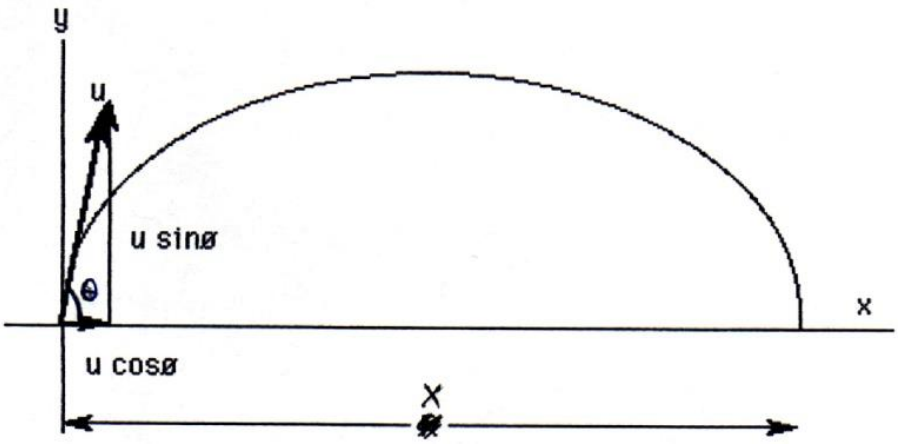
M.5.2 Inclined (Oblique) Projections

A projectile is an object that is thrown through the air. If we ignore air resistance, the only force acting on the body is the gravitational force. We can therefore break the motion down into two parts, horizontal and vertical. In the horizontal direction the acceleration equals zero, in the vertical direction the acceleration is g.

Consider a projectile projected into the air at an angle Ø with the ground as shown:



The motion can be split into two components, horizontal and vertical.

In the horizontal direction we have:

u = u cosø
v = u cosø
a = 0
x = *x*
t = t

from $s = ut + \frac{1}{2} at^2$

$x = ut\cos\phi$ (1)

In the vertical direction we have:

u = u sinø
v = changing
a = -g
x = y
t = t

from $x = ut + \frac{1}{2} at^2$

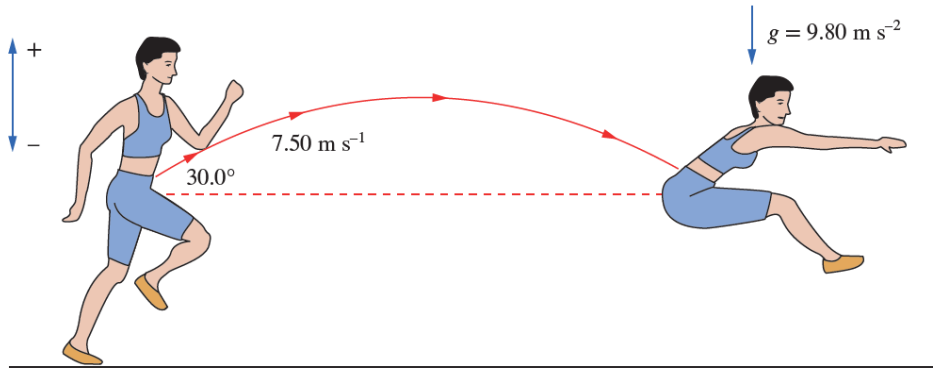
$y = ut\sin\phi - \frac{1}{2} gt^2$ (2)

combining equations (1) and (2) we get:

