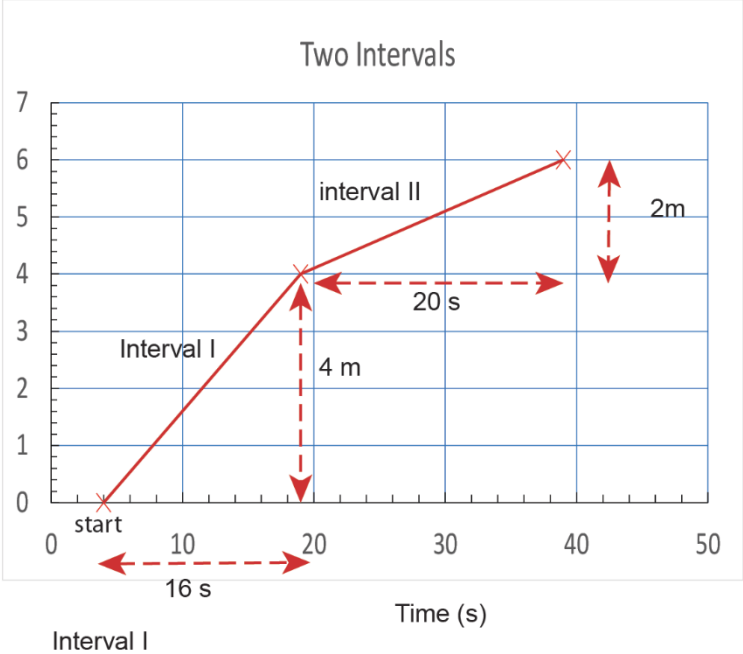
Dynamics

Motion of objects: point particles, spheres, satellites in orbit around the earth or sun, galaxies, expansion of the universe etc.

A large number of the questions raised in physics and often easily solved concerns the motion of objects; is it steady or changing, what causes changes, what can we predict?

Definitions

Speed: $V = \frac{distance}{time}$ meter/second (m/s)



Interval I
average speed =4/16 = 0.25 m/s

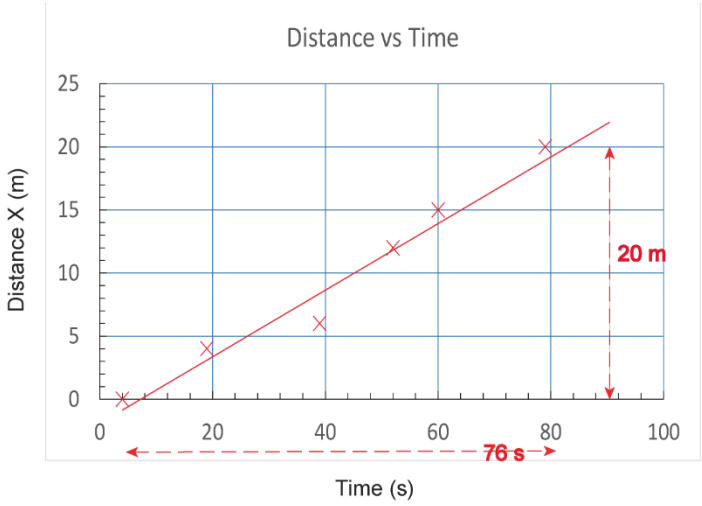
interval II
average speed = 0.10 m/s

The speed changed in magnitude. Increase=acceleration. Decrease =deceleration

Questions: What would cause such a change? (Newton: Force but depends on inertia (mass) also)

What about just a change in direction but speed constant? E.g. motion of Earth around Sun. That ALSO requires a force.)

Average speed



average speed = 20/76 = 0.26 m/s

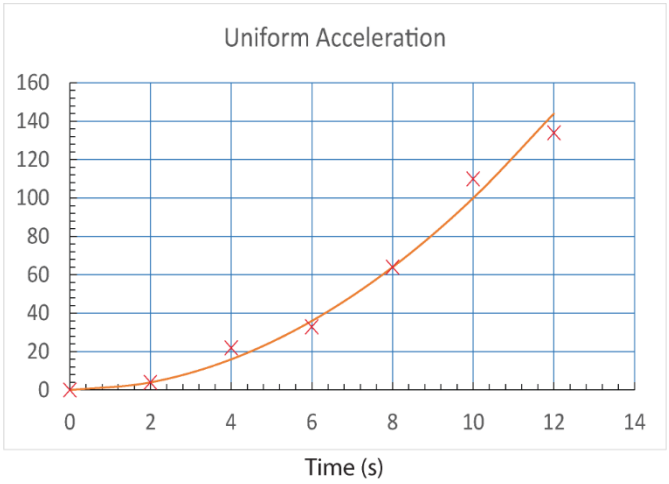
Overall: X = V_{avg} * t

Can predict where object is in 24 hours X =3600*0.26 = 936 m (assuming no changes)

Note some errors in measurements with respect to average speed. Experimenters need to identify origin of these errors and justify as errors and not a physics effect.

