University of M'sila

Faculty of: Technology **Common base**

Third Series of exercises

Exercise 01:

*Two swimmers leave, in same time, a point **A** on one bank of the river to reach point **B** lying right across on the other bank. One of them crosses the river along the straight-line **AB**, while the other swims at right angle to the stream he reaches the point **A** and then walks the distance that he has been carried away by the stream to get to point **B**.*

1°- *What was the speed **u** of his walking if both swimmers reached the destination simultaneously?*

[*The stream speed is* $v_0 = 2\ km/h$, *the speed of each swimmer with respect to water are same and equal to* $v_1' = v_2' = 2.5\ km/h$**]**

Exercise 02: ***(Fig.02)***

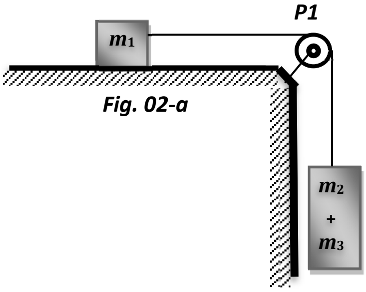

Fig. 02-a

Two masses m_2 *and* m_3*, are connected by an inextensible wire to a mass* m_1 ***(Fig. 02-a),*** *which passes through the groove of a massless and frictionless pulley. The system starts from rest.*

1°/ *Find the accelerations of the two masses.*

2°/ *What is the tension in the wire?*

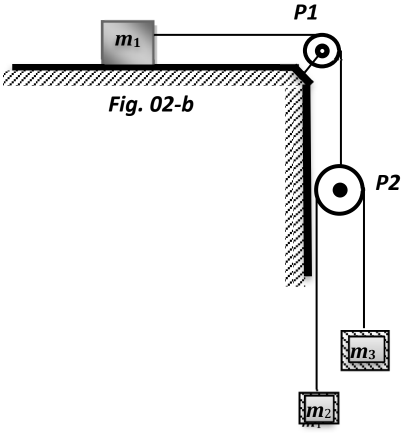

Fig. 02-b

A new configuration in which the two masses $m_2 < m_3$ *are connected by an inextensible and massless wire via another movable pulley* P_2 *which is also connected to a mass* m_1 *via a fixed pulley* P_1*. Pulleys are massless and frictionless* ***(Fig. 02-b).***

3°/ *Find the accelerations of the two masses.*

4°/ *What are the tensions in the wires?*

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Exercise 03 : (Fig.03)

A mass $\boldsymbol{m}$*, is released from rest on frictionless and inclined plane* $\alpha = \pi/6$*. Starting from the point* $\boldsymbol{A}$ *on, arrives at* $\boldsymbol{B}$*, continues its motion on the horizontal rough plane* $\boldsymbol{BC}$ *and stops at* $\boldsymbol{C}$*.*

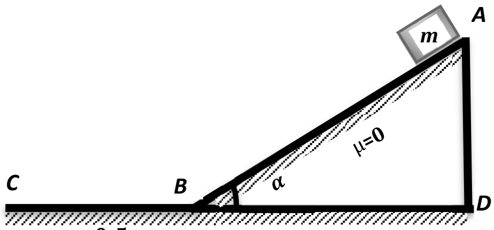

Fig. 03

1°/ *What is its speed* v_B *at the point* $\boldsymbol{B}$*. What will be its speed* v_D *at* $\boldsymbol{D}$ *if it falls from* $\boldsymbol{A}$ *to* $\boldsymbol{D}$*?*

What do you conclude? (We take: $g = 10\ m/s^2$*,* $\mu = 0.5$ *and* $AB = 3.6\ m$*)*

2°/ *Determine the distance traveled until it stops. (We take:* $g = 10\ m/s^2$*,* $\mu = 0.5$*).*

Exercise 04: (Fig.04)

Two blocks of masses "m_1*" and "*m_2*" are superimposed and connected by an inextensible massless wire passing through the groove of a pulley of mass "*M*", radius "*r*" and moment of inertia "*I*". Assume that the coefficient of friction "*μ*" between the two masses is the same as that of the supposedly rough table. The force "*$\vec{F}$*" applied to* m_1 *is horizontal.*

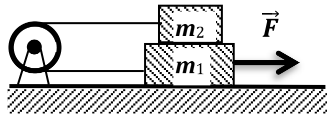

Fig. 04

1°/ *Represent the free body diagram for each element (forces on each element).*

Find the acceleration of the system.

2°/ *Find the tensions in the wires.*

Exercise 05: (Fig.05)

A ball follows a rough track of a parabolic form "$\frac{1}{2}x^2$*" and coefficient of friction* $\mu = 0.5$*. At the position* $A(2,2)$*, it acquires speed* $v = 5\ m/s$*. What is the normal force at this point? What will be its tangential acceleration?*

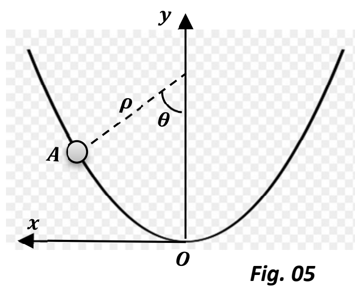

Fig. 05

(Radius of curvature: $\rho = \frac{[1+(y')^2]^{3/2}}{y''}$ *;* $y' = \frac{dy}{dx}$ *;* $m = 2\ kg$ *)*

Exercise 06: (Additional) (Fig.06)

