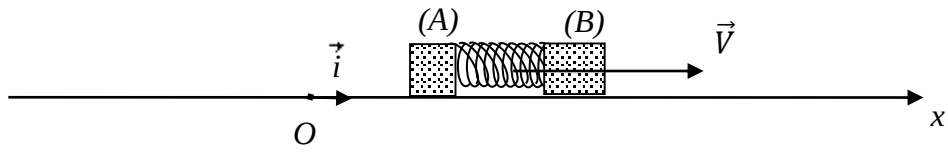
Exercise 1 **Comparing some physical quantities**

The aim of this exercise is to compare some physical quantities of a system before and after the "explosion".

A system (S) formed of two pucks (A) and (B), of respective masses $m_A = 100$ g and $m_B = 120$ g, move without friction on a horizontal table. The two pucks (A) and (B) are tied together by a massless and inextensible string compressing a massless spring of stiffness k = 293 N/m between them. The spring is compressed by 9 cm. The system (S) is initially moving at the velocity $\vec{V} = V\vec{\imath}$ (m/s) whose its position of center of mass is $x_G = 2t$ (in SI unit) as shown in (Doc.1).

At some instant t, which is considered as new origin of time, the string connecting the pucks breaks and the spring expands and the system is said to be "explode". (A) and (B) move on the same trajectory with position of the center of mass of each puck is $x_A = -1.6t + 0.4$ and $x_B = 5t + 0.5$ (in SI unit) respectively. Take the horizontal plane through center of mass G of the system (S) as a gravitational potential energy reference. g = 10 m/s^2.



Doc. 1

1- Center of mass and linear momentum

1.1) Determine the velocity $\vec{V}_G$ of center of mass of the system (S) before the "explosion".

1.2) Deduce the linear momentum $\vec{P}_G$ of center of mass of the system (S) before the "explosion".

1.3) Determine the velocities $\vec{V}'_A$ and $\vec{V}'_B$ of pucks (A) and (B) after the "explosion" respectively. Deduce the velocity $\vec{V}'_G$ of center of mass of the system (S) after the "explosion".

1.4) Compare $\vec{V}_G$ and $\vec{V}'_G$.

1.5) Calculate the linear momenta $\vec{P}'_A$ and $\vec{P}'_B$ of pucks (A) and (B) after the "explosion" respectively.

1.6) Deduce the linear momentum $\vec{P}'_G$ of center of mass of the system (S) after the "explosion".

1.7) Compare $\vec{P}_G$ and $\vec{P}'_G$. Deduce.

2-Newton's 2nd law

2.1) Name the external forces acting on the puck (B) during the "explosion".

2.2) Apply Hooke's law to determine the magnitude of the net force F_{net} acting on the puck (B) during the "explosion".

2.3) Calculate $\frac{\Delta P}{\Delta t}$ for the puck (B) where $\Delta t = 13.6$ ms is the time interval of the explosion.

2.4) Compare F_{net} and $\frac{\Delta P}{\Delta t}$.

3- Mechanical energy

3) Determine the mechanical energy of the system [(S), Earth]:

3.1) ME_i before the "explosion".

3.2) ME_f after the "explosion".

3.3) Compare ME_i and ME_f. Deduce.