Mon: Warm Up 4 D2L

Group Exercise Attend!

Tues: Discussion / quiz

Ex: On website 112, 115, 116, 120, 122, 126, 129

Two dimensional motion with constant acceleration

An object that moves with constant acceleration in two dimensions has acceleration vector

$$a = a_x \hat{i} + a_y \hat{j}$$

where both a_x and a_y are constant as time passes. Then two rounds of integration give the two dimensional kinematics equations:

$$v_{fx} = v_{ix} + a_x \Delta t$$

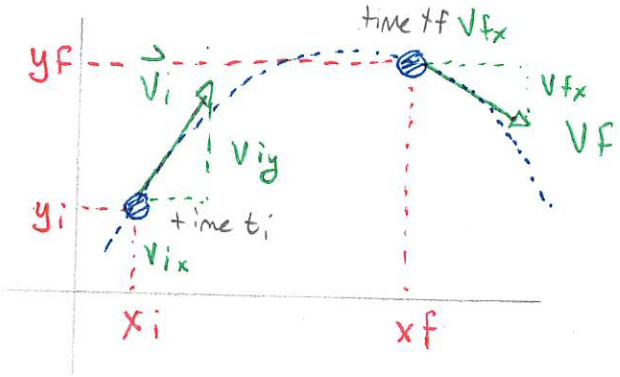
$$x_f = x_i + v_{ix} \Delta t + \tfrac{1}{2} a_x (\Delta t)^2$$

$$v_{fx}^2 = v_{ix}^2 + 2a_x (x_f - x_i)$$

$$v_{fy} = v_{iy} + a_y \Delta t$$

$$y_f = y_i + v_{iy} \Delta t + \tfrac{1}{2} a_y (\Delta t)^2$$

$$v_{fy}^2 = v_{iy}^2 + 2a_y (y_f - y_i)$$



Note that the horizontal and vertical components can be treated separately. The only common connection is the time variable.

Projectile motion

A projectile is an object that only moves under the influence of Earth's gravity. Experiments indicate that

> For projectiles acceleration is constant and
>
> $a_x = 0 m/s^2$
>
> $a_y = -g = -9.80 m/s^2$
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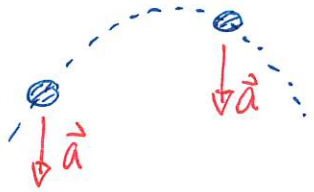
> 
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Note that, for projectiles:

> The vertical and horizontal motions are independent

Quiz 1 80% - 95% } 90% -

Demo: Ball dropped versus launched

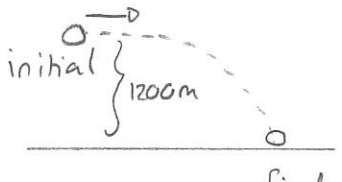
Demo: U of Iowa site - UMd QOTW #47

119 Aircraft dropping object

An aircraft flies horizontally with a constant speed of 600 km/h at a height of 1200 m above a flat surface. It drops an object from its underside; this object is supposed to hit a particular spot on the ground. How far (horizontally) from the spot must the aircraft be for the object to hit the spot? *(131F2024)*

Answer: 2610 m

Answer: ① Sketch



* not a straight line

② list variables

$x_i = 0m$ $\quad \Delta t =$

$y_i = 1200m$ $\quad x_f = ??$

$v_{ix} = 167 m/s$ $\quad y_f = 0m$

$v_{iy} =$ $\quad v_{fx} =$

$v_{fy} =$

$a_x = 0 m/s^2$ $\quad a_y = -9.80 m/s^2$

③ list velocity information

* $v_f \neq 0$ (just before hitting)

draw $\vec{v}_i$ →

horizontal only

$v_{ix} = 167 m/s$

$v_{iy} = 0 m/s$

convert $\frac{600km}{hr} = \frac{6 \times 10^5 m}{3600s} = 167 m/s$

④ $x_f = \cancel{x_i}^{0} + v_{ix}\Delta t + \frac{1}{2}\cancel{a_x}^{0}(\Delta t)^2$

$x_f = 167 m/s\ \Delta t$

we need Δt. Use vertical motion

$y_f = y_i + \cancel{v_{iy}\Delta t} + \frac{1}{2}a_y(\Delta t)^2$

$0m = 1200m + \frac{1}{2}(-9.80 m/s^2)(\Delta t)^2$

$\Rightarrow 4.90 m/s^2 (\Delta t)^2 = 1200m$

$\Rightarrow \Delta t = \sqrt{\frac{1200m}{4.90 m/s^2}}$

$\Rightarrow \Delta t = 15.6s$

So $x_f = 167 m/s \times 15.6s$

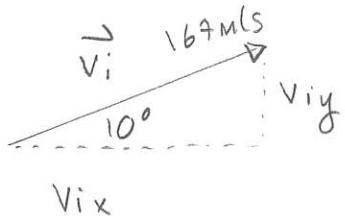
$x_f = 2610m$

Quiz 2 50% – 70% } 30% — 70%

Quiz 3 80% }

Suppose that in the example, the object was released while the aircraft ascends at an angle of 10°. How would this affect the answer?

The initial velocity vector would be



Then $v_{ix} = 167\text{m/s} \cos 10° = 164\text{m/s}$

$v_{iy} = 167\text{m/s} \sin 10° = 29\text{m/s}$

We would have to solve

$x_f = 164\text{m/s}\ \Delta t$

$y_f = y_i + v_{iy}\Delta t + \frac{1}{2} a_y (\Delta t)^2$

$0\text{m} = 1200\text{m} + 29\text{m/s}\cdot \Delta t - 4.90\text{m/s}^2 (\Delta t)^2$

solve quadratic