Physics in the classroom

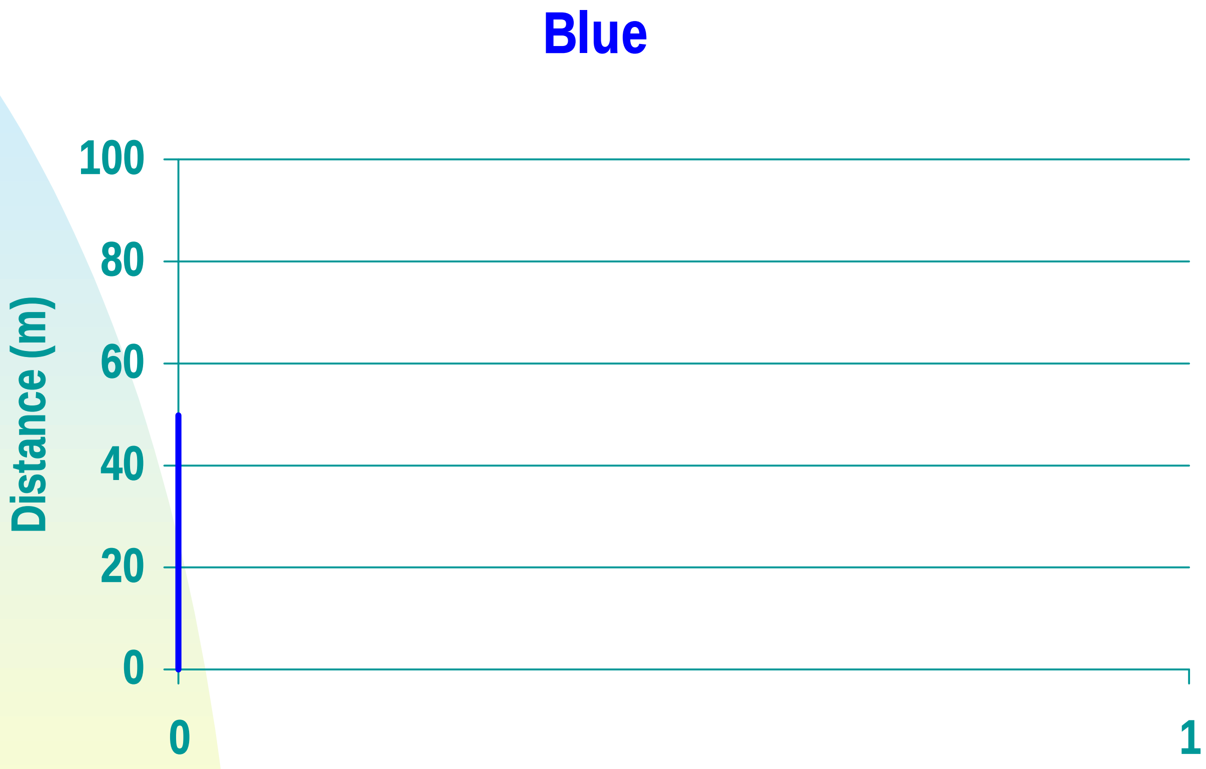
Lecture 2

Distance

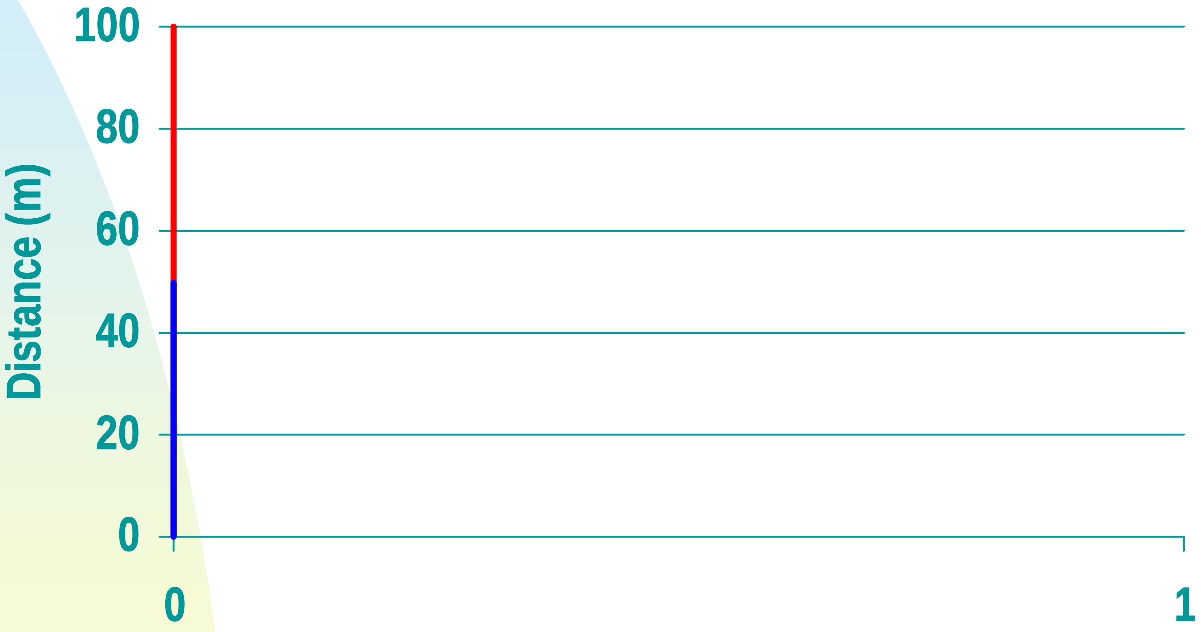
Speed

Acceleration

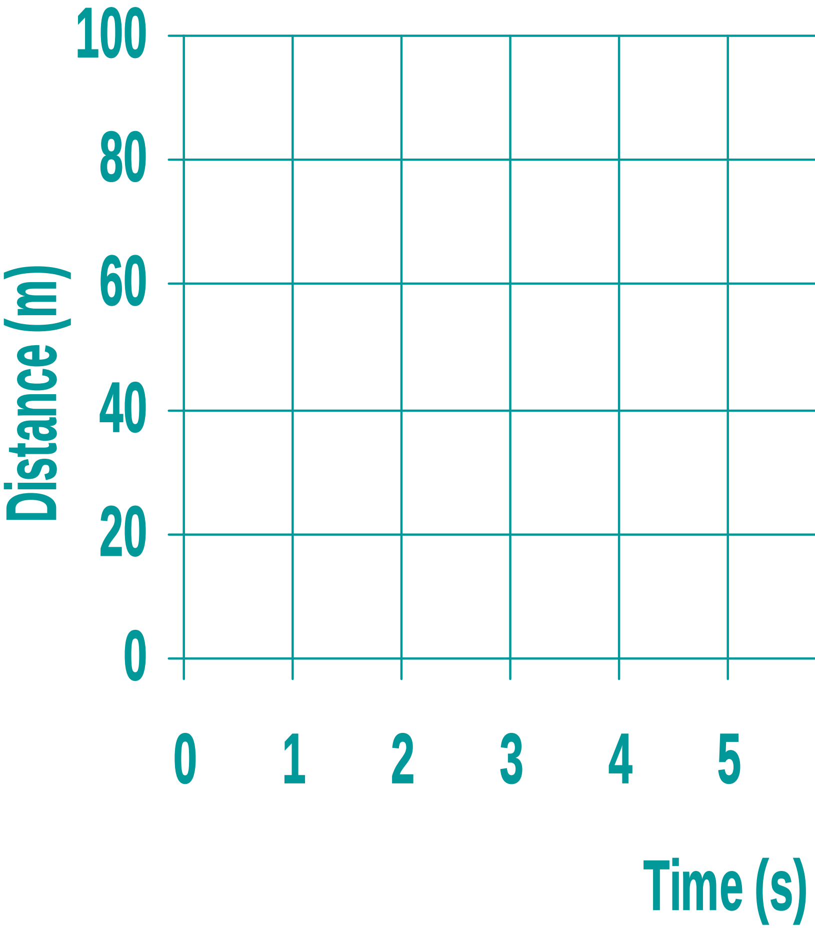

Red
Distance (m)
100
80
60
40
20
