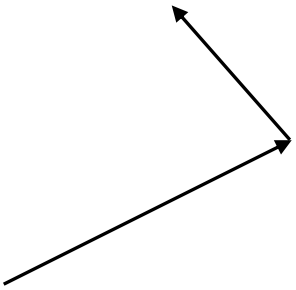
Vectors and 2-D Motion

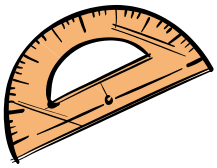
Name: _____

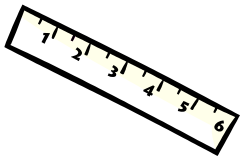
Video 2d03 (5:35)

resultant: the single vector that has the same effect as several vectors added together



Vector Addition: Graphical Method



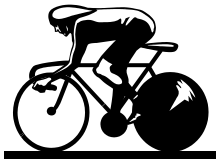


1. Choose a scale.
2. Use ruler and protractor to draw first vector to scale at proper angle.
3. Draw subsequent vectors tip-to-tail.
4. Draw resultant by connecting tail of first vector to tip of last.

EX. Add. d_1 = 420 m horiz.

d_2 = 280 m @ 30.^{o} above horiz. scale:

Video 2d06 (6:40)



Add. v_1 = 53 km/h @ 25^o N of W

v_2 = 32 km/h @ 20.^{o} S of W

v_3 = 45 km/h @ 25^o E of S scale:

EX. Add. d_1 = 1160 km @ 20.^{o} N of E

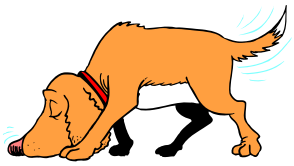
d_2 = 470 km @ 60.^{o} S of E

d_3 = 280 km @ 70.^{o} N of W scale:

Video 2d09 (3:18)

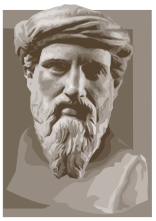
Add. d_1 = 65 m @ 15^o N of E

d_2 = 48 m @ 63^o N of E scale:



Video 2d12 (5:47)

Vector Addition: Algebraic Method



If vectors are ⊥, use Pythagorean theorem and trigonometry (i.e., $\tan^{-1}$).

EX. Add. d_1 = 75 km S d_2 = 45 km W

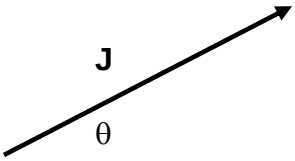
EX. Add. v_1 = 380 km/h N v_2 = 145 km/h E

Video 2d15 (7:07)

How to Add Vectors Algebraically if the Vectors are NOT ⊥

vector resolution: taking a vector and breaking it down ("resolving" it) into two ⊥ component vectors

Use θ along with sin and cos functions, as appropriate.



EX. Resolve into components.

F = 68 N @ 32° above horiz.

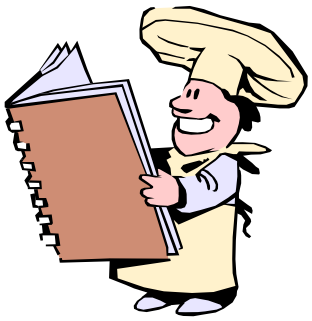
v = 14.7 m/s @ 15.0° below horiz.

a = 3.2 m/s² @ 38° S of W

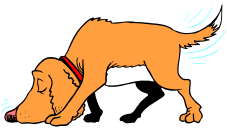
Video 2d18 (7:21)

To add non-perpendicular vectors algebraically…

1. Resolve all vectors into "x" and "y" components.
2. Add "x" components, taking into account direction of each.
3. Add "y" components in the same way.
4. Vectors resulting from Steps 2 and 3 are ⊥ . Add them as you would any two ⊥ vectors, using Pythagoras and $\tan^{-1}$.



EX. Add algebraically. d_1 = 65 m @ 15º N of E d_2 = 48 m @ 63º N of E



d_{1EW} = d_{2EW} =

d_{1NS} = d_{2NS} =

add comp.'s { d_{rEW} = ; d_{rNS} = }

d_r =

θ =

Video 2d21 (8:44)

Add algebraically. d_1 = 425 km @ 12º E of N d_2 = 182 km @ 28º E of S

d_{1EW} = d_{2EW} =

d_{1NS} = d_{2NS} =

add comp.'s { d_{rEW} = ; d_{rNS} = }

d_r =

θ =

Video 2d24 (7:01)

Projectile Motion

projectile: an airborne object acted upon "only" by gravity

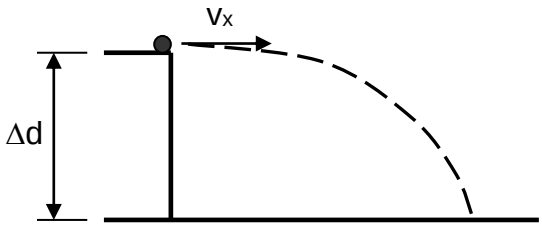
-- other forces are NOT significant

examples:

non-examples:

Horizontally-Launched Projectiles

Theory: A projectile is launched horizontally w/velocity v_x from height Δd.



-- v_x is...

-- a_x is…

-- v_y starts at...

