} = -g \vec{k} + \omega^2 R \cos \lambda (\sin \lambda \vec{i} + \cos \lambda \vec{k}) - 2\omega \left\{ -\dot{x}_y \sin \lambda \vec{i} + (\dot{x}_x \sin \lambda + \dot{x}_z \cos \lambda) \vec{j} - \dot{x}_y \cos \lambda \vec{k} \right\}$$

CENTRIFUGA

CORIOLIS

$$a) \omega = \frac{2\pi}{24 \cdot 3600} = 7'272 \cdot 10^{-5} \text{ rad/s} ; R = 6'38 \cdot 10^6 \text{ m} ; \lambda = 45^\circ$$

$$\vec{a}_{\text{cent}} = \omega^2 R \cos \lambda (\sin \lambda \vec{i} + \cos \lambda \vec{k}) = 0'01687 (\vec{i} + \vec{k}) \text{ m/s}^2$$

$$b) \vec{v} = 500 \vec{i} \quad \downarrow$$

$$\vec{a}_{\text{Coriolis}} = -2\omega \vec{v} \times \sin \lambda \vec{j} = -0'0514 \vec{j} \text{ m/s}^2.$$

$$c) \lambda = -45^\circ. \cos \sin (-45^\circ) = -\sin (45^\circ) \text{ i } \cos (-45^\circ) = \cos (45^\circ)$$

$$\vec{a}_{\text{cent}} = 0'01687 (-\vec{i} + \vec{k}) \text{ m/s}^2$$

$$\vec{a}_{\text{Coriolis}} = 0'0514 \vec{j} \text{ m/s}^2$$

6.14

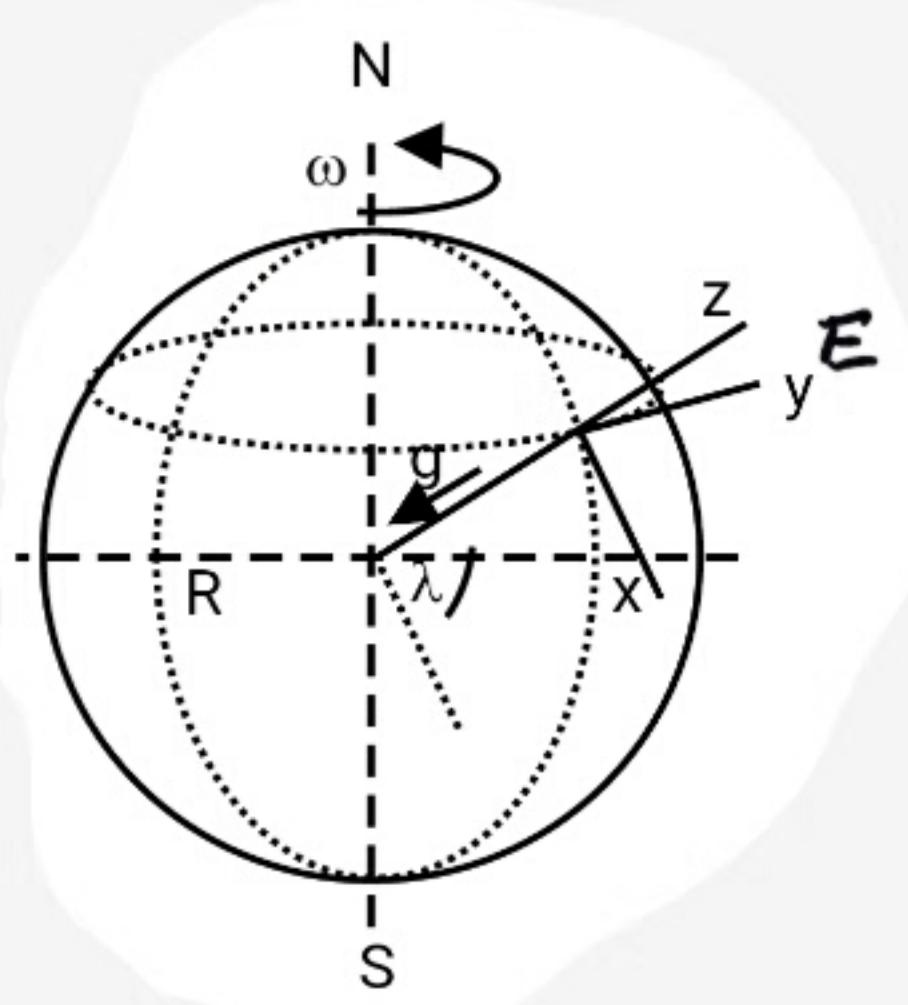
a) Pel cas d'un observador inercial $\vec{a}_{abs} = -g \vec{k}$

b) Pel cas d'un observador sobre la superfície terrestre, com s'ha admetit al problema anterior:

$$\vec{a}_{rel} = -g \vec{k} + \omega^2 R \cos \lambda (\sin \lambda \vec{i} + \cos \lambda \vec{k}) - 2\omega \{-\dot{\gamma}_y \sin \lambda \vec{i} + \\ + (\dot{\gamma}_x \sin \lambda + \dot{\gamma}_z \cos \lambda) \vec{j} - \dot{\gamma}_y \cos \lambda \vec{k}\}$$

