Thurs: HW by 5pm

Ex: 72, 82, 87, 89, 93, 94, 99, 100

Fri: Review

Mon: Exam I Covers all material to date

See 2016, 2019 Class Ex 1

This class: Projectile motion - angled launch.

Projectile Motion

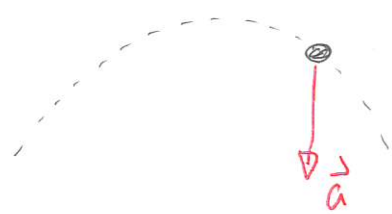
Projectile motion is motion where an object moves solely under the influence of Earth's gravity. For such motion

1) the horizontal components of the motion are independent of the vertical components.

2) acceleration is constant

$a_x = 0 m/s^2$

$a_y = -g = -9.80 m/s^2$



Warm Up 1

DEMO: Cart + Ball launcher

Explanation: The horizontal component of velocity is constant

$\Rightarrow$ ball /ship have same horizontal motion.

Quiz 1 50% - 90%

Warm Up 2

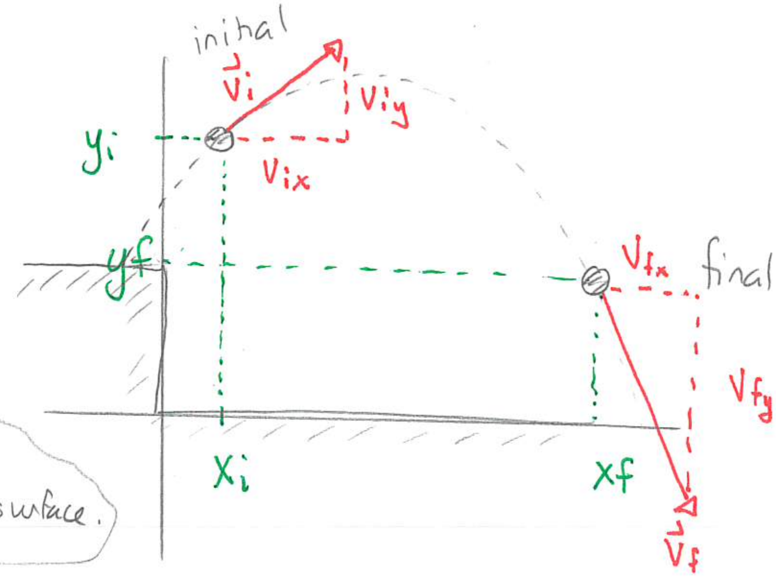
A doubled set of kinematics equations applies provided that only gravity acts on the object.

These do not apply:

1) During launch
2) As it hits any surface

They apply from

Just after launch until just before hitting the same surface.



Horizontal Only	Vertical Only
$V_{fx} = V_{ix} + a_x \Delta t$	$V_{fy} = V_{iy} + a_y \Delta t$
$X_f = X_i + V_{ix} \Delta t + \frac{1}{2} a_x (\Delta t)^2$	$y_f = y_i + V_{iy} \Delta t + \frac{1}{2} a_y (\Delta t)^2$
$V_{fx}^2 = V_{ix}^2 + 2a_x (X_f - X_i)$	$V_{fy}^2 = V_{iy}^2 + 2a_y (y_f - y_i)$
$a_x = 0 \, m/s^2$	$a_y = -9.8 \, m/s^2$

$$\Delta t = t_f - t_i$$

96 Jumping over a ditch

A dog attempts to jump over a ditch, which is 2.0 m wide. The dog launches itself from one edge of the ditch with speed 5.0 m/s at an angle of 30° from the horizontal. The aim of this exercise is to determine whether the dog will reach the other side of the ditch. First we will find out whether the dog reaches its maximum height before or after it is above the middle of the ditch. *(111F2023)*

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

$t_i =$	$t_f =$
$x_i =$	$x_f =$
$y_i =$	$y_f =$
$v_{ix} =$	$v_{fx} =$
$v_{iy} =$	$v_{fy} =$
$a_x =$	$a_y =$

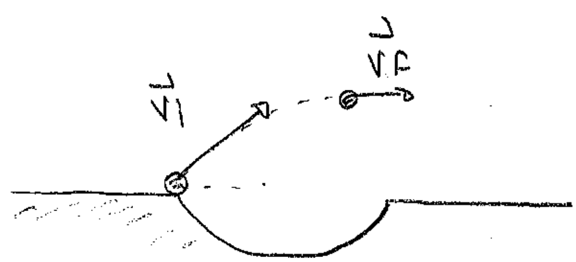
b) Draw the velocity vector at the earlier instant and use this to determine the components of $\vec{v}_i$. Enter these in the list above.

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 horizontal distance traveled by the dog by the time that it reaches it's maximum height.

e) As the dog descends from its maximum height back to the ground, how much further does it travel? Does it reach the other side of the ditch?

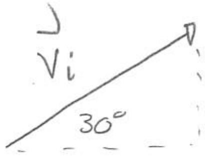
Answer a)



$t_i = 0s$	$t_f =$
$X_i = 0m$	$X_f =$
$y_i = 0m$	$y_f =$
$V_{ix} = 4.33 m/s$	$V_{fx} =$
$V_{fx} = 2.5 m/s$	$V_{fy} =$

from b) →

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

b) 

$V_{iy} = V_i \sin 30^\circ = 5.0\,m/s \sin 30^\circ$

$= 2.5\,m/s.$

$V_{ix} = V_i \cos 30^\circ$

$= 5.0\,m/s \cos 30^\circ$

$= 4.33\,m/s$

c) $\longrightarrow \vec{V_f}$ $\quad$ $\boxed{V_{fy} = 0}$ ← important.

$V_{fx} \neq 0$ positive

d) Need time at max height (when it gets there).

and then

$X_f = \cancel{X_i}^{\,0} + V_{ix}\Delta t + \frac{1}{2}a_x^{\,0}(\Delta t)^2 \Rightarrow \boxed{X_f = 4.33\,m/s\,\Delta t}$

To get time

$V_{fy} = V_{iy} + a\Delta t$

$\Rightarrow 0\,m/s = 2.5\,m/s + (-9.80\,m/s^2)\,\Delta t$

$\Rightarrow 9.80\,m/s^2\,\Delta t = 2.5\,m/s$

$\Rightarrow \Delta t = \frac{2.5\,m/s}{9.8\,m/s^2} = 0.26\,s$

Combine

$X_f = 4.33\,m/s \times 0.26\,s$

$= 1.10\,m$

e) The motion reverses and the dog travels an additional 1.10m. Thus it travels 2.20m before reaching the ground

Alternative answer:

Get time to return to ground

$y_f = 0\,m$

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

$0\,m = 0\,m + 2.5\,m/s\,\Delta t + \frac{1}{2}(-9.80\,m/s^2)\,\Delta t^2$

$4.90\,m/s^2(\Delta t)^2 = 2.5\,m/s\,\Delta t$

If $\Delta t \neq 0$ then

$(\Delta t)^{\cancel{2}} = \frac{2.5\,m/s}{4.90\,m/s^2}\cancel{\Delta t}$

$\Rightarrow \Delta t = 0.52\,s$

$X_f = X_i + V_{ix}\Delta t = 0\,m + 4.33\,m/s \times 0.52\,s$

$= 2.20\,m$