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General Physics I, Quiz 1
PHYS1000AA, Class year102
09-26-2013

SN:_______________, Name:________________

Chapter 1-6, Serway; ABSOLUTELY NO CHEATING!
Please write the answers on the blank space or on the back of this paper to save resources.

1. Model the fish as a particle under constant acceleration. We use our old standard equations for constant-acceleration straight-line motion, with x and y subscripts to make them apply to parts of the whole motion. At $t = 0$,

$$\vec{\mathbf{v}}_i = \left(4.00\hat{\mathbf{i}} + 1.00\hat{\mathbf{j}}\right)\text{m/s and } \hat{\mathbf{r}}_i = (10.00\hat{\mathbf{i}} - 4.00\hat{\mathbf{j}})\text{ m}$$

At the first "final" point we consider, 20.0 s later,

$$\vec{\mathbf{v}}_f = \left(20.0\hat{\mathbf{i}} - 5.00\hat{\mathbf{j}}\right)\text{m/s}$$

(a) $a_x = \dfrac{\Delta\upsilon_x}{\Delta t} = \dfrac{20.0\text{ m/s} - 4.00\text{ m/s}}{20.0\text{ s}} = \boxed{0.800\text{ m/s}^2}$

$a_y = \dfrac{\Delta\upsilon_y}{\Delta t} = \dfrac{-5.00\text{ m/s} - 1.00\text{ m/s}}{20.0\text{ s}} = \boxed{-0.300\text{ m/s}^2}$

(b) $\theta = \tan^{-1}\left(\dfrac{-0.300\text{ m/s}^2}{0.800\text{ m/s}^2}\right) = -20.6° = \boxed{339°\text{ from } +x\text{ axis}}$

(c) At $t = 25.0$ s the fish's position is specified by its coordinates and the direction of its motion is specified by the direction angle of its velocity:

$$x_f = x_i + \upsilon_{xi}t + \frac{1}{2}a_x t^2$$

$$= 10.0\,\text{m} + (4.00\,\text{m/s})(25.0\,\text{s}) + \frac{1}{2}(0.800\,\text{m/s}^2)(25.0\,\text{s})^2$$

$$= \boxed{360\,\text{m}}$$

$$y_f = y_i + \upsilon_{yi}t + \frac{1}{2}a_y t^2$$

$$= -4.00\,\text{m} + (1.00\,\text{m/s})(25.0\,\text{s}) + \frac{1}{2}(-0.300\,\text{m/s}^2)(25.0\,\text{s})^2$$

$$= \boxed{-72.7\,\text{m}}$$

$$\upsilon_{xf} = \upsilon_{xi} + a_x t = 4.00\,\text{m/s} + \left(0.800\,\text{m/s}^2\right)(25.0\,\text{s}) = 24\,\text{m/s}$$

$$\upsilon_{yf} = \upsilon_{yi} + a_y t = 1.00\,\text{m/s} - \left(0.300\,\text{m/s}^2\right)(25.0\,\text{s}) = -6.50\,\text{m/s}$$

$$\theta = \tan^{-1}\left(\frac{\upsilon_y}{\upsilon_x}\right) = \tan^{-1}\left(\frac{-6.50\,\text{m/s}}{24.0\,\text{m/s}}\right) = \boxed{-15.2°}$$

2. With 100 km/h = 27.8 m/s, the resistive force is

$$R = \frac{1}{2}D\rho A\upsilon^2 = \frac{1}{2}(0.250)\left(1.20\ \text{kg/m}^3\right)\left(2.20\ \text{m}^2\right)\left(27.8\,\text{m/s}\right)^2$$
$$= 255\ \text{N}$$

$$a = -\frac{R}{m} = -\frac{255\,\text{N}}{1\,200\,\text{kg}} = \boxed{-0.121\ \text{m/s}^2}$$