$$y = x\tan\phi - \frac{g x^2}{2u^2 \cos^2\phi}.$$

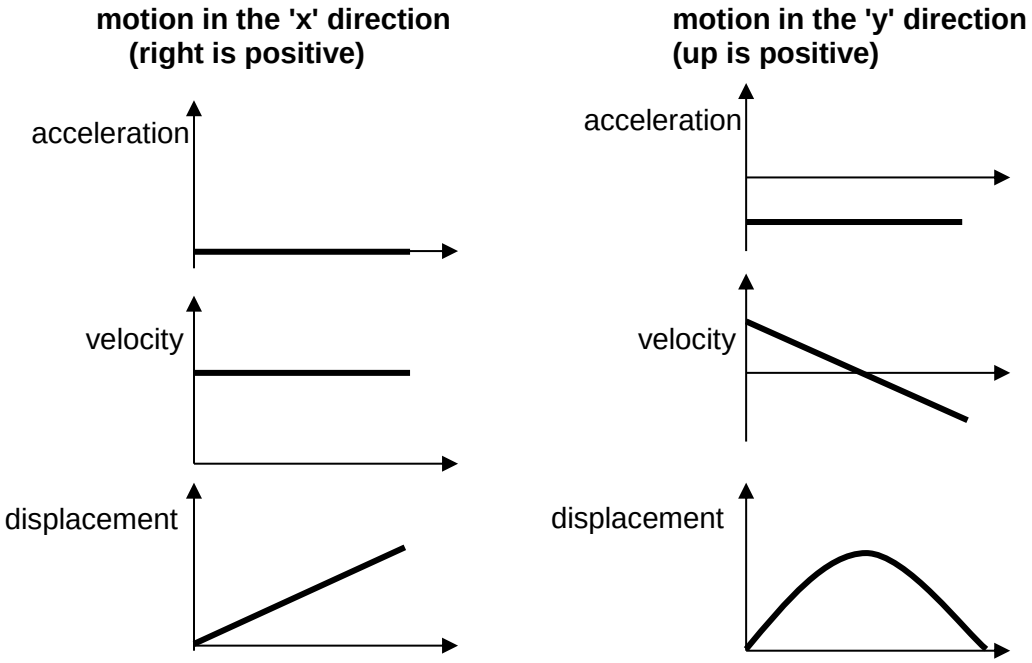
Which is a parabola.

Example.
A 65 Kg athlete in a long-jump event leaps with a velocity of 7.5 ms^{-1} at an angle of 30.0° to the horizontal.



a) What is the athlete's velocity at the highest point?
b) What is the maximum height gained by the Athlete during the jump?
c) Assuming a return to the original height, what is the total time the athlete is in the air?

M.5.3 Graphs for projectile motion



M.5.4 Symmetrical flights

If there is no air resistance, and the projectile starts and ends at the same height, then the range is given by: $R = \frac{v^2 \sin 2\theta}{g}$ R is the range, v is the initial speed and θ the angle of projection. Be careful using this formula, because it only works under the conditions specified above.

M.5.5 The Effect of Air Resistance

Air resistance will have an effect on the motion of objects travelling through the air, particularly if the projectile has a large surface area and a relatively low mass.

The size of the **air resistance** or drag force that acts on an object as it moves depends on several factors:

- The speed, *v*, of the object. The faster an object moves, the greater the drag force becomes
- The cross-sectional area of the object in its direction of motion. Greater area means greater drag.
- The aerodynamic shape of the object. A more streamlined shape experiences less drag.
- The density of the air. Higher air density means greater drag.

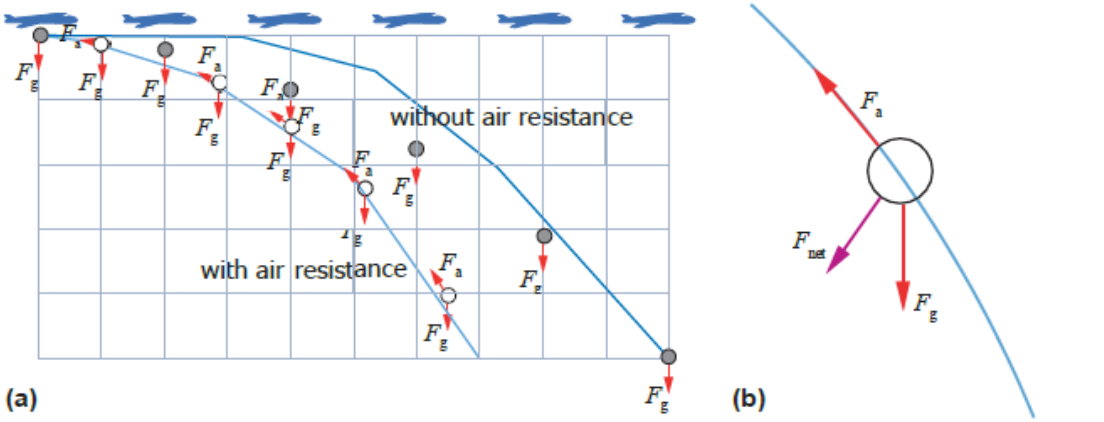


FIGURE 5.5.5 (a) The paths of a supply parcel dropped from a plane with and without air resistance. (b) When air resistance is acting, the net force on the parcel is not vertically down.

Text Questions: Page 190 All Questions