En el norte cas $\lambda = 40^\circ$ i $\vec{r} = -500 \vec{i}$ m/r. Per tant:

$$\underline{\vec{a}_{rel}} = -g \vec{k} + 0'0166 \vec{i} + 0'0198 \vec{k} - \underbrace{2\omega \dot{\gamma}_x \sin \lambda \vec{j}}_{= 0'0467 \vec{j}} = \\ = 0'0166 \vec{i} + 0'0467 \vec{j} - 9'7934 \vec{k} \text{ m/s}^2$$



Com els components a_x i a_y són positius, les direccions són cap el S i l'E. Així, doncs, l'observador no inercial varia una derivació cap el S i l'E.

6.15

A hand-drawn diagram of a 2D Cartesian coordinate system with x and y axes. A vector is drawn from the origin at an angle $\alpha = 60^\circ$ to the positive x-axis. The z-axis is shown as a vertical line pointing upwards.

$$\vec{r}_{rel} = \vec{r}_0 \cos \omega \vec{j} + \vec{r}_0 \sin \omega \vec{\kappa} = \\ = 200 \vec{j} + 346'4 \vec{\kappa}$$

l'accelerazione relativa è:

$$\vec{a}_{\text{rel}} = -g \vec{\kappa} + \omega^2 r \cos \lambda (\sin \lambda \vec{i} + \cos \lambda \vec{\kappa}) - 2\omega \{-\ddot{\vartheta}_y \sin \lambda \vec{i} + \\ + (\ddot{\vartheta}_x \sin \lambda + \ddot{\vartheta}_z \cos \lambda) \vec{j} - \ddot{\vartheta}_y \cos \lambda \vec{k}\}$$

$\lim_{x \rightarrow 0} f_x = 0$, quindi:

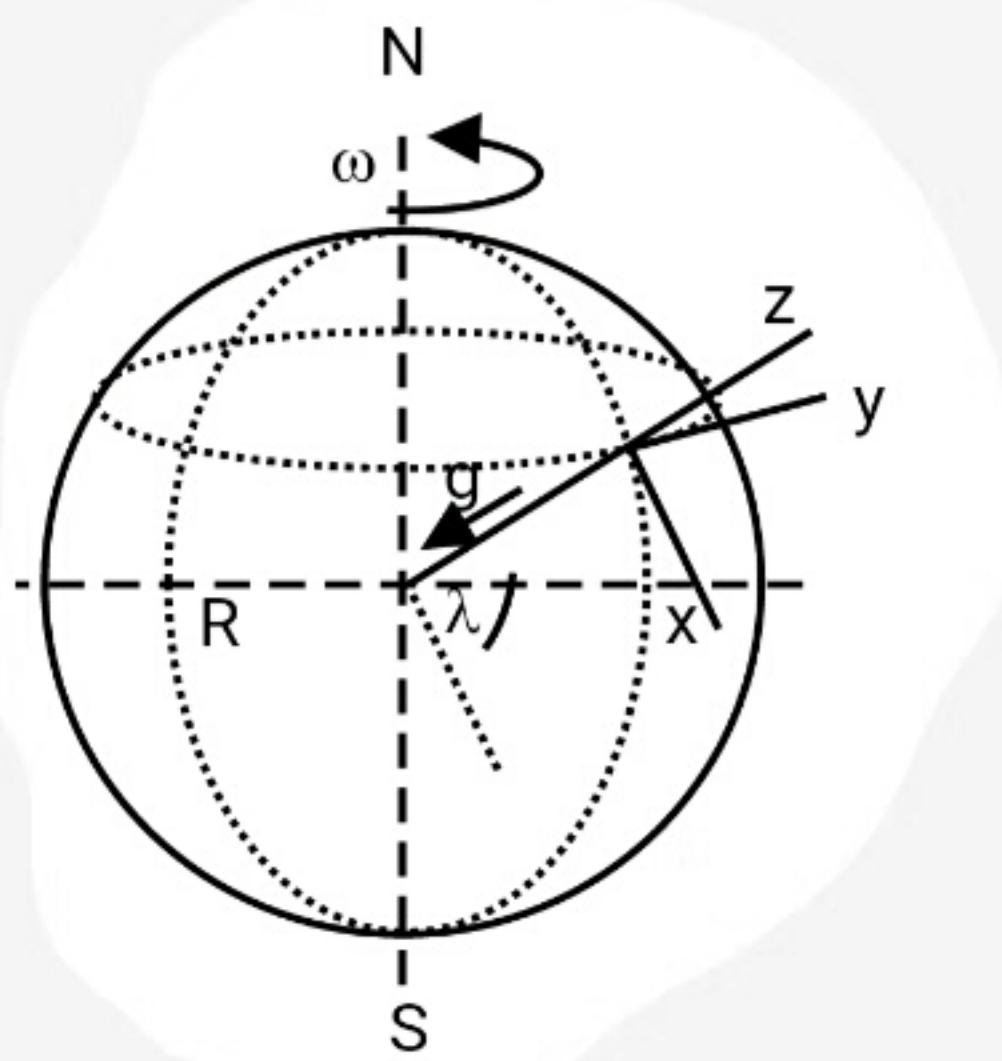
$$\vec{a}_{cl} = -g \vec{\kappa} + \omega^2 r \cos \lambda (\sin \lambda \vec{i} + \cos \lambda \vec{k}) - 2\omega \left\{ -\partial_y \sin \lambda \vec{i} + \right. \\ \left. + \partial_z \cos \lambda \vec{j} - \partial_y \cos \lambda \vec{k} \right\}$$

