EPITA Last & First name ..... Class : ....

PHYSICS EXAM - MAY 2022 - SECOND SEMESTER

Documents and calculators are forbidden.

EXERCISE 1 : MCQ [NO NEGATIVE POINT - 3 POINTS]

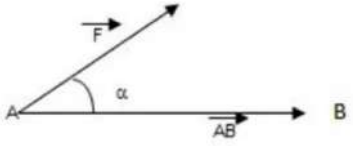
Encercler la bonne réponse. Une question peut avoir plusieurs bonnes réponses.

1. A force is exerted at an angle α on a box of mass m dragged on the ground at constant speed. If the box travels a distance AB , then the work done by the force on the box is given by:

a. $W = F \,.\, AB$

b. $W = F \,.\, AB \,.\, \sin(\alpha)$

c. $W = \overrightarrow{F} \,.\, \overrightarrow{AB}$



d. Aucune bonne réponse.

2. When a bus starts suddenly, the passengers are pushed back. This is an example of which of the following laws ?

a. Newton's first law

b. Newton's second law

c. Newton's third law loi

d. Kinetic energy law

3. A force applied on a body is represented as $\overrightarrow{F} = 6\overrightarrow{u}_x - 8\overrightarrow{u}_y + 10\overrightarrow{u}_z$. The body acquires an acceleration of magnitude $1\ m/s^2$. The mass of this body is :

a. $10\sqrt{2}$ kg.

b. 10 kg

c. $2\sqrt{10}$ kg

d. 8 kg

4. According to the kinetic energy theorem, the sum of the works of the external forces acting on a system is equal to

a. The kinetic energy of the system

b. The potential energy of the system

c. The variation of the kinetic energy of the system

d. The variation of the potential energy of the system

5. What cannot be said of the mechanical energy of a system?

a. It is equal to the sum of the kinetic and potential energies of the system.

b. It is zero for a mass animated by a rectilinear motion.

c. It is always conserved..

d. It is equal to the potential energy for a system at rest.

EXERCISE 2 : NEWTON LAWS OF MOTION [8 POINTS]

Consider the system shown in Figure 1: Two equal masses $M = 2.0$ kg are attached to a rope wound on a locked pulley. The mass on the left rests on the ground, the one on the right is suspended 1.0 m above the ground.

There is another mass $m = 0.5$ kg attached to the rope, above the right mass.

We neglect the rope and the pulley masses as well as the friction.

The pulley is finally released. We have $g = 10\, m/s^2$.

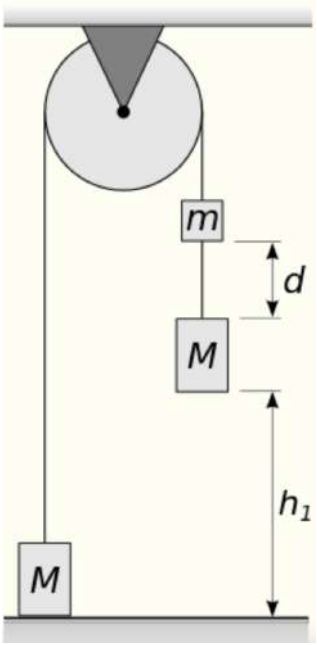


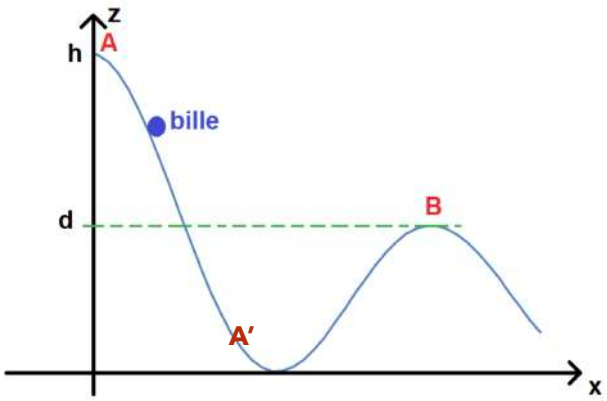
Figure 1

1. Represent on the diagram the different external forces that act on each of the masses of the system.
2. What relationships exist between the different tensions of the rope in the system. Justify your answer.

3. Use Newton's second law for each of the three masses and deduce that the expression for the acceleration of the system is given by: $a = \frac{mg}{2M + m}$. Calculate its numerical value.

EXERCISE 3 : MECHANICAL ENERGY [4,5 POINTS]

An object of mass m assimilated to a material point is released without initial speed from the top of a basin (point A') located at a height h above the ground. The ball slides along the bowl and goes up to a second vertex (point B) located at a height d, before continuing on its way. The friction undergone by the ball will be neglected. We give $g = 10\, m/s^2$.



1. Give the expressions for the kinetic, potential and mechanical energies at the points A, A' and B.

2. Using the mechanical energy theorem, determine the expression for the velocity v_B of the ball at point B?

3. What relationship must exist between h and d for the ball to stop at point B?

EXERCISE 4 : WORK AND KINETIC ENERGY [4,5 POINTS]

A hockey puck launched at a speed v_A travels a horizontal distance x before coming to rest. We study its movement in the terrestrial frame of reference.

1. Give the balance of the external forces acting on the puck.

2. What force is responsible for slowing down the puck?

3. Express the work of each of these forces.

4. Write the kinetic energy theorem in the present case and deduce the expression for the magnitude of the force mentioned in question b.