(Midterm Exam 01, Fall 2015, PHYS 205A)

Solutions

Prob. 1

$$[kx] = 1 \Rightarrow [k] = \frac{1}{L}$$

$$[\omega t] = 1 \Rightarrow [\omega] = \frac{1}{T}$$

Thus, $$\left[\frac{\omega}{k}\right] = \frac{\left(\frac{1}{T}\right)}{\left(\frac{1}{L}\right)} = \frac{L}{T}.$$

Prob. 2

$$V_{avg} = \frac{d_1 + d_2}{t_1 + t_2} = \frac{2d}{t_1 + t_2} \qquad (d_1 = d_2)$$

$$\Rightarrow \frac{2}{V_{avg}} = \frac{1}{V_1} + \frac{1}{V_2}$$

$$\frac{1}{V_2} = \frac{2}{V_{avg}} - \frac{1}{V_1} = \frac{2}{60} - \frac{1}{50} = \frac{40}{60 \times 50} = \frac{1}{75}.$$

$$V_2 = 75 \ \frac{\text{miles}}{\text{hour}}$$

Prob. 3

$$x(t) = 24t - 2.0t^3$$

$$v(t) = \frac{dx}{dt} = 24 - 6.0t^2$$

$$a(t) = \frac{dv}{dt} = -12t$$

Stopping implies $v = 0$

$$\Rightarrow 24 - 6.0t^2 = 0 \Rightarrow t = \pm 2.0 \text{ s}$$

→ negative solution happens in the past, so is unphysical.

At $t = +2.0$ sec we have

$$a(2) = -12 \times 2.0$$
$$= -24 \ \frac{m}{s^2}$$

Prob. 4

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

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

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

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

$$44.0 = V_f\;2.00 + 6.00$$

$$V_f = \frac{44.0 - 6.00}{2.00} = 19.0\,\frac{m}{s}$$

Prob. 5

player 1

$$x_1 = v\,t$$

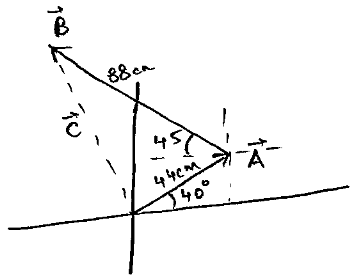
player 2

$$x_2 = \frac{1}{2}\,a\,t^2.$$

$$x_1 = x_2$$

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

$$t = \frac{2V}{a} = \frac{2 \times 2.0}{0.20} = 20 \text{ seconds.}$$



Prob. 6

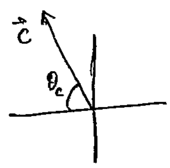
$$\vec{A} = 44\,\text{Cos}\,40\,\hat{i} + 44\,\text{Sin}\,40\,\hat{j}$$

$$= 33.7\,\hat{i} + 28.3\,\hat{j}$$

$$\vec{B} = -88\,\text{Cos}\,45\,\hat{i} + 88\,\text{Sin}\,45\,\hat{j}$$

$$= -62.2\,\hat{i} + 62.2\,\hat{j}$$

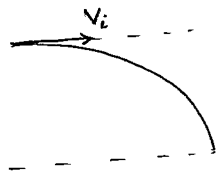
$$\vec{C} = \vec{A} + \vec{B} = -28.5\,\hat{i} + 90.5\,\hat{j}$$



$$|\vec{C}| = \sqrt{28.5^2 + 90.5^2} = 95\,cm$$

$$\theta_c = \tan^{-1}\left(\frac{90.5}{28.5}\right) = 72.5^\circ$$ clockwise w.r.t $-x$ axis.

Prob. 7



x-dir

$x =$

$V_{ix} = 20.0 \frac{m}{s}$

$\Delta t =$

y-dir

$y = -400.0 m$

$\Delta t =$

$V_{iy} = 0$

$V_{fy} =$

$a_y = -9.8 \frac{m}{s^2}$.

$$y = \overset{=0}{\cancel{V_{iy}}} \Delta t + \frac{1}{2} a_y \Delta t^2$$

$$-400.0 = \frac{1}{2}(-9.8) \Delta t^2.$$

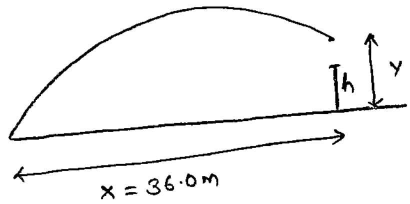
$$\Delta t = \sqrt{\frac{2 \times 400.0}{9.8}} = 9.04 \text{ sec}$$

$$x = V_{ix} \Delta t$$

$$= 20.0 \frac{m}{s} \times 9.04 s$$

$$= 180 m.$$

Prob. 8



$x = 36.0 m$

$V_{ix} = V_0 \cos\theta_0$

$= 20.0 \cos 45$

$= 14.1 m/s$

$$\Delta t = \frac{x}{V_{ix}}$$

$$= \frac{36.0}{14.1}$$

$$= 2.55 \text{ sec}$$

$y =$

$\Delta t =$

$V_{iy} = V_0 \sin\theta_0$

$= 20.0 \sin 45$

$= 14.1 \frac{m}{s}$

$V_{fy} =$

$a_y = -9.8 \frac{m}{s^2}$.

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

$$= 14.1 \times 2.55 - \frac{1}{2} 9.8 (2.55)^2$$

$$= 36.0 - 31.9$$

$$= 4.1 m$$

$$y - h = 4.1 m - 3.05 m$$

$$= 1.1 m$$

Thus, the football clears the crossbar by 1.1 m.