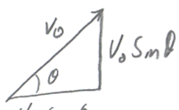
Key

PHYSICS 161, Spring 2003

Discussion Quiz 2, Thursday, Feb 20

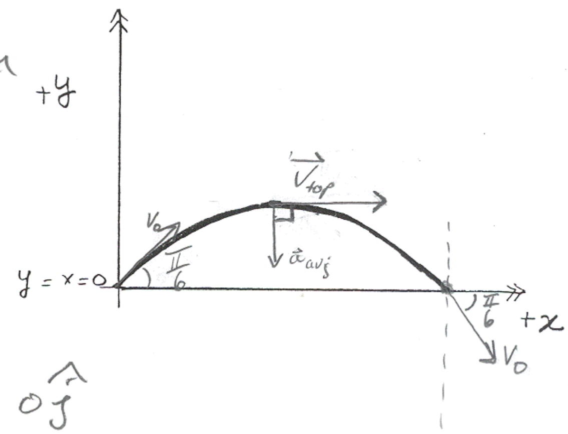
Q1). A ball is thrown with an initial velocity v_0 at an angle of 30^0 above the horizontal. A y vs x plot of its motion is given below.



a). In term of unit vectors $\hat{\imath}$ and $\hat{\jmath}$, write down the initial velocity vector $\vec{v}_i$.

$\vec{V}_i = V_0 \cos\theta\, \hat{\imath} + V_0 \sin\theta\, \hat{\jmath}$

$= V_0\left(\frac{\sqrt{3}}{2}\right)\hat{\imath} + V_0\left(\frac{1}{2}\right)\hat{\jmath}$



b). Write down the velocity vector $\vec{v}_{top}$ at the instant the ball reaches the peak of its trajectory. Indicate this velocity vector on the plot above.

$\vec{V}_{top} = \frac{\sqrt{3}}{2} V_0\, \hat{\imath} + 0\, \hat{\jmath}$

c). If the time taken to reach the peak is T, figure out the average acceleration vector $\vec{a}_{avg}$ **graphically as well as by using components.** What angle does this vector make with the horizontal? What do you expect to be its magnitude?

$V_{f_y} = V_{0_y} + a_y t$

$0 = V_0 \sin\theta + a_y T$

$\vec{a}_y = \frac{-V_0 \sin\theta}{T}\hat{\jmath} = \frac{-V_0}{2T}\hat{\jmath} = \frac{\Delta V}{\Delta t}$

d). Write down the final velocity vector when the ball reaches $y_f = 0$ at $t = t_f$. Also, indicate it on the plot.

$\vec{V}_f = \frac{\sqrt{3}}{2} V_0 \hat{\imath} - \frac{V_0}{2}\hat{\jmath}$

$\hat{x}$ direction stays the same
$\hat{y}$ direction keeps the same magnetude but swiches sign

e). Write down the position vector $\vec{r}(t)$ for the ball valid between $t = 0$ to $t = t_f$.

$X = V_0 \frac{\sqrt{3}}{2}$; $Y = \frac{V_0}{2}t + \frac{1}{2} a_y t^2$

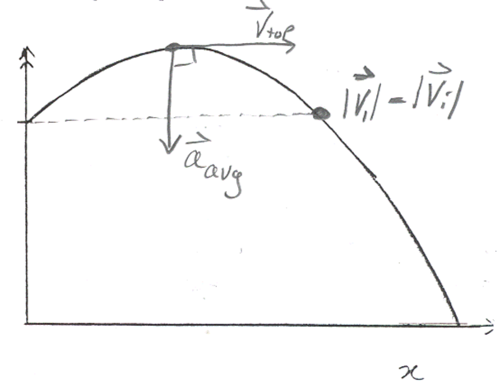
$\Rightarrow \vec{r}(t) = \frac{\sqrt{3}}{2} V_0\, \hat{\imath} + \left(\frac{V_0}{2}t + \frac{1}{2}\left(\frac{V_0}{2T}\right)t^2\right)\hat{\jmath}$

key

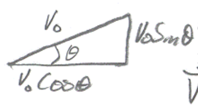
PHYSICS 161, Spring 2003

Discussion Quiz 2, Friday, Feb 21

Q1). A ball is thrown from a cliff a height h above the ground with an initial velocity v_0 at an angle of 30^0 above the horizontal. A y vs x plot of its motion is given below.



a). In term of unit vectors $\hat{i}$ and $\hat{j}$, write down the initial velocity vector $\vec{v}_i$.



$$\vec{V}_i = V_0 \cos\theta\,\hat{i} + V_0 \sin\theta\,\hat{j}$$
$$= \frac{\sqrt{3}}{2} V_0\,\hat{i} + \frac{1}{2} V_0\,\hat{j}$$

b). Write down the velocity vector $\vec{v}_{top}$ at the instant the ball reaches the peak of its trajectory. Indicate this velocity vector on the plot above.

$$\vec{V}_{top} = V_0 \cos\theta\,\hat{i} + 0\,\hat{j}$$

c). If the time taken to reach the peak is T, figure out the average acceleration vector $\vec{a}_{avg}$ **graphically as well as by using components**. What angle does this vector make with the horizontal? What do you expect to be its magnitude?

$$V_{f_y} = V_{0y} + a_y t$$
$$0 = V_0 \sin\theta + a_y T \Rightarrow a_y = -\frac{V_0 \sin\theta}{T}\hat{j} = -\frac{V_0}{2T}\hat{j}$$

d). On the y vs x plot indicate the instant at which the ball has the **same speed** as at the instant it was thrown. Write down the velocity vector in terms of unit vectors $\hat{i}$ and $\hat{j}$ at that instant.

$$\vec{V}_1 = V_0 \cos\theta\,\hat{i} - V_0 \sin\theta\,\hat{j} = \frac{\sqrt{3}}{2} V_0 - \frac{V_0}{2}\hat{j}$$

e). Write down the position vector $\vec{r}(t)$ for the ball valid between $t = 0$ to $t = t_f$.

$$X = (V_0 \cos\theta)\hat{i} = \left(\frac{\sqrt{3}}{2} V_0\right)\hat{i}$$
$$Y = \left(h + V_0 \sin\theta t - \frac{1}{2} g t^2\right)\hat{j} = \left(h + \frac{V_0}{2} t - \frac{1}{2} g t^2\right)\hat{j}$$
$$r(t) = \left(\frac{\sqrt{3}}{2} V_0\right)\hat{i} + \left(h + \frac{V_0}{2} t - \frac{1}{2} g t^2\right)\hat{j}$$