Chap 5

Practical Session n°9: STUDYING MOTIONS

INTRODUCTORY PART

☒ **Classical mechanics** is divided into three main branches:

- **statics**: the branch of physics that study systems that remain motionless in Galilean frames of reference,
- **kinematics**: the branch of physics that study motions without studying their causes,
- **dynamics**: the branch of physics that deals with forces and their effects on motion.

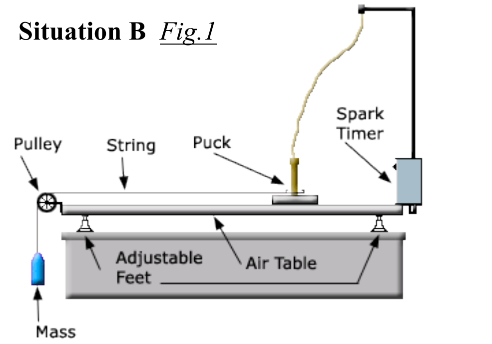
☒ **Velocity** is a vector physical quantity. Its scalar magnitude is called **speed**.

OBJECTIVE

We aim at:

- studying the motion of a puck placed on a horizontal table,
- representing velocity and acceleration vectors,
- giving their features (orientation, direction and magnitude),
- checking the Newton's first and second laws by means of experiments.

Situation B *Fig.1*



SET UP

An air puck of mass m, equipped with a plotter, is placed on a horizontal table.

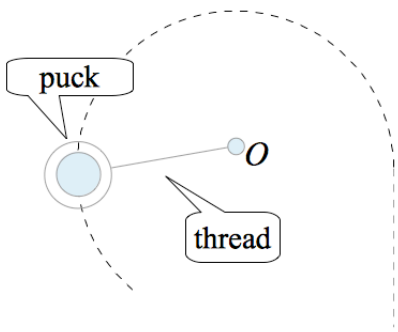
The plotter, which is placed at the centre of the underneath face of the puck, is connected to a supply that delivers electric pulses at equal intervals of time (τ = 40 ms). Therefore each spark leaves a track on the paper, which has been previously placed under the puck, and the path of the centre of inertia of the puck is plotted on the paper at real scale.

A blower, placed inside the puck, creates an air cushion under the puck that enables it to move on the table without any friction.

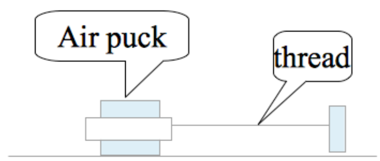
Three different motions have been recorded:

- **A**: the puck is just pushed across the horizontal table.
- **B**: the puck is attached to a string to which a mass (m_1) is held.
- **C**: the puck, attached to a heavy motionless object (which position is denoted O), is launched on the horizontal table and rotates around the point O.
- **C'**: after a while, the thread is burnt.

Situation C and C'



Top view *Fig. 2*



Side view *Fig. 3*

1- QUALITATIVE STUDY OF MOTIONS A, B AND C

a. *With regard to which frame of reference are the motions studied?*

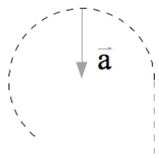
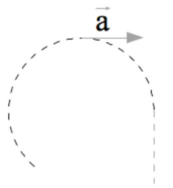
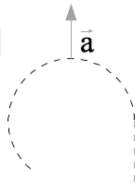
b. *How does the velocity vary in these three studied situations?*

c. *Define each following term:*
rectilinear, curvilinear, circular, speeded-up, uniform, slowed-down.

d. *Characterize each motion choosing among the above proposed terms.*

2- QUANTITATIVE STUDY OF MOTION C

2.1- Anticipation

The **velocity** is constant.	☐ Right	☐ Wrong	
The **speed** is constant.	☐ Right	☐ Wrong	
The velocity is tangent to the path.	☐ Right	☐ Wrong	
The magnitude of the acceleration	☐ is nil	☐ is constant	☐ varies
The acceleration vector is constant	☐ Right	☐ Wrong	
The orientation of the acceleration vector is	☐  Centripetal	☐  tangent to the path	☐  Centrifugal

2.2- Work to be done

a. *With the help of the following link, build the velocity and acceleration vectors at different points:*

http://www.spc.ac-aix-marseille.fr/phy_chi/Menu/Activites_pedagogiques/livre_TS/41_newton/Vit_accel.htm

b. *Give the features of the velocity and acceleration vectors (orientation, direction and magnitude).*

c. *Compare the magnitude of the acceleration vector to $\frac{v^2}{R}$ (R is the radius of the circular path). Conclude.*

3- INTERPRETATION

a. *For each situation, make the list of the external forces acting on the puck.*

Represent these forces on Figures 1 and 3 (without taking into account any scale).

b. The **net force**, also called **resultant**, is the vectorial sum of all the external forces acting on the system: $\sum \overrightarrow{F_{ext}}$.

Compare the net force in each situation and fill in the following table:

If the speed is constant, $\sum \overrightarrow{F_{ext}} = \vec{0}$.	If the acceleration vector is nil, $\sum \overrightarrow{F_{ext}} = \vec{0}$.	The direction of the acceleration vector is the same as $\sum \overrightarrow{F_{ext}}$.
☐ Right ☐ Wrong	☐ Right ☐ Wrong	☐ Right ☐ Wrong

c. *What does happen when the string is burnt (situation C')? Justify the motion C' with a dynamic study.*