Com $\lambda = -45^\circ$

$$\vec{a}_{rel} = -9'81 \vec{i} - 0'01687 \vec{i} + 0'01687 \vec{k} - 0'0206 \vec{i} - 0'0356 \vec{j} + 0'0206 \vec{k}$$

CENTRIFUGA

$$\vec{a}_{\text{rel}} = -0.0395\vec{i} - 0.0356\vec{j} - 0.7725\vec{k} \quad \text{m/s}^2$$



Com així agòs negatius, les derivacions agòs cap el N i l'O.

6.16

$$\bar{v} = 9 \text{ km/h} = 25 \text{ m/s}$$

com la direcció és Nord

$$\lambda = 45^\circ$$

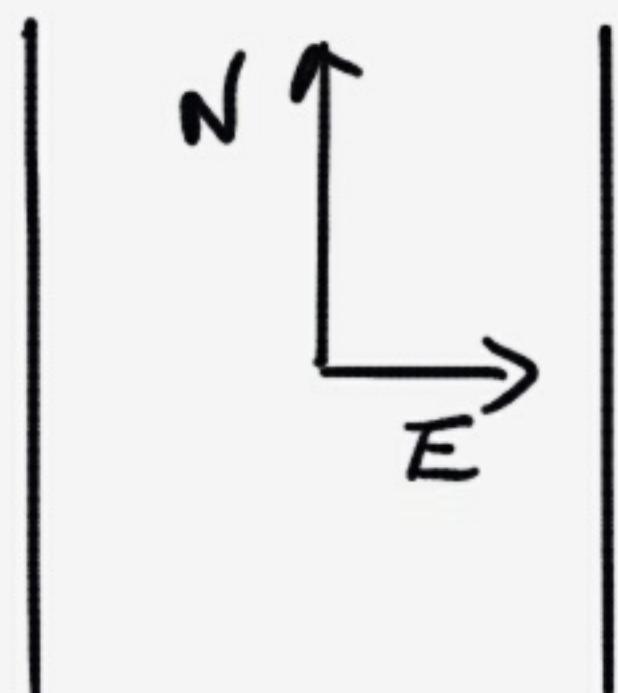
El terme de Coriolis és:

$$\vec{a}_{\text{Coriolis}} = -2\omega \left\{ -\bar{v}_y \sin \lambda \vec{i} + (\bar{v}_x \sin \lambda + \bar{v}_z \cos \lambda) \vec{j} - \bar{v}_y \cos \lambda \vec{k} \right\}$$

Com $\bar{v}_y = \bar{v}_z = 0$, tenim:

$$\vec{a}_{\text{Coriolis}} = -2\omega \bar{v}_x \sin \lambda \vec{j} = \underline{257 \cdot 10^{-4} \vec{j} \text{ m/s}^2}$$

