Fri: Review Class Exam I

Mon: Class Exam I

See 2016, 2019, Class Exam I

Survey: Class do? provide info, deliver content, prepare for tests, understand discussion

- actually doing material

Text backup, supplement., HW, practice problems
read before.

- how to read text... - back + forth, examples

Projectile motion

Recall that for projectile motion, the acceleration is down

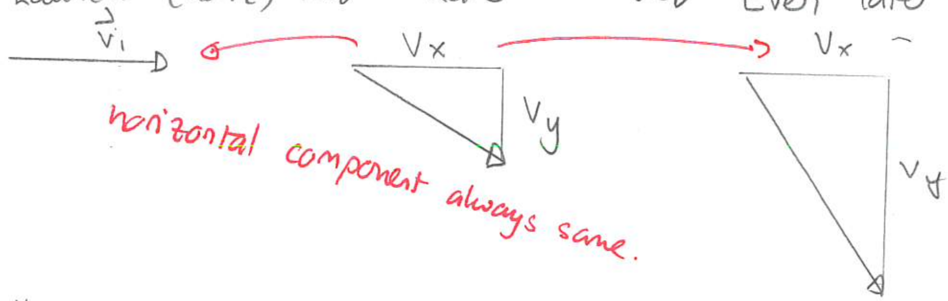
$a_x = 0 m/s^2$

$a_y = -9.8 m/s^2$ ↓

We can use this to determine the curve/trajectory followed by the projectile.

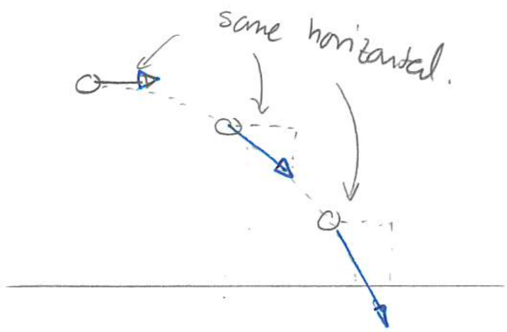
Quiz 1 30% - 70%

Launch (horiz) → Later → Even later



This allows us to reconstruct the trajectory

Quiz 2 80% -

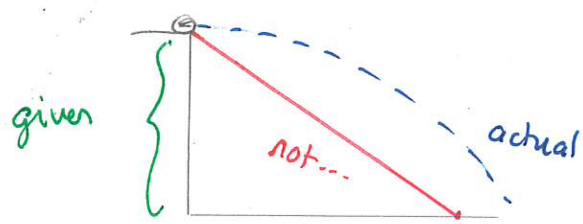


DEMO: Google Images - Grain Pouring Conveyor.

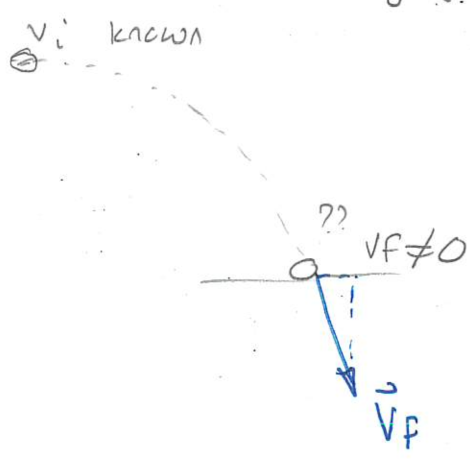
<u>Note</u>: Common pitfalls with projectile motion

1) It's not straight line motion - triangles for velocity components

- no triangles for position



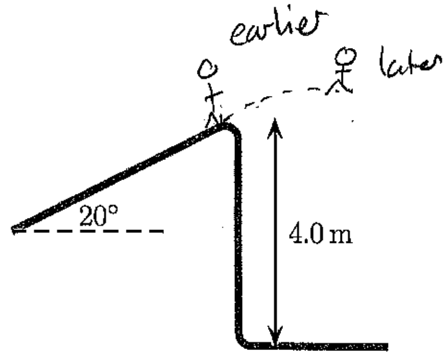
2) $\vec{V}_f = 0$ when reaching ground



3) mixing x,y for acceleration

$a_x = 0$

97 Launching off a ski ramp, 1



A ski ramp is arranged as illustrated. A skier launches off the ramp with a speed of 15 m/s. Initially the aim of this exercise is to determine the maximum height reached by the skier and the velocity at this point. A later goal is to determine the distance at which the skier lands from the bottom of the ramp. *(111F2023)*

a) Sketch the situation with the "earlier" instant being that at which the skier launches and the "later" instant being the moment when she reaches its highest point. List as many of the variables as possible. Use the format

$t_i = 0\,s$	$t_f =$
$x_i = 0\,m$	$x_f =$
$y_i = 4.0\,m$	$y_f =$
$v_{ix} =$	$v_{fx} =$
$v_{iy} =$	$v_{fy} = 0\,m/s$
$a_x = 0\,m/s^2$	$a_y = -9.80\,m/s^2$

b) Draw the velocity vector at the earlier instant and use this to determine the components of $\vec{v}_0$. Enter these in the list above.

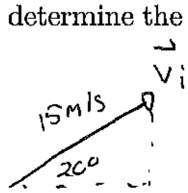
c) Draw the velocity vector at the later instant. Describe whether the components are positive, negative or zero and enter as much information about these in the list above.

d) Determine the time taken to reach the maximum height and then the horizontal distance traveled by the skier to reach her maximum height. Determine the velocity at this point.