0
0
1


Blue
Distance (m)
100
80
60
40
20
0
0
1

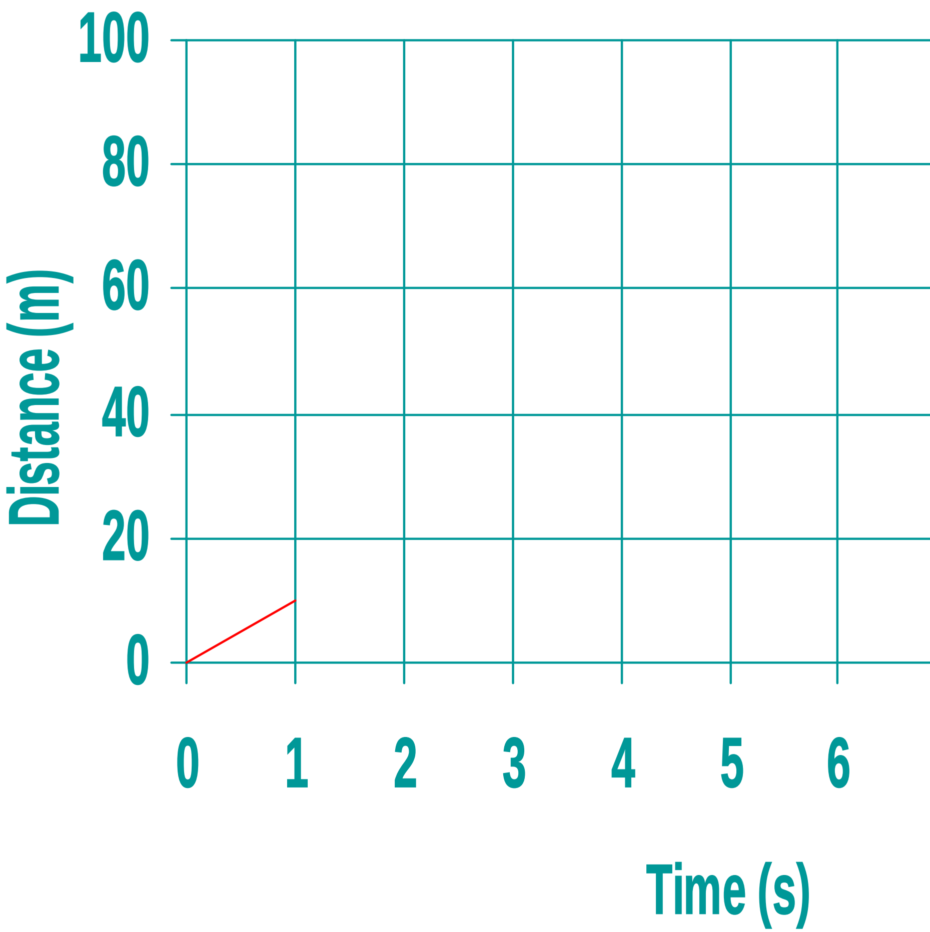
Blue/Red Race



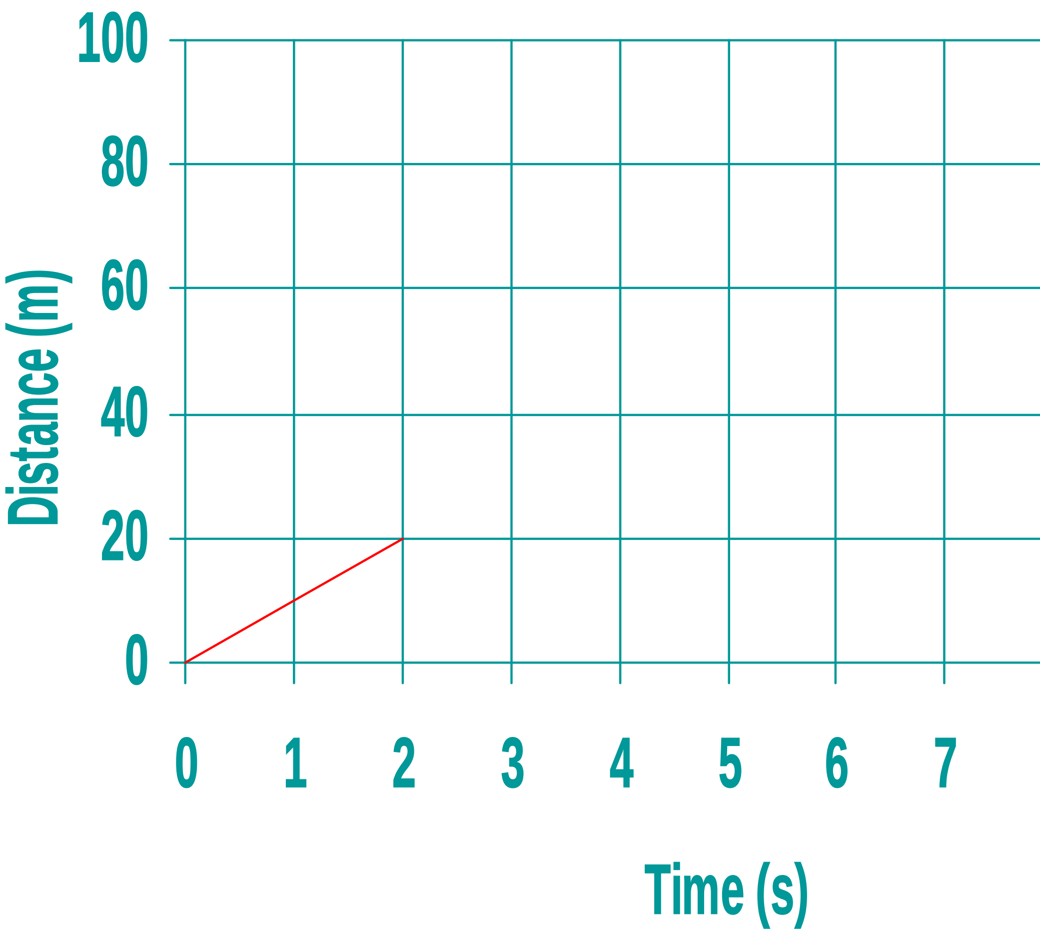
Strip Chart



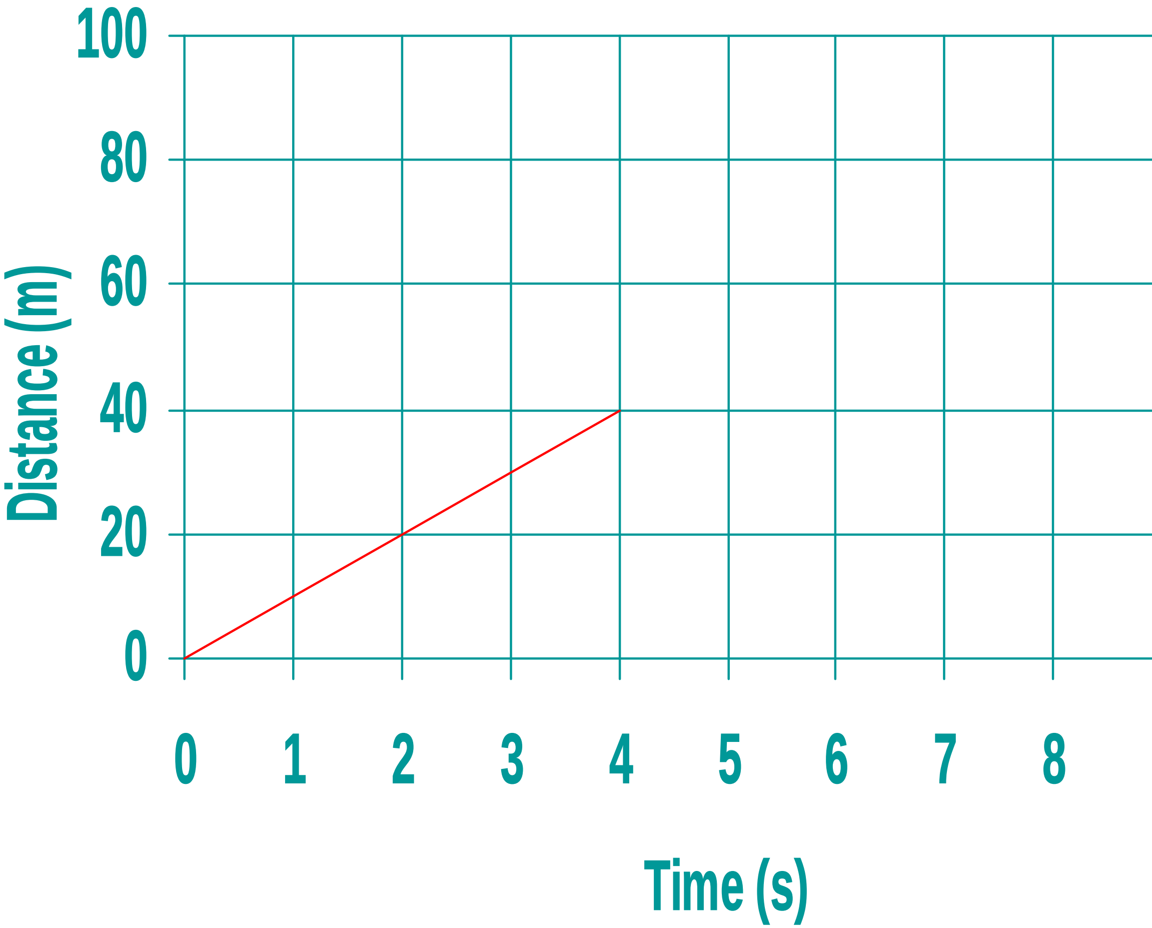
Strip Chart



