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

Exercise 1 (7 points) Diver's jump

A diver, considered as a particle of mass m = 80 kg, jumps into the water of a swimming pool from the board at point A situated at a height h_A = 6 m above the surface of the water.
The diver leaves the board with a speed V_A = 5 m/s, reaches the highest position at point B, then he passes through point A' of height $h_{A'} = h_A$ and reaches the surface of water at point D.
Take:

- the surface of water as a reference level for gravitational potential energy;
- g = 10 m/s^2.

1) Calculate at point A:
  1-1) the kinetic energy KE_A of the diver;
  1-2) the gravitational potential energy GPE_A of the system (diver, Earth);
  1-3) the mechanical energy ME_A of the system (diver, Earth).

2) The diver attains point B, situated at a height h_B = 7 m, with a kinetic energy KE_B = 200 J.
  2-1) Determine the mechanical energy ME_B of the system (diver, Earth) at point B.
  2-2) Deduce that air resistance is negligible.

3) Choose with justification the correct answer.
  3-1) During the motion between B and D, the kinetic energy of the diver:
    a) increases **b)** decreases **c)** remains the same
  3-2) The gravitational potential energy of the system (diver, Earth) at A (GPE_A) and that at A' ($GPE_{A'}$) are such that:
    a) $GPE_A < GPE_{A'}$ **b)** $GPE_A = GPE_{A'}$ **c)** $GPE_A > GPE_{A'}$
  3-3) The speed of the diver at point A (V_A) and that at point A' ($V_{A'}$) are such that:
    a) $V_A < V_{A'}$ **b)** $V_A = V_{A'}$ **c)** $V_A > V_{A'}$
  3-4) The work (W) done by the weight of the diver between A' and D is:
    a) W = 1000 J **b)** W = 4800 J **c)** W = 5600 J

Exercise 2 (7 points) Efficiency of a nuclear power plant

A nuclear power plant uses uranium $^{235}_{92}U$ to produce electric energy.

The aim of this exercise is to determine the efficiency of this nuclear power plant.

One of the possible nuclear reactions of the uranium $^{235}_{92}U$ is given by the following equation:

$$^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{94}_{38}Sr + {}^{139}_{z}Xe + x\,{}^{1}_{0}n$$

1) The above nuclear reaction is fission. Justify.
2) Indicate the approximate value of the kinetic energy of a neutron that produces a nuclear fission.
3) Determine z and x, indicating the laws used.
4) **Take:** m ($^{1}_{0}n$) = 1.0087 u;

Nucleus	$^{235}_{92}U$	$^{94}_{38}Sr$	$^{139}_{z}Xe$
Mass in u	234.9942	93.8945	138.8892

Calculate, in u and then in kg (1 u = 1.66×10^{-27} kg), the loss of mass Δm that occurs in this reaction.

5) Calculate, in J, the energy liberated by the fission of one nucleus of uranium $^{235}_{92}U$.
Take : c = 3×10^{8} m/s

6) The nuclear power plant consumes 1 kg of uranium $^{235}_{92}U$ in one day.

Assume that all the nuclei of uranium $^{235}_{92}U$ undergo fission according to the above equation.

6-1) Show that the energy liberated by the fission of 1 kg of uranium $^{235}_{92}U$ is E = 7.3955 $\times 10^{13}$J.

6-2) Deduce the energy E_1 liberated by the fission of the uranium $^{235}_{92}U$ in one second.

6-3) The efficiency of this power plant is given by:

$r = \frac{E_{electric}}{E_1}$ where $E_{electric}$ is the electric energy produced in one second.

Calculate the efficiency of this power plant knowing that $E_{electric} = 2.575 \times 10^8$ J.

Exercise 3 (6 points) The history of astronomy

Read carefully the text of document 2 and then answer the questions that follow.

The ancients believed that the Earth is flat and it is at the center of the universe. The Sun, stars and the other planets rotate around the Earth.
In the 16th century, the Polish astronomer Nicolas Copernicus claimed that the Earth and the other planets revolve around the Sun and rotate around their axis.
In 1609, when Galileo Galilei made the first astronomical telescope, he was the first who discovered four satellites of Jupiter (Galilean satellites).
Until 1609, astronomers thought that the orbits of the planets were circles.
Johannes Kepler published three laws bearing his name: the first two in 1609 and the third in 1619.
Few years later, in 1687, Isaac Newton established the law of universal gravitation.

According to the site "*solar system*"

Doc. 2

1) The text of document 2 refers to two theories of astronomy.
- **1-1)** Name these two theories.
- **1-2)** Pick up, from document 2, a sentence that related to each theory.
- **1-3)** Indicate one similarity between these two theories.

2) Pick up from document 2 the major contribution in astronomy of:
- **2-1)** Galileo Galilei;
- **2-2)** Isaac Newton.

3) Document 3 below shows expressions corresponding to Copernicus' theory and/or to Kepler's laws.

Expression 1	the planets revolve around the Sun
Expression 2	the motion of a planet around the Sun is uniform
Expression 3	The period of revolution of a planet increases with its distance from the Sun
Expression 4	the trajectory of a planet around the Sun is elliptic
Expression 5	the speed of a planet varies with its distance from the Sun
Expression 6	the trajectory of a planet around the Sun is circular

Doc. 3

Using document 3 choose:

- **a.** The two expressions refer to Copernicus' theory.
- **b.** The two common expressions refer to Copernicus' theory and Kepler's laws.
- **c.** The two expressions refer to Kepler's laws.