

**This exam is formed of three exercises in two pages.**  
**The use of non-programmable calculator is recommended**

**Exercise 1: (7 1/2 points)**

**Mechanical energy**

A girl standing on a platform throws a stone, considered as a particle of mass  $m = 0.1$  kg, vertically upwards from point A found at a height  $h_A = 30$  m above sea level. The stone is launched from point A with a speed  $V_A = 12$  m/s, reaches its maximum height at point B, and then it falls down to reach point C at sea level.

Take:

- the sea level as a gravitational potential energy reference for the system [stone, Earth];
- $g = 10$  m/s<sup>2</sup>.

1- Calculate, at point A, at the launching instant:

- 1-1) the kinetic energy of the stone;
- 1-2) the gravitational potential energy of the system [stone, Earth];
- 1-3) the mechanical energy of the system [stone, Earth].

2- In this part, air resistance is neglected.

- 2-1) Specify the value of the mechanical energy of the system [stone, Earth] at point B.
- 2-2) Determine the maximum height  $h_B$  reached by the stone above sea level.
- 2-3) Determine the speed  $V_C$  of the stone as it reaches point C.

3- In reality air resistance is not neglected. The stone reaches point C with a speed  $V'_C = 21$  m/s.

- 3-1) Calculate the new value of the mechanical energy of the system [stone, Earth] at point C.
- 3-2) Calculate the decrease in the mechanical energy of the system [stone, Earth] between points A and C.
- 3-3) In what form of energy does this decrease in mechanical energy appear?

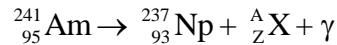
## **Exercise 2: (6 1/2 points)**

### **The americium-241 nucleus**

The americium nucleus  ${}^{241}_{95}\text{Am}$  is a radioactive nucleus which is usually used in archeology.

1- Indicate the number of protons and that of nucleons in the nucleus of americium  ${}^{241}_{95}\text{Am}$ .

2- The reaction of disintegration of americium  ${}^{241}_{95}\text{Am}$  is given by :



2-1) Define radioactivity.

2-2) Calculate A and Z indicating the used laws.

2-3) Indicate the name and the symbol of the emitted particle  ${}^A_Z\text{X}$ .

2-4) This disintegration is accompanied with the emission of  $\gamma$  radiation. Indicate:

2-4-1) the cause of the emission of the  $\gamma$  radiation;

2-4-2) the nature of the  $\gamma$  radiation.

3- The energy liberated due to this disintegration of the americium-241 nucleus is  $E = 5.63 \text{ MeV}$ . Calculate, in kg, the mass defect  $\Delta m$  due to this disintegration.

Given:

$1 \text{ MeV} = 1.6 \times 10^{-13} \text{ J}$  ; speed of light in vacuum  $c = 3 \times 10^8 \text{ m/s}$ .

## **Exercise 3: (6 points)**

### **Mars**

Mars, the red planet, is the fourth planet according to its average distance from the Sun.

It is a terrestrial planet which can be observed by the naked eye.

The period of revolution of Mars is  $T_M = 1.881$  years, whereas that of Earth is  $T_E = 1 \text{ year} = 365.25$  days.

### **Doc. 1**

1- Name the terrestrial planets of our solar system.

2- Pick out from document 1 an indicator which shows that Mars:

2-1) is a rocky planet;

2-2) contains large quantities of iron oxide in the rocks and stones scattered on its surface.

3- Document 1 indicates the periods of revolution of Mars and Earth.

3-1) What does the « period of revolution » of a planet represent?

3-2) Calculate, in days, the period of revolution of Mars.

3-3) Using the periods of revolution of Mars and Earth, specify which of the two planets is closer to the Sun.

3-4) State Kepler's law which confirms the answer of question (3-3).