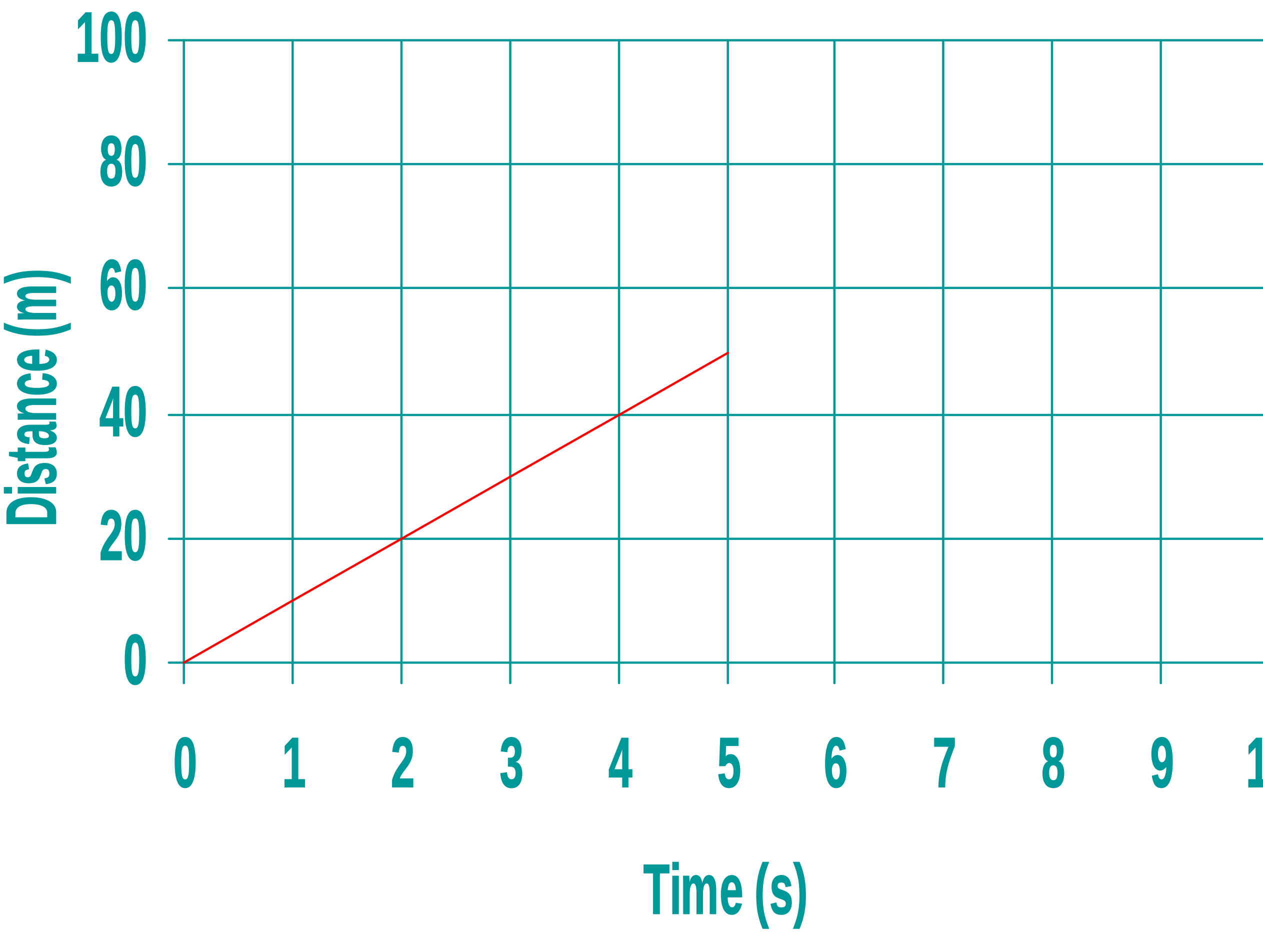
Strip Chart



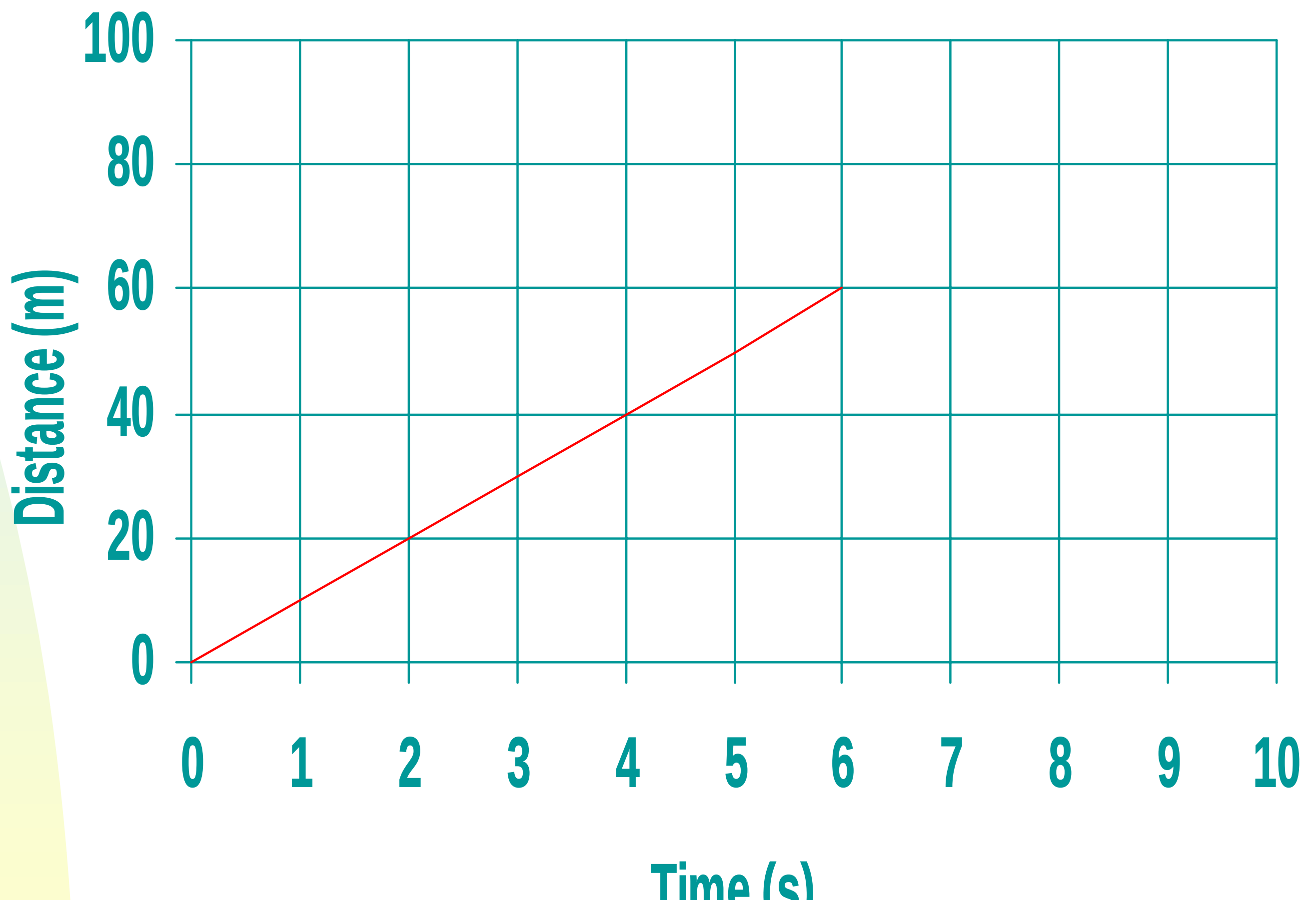
Strip Chart



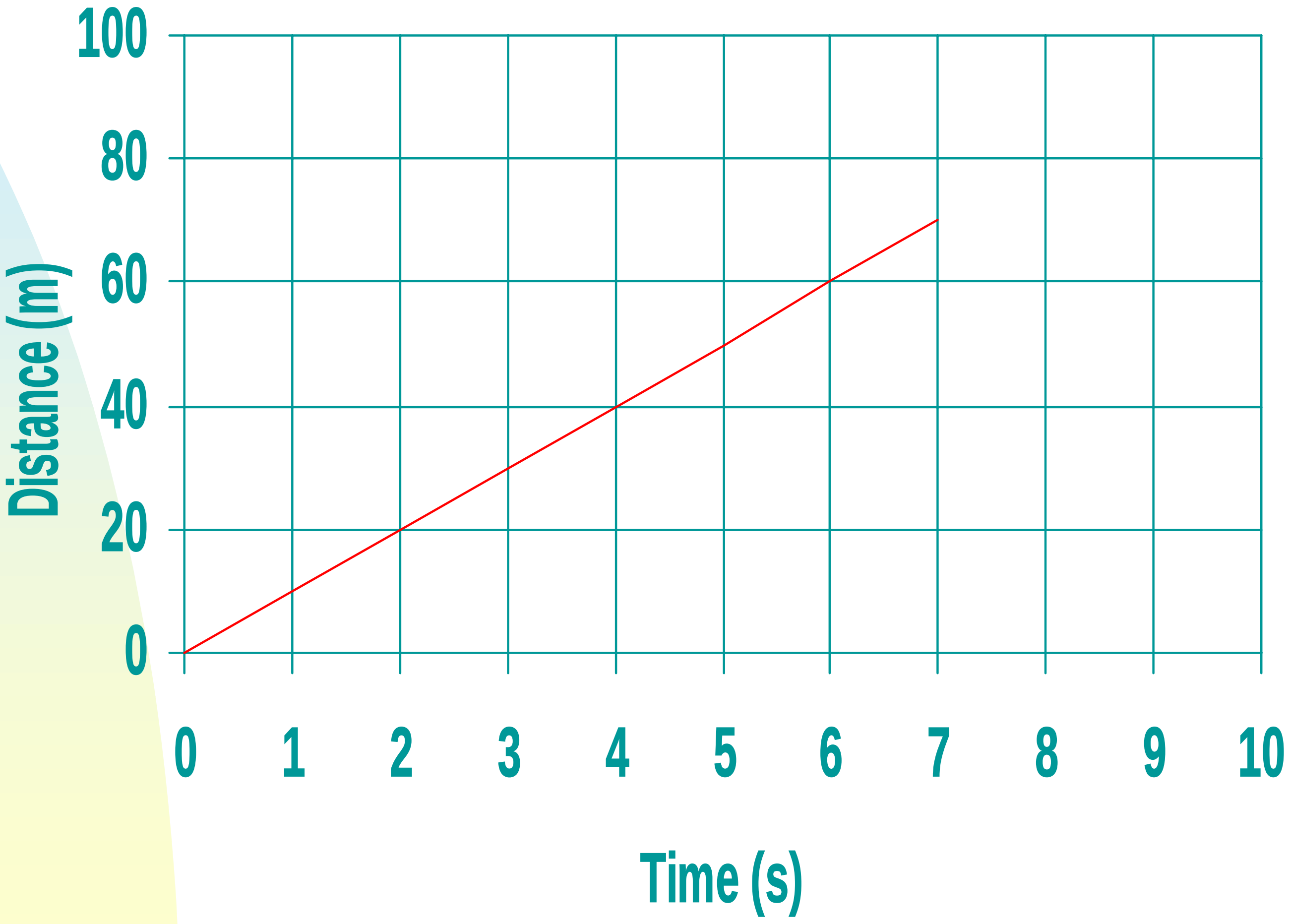
Strip Chart



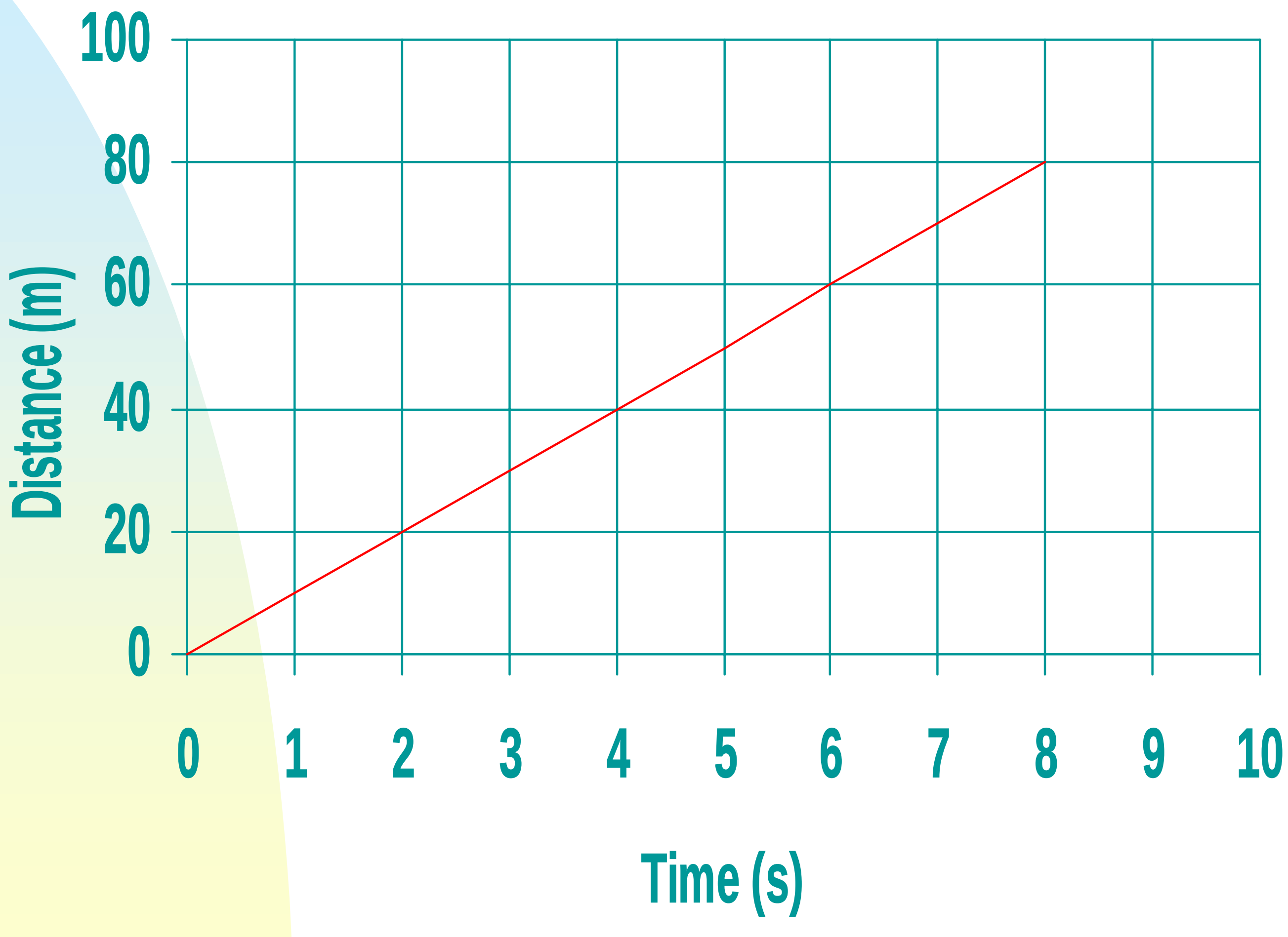
Strip Chart



