September 29, 2017 4:38 PM

Phys 204/03
Assignment 2
solutions

1. $\vec{r}_i = (2\hat{i} + 3\hat{j})\ m$

$\vec{r}_f = (-2\hat{i} - \hat{j})\ m$

$\Delta t = 4\ s$

$\vec{a} = (-\hat{i} + \hat{j})\ \frac{m}{s}$

a) $\vec{r}_f = \vec{r}_i + \vec{v}_i \Delta t + \frac{1}{2}\vec{a}\Delta t^2$

$(-2\hat{i} - \hat{j}) = (2\hat{i} + 3\hat{j}) + 4\vec{v}_i + \frac{1}{2}(-\hat{i} + \hat{j})(4)^2$

$-2\hat{i} - \hat{j} = 2\hat{i} + 3\hat{j} + 4\vec{v}_i - 8\hat{i} + 8\hat{j}$

$-2\hat{i} - \hat{j} = -6\hat{i} + 11\hat{j} + 4\vec{v}_i$

$$-2\hat{i}-\hat{j} = -6\hat{i}+11\hat{j}+4\vec{v}_i$$

$$4\hat{i}-12\hat{j} = 4\vec{v}_i \Rightarrow \boxed{\vec{v}_i = \hat{i}-3\hat{j} \ \frac{m}{s}}$$

b) $\vec{v}_f = \vec{v}_i + \vec{a}\Delta t$

$$\vec{v}_f = \hat{i}-3\hat{j}+4(-\hat{i}+\hat{j}) = \hat{i}-3\hat{j}-4\hat{i}+4\hat{j}$$

$$\boxed{\vec{v}_f = -3\hat{i}+\hat{j} \quad \frac{m}{s}}$$

2 $R = 2h$

$$\frac{\cancel{v_i^2}\sin(2\theta)}{\cancel{g}} = 2\,\frac{\cancel{v_i^2}\sin^2\theta}{2\cancel{g}}$$

$$\cancel{\sin\theta}\cos\theta = \cancel{\sin\theta}\sin\theta$$

$\cancel{\sin}\theta\cos\theta =$

$$2 = \frac{\sin\theta}{\cos\theta} = \tan\theta$$

$$\boxed{\theta = \tan^{-1}(2) = 63.43^\circ}$$

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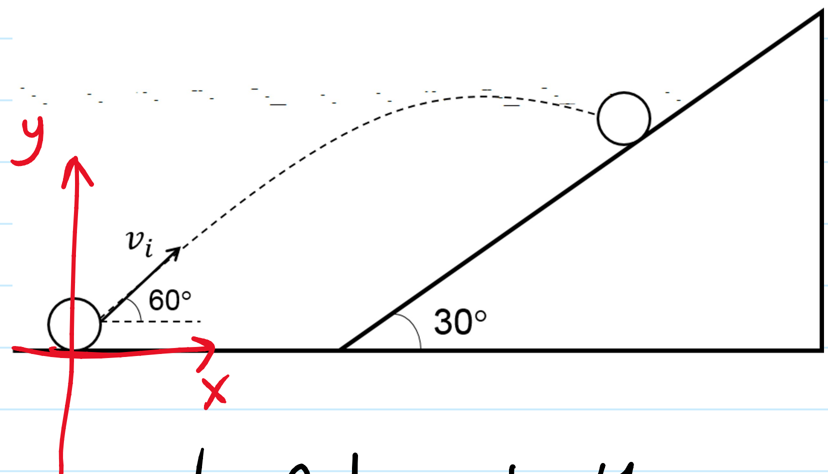
(3) $V_i = 20 \ \frac{m}{s}$

$\theta = 60^\circ$

$\alpha = 30^\circ$



To find the coordinates of the landing point, we should set the coordinates of the projectile and the inclined surface to be equal:

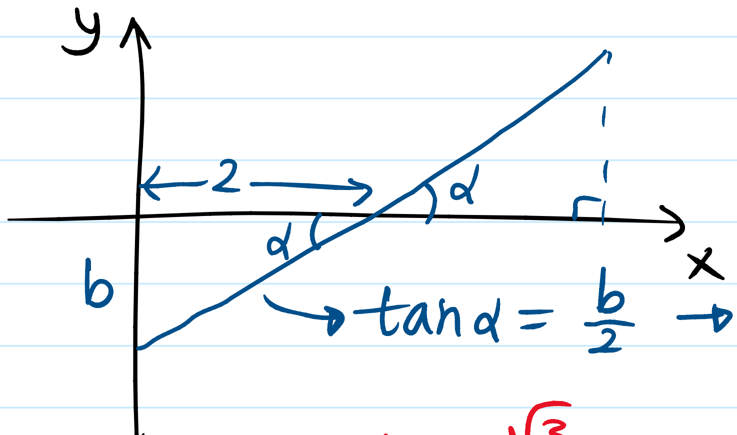
<u>projectile</u>:

$$y_p = x_p \tan\theta - \frac{1}{2} g \frac{x_p^2}{v_i^2 \cos^2\theta}$$

<u>incline surface:</u>

$$y_s = m x_s + b \qquad m = \tan\alpha$$

to find b, we should find out where the line hits the y-axis (y-intercept)