Two masses $m_1 = 10kg$ *and* $m_2 = 20kg$ *connected by an inextensible massless rope which passes through the grooves of two massless and frictionless pulleys. The pulley (*P_2*) is movable, the other (*P_1*) is fixe.*

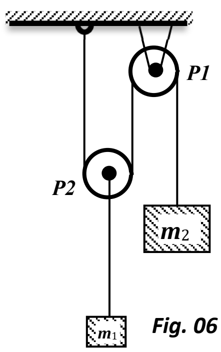

Fig. 06

1°/ *Find the accelerations* a_1 *and* a_2 *of each of the masses.*

2°/ *Find the tension of the rope on each side of the pulleys.*

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Exercise 07: (*Additional*)

Two masses $m_1 = 1.5\ kg$ *and* $m_2 = 2\ kg$, *are connected by an inextensible massless wire, through a massless and frictionless pulley. The pulley* $'P_2'$ *is movable* (***fig.07***).

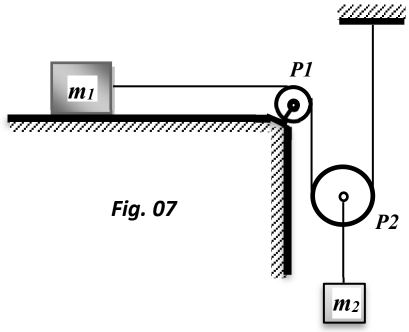

Fig. 07

1°/ *Find the accelerations* a_1 *and* a_2 *of each mass.*

2°/ *Find the tensions in the wire on each side of the pulleys*

Exercise 08(*D.M*): (Fig.08)

A particle of mass, $''m''$, *is launched via a compressed spring. Acquires an initial velocity* $''v_0 = v_C = \sqrt{2Rg}''$ *(The spring is at rest when its length is* $''l_0 = CD''$*). It travels along the rough section* $'BC = R'$ *of dynamic coefficient of friction* $''\mu = 0.5''$, *then begins the smooth section* $''BA''$ *which is a quarter circle of radius* $'R'$.

Using intrinsic coordinates system

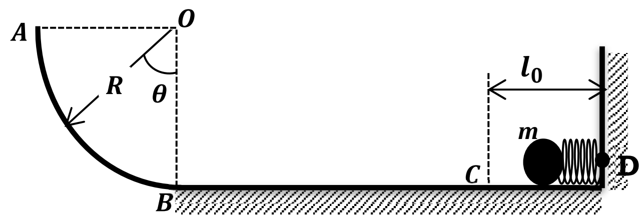

Fig. 08

1°/ *What is its speed at the point* $'B'$ **?**

2°/ *What is its speed at any point in the section* $'BA'$ *(*$'\theta'$ *is counted from* OB*).*

3°/ *Does it reaches the point* $'A'$ *? Justify. Where does it stops?*

4°/ *At what point does it stops if it resumes its motion? (*CD *is also smooth).*

Exercise 09: (Additional) (FIG.09)

- *A projectile is launched with an initial velocity* v_0 *at an angle* $\alpha = \frac{\pi}{6}$ *to the horizontal* $\overrightarrow{ox}$. *Neglecting the air resistance and applying the fundamental principle of dynamics:*

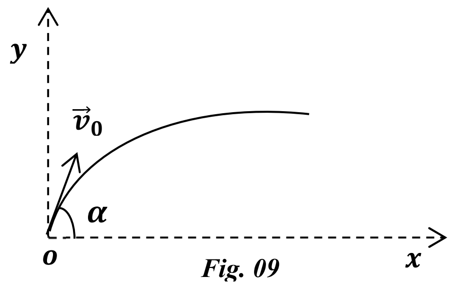

Fig. 09

1°/ *Determine the equations of motion* $x(t)$ *and* $y(t)$.

2°/ What is the nature of the trajectory?

3°/ *What is the maximum Hight and Range?*

Is the curve symmetric?

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- *If, now, the projectile is launched into a liquid under the same conditions, it will experience a frictional force proportional to the velocity* $\vec{R} = -k\vec{v}$.

4°/ *Find the equations of motion* $x(t)$ *and* $y(t)$.

5°/ *What is the maximum Hight and Range?*

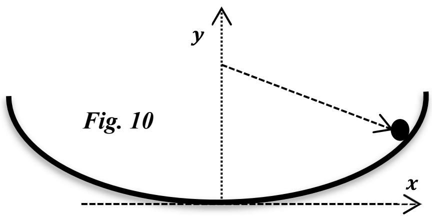
Is the curve symmetric?

Exercise 10: *(Additional)* **(FIG.10)**

A ball of mass $''m''$ *slides frictionlessly inside a cycloid located in the vertical plane* $''xoy''$. *The cycloid is expressed by the following parametric equations:*

$$\begin{cases} x = R(\theta + sin\theta) \\ y = R(1 - cos\theta) \end{cases}$$

1°/ *Calculate the variation of the abscissa* $''ds''$ *as a function of* $''R, \theta, d\theta''$. *Deduce* $s = f(R, \theta)$



2°/ *Determine the relationship between* $''\theta''$ *and the angle* $''\varphi''$ *between the tangent to the curve and the axis* $''\overrightarrow{ox}''$.

3°/ *Using the fundamental principle of dynamics, show that the abscissa curvilinear obeys the law:* $\frac{d^2s}{dt^2} + \frac{g}{4R}s = 0$

4°/ *What is the nature of the movement?*

Deduct its period.

5°/ *Find its equation of motion* $s(t)$.