You will now consider the motion from the highest point back to the ground.

e) Repeat the problem set-up with the"earlier" instant being that at which the skier is at maximum height and the "later" instant being the moment *just before* she reaches hits the ground. Determine the time taken for this portion of the motion and use it to determine the horizontal distance from the base of the ramp to the skier's landing point.

b)



$$V_{iy} = V_i \sin 20^\circ = 15\,m/s \sin 20^\circ$$
$$= 5.1\,m/s$$

$$V_{ix} = V_i \cos 20^\circ$$
$$= 15\,m/s \cos 20^\circ$$
$$= 14.1\,m/s$$

c) $\longrightarrow \vec{V}_P$ $\qquad V_{fy} = 0$

$V_{fx} > 0.$

d) $V_{fy} = V_{iy} + a_y \Delta t$

$0\,m/s = 5.1\,m/s - 9.8\,m/s^2\ \Delta t$

$\Rightarrow 9.8\,m/s^2\ \Delta t = 5.1\,m/s$

$\Rightarrow \Delta t = \dfrac{5.1\,m/s}{9.8\,m/s^2} = 0.52\,s$

$X_f = \overset{0}{\cancel{x_i}} + V_{ix}\,\Delta t + \frac{1}{2}\overset{0}{\cancel{a_x}}(\Delta t)^2$

$X_f = 14.1\,m/s \times 0.52\,s \Rightarrow X_f = 7.3\,m$

$V_{fx} = V_{ix} + \cancel{a_x}\,\Delta t \Rightarrow V_x = V_{ix} = 14.1\,m/s$ $\qquad \xrightarrow{14.1\,m/s} \vec{V}_i$

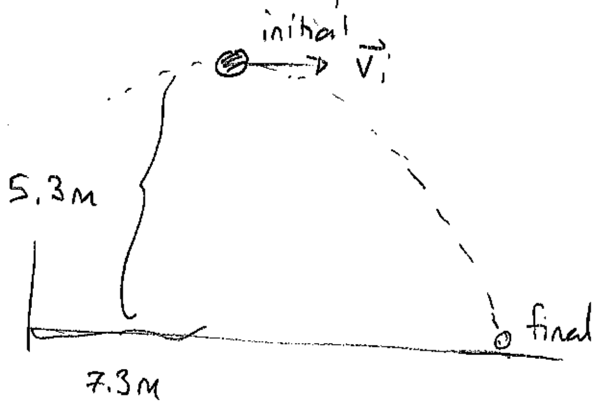
We also need the maximum height

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

$= 4\,m + 5.1\,m/s \times 0.52\,s - \frac{1}{2}\, 9.80\,m/s^2 \times (0.52\,s)^2$

$= 5.3\,m$

e) consider this period



$t_i = 0s$

$x_i = 7.3m$ $\quad x_f =$

$y_i = 5.3m$ $\quad y_f = 0m$

$V_{ix} = 14.1m/s$ $\quad V_{fx} =$

$V_{iy} = 0m/s$ $\quad V_{fy} =$

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

$x_f = 7.3m + 14.1m/s\ \Delta t$

Get Δt from vertical

$\cancel{y_f}^{0} = y_i + \cancel{V_{iy}}^{0}\Delta t + \frac{1}{2}a_y(\Delta t)^2$

$0m = 5.3m - \frac{1}{2}(9.80m/s^2)(\Delta t)^2$

$\Rightarrow\ 4.90m/s^2(\Delta t)^2 = 5.3m \quad \Rightarrow \quad \Delta t^2 = \frac{5.3m}{4.90m/s^2} = 1.09s^2$

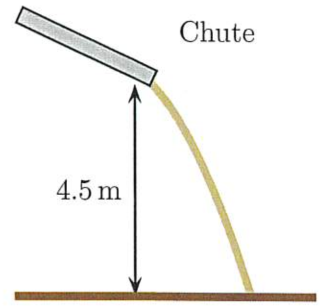
$\Rightarrow\ \Delta t = 1.04s.$

Thus $x_f = 7.3m + 14.1m/s \times 1.04s =$

$= 22m$

106 Grain chute

Grain pours off a chute that is at an angle of 25° above the horizontal. It leaves the end of the chute with speed 5.0 m/s. Determine how far it travels horizontally. *(111F2023)*



Data

Answer: ① $t_i = 0\,s$ $\quad t_f =$

$x_i = 0\,m$

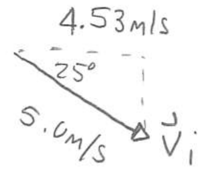
$y_i = 4.5\,m \quad y_f = 0\,m$

$a_x = 0\,m/s^2 \quad a_y = -9.8\,m/s^2$

$v_{ix} = \quad v_{fx} = 0$

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

② Velocity components



$v_{ix} = v_i \cos 25°$

$= 5.0\,m/s \cos 25°$

$= 4.53\,m/s$

$v_{iy} = -v_i \sin 25° = -5.0\,m/s \sin 25° = -2.1\,m/s$

③ kinematic equations

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

$x_f = 4.53\,m/s\ \Delta t$

Need Δt (t_f)

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

$0\,m = 4.5\,m - 2.1\,m/s\ \Delta t + \frac{1}{2}(-9.8\,m/s^2)(\Delta t)^2$

$0\,m = 4.5\,m - 2.1\,m/s\,\Delta t - 4.9\,m/s^2(\Delta t)^2$

$$\Delta t = \frac{-(-2.1\,m/s) \pm \sqrt{(2.1\,m/s)^2 - 4(-4.9\,m/s^2)4.5\,m}}{2(-4.9\,m/s^2)}$$

$$= \frac{2.1\,m/s \pm 9.6\,m/s}{-9.8\,m/s^2} = \frac{-7.5\,m/s^2}{-9.8\,m/s^2} \approx 0.77\,s$$

only negative

$x_f = 4.53\,m/s \times 0.77\,s$

$x_f = 3.5\,m$