Solution to Midterm Exam 01, PHYS 203A (SPRING 2016)

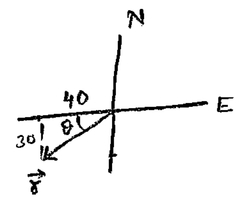
Prob. 1

$$[x] = \left[\frac{1}{4!} c\, t^4\right] = [c]\,[t]^4 \quad \Rightarrow \quad [c] = \frac{[x]}{[t]^4} = \frac{L}{T^4}$$

Prob. 2

(a) $$|\vec{r}| = \sqrt{(-40.0\,m)^2 + (-30.0\,m)^2} = 50.0\ m$$

(b) $$\theta = \tan^{-1}\left(\frac{30}{40}\right) = 36.9^\circ \text{ (South of West)}$$

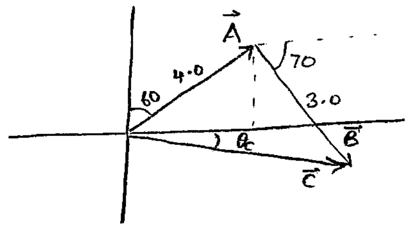


Prob. 3

$$\vec{A} = 4.0 \sin 60\ \hat{i} + 4.0 \cos 60\ \hat{j}$$
$$\vec{B} = 3.0 \cos 70\ \hat{i} - 3.0 \sin 70\ \hat{j}$$
$$\vec{A} + \vec{B} = \vec{C} = 4.49\ \hat{i} - 0.819\ \hat{j}$$

$$|\vec{C}| = \sqrt{4.49^2 + (-0.819)^2} = 4.56\ m$$

$$\theta_c = \tan^{-1}\left(\frac{0.819}{4.49}\right) = 10.34^\circ$$

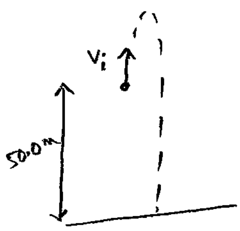


magnitude = 4.56 m

direction : 10.3° South of East

Prob. 4

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$
$$-50.0 = 6.0\ \Delta t + \frac{1}{2}(-9.8)\Delta t^2$$
$$4.9\ \Delta t^2 - 6.0\ \Delta t - 50.0 = 0$$
$$\Delta t = \frac{6.0 \pm \sqrt{(-6.0)^2 - 4 \times 4.9 \times (-50.0)}}{2 \times 4.9}$$
$$= +3.86\,s \quad \text{or} \quad -2.64\ s$$



$v_i = +6.0\ m/s$

$v_f =$

$\Delta y = -50.0\ m$

$\Delta t = ?$

$a = -9.8\ m/s^2$

Since the fish hits the water in a future time after it has been dropped the correct answer is +3.86 seconds.

Prob. 5

$\Delta x = +44.0\,m$ $\quad V_i =$ $\quad a = -3.00\,\frac{m}{s^2}$

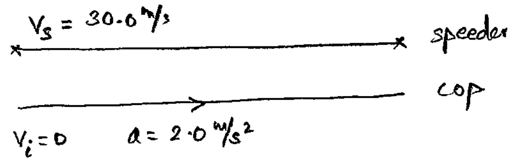
$\Delta t = +2.00\,s$ $\quad V_f = ?$

$$\Delta x = V_f\,\Delta t - \frac{1}{2}\,a\,\Delta t^2$$

$$44.0 = V_f\,2.00 - \frac{1}{2}(-3.00)(2.00)^2$$

$$\Rightarrow \quad V_f = 19\ m/s$$

Prob. 6



distance travelled by speeder: $x_s = V_s t$

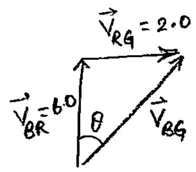
distance travelled by cop: $x_c = \frac{1}{2} a t^2$

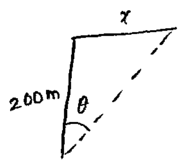
$$x_s = x_c \qquad \text{(when overtaking)}$$

$$V_s \cancel{t} = \frac{1}{2} a t^{\cancel{2}}$$

$$t = \frac{2\,V_s}{a} = \frac{2 \times 30.0}{2.0} = 30.\ \text{seconds.}$$

Prob. 7





$$\vec{V}_{BG} = \vec{V}_{BR} + \vec{V}_{RG}$$

$$= 2.0\,\tfrac{m}{s}\,\hat{i} + 6.0\,\tfrac{m}{s}\,\hat{j}$$

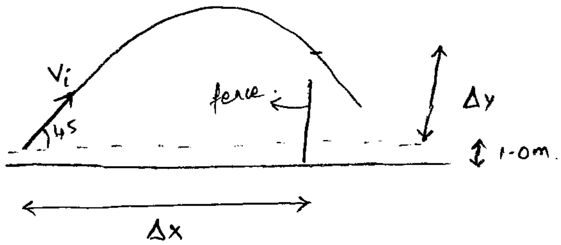
$$\Rightarrow \quad |\vec{V}_{BG}| = 6.33\ m/s \qquad \theta = 18.4^\circ.$$

Let x be the distance drifted. The triangle formed by the distances is similar to that of velocity. Thus $\theta = 18.4^\circ$ is same for both. Thus,

$$x = 200\,m \tan 18.4$$

$$= 66.7\ m$$

Prob. 8



x-dir

$V_{ix} = 30.0 \cos 45$

$= 21.2 \text{ m/s}$

$\Delta x = 100.0 \text{ m}$

$\Delta t =$ ⟶

y-dir

$V_{iy} = 30.0 \sin 45$

$= 21.2 \text{ m/s}$

$\Delta y = ?$

$\Delta t =$

$V_{fy} =$

$a_y = -9.8 \text{ m/s}$

$$\Delta t = \frac{\Delta x}{V_{ix}} = \frac{100.0}{21.2} = 4.72 \text{ s}$$

$$\Delta y = V_{iy}\,\Delta t + \frac{1}{2} a_y \Delta t^2$$

$$= 21.2 \times 4.72 + \frac{1}{2}(-9.8)(4.72)^2$$

$$= 100.1 - 109.2 = -9.1 \text{ m}$$

Negative Δy means it is below the initial height of 1.0 m.

Thus, the ball hits the ground before it reaches the fence.

The ball does not clear the fence.