KHEMIS MILIANA University
Faculty of Science and Technology
Department of Science of Matter - L1 ST-SM
Exercise Series of Physics 1, 2023-2024
Exercise Series Number 4. Work and energy

Exercise 01:

A particle of mass $m = 100kg$ falls in free fall of a height $h = 10m$ with an initial velocity.

1. Calculate the work produced by gravity so that the mass reaches the ground.

2. What is the kinetic energy and velocity of the particle at the end of the fall?

Exercise 02:

1. What work is required to lift a mass $m = 2kg$ from the ground up to a height $h = 1.8m$ at a constant velocity?

2. To lift a mass $m = 200kg$, a work of $10000\,J$ was performed. How high was the mass m lifted.

Exercise 03:

What is the work performed by a force with an intensity $F = 420N$ exerted on a body of mass $m = 100kg$ over a distance $x = 5m$ (it is assumed that the movement is rectilinear uniform):

1. Horizontally.

2. $\vec{F}$ making an angle θ = 35° with the horizontal.

3. Compare between the two previous works.

Exercise 04:

What is the velocity of an object pulled using a force of intensity $F = 400N$ while providing a power of $1kW$ (we assume that the movement is uniform rectilinear).

Exercise 05:

1. Calculate the kinetic energy of a mobile of mass $m = 1kg$ with a velocity $v = 20ms^{-1}$

2. What is the velocity of a mobile of mass $m = 1kg$ when its kinetic energy is $E_C = 1J$.

Exercise 06:

Calculate the power produced by a car engine of mass $m = 1200kg$ which accelerates uniformly from to in $10s$.

Exercise 07:

Let x be the direction normal to the surface of the earth, directed upwards, the gravitational force is $\vec{F} = -mg\vec{k}$, where g is the acceleration of gravity which is assumed to have the approximate value of .

1. Calculate the work produced by gravity when a mass $m = 10kg$ falls from a height $h = 10m$.
2. If the previous mass was initially at rest, what is its kinetic energy and its speed at the end of its fall $h = 10m$.
3. calculate the speed at the end of the fall using the fundamental law of dynamics.
4. Compare the two previous results. What can you say?

Exercise 08:

A force F is applied to a body of mass m = 10kg to move it on an inclined plane at an angle $\theta = 45°$ relative to the horizontal. The body acquires an acceleration $a = 1ms^{-2}$.

Calculate the work produced by the forces applied to the body. Friction forces are negligible.

Exercise 09:

Consider a particle of mass m subjected to a linear restoring force in the x direction $\vec{F_h} = -kx\vec{\imath}$ (Hooke's law) where k is the elasticity constant. Let's assume that the movements made are sufficiently small.

1. what is the work done to the particle by the force applied during the movement.
2. If we release the particle of mass m from position x_{max} at rest, what is its kinetic energy when it reaches the origin.
3. What is the relationship between the velocity of the particle at the origin and the maximum displacement x_{max}.

Exercise 10:

Show that the following force field derives from a potential:

$$\vec{F} = (y^2z^3 - 6xz^2)\vec{\imath} + 2xyz^3\vec{\jmath} + (3xy^2z^2 - 6x^2z)\vec{k}$$

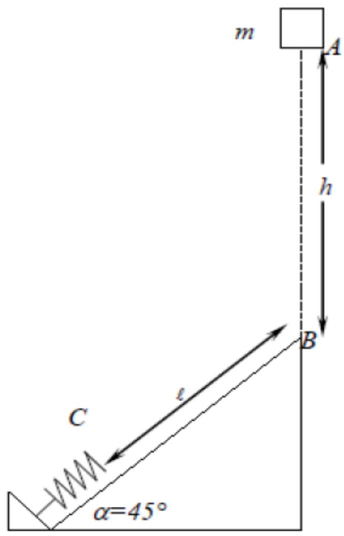
Exercice 11 :

A mass m falls with an initial speed from a height h (1).

