You have been a castaway in your life raft for at least a week. Unfortunately, you have been paddling in a circle of radius r_B, at V_B, because you only have one paddle.
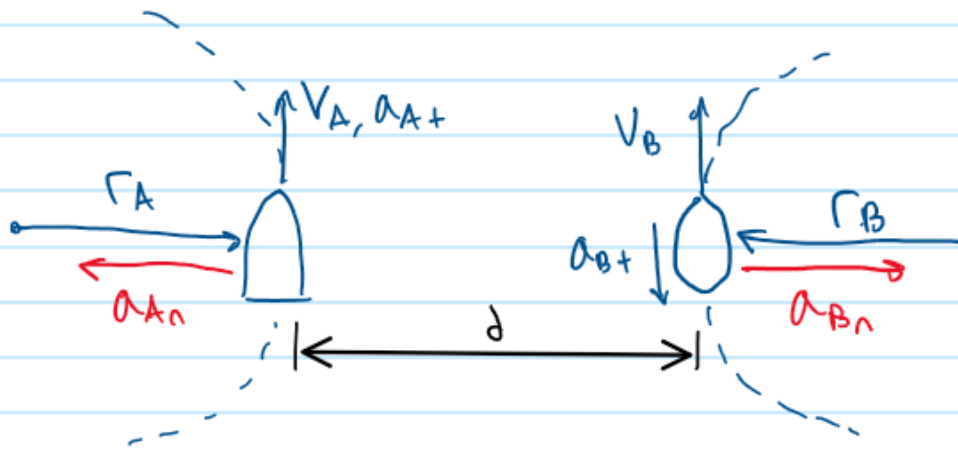
You hear a motor boat and you stop paddling, causing your raft to decelerate at a rate of a_{B+}.

The boat is travelling in a circular path of radius r_A, a distance of d m away. The boat is moving at V_A, and its speed is increasing at a speed of a_{A+}.

You hope they spot you and come to rescue you, however, in the mean time, you decide to pass the time with a physics problem.

What is the magnitude of the motor boat's (A) velocity relative to your raft (B)?

What is the magnitude of the motor boat's (A) acceleration relative to your raft (B)?

given
r_A r_B
d V_A V_B
a_{A_t} a_{B_t}

find
a_{A_n} a_{B_n}
a_A a_B

Since both the motor boat and the raft are travelling in curved paths, there are both normal & tangential components.

velocity

$$V_A = V_B + V_{A/B}$$

$$+\hat{\jmath} \quad\quad +\hat{\jmath}$$

$$\underline{V_{A/B} = V_A - V_B}$$

acceleration

$$a_{A_n} = \frac{V_A^2}{r_A}(-\hat{\imath}) \quad\quad a_{B_n} = \frac{V_B^2}{r_B}(+\hat{\imath})$$

$$a_A = -a_{A_n}\hat{\imath} + a_{A_t}\hat{\jmath} \quad\quad a_B = a_{B_n}\hat{\imath} - a_{B_t}\hat{\jmath}$$

$$a_A = a_B + a_{A/B}$$

$$-a_{A_n}\hat{\imath} + a_{A_t}\hat{\jmath} = a_{B_n}\hat{\imath} - a_{B_t}\hat{\jmath} + a_{A/B}$$

$$a_{A/B} = (-a_{A_n} - a_{B_n})\hat{\imath} + (a_{A_t} + a_{B_t})\hat{\jmath}$$

$$|a_{A/B}| = \sqrt{(-a_{A_n} - a_{B_n})^2 + (a_{A_t} + a_{B_t})^2}$$