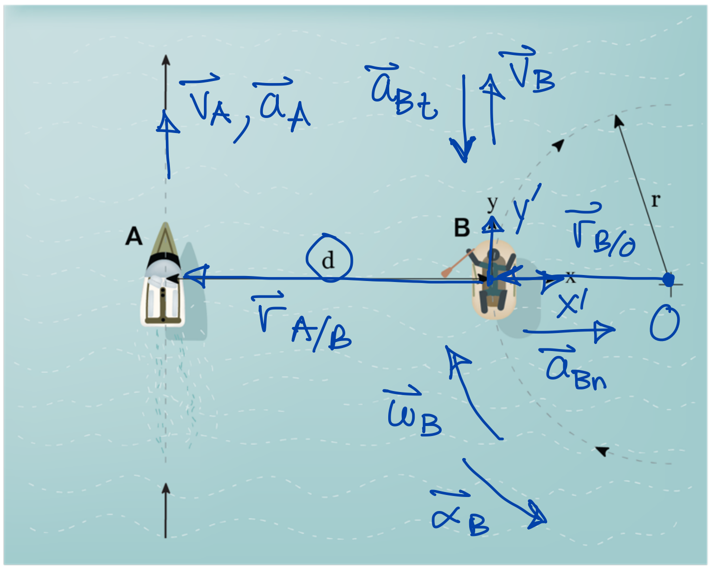
Boat A is travelling forward (in positive y) with a velocity of 25 m/s and an acceleration of 4 m/s^2. The person in dingy B is travelling in a circle (as they only have one oar). They have a forward (in positive y) velocity of 5 m/s and acceleration of -1 m/s^2 (as they have lost focus while watching boat A). The radius of dingy B's path is r = 20 m, and the distance between the vessels is d = 10 m.

Find the velocity and acceleration of boat A as seen by the occupants of dingy B.



Find $(\vec{v}_{A/B})_{rel}$ & $(\vec{a}_{A/B})_{rel}$

$$\vec{v}_B = \vec{v}_O^{\,0} + \vec{\omega}_B \times \vec{r}_{B/O}$$

$$v_B\hat{j} = -\omega_B\hat{k} \times r(-\hat{i})$$

$$v_B\hat{j} = \omega_B r\hat{j}$$

$$\omega_B = \frac{v_B}{r} = 0.25\ \text{rad/s}$$

$$\vec{\omega}_B = -0.25\ \text{rad/s}\ \hat{k} = \vec{\Omega}$$

$$\vec{a}_{Bt} = \vec{\alpha}_B \times \vec{r}_{B/O}$$

$$-a_{Bt}\hat{j} = \alpha_B\hat{k} \times (-r\hat{i})$$

$$-a_{Bt}\hat{j} = -\alpha_B r\hat{j}$$

$$\alpha_B = \frac{a_{Bt}}{r} = 0.05\ \text{rad/s}^2$$

$$\vec{\alpha}_B = 0.05\ \text{rad/s}^2\ \hat{k} = \dot{\vec{\Omega}}$$

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

$$(\vec{v}_{A/B})_{rel} = \vec{v}_A - \vec{v}_B - \vec{\Omega} \times \vec{r}_{A/B} \leftarrow d$$

$$= 25\ \text{m/s}\ \hat{j} - 5\ \text{m/s}\ \hat{j} - (-0.25\ \text{rad/s}\ \hat{k}) \times (-10\ \text{m}\ \hat{i})$$

$$= 20\ \text{m/s}\ \hat{j} - 2.5\ \text{m/s}\ \hat{j}$$

$$\boxed{(\vec{v}_{A/B})_{rel} = 17.5\ \text{m/s}\ \hat{j}}$$

$$\vec{a}_A = \vec{a}_B + \dot{\vec{\Omega}} \times \vec{r}_{A/B} - \Omega^2\vec{r}_{A/B} + 2\vec{\Omega} \times (\vec{v}_{A/B})_{rel} + (\vec{a}_{A/B})_{rel}$$

$$\vec{a}_B = \vec{a}_{Bt} + \vec{a}_{Bn} = -1\ \text{m/s}^2\ \hat{j} + \underbrace{\omega_B^2}_{\Omega} r\hat{i}$$

$$4\ \text{m/s}^2\ \hat{j} = \overbrace{-1\ \text{m/s}^2\ \hat{j} + (0.25\ \text{rad/s})^2(20\ \text{m}\ \hat{i})}^{\vec{a}_B} + (0.05\ \text{rad/s}^2\ \hat{k}) \times (-10\ \text{m}\ \hat{i})$$

$$-(0.25\ \text{rad/s})^2(-10\ \text{m}\ \hat{i}) + 2(-0.25\ \text{rad/s}\ \hat{k}) \times (17.5\ \text{m/s}\ \hat{j})$$

$$+ (\vec{a}_{A/B})_{rel}$$

$$4\hat{j} = -1\hat{j} + 1.25\hat{i} - 0.5\hat{j} + 0.625\hat{i} + 8.75\hat{i} + (\vec{a}_{A/B})_{rel}$$

$$4\hat{j} = -1.5\hat{j} + 10.625\hat{i} + (\vec{a}_{A/B})_{rel}$$

$$\Rightarrow \boxed{(\vec{a}_{A/B})_{rel} = -10.625\hat{i} + 5.5\hat{j} \ m/s^2}$$