المركز التربوي للبحوث والإنماء	الهيئة الأكاديميّة المشتركة قسم: العلوم	المادة: الفيزياء الشهادة: الثانوية العامّة فرعا: الإجتماع والاقتصاد / الآداب والإنسانيات نموذج رقم 1 المدّة: ساعة واحدة

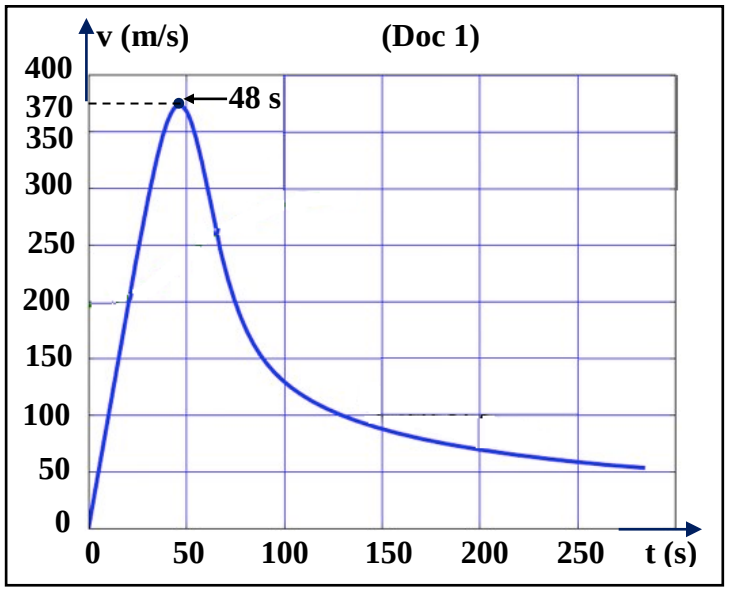
نموذج مسابقة (يراعي تعليق الدروس والتوصيف المعدّل للعام الدراسي 2016-2017 وحتى صدور المناهج المطوّرة)

This test includes three mandatory exercises. The use of non-programmable calculators is allowed.

Exercise 1 (7 points) Felix Jump

On October 14, 2012, Felix Baumgartner broke through the sound barrier thus reaching a maximum speed of 370 m/s.

Felix went up in the atmosphere to the altitude 39000 m in a helium-filled balloon, and then he jumped back towards the ground. Felix's entire trip back to the ground lasted 9 minutes and 3 seconds.



The aim of this exercise is to study the motion of Felix before opening his parachute. This motion is formed of two phases:
The first between the instants $t_0 = 0$ and $t_1 = 48$ s;
The second between the instants $t_1 = 48$ s and $t_2 = 260$ s.

The graph of the adjacent document (Doc 1) shows the variation of the speed of Felix as a function of time.

Given:
Mass of Felix (with his equipment): m = 110 kg.
At the instant $t_1 = 48$ s, Felix is at the altitude 32155 m relative to the ground.

We suppose that the gravitational acceleration g is constant where g = 10 m/s^2.
The ground is taken as a reference level for the gravitational potential energy.

1) Referring to the text, indicate the altitude from which Felix jumped, and the duration of his trip.

2)

2-1) Referring to the graph, calculate the kinetic energy of Felix at $t_0 = 0$ and $t_1 = 48$ s.

2-2) Determine the gravitational potential energy of the system (Felix; Earth) at $t_0 = 0$ and $t_1 = 48$ s.

2-3) Deduce the mechanical energy of the system (Felix; Earth) at $t_0 = 0$ and $t_1 = 48$ s.

2-4) What can we conclude about air resistance?

3)

3-1) Referring to the graph, prove that the mechanical energy of the system (Felix; Earth) decreases between $t_1 = 48$ s and $t_2 = 260$ s.

3-2) Indicate the energy transformation that takes place between $t_1 = 48$ s and $t_2 = 260$ s.

Exercise 2 (7 points) Trouble in the thyroid

A patient suffers from a disorder in his thyroid gland. To detect the cause of this disorder, the doctor injects the patient with 1.5×10^{11} nuclei of the iodine $^{131}_{53}$I.
This radioactive nuclide, a β^- emitter, has a period (half-life) of 8 days.
The disintegration of an $^{131}_{53}$I nucleus gives rise to a daughter nucleus $^{A}_{Z}$Xe supposed at rest.

1) Define radioactivity.
2) Identify the β^- particle.
3)
- **3-1)** Write the equation of the disintegration of an $^{131}_{53}$I nucleus.
- **3-2)** Determine A and Z.

4) This disintegration is accompanied by the emission of γ-rays. Due to what is this emission?
5) Calculate the number of the remaining nuclei at the end of 16 days. Deduce the number of the decayed nuclei at the end of 16 days.
6) The energy liberated due to the decay of a nucleus of iodine-131 is $E = 1.55376 \times 10^{-13}$ J.
- **6-1)** Calculate the energy liberated by the decay of iodine at the end of 16 days.
- **6-2)** The thyroid absorbs 92.8 % of the liberated energy. Calculate the energy absorbed by the thyroid at the end of 16 days.