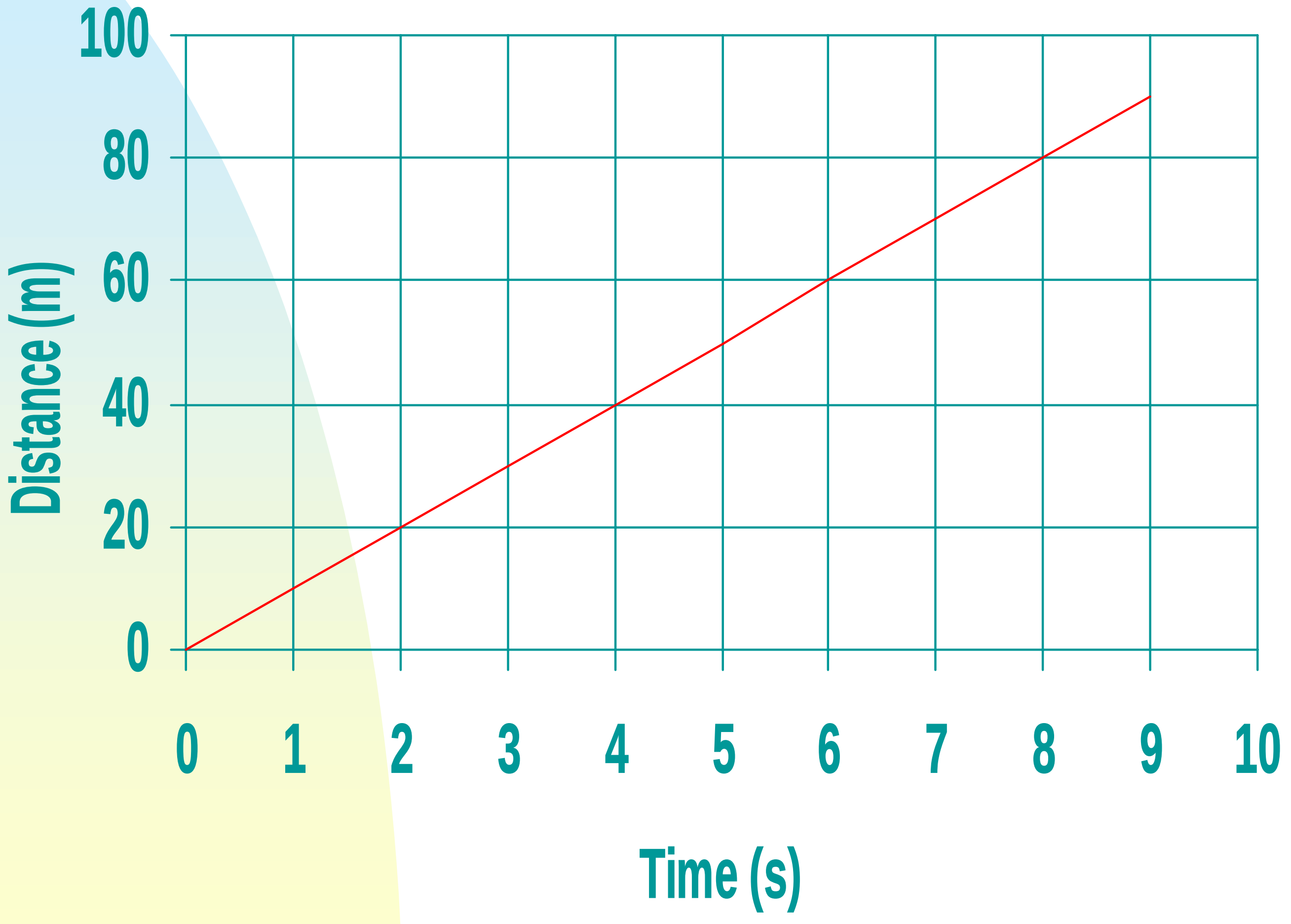
Strip Chart



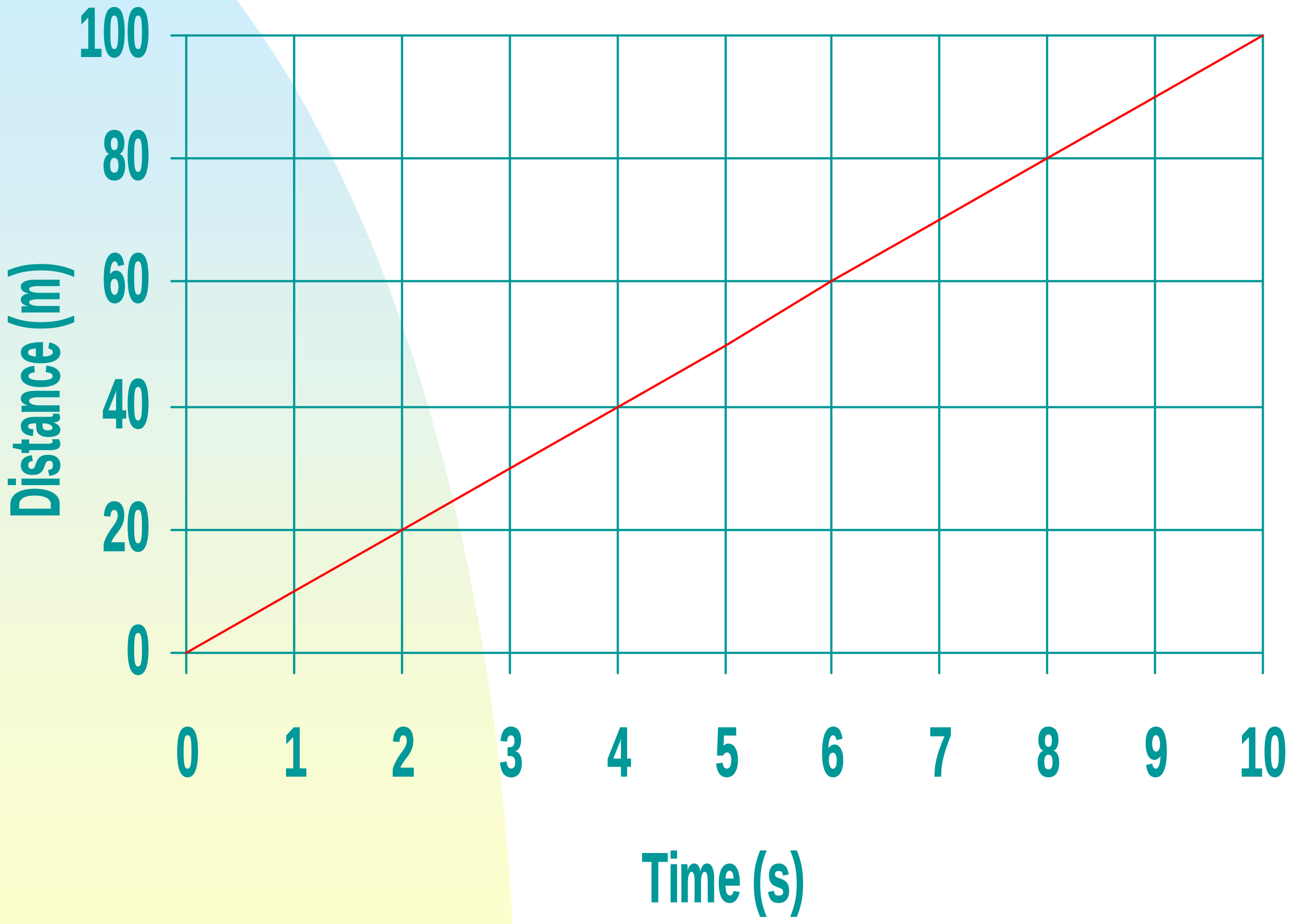
Strip Chart



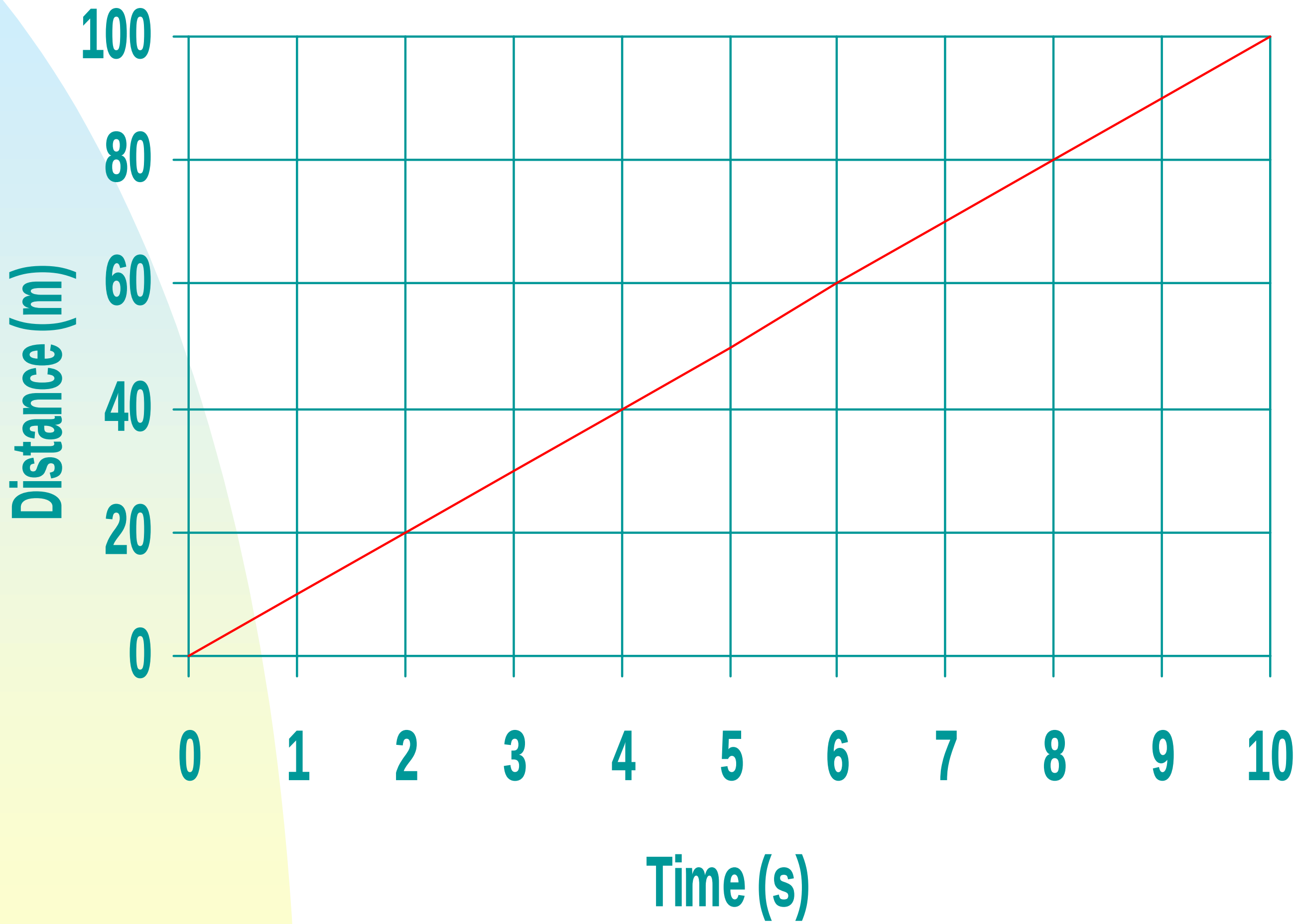
Strip Chart



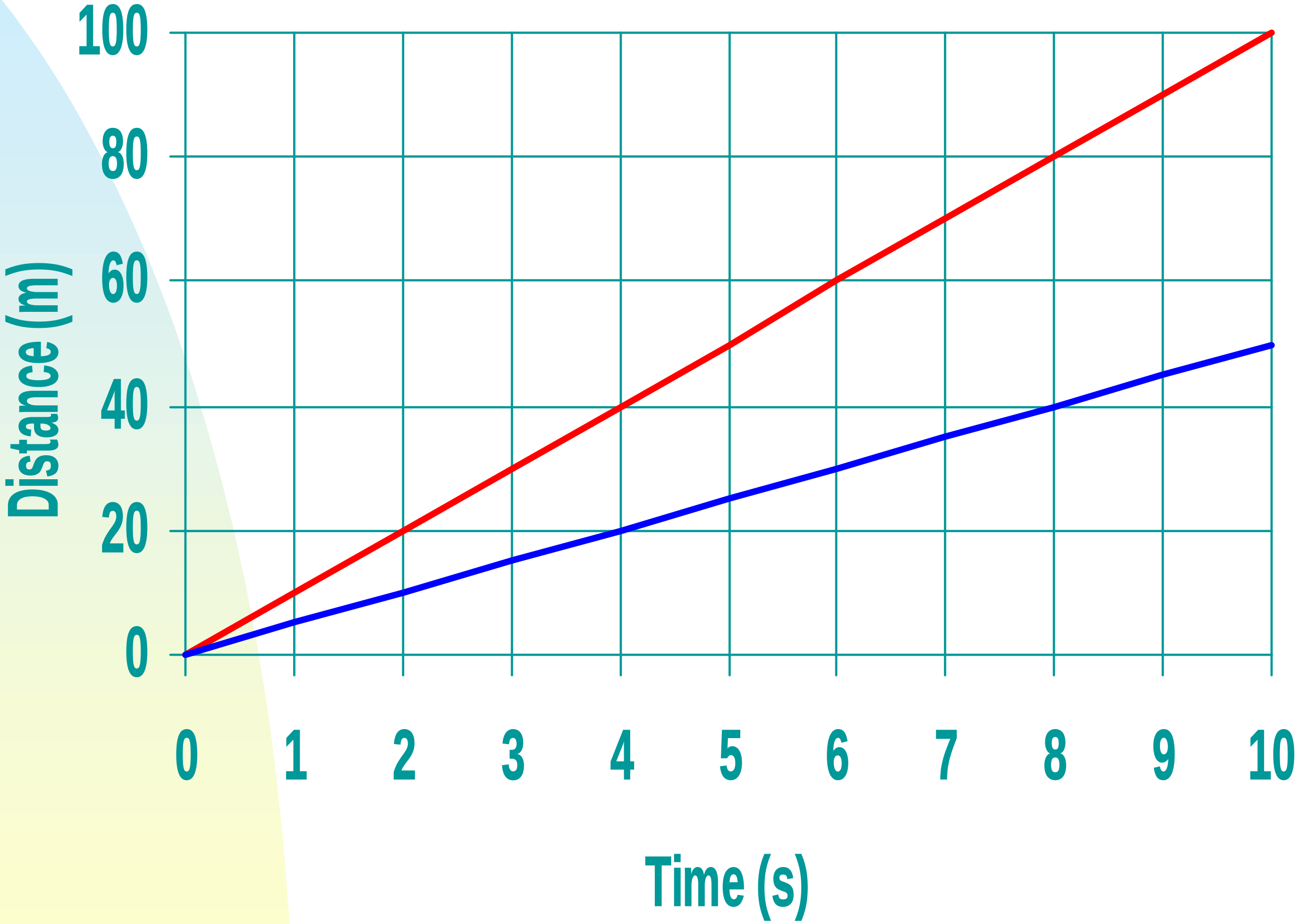
Strip Chart

