Physics I

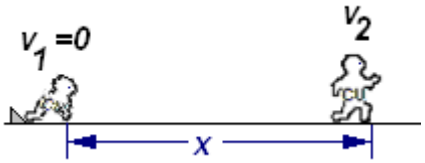
Constant Acceleration

Equations for constant acceleration in 1 dimension

$$x = v_1 t + \frac{1}{2} a t^2 \qquad v_2 = v_1 + at \qquad v_2{}^2 = v_1{}^2 + 2ax \qquad \langle v \rangle = \frac{v_1 + v_2}{2} = \frac{x}{t}$$

Problem 1.- In the 100-m race an athlete accelerates uniformly from rest to his top speed of v_2=10m/s in the first x=15m as shown in the figure.

a) Find his acceleration in the first 15m.
b) Find the time it takes to cover those first 15 m.



Problem 2.- If we could neglect air resistance and other secondary effects, how long would it take for a bullet fired straight up with an initial velocity of 350m/s to hit the shooter?

Problem 3.- You dangle your watch from a thin piece of string while the jetliner you are in accelerates for takeoff. Calculate the acceleration if the string makes an angle of 35º with respect to the vertical.

Problem 4.- A rocket needs to reach a speed of 8,000 m/s starting from rest.
Assuming a constant acceleration of 25 m/s^2 calculate:

i) The time it will take to reach that velocity
ii) The distance covered in that time

Problem 5.- A plane on an aircraft carrier has only 122m to accelerate on take-off. How much must be the acceleration (assumed constant) if it has to reach 195 km/h starting from rest?

Problem 6.- A car traveling at 88 km/h strikes a tree. Thanks to the seat belts, air bag and modern design of the front of the car, the driver is brought to rest with constant acceleration after traveling 1.1 m. What was the driver's acceleration during the collision?

Problem 7.- A driver going at 60 miles/hour (=26.8m/s) sees a deer crossing the road in front of him and hits the brakes when he is 60 m away. The coefficient of static friction is 0.75 (the car has ABS, so it doesn't slip). Is the deer safe?

Problem 8.- Calculate the distance covered by a "model T" car that accelerates from zero to its maximum speed of 45 mph in 15.0 seconds. [1 mile=1609m]

Problem 9.- A roadster accelerates from zero to 105 miles per hour in 6.0 seconds. Calculate the average acceleration in m/s^2. (1 mile = 1609 m)

Problem 10.- A plane accelerates along a runway at $6.55m/s^2$ staring from rest. It needs to reach 370 km/h for take-off. What should be the minimum length of the runway for a safe take-off?

Problem 11.- In coming to a stop, a car leaves a 95m-long skid mark along the highway. Assuming an acceleration of $-7.5\ m/s^2$, determine the initial velocity of the car just before the brakes were applied (you can give the answer in m/s).

Problem 12.- The brakes of an 855-kg car apply a force of -4880N. Calculate the distance needed to stop the car if it is going at 65 miles per hour. [1 mile=1609 m]

Problem 13.- You design the front of a car so in the case of a collision at 55 km/h the passenger will experience a maximum of 20 "g"s of acceleration.
Calculate how much distance you have to slow down the passenger to rest without exceeding the maximum acceleration.
1 "g"=$9.8m/s^2$