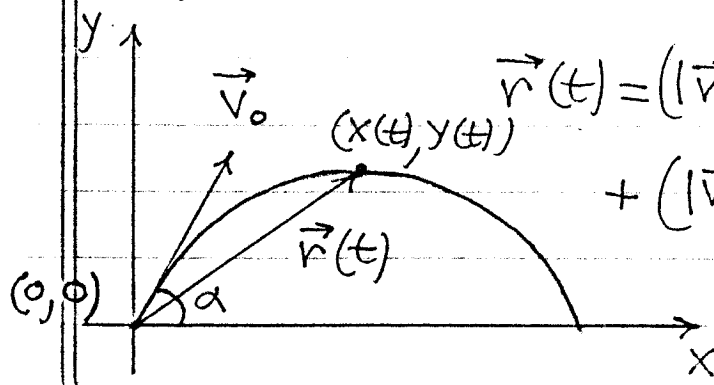
Math 21D
Kouba
Projectile Motion

Cheat Sheet for Exams



$$\vec{r}(t) = (|\vec{v}_0| \cos\alpha \cdot t)\,\vec{i} + \left(|\vec{v}_0| \sin\alpha \cdot t - \frac{1}{2} g t^2\right)\vec{j}$$

$$x(t) = |\vec{v}_0| \cos\alpha \cdot t \,, \quad y(t) = |\vec{v}_0| \sin\alpha \cdot t - \frac{1}{2} g t^2$$

I.) Flight time: $t = \dfrac{2|\vec{v}_0| \sin\alpha}{g}$

II.) Maximum height: $y = \dfrac{|\vec{v}_0|^2 \sin^2\alpha}{2g}$

(occurs when $t = \dfrac{|\vec{v}_0| \sin\alpha}{g}$)

III.) Downrange distance ($y(t) = 0$):

$$x = \frac{2|\vec{v}_0|^2 \cos\alpha \sin\alpha}{g}$$

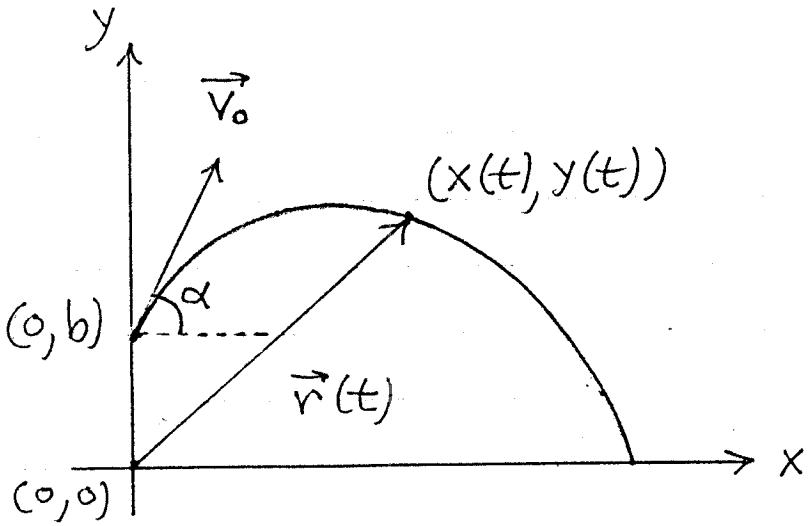
(occurs when $t = \dfrac{2|\vec{v}_0| \sin\alpha}{g}$)

IV.) Maximum downrange distance for given $|\vec{v}_0|$:

$$x = \frac{|\vec{v}_0|^2}{g}$$

(occurs when $\alpha = 45°$ and $t = \dfrac{\sqrt{2}\,|\vec{v}_0|}{g}$)

New Initial Position



$$\vec{r}(t) = (|\vec{v}_0| \cos\alpha \cdot t)\,\vec{i} + \left(b + |\vec{v}_0| \sin\alpha \cdot t - \frac{1}{2} g t^2\right)\vec{j}$$

$$x(t) = |\vec{v}_0| \cos\alpha \cdot t, \quad y(t) = b + |\vec{v}_0| \sin\alpha \cdot t - \frac{1}{2} g t^2 ;$$

if the initial point is $(0, b)$, then the formulas on the previous page do not apply !