MECHANICS PRACTICAL 1

FABIEN PAILLUSSON

1. Towards the mastery of units

Rewrite the following equations by expressing every length units in metres and every time units in seconds.

(a) $x = 3$ inches

(b) $t = 5$ days

(c) $v = 30\ \mathrm{km \cdot h^{-1}}$

(d) $j = 72\ \mathrm{mm^3 \cdot ms^{-1}}$

(e) $f = 21\ \mathrm{week^{-1}}$

(f) $d = 1.4$ light year

2. To be or not to be a complete equation

Give the dimension of either side of the following equations and conclude on whether or not they correspond to complete equations (in the sense of dimensional analysis). Note: in the equations below, x is the relative position in 1D and t is a time interval.

(a) $x^3 = (2\ \mathrm{s^{-1}})t^2$

(b) $(1\ \mathrm{m^{-2} \cdot s})x^2 = t$

(c) $\sqrt{t} = (6\ \mathrm{mm^{-3/2} \cdot s^{-1/2}})x^{3/2}$

(d) $(3\ \mathrm{s^{-2}})x^2 + (20\ \mathrm{m^{-3} \cdot s^{-2}})x^5 = (x/t)^2$

(e) $x = 3$

(f) $1 = \cos\left(\frac{t}{x}(12\ \mathrm{m \cdot s^{-1}})\right)$

3. Fly me to Mars

At its closest to Earth, Mars is some 56 million km away from it. Assuming a rocket would travel from Earth to Mars in a straight line at constant velocity, determine what should be its speed for it to reach Mars in 150 days.

4. Stopping distance

A car is going at 50 kilometres per hour on a country road when suddenly a deer appears on the road 100 metres away from the car.

(a) Assuming the reaction time for the driver to start pushing the breaking pedal is 2 seconds, determine the distance travelled by the car during that time.

(b) Assuming the braking system imposes a constant acceleration a_x, what should be the minimum magnitude of a_x needed for the car to stop before hitting the deer?

5. Deriving the three last "suvat" equations

Under constant acceleration a_x, we have seen in the lectures that the relative position $x(t)$ satisfies $x(t) = x_0 + 1/2(v_x(t) + v_0)t$ and the velocity $v_x(t)$ satisfies $v_x(t) = v_0 + a_x t$. Show that the following equations follow from combining these two equations in an appropriate way:

(a) $x(t) = x_0 + v_0 t + 1/2 a_x t^2$

(b) $v_x(t)^2 - v_0^2 = 2a_x(x(t) - x_0)$

(c) $x(t) = x_0 + v(t)t - 1/2 a_x t^2$