$$\tan\alpha = \frac{b}{2} \rightarrow b = 2\tan\alpha = 2\tan(30^\circ) = \frac{2\sqrt{3}}{3}$$

$$b = \ominus\, 2\sqrt{3}/3$$

under the y-axis

$$\Rightarrow y_s = \frac{\sqrt{3}}{3} x_s - \frac{2\sqrt{3}}{3}$$

setting $y_p = y_s$:

$$x \tan 60^\circ - \frac{1}{2}(10) \frac{x^2}{\ldots} = \frac{\sqrt{3}}{3} x - \frac{2\sqrt{3}}{\ldots}$$

$$x\tan 60^\circ - \frac{1}{2}(10)\frac{x^2}{(20)^2\left(\frac{1}{2}\right)^2} = \frac{\sqrt{3}}{3}x - \frac{2\sqrt{3}}{3}$$

$$\sqrt{3}\,x - \frac{x^2}{20} = \frac{\sqrt{3}}{3}x - \frac{2\sqrt{3}}{3}$$

$$\rightarrow \quad \frac{x^2}{20} - \frac{2\sqrt{3}}{3}x - \frac{2\sqrt{3}}{3} = 0$$

$$\begin{cases} \cancel{x = -0.96\ m} & \text{not acceptable} \\ \boxed{x = 24.05\ m} \end{cases}$$

To find the y-coordinate, we can plug this $\underline{\underline{x}}$ into $y = mx + b$

$$y = \frac{\sqrt{3}}{3}x - \frac{2\sqrt{3}}{3} = \frac{\sqrt{3}}{3}(24.05) - \frac{2\sqrt{3}}{3}$$

$$\boxed{y = 12.73}$$

The projectile lands at $(24.05, 12.73)$ m

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④ $\vec{V}(t) = (2t\hat{i} - t^2\hat{j})\ \frac{m}{s}$

$t_i = 1\,s$

$t_f = 3\,s$

$\vec{V}(3) = 2(3)\hat{i} - (3)^2\hat{j} = 6\hat{i} - 9\hat{j}$

$\vec{V}(1) = 2(1)\hat{i} - (1)^2\hat{j} = 2\hat{i} - \hat{j}$

$$\vec{a}_{avg.} = \frac{\vec{V}(3) - \vec{V}(1)}{3-1} = \frac{6\hat{i} - 9\hat{j} - 2\hat{i} + \hat{j}}{2}$$

$$\vec{a}_{avg.} = \frac{4\hat{i} - 8\hat{j}}{2} = 2\hat{i} - 4\hat{j}$$

a_x a_y

a_x a_y

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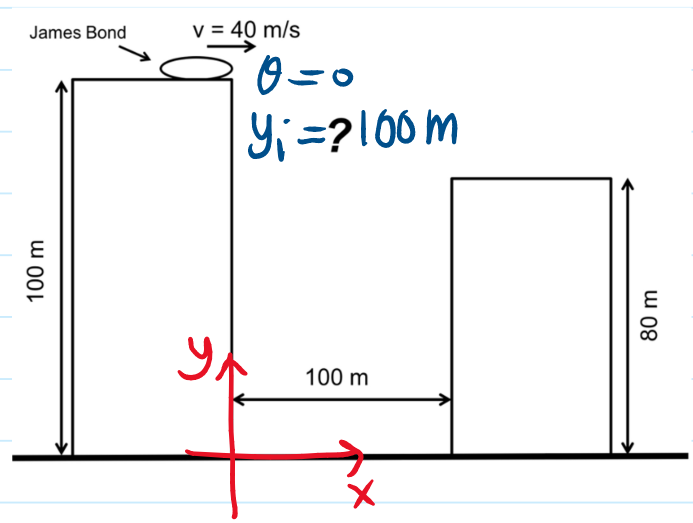
(5)



To find out whether he makes it to the otherside, one way is to find the height of his car, when he travels 100m forward. If his height is smaller than 80 m, he crashes into the building:

$\theta = 0$

$y_i = 0$

$x_i = 0$

$$\begin{cases} (v_i)_x = v_i \cos\theta = v_i \\ (v_i)_y = v_i \sin\theta = 0 \end{cases}$$

x

$x_i' = 0$

$x_f = 100$

x

$$\Delta x = (V_i)_x \cos\theta \, \Delta t$$

y

$$\Delta y = (V_i)_y \Delta t - \frac{1}{2} g \Delta t^2$$

$$\Delta t = \frac{\Delta x}{V_i \cos\theta} = \frac{100}{40} = 2.5\ s$$

$$\Delta y = \cancel{(V_i)_y \Delta t}^{\,0} - \frac{1}{2} g \Delta t^2$$

$$\Delta y = -\frac{1}{2}(10)(2.5)^2 = -31.25\ m$$

$$y_f - 100 = -31.25 \rightarrow \boxed{y_f = 68.75\ m}$$

since $y_f < 80$ → He crashes

But for sure James Bond survives due to his skills