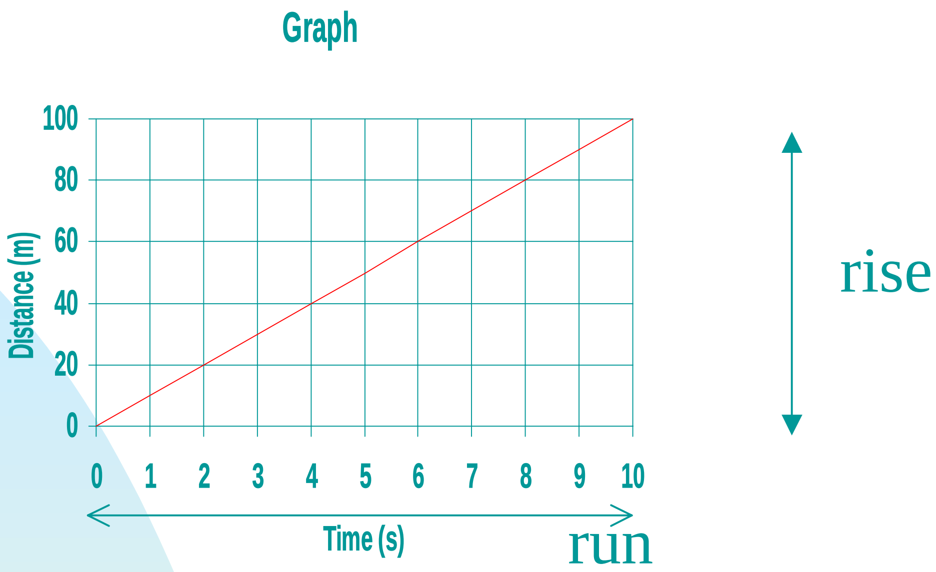


Graph



Graph of race





Slope = rise over run

rise = distance in meters

run = time in seconds

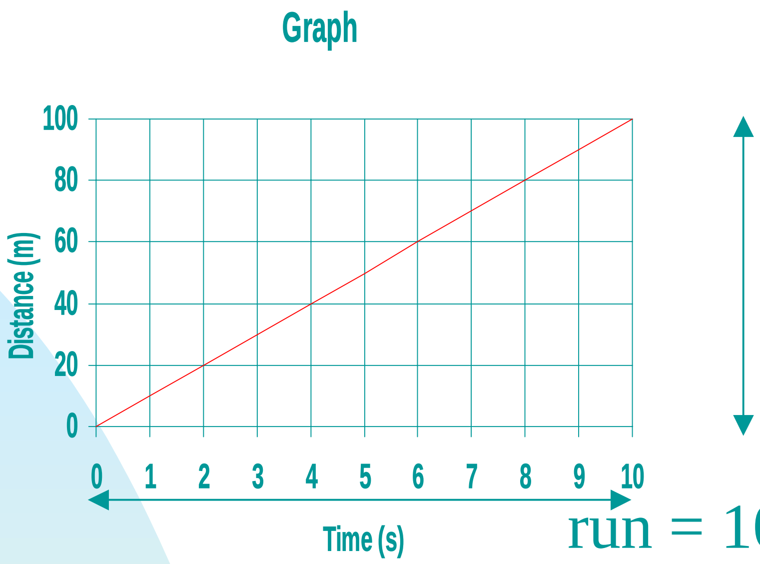
slope = distance divided by time

slope = speed !