Exercice 3 (6 points) The Sun of our solar system

Read the following text carefully and then answer the corresponding questions:

The Sun is a star, a hot ball of glowing gases at the heart of our solar system. Without the Sun's intense energy and heat, there would be no life on Earth.
The temperature at the Sun's core is about 15,600,000 K, while at the Sun's surface is about 5,800 K.
The mass of the Sun changes slowly over time as Sun converts hydrogen to helium in its core.
The Sun orbits the center of the Milky Way at a distance of approximately 24000 to 26000 light-years.

1) One of the planets orbiting the Sun is mentioned in the text.
- **1-1)** Name this planet and indicate the group to which it belongs.
- **1-2)** Name the other planets in this group.

2) Pick out from the text the statement which shows that:
- **2-1)** Our Sun, like all other stars, does not have a solid surface;
- **2-2)** A fusion reaction takes place in the core of the Sun;
- **2-3)** The condition of fusion reaction is satisfied in the core of the Sun.

3) A scientist stated in his theory that the Sun is immobile and is at the center of the universe.
- **3-1)** Name this scientist and name his theory.
- **3-2)** Pick out from the text a statement that contradicts his statement.

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أسس التصحيح (تراعي تعليق الدروس والتوصيف المعدّل للعام الدراسي 2016-2017 وحتى صدور المناهج المطوّرة)

Exercise 1 (7 points) Felix Jump

Question	Answer	Mark
1	The altitude is 39 000 m. The duration of his trip is 9 minutes and 3 seconds.	¼ ¼
2-1	$KE = \frac{1}{2}mv^2$ $KE_0 = (0.5)\ (110)\ (0)^2 = 0$ $KE_1 = (0.5)\ (110)\ (370)^2 = 7\ 529\ 500$ J	½ ½ ½
2-2	$PE_g = m.g.h$ At $t_0 = 0$ s, $PE_{g0} = (110)\ (10)\ (39000) = 42\ 900\ 000$ J. At $t_1 = 48$ s, $PE_{g1} = (110)\ (10)\ (32155) = 35\ 370\ 500$ J.	½ ½ ½
2-3	$ME = KE + PE_g$ At $t_0 = 0$ s, $ME_0 = 0 + 42\ 900\ 000 = 42\ 900\ 000$ J. At $t_1 = 48$ s, $ME_1 = 7\ 529\ 500 + 35\ 370\ 500 = 42\ 900\ 000$ J.	½ ½ ½
2-4	$ME_1 = ME_0 = 42900\ 000$ J. The mechanical energy of the system is conserved and air resistance is negligible.	 ¾
3-1	Referring to the graph, the speed of Felix decreases starting from $t_1 = 48$ s, then KE decreases, and while moving down, PE_g of the system (Felix; Earth) decreases since Felix's altitude decreases. So, $ME = PE_g + KE$ decreases.	¾
3-2	The loss in mechanical energy is transformed into heat energy.	½

Exercise 2 (7 points) Trouble in the thyroid

Question	Answer	Mark
1	It is the spontaneous transformation of a nucleus into another (more stable one) with the emission of particles (and radiation).	1
2	It is an electron $_{-1}^{0}e$	½
3-1	$^{131}_{53}I \longrightarrow {}^{A}_{Z}Xe + {}_{-1}^{0}e$	½
3-2	By applying Soddy's laws: Conservation of the mass number: $131 = A + 0 + 0 \Rightarrow A = 131$ Conservation of the charge number: $53 = Z - 1 + 0 \Rightarrow Z = 54$	½ ½ ½
4	Just after the decay, the daughter nucleus is obtained in an excited state, and the presence in this state is of very small duration. It undergoes a downward transition and this de-excitation of Xenon is accompanied with the emission of γ rays.	½
5	Number de periods = $\frac{16}{8} = 2$: 1.5×10^{11} nuclei $\xrightarrow{T}$ 7.5×10^{10} nuclei $\xrightarrow{T}$ 3.75×10^{10} nuclei $N_{decay} = N_o - N = 1.5 \times 10^{11} - 3.75 \times 10^{10}$ $\Rightarrow N_{decay} = 1.125 \times 10^{11}$ nuclei	1 ½
6-1	$E_{total} = N_{decay} \times E = 1.125 \times 10^{11} \times 1.55376 \times 10^{-13}$ $\Rightarrow E_{total} = 0.01748$ J	1
6-2	$E_{absorbed} = 0.928 \times 0.01748 \Rightarrow E_{absorbed} = 0.01622$ J	½

Exercice 3 (6 points) **The Sun of our solar system**

Question	Answer	Mark
1-1	Earth. Group of inner planets.	¾ ¾
1-2	Mercury. Venus. Mars.	½ ½ ½
2-1	The Sun is a star, a hot ball of glowing gases.	½
2-2	Sun converts hydrogen to helium in its core.	½
2-3	The temperature at the Sun's core is about 15 600 000 K.	½
3-1	Copernicus. The Heliocentric theory.	½ ½
3-2	The Sun orbits the center of the Milky Way.	½