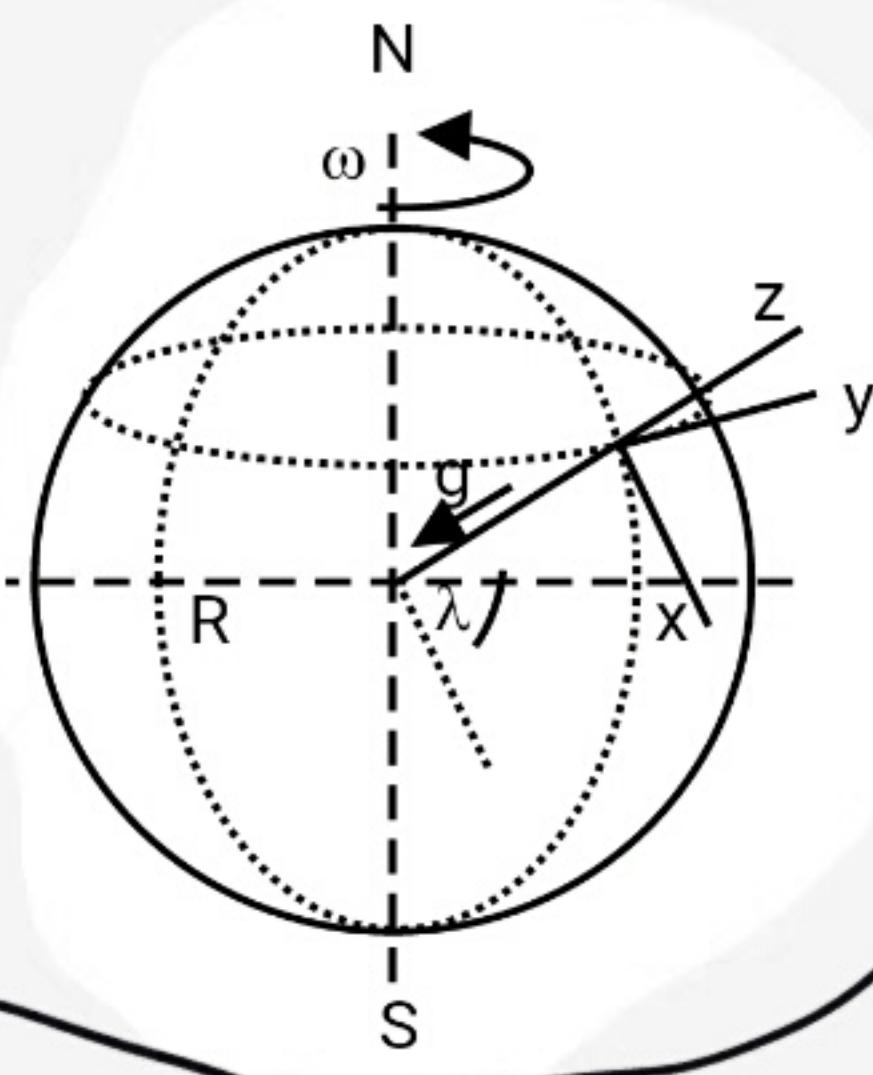
Com la component $a_y > 0$ la derivació és cap el E. Per tant, la riba dreta del riu està més erosionada.



Observem també que l'acceleració centrifògica dóna lloc a components respecte als eixos x i z.

$$\vec{a}_{\text{cent}} = \omega^2 R \cos \lambda (\sin \lambda \vec{i} + \cos \lambda \vec{k})$$

6.17



A l'equador $\lambda = 0$ i, a més,
 $\vec{a}_{rel} = \pm \vec{\omega}_y \vec{j}$.

d'acceleració relativa val:

$$\vec{a}_{rel} = -g \vec{k} + \omega^2 R \cos \lambda (\sin \lambda \vec{i} + \cos \lambda \vec{k}) - 2\omega \{-\vec{\omega}_y \sin \lambda \vec{i} + (\vec{\omega}_x \sin \lambda + \vec{\omega}_z \cos \lambda) \vec{j} - \vec{\omega}_y \cos \lambda \vec{k}\}$$

En el norte \vec{a}_{rel} :

$$\vec{a}_{rel} = -g \vec{k} + \omega^2 R \vec{k} + 2\omega \vec{\omega}_y \vec{k} = (\omega^2 R + 2\omega \vec{\omega}_y - g) \vec{k}$$

Si canvia el sentit de $\vec{\omega}_y$ també canvia el sentit de \vec{a}_{rel} . La variació de l'acceleració relativa és:

$$\Delta \vec{a}_{rel} = 4\omega \vec{\omega}_y \vec{k} = 0'07272 \text{ m/s}^2.$$

$$\omega = 7'272 \cdot 10^{-5} \text{ rad/s}$$

$$\vec{\omega} = 900 \vec{j} \text{ km/h} = 250 \vec{j} \text{ m/s}$$

La diferència de pes seria $\frac{\Delta P}{m \Delta a} = \frac{5'8176 N}{80 \text{ kg}} = 72.72 \text{ N/kg}$

Finalment

$$\Delta m = \frac{\Delta P}{g} = 0'594 \text{ kg} = 594 \text{ g}$$