KHEMIS MILIANA University
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Department of Science of Matter - L1 ST-SM
Exercise Series of GW of Physics 1, 2023-2024
Exercise Series Number 2. Part I. Kinematics of a Particle. Relative Motion

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Exercise 1:

1. Calculate the distance a photon of light travels in one second, one minute, one hour, one day, one year, and one decade. These distances are supposed to be called light-second, light-minute, light-hour, light-day, **light-year**, and light-decade.

2. Compare the light-year to the distance the sound travels in one year. What about the fastest human made object of an average speed $v_{av} = 2 \times 10^5 kmh^{-1}$.

3. Calculate the time required to travel the distance between Earth and Alpha Centauri (Earth-α Cen)[1] which is approximately 4.37 light-years, by sound, by a virtual engine, and by a photon of light. Provide comments on the results obtained.

We give the following values : the speed of light in vacuum $c \approx 3 \times 10^8 ms^{-1}$, speed of sound in air at $30°C$ $v_s \approx 350ms^{-1}$ and the speed of the virtual engine $v_{av} = 200000kmh^{-1}$

*Exercise 2:

A car moves along a straight road with a constant velocity, but it decelerates as it approaches an agglomeration. The car comes to a stop when a red light turns on at the entrance of downtown. Once the light turns green, the car resumes its motion and maintains a constant velocity. As it exits the agglomeration, it accelerates again and continues to move at the same velocity.

1. Provide a qualitative description of the different stages of the car's motion.

2. Give a qualitative representation of how the car's velocity and acceleration vary as functions of time.

3. Provide a qualitative path (trajectory), $x(t)$, as a function of time.

*Exercise 3:

A materiel point moves into a straight line with a velocity given by $v = t^3 + 4t^2 + 2$. If at time $t = 2s$ the position is $x = 4m$,

1. Find the value of x when $t = 3s$.

2. Find the value of the acceleration at the same time.

Ans. 1. $47.6m$, **2.** $51ms^{-2}$

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[1]Alpha Centauri, en abrégé α *Cen* est le système stellaire le plus proche du système solaire situé à une distance de 4.37 année lumière

Exercise 4:

A car is waiting for a red light to change. When the light turns green [1], the car accelerates uniformly for $6s$ at a rate of $2ms^{-2}$, after which it moves with uniform velocity. A the instant that the car began to move at the light, a truck moving in the same direction, with a uniform motion of $10ms^{-1}$, passed by.

1. In what length of time, and how far from the light, will the car and truck meet again.

Ans. 1. $18s$, **2.** $180m$

*Exercise 5:

The velocity, in terms of time, of a moving particle is given in **Fig.** 1. If at a time $t = 0$ the position is $x_0 = 0m$.

1. Find the general expression for the velocity for each stage of the motion.
2. Determine the accelerations of the particle for each stage. Make a sketch of the acceleration as a function of time.
3. Determine the expressions of the position for the first and the second stage.
4. If the expression of the position of the third stage is given by $x_3 = t^2 - 2t + 3.5$, represents on the space diagram, **Fig.** 2, at $t = \tau = 2.5s$ the acceleration vectors, velocity and position.
5. Estimate by two different methods, from the graph and by calculation, the distance covered by the mobile in for the time interval $[2s, 3s]$.

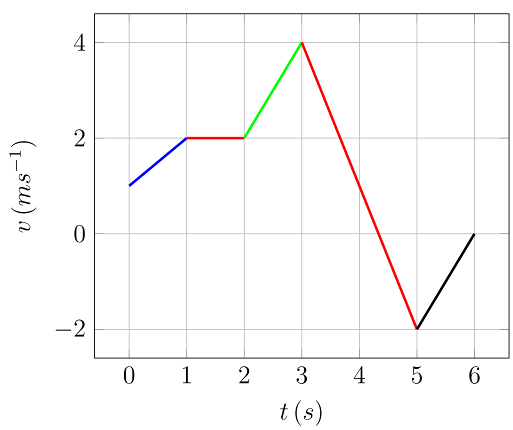

Figure 1: Velocity Diagram

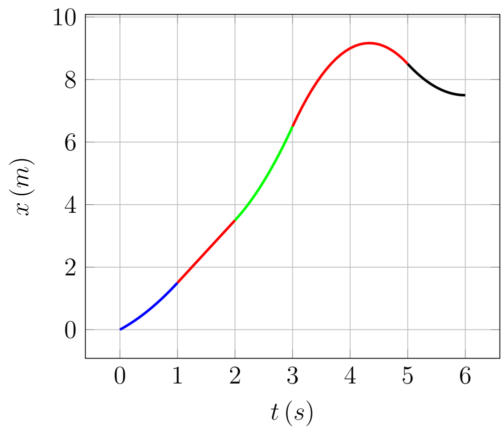

Figure 2: Diagramme des espaces

*Exercice 6:

1. Show that, in the case of rectilinear motion, for which the acceleration depends on the mobile's position, i.e., $a = a(x)$, the velocity is given by:
$$\frac{1}{2}v^2 - \frac{1}{2}v_0^2 = \int_{x_0}^{x} a(x)dx$$
2. What about the case where $a = x - 1$ with $v(t = 0) = v_0 = 1ms^{-1}$ et $x(t = 0) = x_0 = 0m$
3. What about the case $a = const$.

References

[1] ALONSO, Marcelo et FINN, Edward J. Fundamental university physics. Reading, MA : Addison-Wesley, 1967.