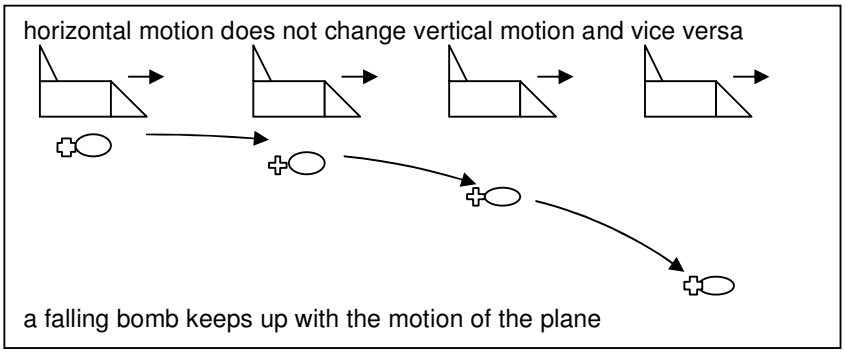
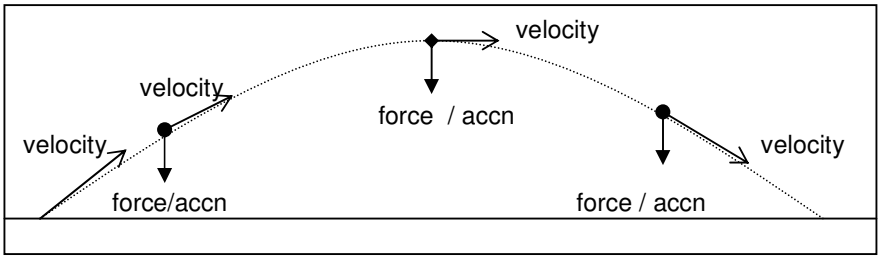


parabolic nature of path

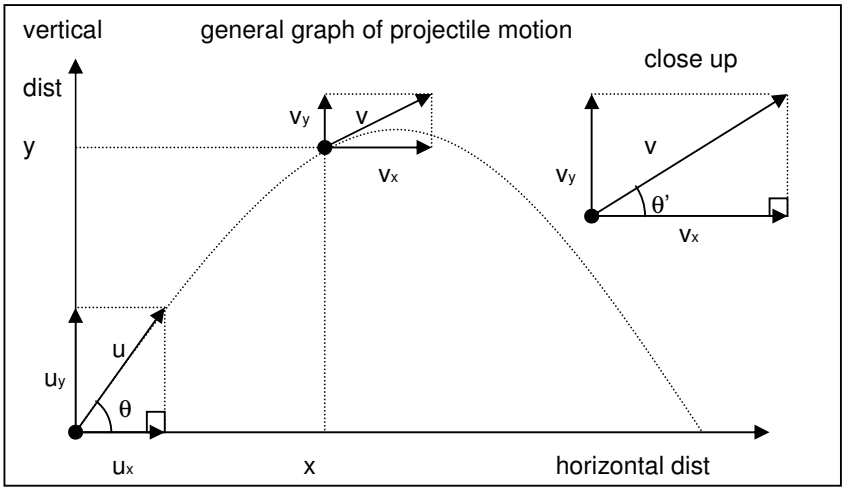
-look at a long exposure photograph of fireworks or metal work sparks.
-the points of light are projectiles and they trace out curved paths.
-the path is always **parabolic**, whether thrown horizontally or upwards at an angle or downwards at an angle.



Key points

-the path of a projectile is always parabolic.

solving projectile problems



-consider a projectile launched with an initial velocity u and at an angle of θ to the horizontal
-the motion can be resolved into its horizontal and vertical components:
-the initial horizontal velocity u_x is given by

$u_x = u \cos \theta$.

-the initial vertical component u_y is given by

$u_y = u \sin \theta$.

-all three vectors are related by

$u^2 = u_x^2 + u_y^2$.

-at some time later, t, the projectile has co-ordinates (x,y).
-it has a new final velocity v at a new angle θ'.
-the final horizontal component is given by

$v_x = v \cos \theta$'.

-the final vertical component is given by

$v_y = v \sin \theta$'.

-all three vectors are related by

$v^2 = v_x^2 + v_y^2$.

-as there is no horizontal force, the horizontal velocity is constant so

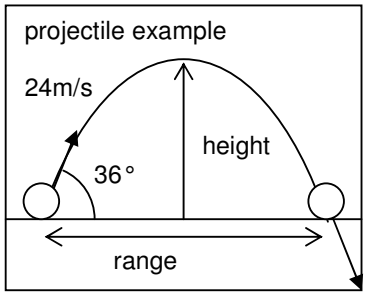
$v_x = u_x$.

-u_x, x and t are related simply by

$x = u_x t$.

-the vertical motion is uniformly accelerated motion:

$v_y = u_y + gt$	(from $v = u + at$)
$y = u_y t + \frac{1}{2} gt^2$	(from $s = ut + \frac{1}{2} at^2$)
$y = (v_y + u_y)t/2$	(from $s = (v+u)t/2$
$v_y^2 - u_y^2 = 2gy$	(from $v^2 - u^2 = 2as$)



-here g is the acceleration due to gravity.
-up is taken as positive, down as negative
so gravity $g = -10.m/s^2$.

-example, see the diagram opposite.
-consider a football kicked with an initial velocity of u = 24m/s.
-the ball leaves the ground at and angle of $\theta = 36°$ to the horizontal.
-how long does the ball take to reach the top of its path?
-first find the vertical component from

$u_y = u \sin \theta$.
$u_y = 24 \sin 36 = 14.1$m/s

-at the top of the path, the vertical component $v_y = 0$

$v_y = u_y + gt$, so $0 = 14.1 - 10t$ and rearranging
$t = 1.41$s (1.4s)

-how high did the football reach?
-using $y = (v_y + u_y)t/2$