Units: meters divided by seconds

Units: meters per second

m/s



rise = 100 meters

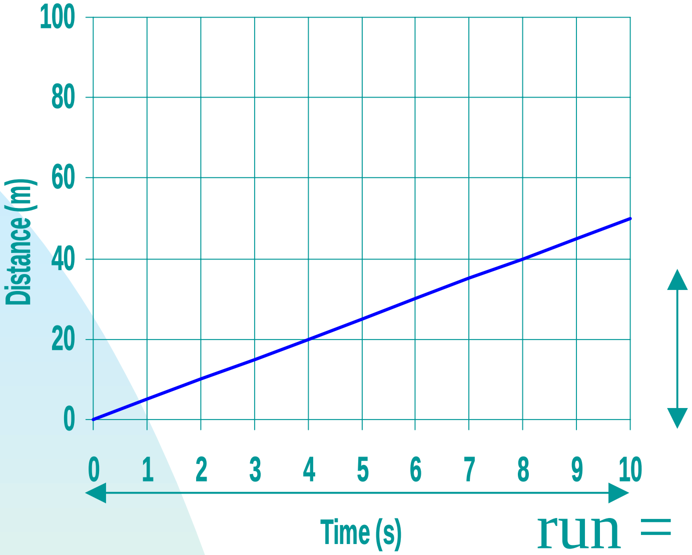
run = 10 seconds

Lets do the numbers for the red one

slope = 100 meters divided by 10 seconds

slope = 10 meters per second

slope = speed = 10 m/s



rise = 50 meters

run = 10 seconds

Lets do the numbers for the blue one

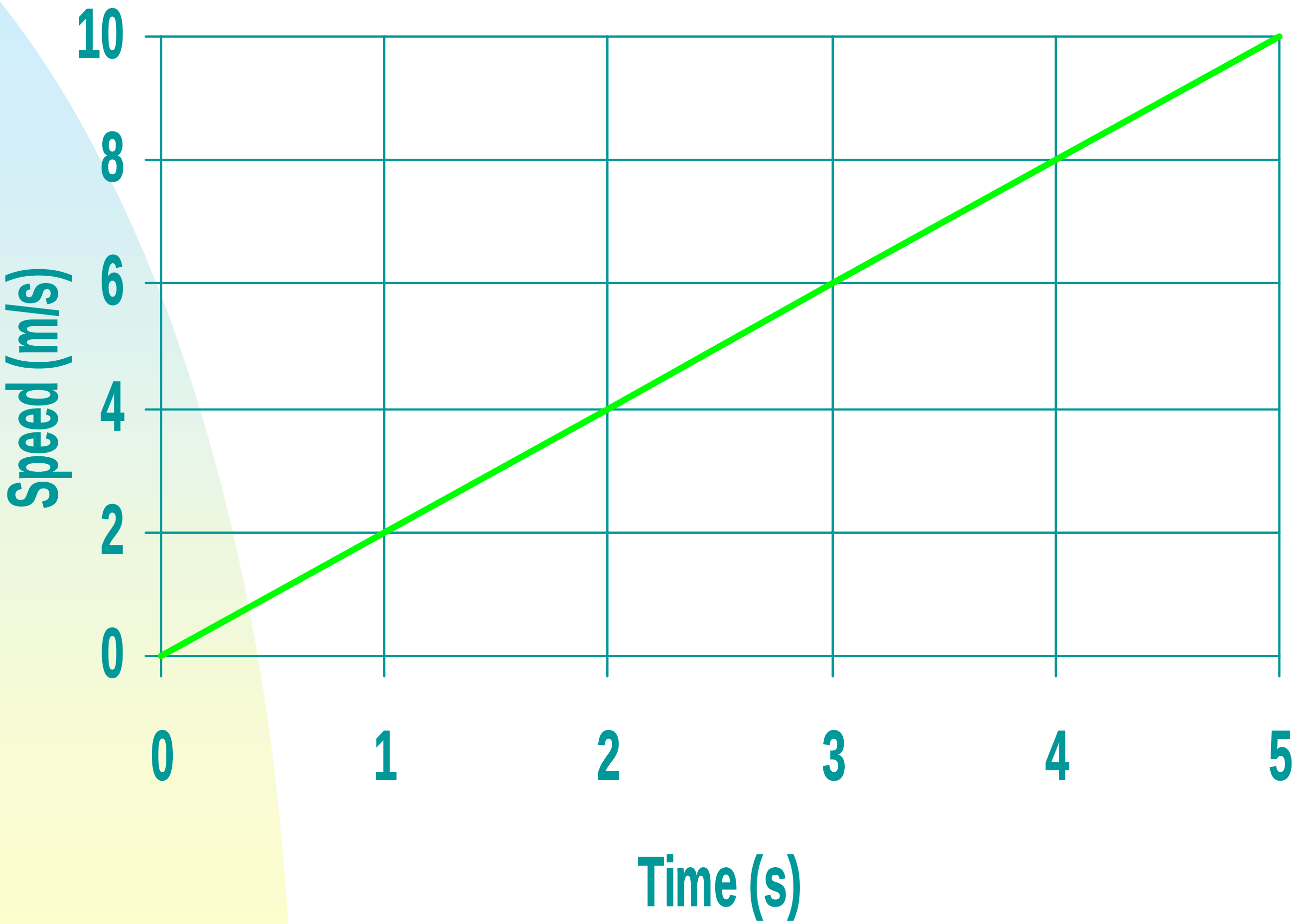
slope = 50 meters divided by 10 seconds

slope = 5 meters per second

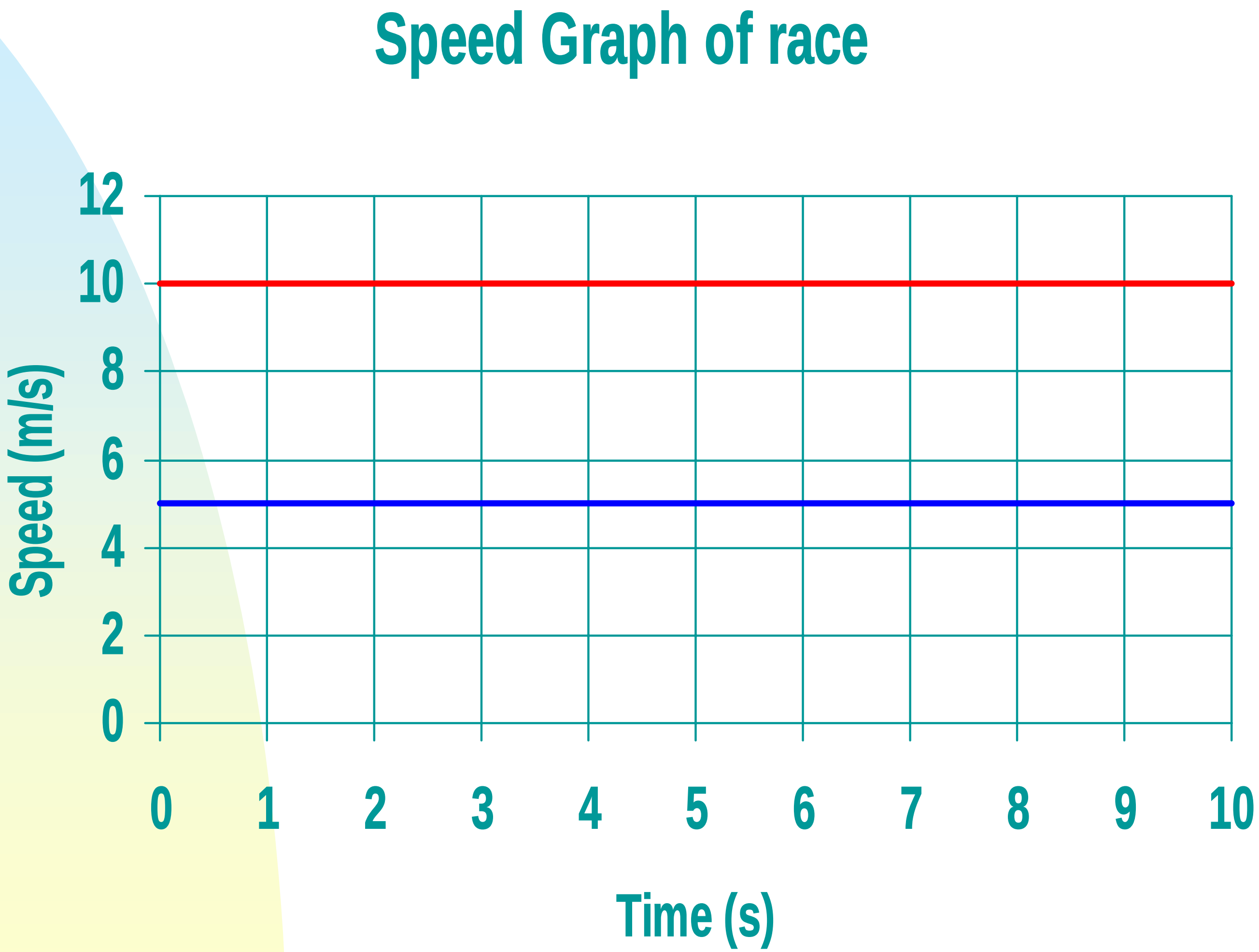
slope = speed = 5 m/s

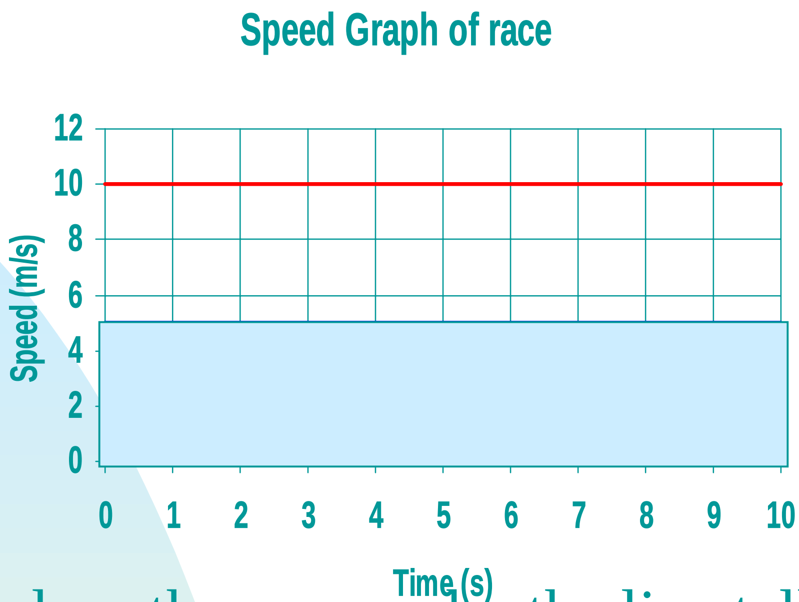
Fancy Speedometer

Speed Graph

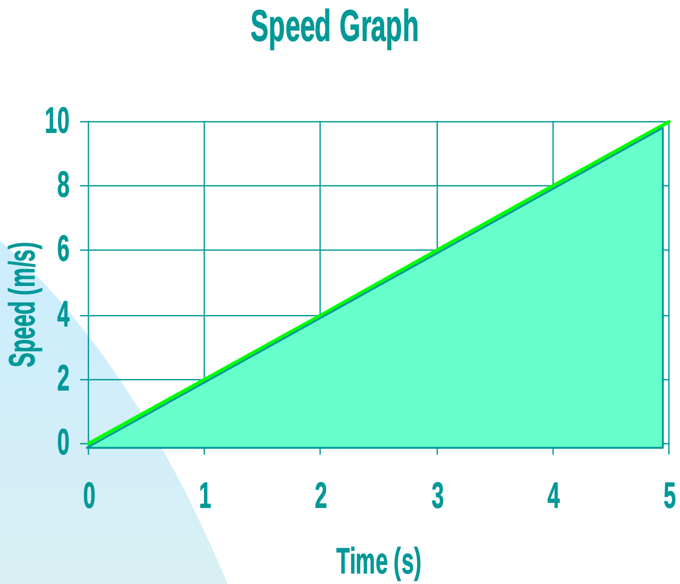


What does the race look like on this kind of graph?

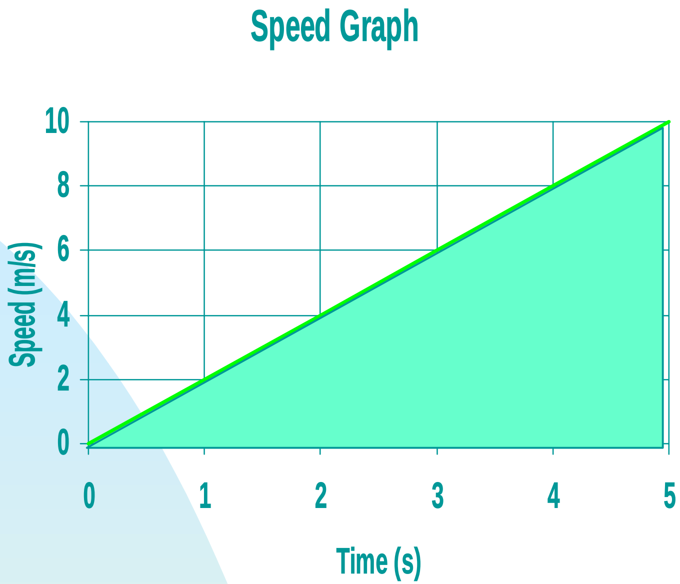




Now what does the area under the line tell us?
