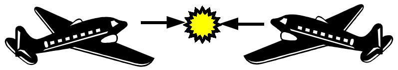
Chapter 9 Computing the Next Move

Collision Course



1000 km per hour — 1000 km per hour

distance apart 10 km
Velocity of approach 2000 km

time to collision = distance apart / velocity of approach

time to collision = 10 km / 2000 km per hour

time to collision = 1/200 hour = 18 sec

acceleration = change in velocity / time
= (final velocity—initial velocity) / time

average velocity = (initial velocity + final velocity) / 2

Units: m s^{-2} (acceleration); m s^{-1} (velocity)

Acceleration due to gravity: 9.8m s^{-2} (On earth!)

The Kinematic Equations

$v = u + at$

$s = \frac{u+v}{2} \times t$

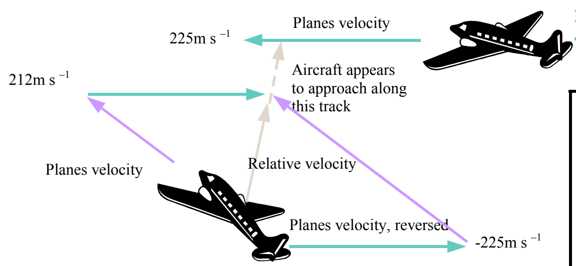
$s = ut + 1/2\ at^2$

$v^2 = u^2 + 2as$

v is initial velocity
u is final velocity
a is acceleration
s is displacement
t is time

These equations may not be useful when motion is irregular (kinematic equations can only be used when acceleration is constant) so this is when graphs are useful.
What ever the shape of the graph:

- the slope (Gradient) at any point on a distance—time graph gives the speed at that point in time.
- the area under a speed—time graph gives the distance travelled.



Rules:

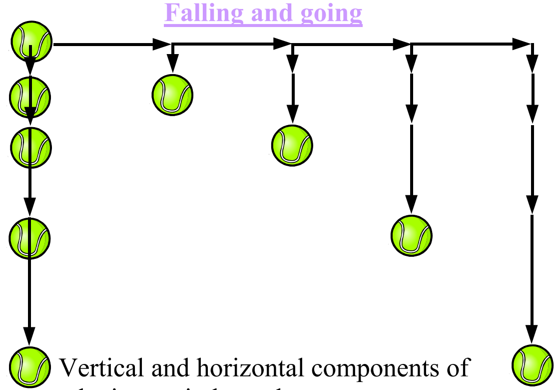
1) Add velocity opposite to that of one plane to the velocities of both.
2) Find the resultant relative velocity, adding vectors tip to tail.
3) See if the direction of the relative velocity hits the plane. If so, take avoiding action.

Potential Energy

As an object moves upwards its potential energy increases!

Force to lift object = mg
Work done = force x displacement mgh
Energy going to gravitational potential energy = mgh

Falling and going



Vertical and horizontal components of velocity are independent.
Vertical component increases uniformly with time.

Force (N), mass (kg), acceleration (ms^{-2})

F = ma

Acceleration is often replaced with g (gravity) because the acceleration of a falling object is the gravitational pull on it.

Momentum: how big a force is needed to stop in a given time.

Kinetic energy = Energy transferred = work done = force x distance
Start by calculating: **force x time**
Since **F = ma** & **at** is the increase in **v**
Force x time = mv
THIS IS MOMENTUM!
force x displacement = force x time x average velocity
If acceleration is uniform, the average velocity is v/2 so:
force x displacement = $1/2mv^2$

- Energy comes from the gravitational field: decrease in potential energy = mgh
- Energy now carried by motion of object; increase in kinetic energy = $1/2mv^2$
- Decrease in potential energy = increase in kinetic

Power = force x velocity

Energy from train to surroundings = drag force x displacement (E = Fs)
Power used by train = rate of dissipation of energy
P=E/t
P=Fs/t with s = vt
P = Fv
Power used by train = drag force x velocity