1D motion

1. (*)The period of small oscillations of a pendulum is independent of its amplitude (Galileo). Use this to find the dependence of the period T on the length of the pendulum L, gravitational acceleration g and, possibly, mass M. Namely, look for

$$T \sim L^{\alpha} g^{\beta} M^{\gamma}$$

and find α, β and γ .

- 2. A motorcycle with $V_M = 60 m/s$ is catching up with a car with $V_C = 30 m/s$, originally D = 300 m ahead. When and where will they meet? Give the graphic solution.
- 3. A driver hits the brakes on icy road, and the car slows down at $a = 0.5 \text{ m/s}^2$. After L = 100 m it has v = 2 m/s. Find the initial velocity v_0 .
- 4. The catch-a-ruler demo is used to find the reaction time t. (a) Derive a formula relating t to h, the vertical displacement of the ruler. (b) Do several experiments and find the average t. (c) derive an expression for the velocity v just before the ruler is caught. Calculate v from your average t.
- 5. A fast train moving at a constant speed v = 70 m/s passes the platform. 10 seconds later a second train starts from from rest and accelerates at $a = 3 m/s^2$. When and how far from the platform will it catch up with the first train?
- 6. Two trains leave two stations separated by 100 km at the same time and move towards each other. The speeds of trains A and B is 30 km/h and 70 km/h, respectively. Plot the position vs. time graphs for both trains on the same plot and determine the meeting point.
- 7. (*) The same, but the A train with $v_0 = 30$ km/h also has acceleration of 60 km/h². (You do not have to change units in this problem.)
- 8. A projectile is fired vertically up from a cliff H=100 m tall above the ground. The initial sped of the projectile is 40 m/s. How long will it take before the projectile hits the ground? What will be the speed upon impact?