The area under the blue curve is just a square 5 m/s high and 10 seconds wide.
Multiplying the height by the width we get 5 x 10 = 50 for the numeric part and meters per second times seconds for the units. The seconds cancel giving simply meters, so our answer is 50 meters, which is what we read from the distance graph!
A similar calculation for the red line gives 100 meters for the red line, which is again the same as what we read from the distance graph!



Now what does the area under this line tell us?
The area of a triangle is 1/2 height times base.
Height - meters per second
base - seconds
area units - meters per second time seconds
the seconds cancel leaving meters again
The area under the curve is the distance traveled.



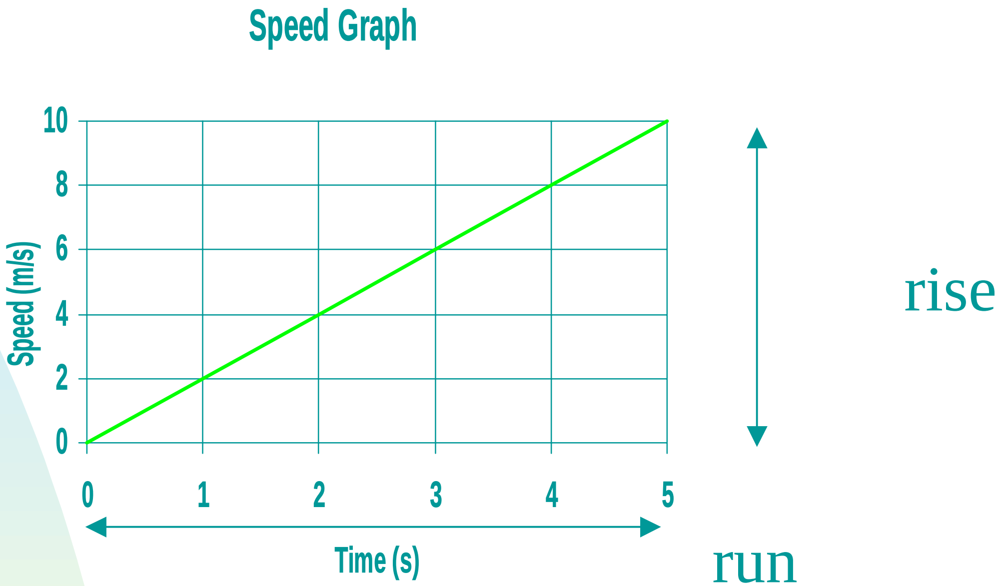
Lets do the math.

1/2 height times the base.