1. Calculate the work W_1 done by the gravitational force between points A and B.
2. Calculate the speed v_B of the mass m once arrived at point B of the inclined plane.
3. The mass m moves on the inclined plane by an angle α without friction under the effect of a force $\vec{F_g}$. Define and calculate this force.
4. Calculate the work done by the force $\vec{F_g}$ between points B and C separated by a distance ℓ.
5. Calculate the speed v_C of the mass m just before contact with the spring.

6. After contact between the mass and the spring, the latter is compressed under the effect of an applied force $\vec{F}$. Give the form of this force.
7. Applying the theorem of conservation of (total) mechanical energy, calculate the maximum deformation of the spring.

We give: $m = 0.5kg, v0 = 0ms^{-1}, h = 10m, g = 9.8ms^{2-}, \alpha = 45°, \ell = 3m$ and (spring stiffness constant).



Exercise 12:

When moving from a point A of altitude y_A to a point B of altitude y_B, the work of the weight of a balloon of mass $m = 500\ g$ is worth $W_{A\rightarrow B}(\vec{P}) = 5.4J$.

1. Does the ball go up or down during this move?
2. Calculate the altitude difference$y_A - y_B$.

Exercise 13:

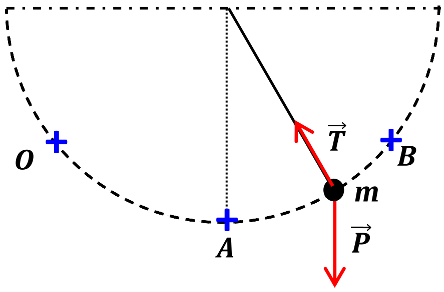
A hockey puck of mass m = 160 g thrown at a velocity $v_A = 20\ m.s^{-1}$ travels a distance $AB = 60m$ before coming to rest. We study its movement in the terrestrial frame of reference.

1. Take stock of the forces exerted on the puck.
2. What is the force responsible for its slowdown?
3. Express the work of each force.
4. Write the kinetic energy theorem in the present case.
5. Deduce the magnitude of the force mentioned in question 2.

Exercise 14:

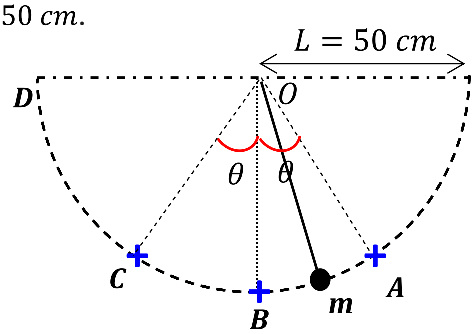
A simple pendulum allows time to be measured by its oscillations. See figure. The mass of $20\ g$ at the end of the wire is likened to a material point subject to two forces, the tension of the wire $\vec{T}$ and its weight $\vec{P}$. The mass is released without initial velocity at point O.

1. Justify that the work of the wire tension $W(\vec{T})$ is zero.
2. State the kinetic energy theorem and apply it to the mass of the pendulum on the path OA.
3. Knowing that at point A, the pendulum reaches a speed $v = 2\ m.s^{-1}$, calculate the work of the weight on the path OA.
4. The pendulum continues its course to point B where its speed is zero. Indicate whether the work of the weight during the movement AB is motor or resistant.



Exercise 15:

A small object of mass m modeled by a point is suspended at the end of an inextensible wire of length L, the other end is fixed to a support (see the figure). We do the study in the terrestrial frame of reference. The initial angle is $\theta = 20°$, the length $L = 50\ cm$.



a. Trace the forces acting on the object.

b. We release the object from point A. Using the kinetic energy theorem, express its velocity v_B at point B as a function of g, L and θ, and then calculate it.

c. What is its velocity at point C?

d. We now throw the object from point A with speed $\vec{V}_A$ tangent to the circle, towards the left. Express the minimum value of the norm of V_A for the object to go to point D as a function of g, L and θ. Calculate it.