Homework #2 Solutions

12–15.

known: $t_s = 0.75\ s$, $t_d = 3\ s$, $V_i = 44\ ft/s$,
$a = -2\ ft/s^2$

Find: $d_{sober} = ?$ $d_{drunk} = ?$

Solution:

$$V_f^2 = V_i^2 + 2a\,d_{stop} \Rightarrow d_{stop} = \frac{V_f^2 - V_i^2}{2a}$$

$$V_f = 0 \Rightarrow d_{stop} = \frac{V_i^2}{-2a}$$

A. Sober: $d_{sober} = V_i t_s + \frac{V_i^2}{-2a}$

$$= (44\ ft/s)(0.75\ s) + (44\ ft/s)^2/(-2 \cdot -2\ ft/s^2)$$

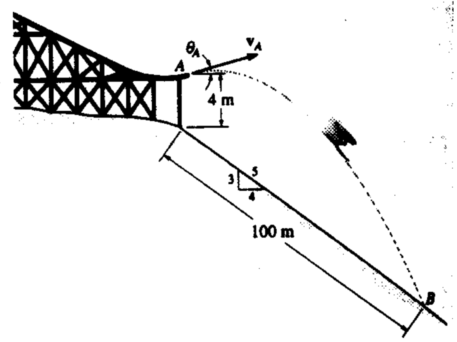
$$= 484 + 33 = \boxed{517\ ft}$$

B. Drunk: $d_{drunk} = V_i t_d + \frac{V_i^2}{-2a}$

$$= (44\ ft/s)(3\ s) + (44\ ft/s)^2/(-2 \cdot 2\ ft/s^2)$$

$$= 484 + 132 = \boxed{616\ ft}$$

12-91. It is observed that the skier leaves the ramp A at an angle $\theta_A = 25°$ with the horizontal. If he strikes the ground at B, determine his initial speed v_A and the time of flight t_{AB}.



$(\overset{+}{\rightarrow})$ $\quad s = v_0 t$

$$100\left(\frac{4}{5}\right) = v_A \cos 25° t_{AB}$$

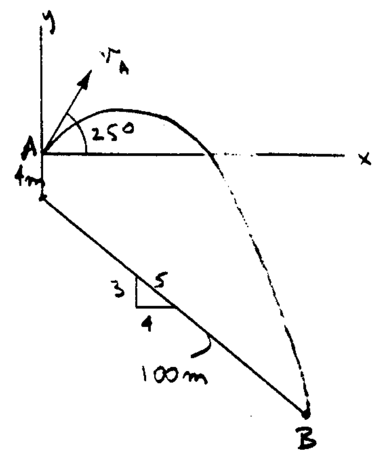
$(+\uparrow)$ $\quad s = s_0 + v_0 t + \frac{1}{2} a_c t^2$

$$-4 - 100\left(\frac{3}{5}\right) = 0 + v_A \sin 25° t_{AB} + \frac{1}{2}(-9.81) t_{AB}^2$$

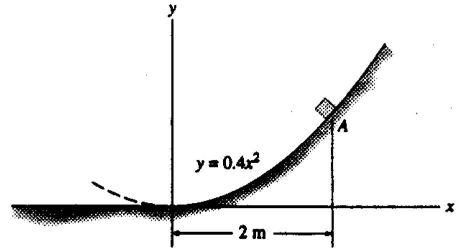
Solving,

$v_A = 19.4$ m/s **Ans**

$t_{AB} = 4.54$ s **Ans**



12-121. The box of negligible size is sliding down along a curved path defined by the parabola $y = 0.4x^2$. When it is at A ($x_A = 2$ m, $y_A = 1.6$ m), the speed is $v_B = 8$ m/s and the increase in speed is $dv_B/dt = 4\text{ m/s}^2$. Determine the magnitude of the acceleration of the box at this instant.



$$y = 0.4\,x^2$$

$$\left.\frac{dy}{dx}\right|_{x=2\text{ m}} = 0.8x\Big|_{x=2\text{ m}} = 1.6$$

$$\left.\frac{d^2y}{dx^2}\right|_{x=2\text{ m}} = 0.8$$

$$\rho = \left.\frac{\left[1+\left(\frac{dy}{dx}\right)^2\right]^{3/2}}{\left|\frac{d^2y}{dx^2}\right|}\right|_{x=2\text{ m}} = \frac{\left[1+(1.6)^2\right]^{3/2}}{|0.8|} = 8.396\text{ m}$$

$$a_n = \frac{v_B{}^2}{\rho} = \frac{8^2}{8.396} = 7.622\text{ m/s}^2$$

$$a = \sqrt{a_t^2 + a_n^2} = \sqrt{(4)^2 + (7.622)^2} = 8.61\text{ m/s}^2 \qquad \textbf{Ans}$$

12-158

known: $r = 1.5\theta$ (ft), $\theta = 60^\circ = 1.05$ rad.