Speed changing constantly at same rate

Uniform acceleration: a meters/second/second ($m/s^{2)}$



$Distance$: $X = \frac{1}{2}at^2$ Parabola

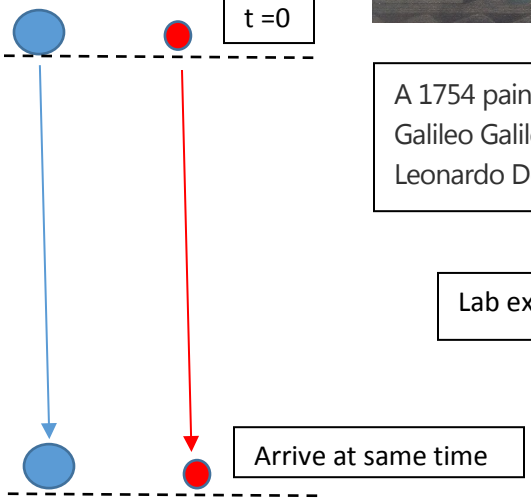
Example of constant acceleration

Motion under gravity. $g = 9.8 m/s^2$

*Attributed first to **Galileo Galilei***

All objects fall under gravity with the same acceleration.

independent of mass m



A 1754 painting by H. Detouche shows Galileo Galilei displaying his telescope to Leonardo Donato and the Venetian Senate.

Lab experiment on this topic

Credit: media4.picsearch.com

Need Newton's Laws and concepts …. could predict events (revolutionary), also developed calculus

FORCE: F= ma

Concept of inertia Mass m (kilograms)

Concept of Force = rate of change of momentum mass * velocity, P =mV

Newton went further to show from Kepler's laws obervation of planetary motion

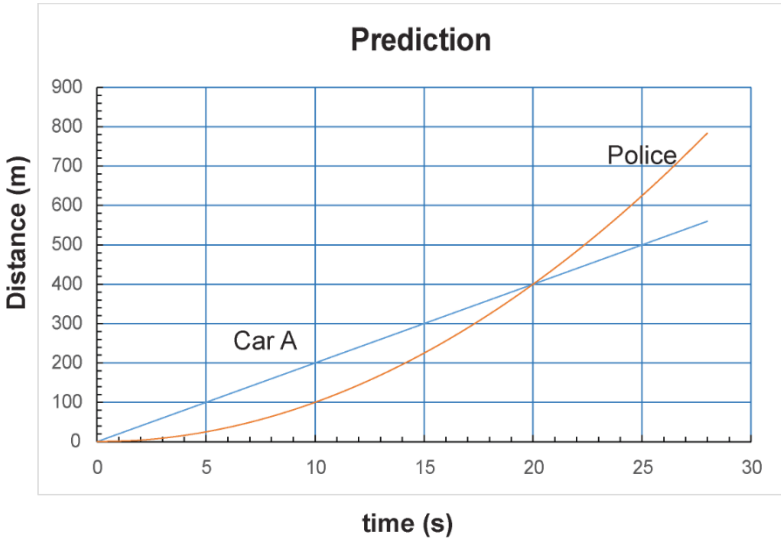
that force of gravity $F_G = GMm/R^2$ R= separation of two masses m and M

G = universal constant

Newton's Laws

1. **Every body continues in state of motion UNLESS acted on by a force (Galileo's principal of inertia)**
2. **Change in motion (change in momentuim) = impressed force and in direction of that force (pure Newton)**
3. **To every action, there is an equal and opposite reaction (mutual actions of two bodioes always equal in magnitude and opposite) (momentum conservation)**

Prediction



A car driving at 20 m/s (72 km/h) passes a stationary police vehicle. At the moment of passing the police vehlce accerates at $2m/s^2$. When dioes the police car catch up with the car?

Car A: $x = 2t$ = blue line (constant speed)
Police (red) $x=(1/2)2t^2 = t^2$ red line (parabola)
Equal distance at t=20 s.

Can continue prediction for complicated objects, orbits of plants and comets: prediction of return of Halley's comet (actually calculated by Halley using Newton's Laws).

Australian Astronomical Observatory
March 8. 1986, Period ~ 76 years