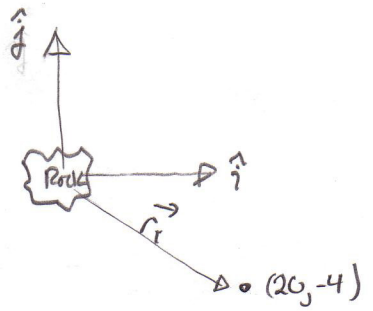
Problem 3

A fish swimming in a horizontal plane has velocity $\mathbf{v}_i = \left(4.00\hat{\mathbf{i}} + 1.00\hat{\mathbf{j}}\right)\text{m/s}$ at a point in the ocean where the position relative to a certain rock is $\mathbf{r}_i = \left(10.0\hat{\mathbf{i}} - 4.00\hat{\mathbf{j}}\right)\text{m}$. After the fish swims with constant acceleration for 20.0 s, its velocity is $\mathbf{v} = \left(20.0\hat{\mathbf{i}} - 5.00\hat{\mathbf{j}}\right)\text{m/s}$. (a) What are the components of the acceleration? (b) What is the direction of the acceleration with respect to unit vector $\hat{\mathbf{i}}$? (c) If the fish maintains constant acceleration, where is it at $t = 25.0$ s, and in what direction is it moving?

a) $\vec{a} = \dfrac{\vec{V}_f - \vec{V}_i}{t}$

$= \dfrac{(20\hat{i} + 5\hat{j})\,m/s - (4\hat{i} + 1\hat{j})\,m/s}{20\,sec}$

$= \dfrac{(16\hat{i} + 6\hat{j})\,m/s}{20\,sec} = \dfrac{16}{20}\hat{i}\,m/s^2 - \dfrac{6}{20}\hat{j}\,m/s^2$



$\vec{a} = a_i\hat{i} + a_j\hat{j} \rightarrow a_i = 0.8\,m/s^2$

$a_j = -0.3\,m/s^2$

b) $\theta = \tan^{-1}\left(\dfrac{-0.3}{0.8}\right) = -20.56^\circ$ Relative to the x-axis (339° From The x-axis)

c) $\vec{r}_{f\hat{i}} = \vec{r}_{i\hat{i}} + \vec{V}_{0\hat{i}}t + \frac{1}{2}\vec{a}_{\hat{i}\hat{i}}t^2$

$= 10.m + 4\,m/s\,(25\,sec)\hat{i} + \frac{1}{2}(0.8\,m/s^2)(25\,sec)^2$

$= 360m\,\hat{i}$

$\vec{r}_{f\hat{j}} = -4m\hat{j} + 1\,m/s\,(25)\hat{j} + \frac{1}{2}(-0.3\,m/s^2)(25\,sec)^2$

$= -72.75m\,\hat{j}$

$\vec{V}_{f\hat{i}} = \vec{V}_{i\hat{i}} + \vec{a}_{i\hat{i}}t = 4\,m/s\,\hat{i} + 0.8\,m/s^2(25\,sec)\hat{i} = 24\,m/s\,\hat{i}$

$\vec{V}_{f\hat{i}} = \vec{V}_{i\hat{j}} + \vec{a}_{j\hat{j}}t = 1\,m/s\,\hat{j} + (-.3\,m/s^2)(25s) = -6.5\,m/s\,\hat{j}$

$\theta = \tan^{-1}\left(\dfrac{-6.5}{24}\right) = -15.15^\circ$