Kinematics Equations:

A $\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$

B $v_f^2 = v_i^2 + 2\,a\,\Delta d$

C $v_{avg} = \frac{\Delta d}{\Delta t} = \frac{1}{2}(v_f + v_i)$

D $\Delta d = v_i\,\Delta t + \frac{1}{2}\,a\,(\Delta t)^2$

Video 2d27 (8:09)

A rifle bullet is fired horizontally w/initial speed 850 m/s from height 1.73 m. Find…

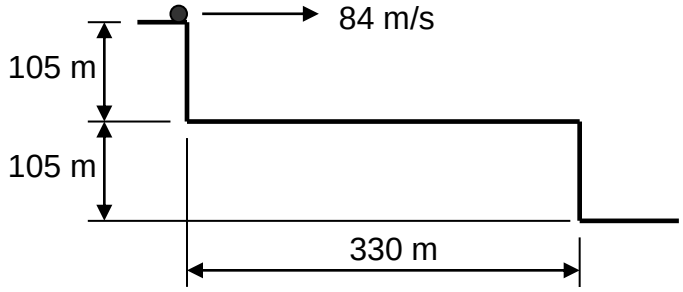
a. …time bullet is in air

b. …bullet's range (max. horizontal displacement)

c. …bullet's height above ground at t = 0.38 s.

Video 2d30 (5:54)

For how long will projectile remain airborne?

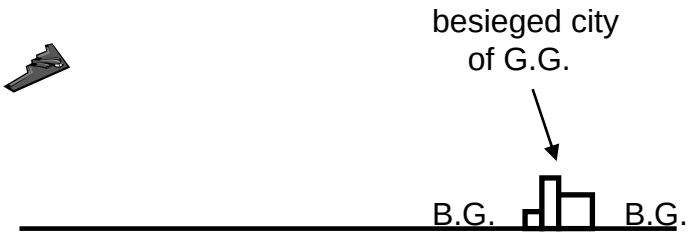


Video 2d33 (6:24)

Projectile is launched horizontally from height 62 m. Range is measured to be 238 m. Find launch speed.

Video 2d36 (7:01)

Military plane flies horizontally at altitude 8000. m at speed 100. m/s. As measured along ground, how far from target must plane be when it releases target's provisions?



How fast are provisions moving when they land?

Video 2d39 (5:07)

Review Problem from 1-D Motion

An object is launched w/initial vel. 37.0 m/s↑ .

a. Find time object is in air.

b. Find max. height object attains.

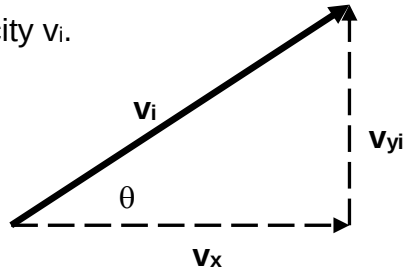
Projectiles Launched at an Angle

Theory: A projectile is launched at initial angle θ with initial velocity v_i.

-- v_x is...

-- a_x is…

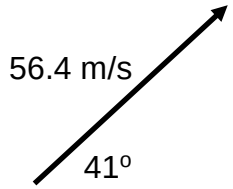
-- v_y starts at...

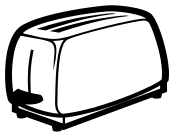


Video 2d42 (6:52)

Projectile is launched w/initial velocity 56.4 m/s at 41° above horizontal.

a. Find time object is in air.





b. Find max. height object attains.

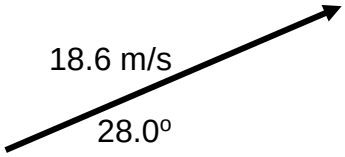
c. Find projectile's range.

An angled projectile...

Video
2d45
(4:40)

Projectile is launched w/initial velocity 18.6 m/s at 28.0º above horizontal.

a. Find time object is in air.



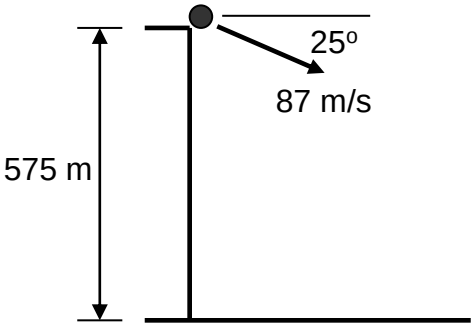
b. Find max. height object attains.

c. Find projectile's range.

Video
2d48
(4:20)

Projectile is launched from height 575 m w/initial velocity 87 m/s @ 25º below horizontal.

a. Find time object is in air.



b. Find projectile's range.

Video
2d51
(7:45)

At Any Time Δt After Launch, WHERE is a Projectile?

Use THIS equation... ...twice.

The x-position will have CHANGED by the amount...

The y-position will have CHANGED by the amount...

These changes, along with the initial x- and y-positions...

EX. An object is launched from the ground w/init. velocity 35.58 m/s @ 55.80^{o} above the horizontal. Find its location relative to its starting point 2.43 s after launch.

EX. Proj. is launched horizontally at 36 m/s from height 92 m. Find its location 3.24 s after launch.

Video
2d54
(8:01)

At Any Time Δt After Launch, What's a Projectile's VELOCITY?

Use THIS equation... ...once

$\rightarrow$ v_x: Horiz. (v_x) is…

$\uparrow$ v_y: Vert. (v_y) is…

To find resultant v_r at any time Δt:

EX. An object is launched from the ground w/init. velocity 35.58 m/s @ 55.80^o above the horizontal. Find its velocity 2.43 s after launch.

EX. Projectile is launched horizontally at 36 m/s from height 92 m. Find its velocity 3.24 s after launch.

Video 2d57 (8:18)

A cannonball is launched off the edge of a cliff at an init. speed of 49.5 m/s at 25.6^{o} above horiz. The ball is in the air for 9.75 s. Find height of cliff, the range, and the impact speed of the cannonball.