1/2 (10 m/s) x (5 s)

= 25 m

Now lets take a look at the slope in this kind of graph



Slope = rise over run

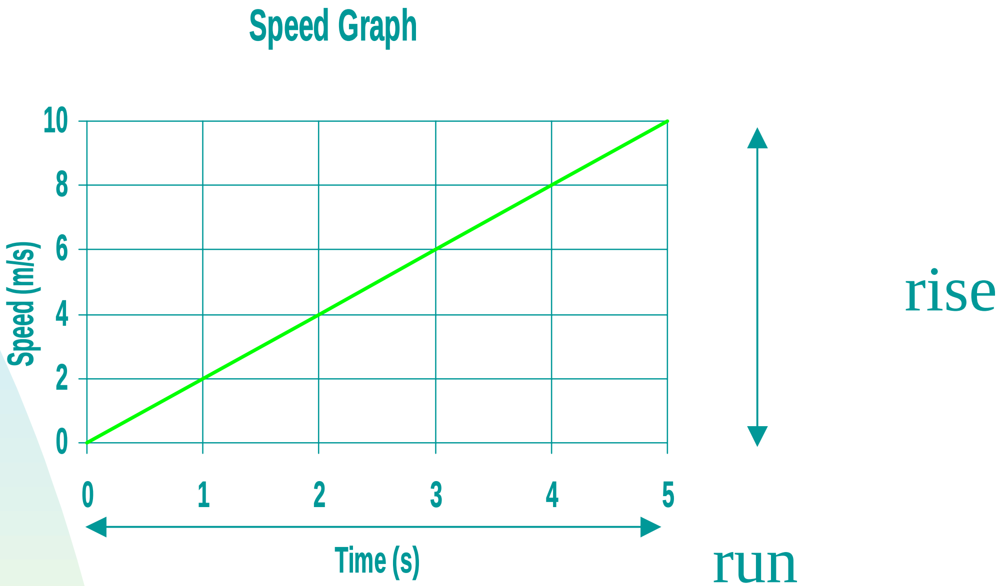
What are the units of this slope?

Rise - speed - meters per second

run - time - seconds

slope - meters per second per second

acceleration - m/s^2



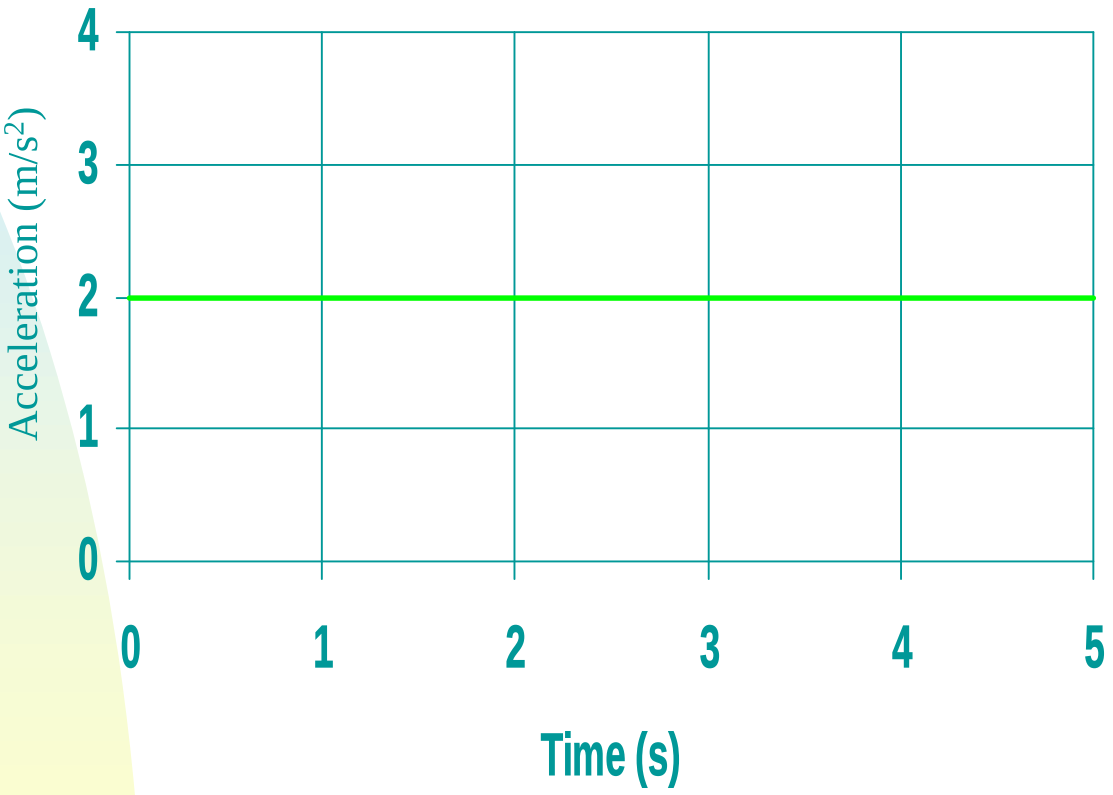
Lets do the math:

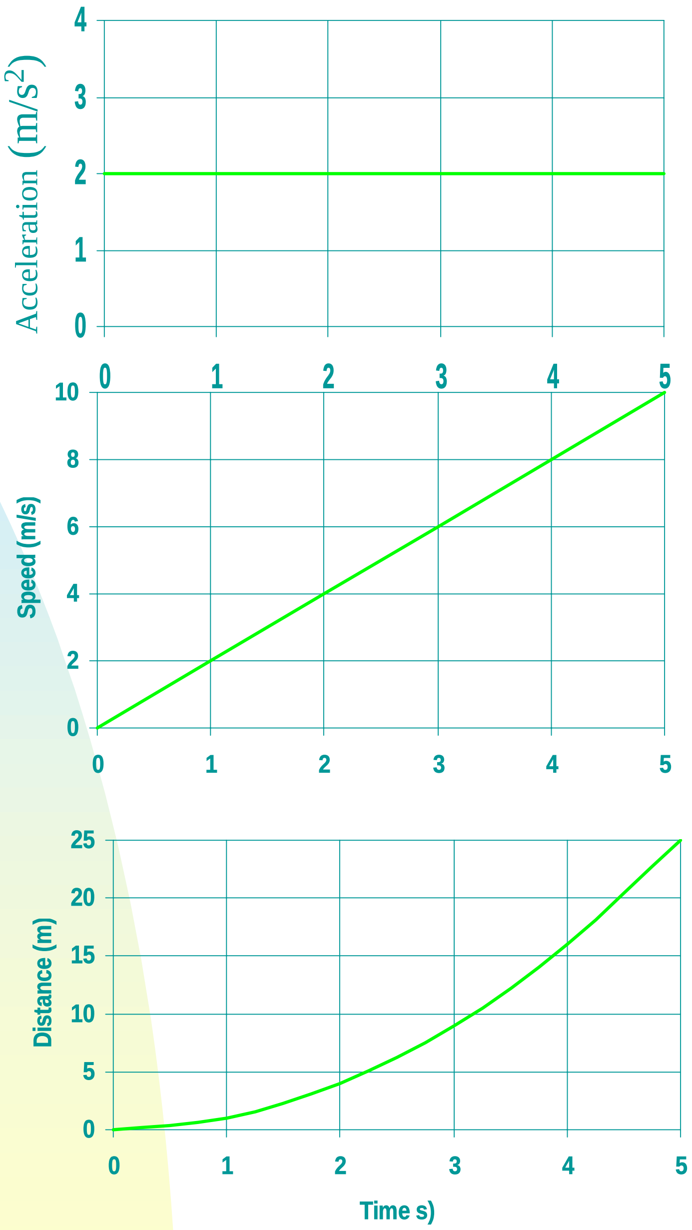
acceleration = slope = rise/run

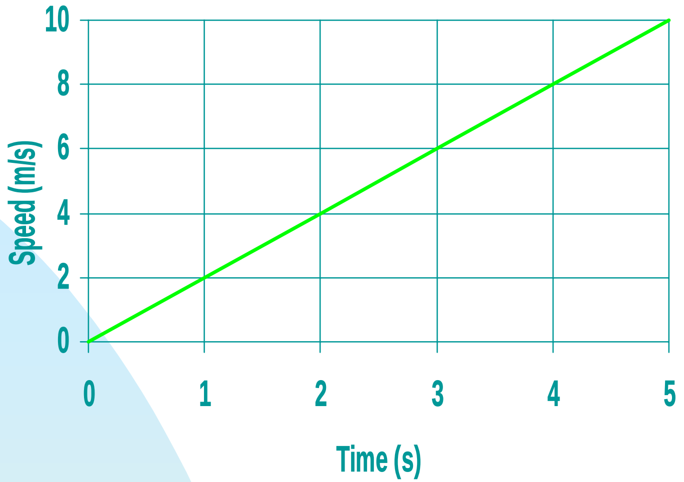
$= \frac{(10 \text{ m/s})}{5 \text{ s}}$

$= 2 \text{ m/s}^2$

Acceleration Graph




Acceleration (m/s²)
4
3
2
1
0
0
1
2
3
4
5
Speed (m/s)
10
8
6
4
2
0
0
1
2
3
4
5
Distance (m)
25
20
15
10
5
0
0
1
2
3
4
5
Time s)



Recall that the area under the line is equal to the distance.
Distance = 1/2 (speed)x(time)
or in shorthand d=1/2 v t where v is for velocity or speed.
Also recall that acceleration = speed divided by time, or
a = v/t
this can be rearranged algebraically to give v = a t
Substituting this back into our first equation, we have,
$d = 1/2\ (a\ t)\ t\ = 1/2\ a\ t^2$
Finally this can be rearranged to give $a = (2d)/t^2$, which is the equation that appears in your lab write-up.