$\dot{\theta} = 4t$, $t = 1\,s$

Find: V_r, V_θ, a_r, a_θ

solution: $\dot{\theta} = 4t \Rightarrow \ddot{\theta} = 4$ rad/s

$\theta = 2t^2 + 1.05$ rad/s

$r = 1.5\theta \Rightarrow \dot{r} = 1.5\dot{\theta}$

$\ddot{r} = 1.5\ddot{\theta}$

we know $V_r = \dot{r}$ $\quad a_r = \ddot{r} - r\dot{\theta}^2$

$V_\theta = r\dot{\theta}$ $\quad a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta}$

Therefore when $t=1$

$V_r = \dot{r} = (1.5)(4) = \boxed{6\ ft/s}$

$V_\theta = r\dot{\theta} = (1.5)(2+1.05)(4) = \boxed{18.3\ ft/s}$

$a_r = \ddot{r} - r\dot{\theta}^2 = (1.5)(4) - (1.5)(2+1.05)(4)^2$

$= \boxed{-67.2\ ft/s^2}$

$a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta} = (1.5)(2+1.05)(4) + 2\cdot 1.5\cdot 4\cdot 4$

$= \boxed{66.3\ ft/s^2}$

12-197

Known: $V_A = 70$ mi/h, $a_A = 0$ $\theta = 30°$

$V_B = 50$ mi/h, $a_B = 1100$ mi/h^2 $\rho_B = 0.7$ mi

Find: $\vec{V}_{B/A}$, $\vec{a}_{B/A}$

Solution: A. $\vec{V}_B = \vec{V}_A + \vec{V}_{B/A}$

$\vec{V}_B = 50 \sin 30° \hat{i} + 50 \cos 30° \hat{j}$ mi/h

$\vec{V}_A = 70 \hat{j}$ mi/h

$\Rightarrow \vec{V}_{B/A} = \vec{V}_B - \vec{V}_A = 25 \hat{i} - 26.7 \hat{j}$ mi/h

$|\vec{V}_{B/A}| = \sqrt{25^2 + 26.7^2} = 36.6$ mi/h

$\tan^{-1}\left(\frac{-26.7}{25}\right) = -46.9°$

Therefore $\boxed{\vec{V}_{B/A} = 36.6 \text{ mi/h}, \quad -46.9°}$

B. $\vec{a}_{B/A} = \vec{a}_B - \vec{a}_A = (\vec{a}_{Bt} + \vec{a}_{Bn}) - 0 = \vec{a}_{Bt} + \vec{a}_{Bn}$

$\because |\vec{a}_{Bt}| = \dot{v} = 1100$ mi/h^2

$\Rightarrow \vec{a}_{Bt} = 1100 \cos 60° \hat{i} + 1100 \sin 60° \hat{j}$ mi/h^2

$\because |\vec{a}_{Bn}| = \frac{v^2}{\rho} = \frac{50^2}{0.7} = 3571$ mi/h^2

$\Rightarrow \vec{a}_{Bn} = 3571 \cos 60° \hat{i} + 3571 \sin 60° \hat{j}$ mi/h^2

$\Rightarrow \vec{a}_{B/A} = \vec{a}_{Bt} + \vec{a}_{Bn} = (1100 \cos 60 \hat{i} + 1100 \sin 60 \hat{j})$
$+ (3571 \cos 60 \hat{i} + 3571 \sin 60 \hat{j})$ mi/h^2

$\vec{a}_{B/A} = (3643 \hat{i} - 833 \hat{j})$ mi/h

$|\vec{a}_{B/A}| = \sqrt{3643^2 + 833^2} = 3737$ mi/h^2

$\tan^{-1}\left(\frac{-833}{3643}\right) = -12.88°$

Therefore $\boxed{\vec{a}_{B/A} = 3737 \text{ mi/h}^2, \quad -12.88°}$