وزارة التربية والتّعليم العالي المديريّة العامّة للتّربية دائرة الامتحانات الرّسميّة	امتحانات الشّهادة الثّانويّة العامّة فرعا: الاجتماع والاقتصاد والآداب والإنسانيات	دورة العام ٢٠١٧ العاديّة الإثنين ١٩ حزيران ٢٠١٧
	مادة : الفيزياء المدة : ساعة واحدة	الإسم : الرقم :

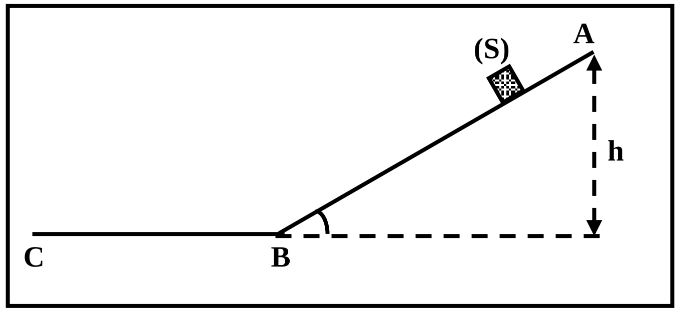
This exam is formed of three exercises in two pages.
The use of non-programmable calculator is recommended.

Exercise 1 (7 points)

Mechanical energy

Consider a track ABC situated in a vertical plane as shown in document 1.
The track ABC is formed of two parts:
- an inclined part AB;
- a horizontal part BC of length BC = 2 m.

A solid (S), considered as a particle of mass m = 0.1 kg, is released from rest from point A.
The solid (S) is submitted to a friction force, of constant magnitude f, only along the path BC.
The horizontal plane passing through BC is taken as a reference level for gravitational potential energy.



Doc. 1

Given:
- The height of point A relative to the reference level is: h = 1.5 m;
- $g = 10\ m/s^2$.

1) At point A:
- **1-1)** Calculate the value of the kinetic energy $KE_{(A)}$ of the solid (S).
- **1-2)** Calculate the value of the gravitational potential energy $PEg_{(A)}$ of the system [(S) - Earth].
- **1-3)** Deduce the value of the mechanical energy $ME_{(A)}$ of the system [(S) - Earth].

2) The solid (S) reaches point B with a speed V_B.
- **2-1)** The mechanical energy of the system [(S) - Earth] is conserved between A and B. Why?
- **2-2)** Deduce the value of the mechanical energy $ME_{(B)}$ of the system [(S) - Earth] at point B.
- **2-3)** Determine the speed V_B.

3) The solid (S) continues its motion along BC and reaches point C with a zero speed ($V_C = 0$).
- **3-1)** Calculate the mechanical energy $ME_{(C)}$ of the system [(S) - Earth] at point C.
- **3-2)** Calculate f knowing that $ME_{(B)} - ME_{(C)} = f \times BC$.

Exercise 2 (6.5 points)

Nuclear fusion

If nuclear fusion were controlled in nuclear reactors, it would open prospects for sustainable economic development in the long term. Nuclear fusion usually concerns the hydrogen isotopes: deuterium ${}^{2}_{1}H$ and tritium ${}^{3}_{1}H$ which may merge to produce a helium nucleus ${}^{4}_{2}He$ and a particle ${}^{A}_{Z}X$.

Given:

$1u = 1.66\times10^{-27}$ kg; $c = 3\times10^{8}$ m/s.

Nucleus or particle	${}^{3}_{1}H$	${}^{2}_{1}H$	${}^{4}_{2}He$	${}^{A}_{Z}X$
Mass (in u)	3.0160	2.0134	4.0015	1.0087

1) The nuclei ${}^{2}_{1}H$ and ${}^{3}_{1}H$ are isotopes. Why?

2) The fusion of ${}^{2}_{1}H$ and ${}^{3}_{1}H$ needs a very high temperature. Give an approximate value of this temperature.

3) The equation of the fusion reaction between deuterium and tritium is: ${}_{1}^{2}H + {}_{1}^{3}H \rightarrow {}_{2}^{4}He + {}_{Z}^{A}X$.

3-1) Calculate Z and A, indicating the laws used.

3-2) Name the emitted particle.

3-3) Show that the mass defect of this reaction is: $\Delta m = 0.0192$ u.

3-4) Calculate the energy E liberated by this reaction.

3-5) This energy E is liberated by the fusion of one nucleus of deuterium and one nucleus of tritium of total mass of 8.35×10^{-24} g. Show that the energy liberated by the fusion of 1 g of a mixture containing equal numbers of deuterium and tritium nuclei is $E_1 = 3.4353 \times 10^{11}$ J.

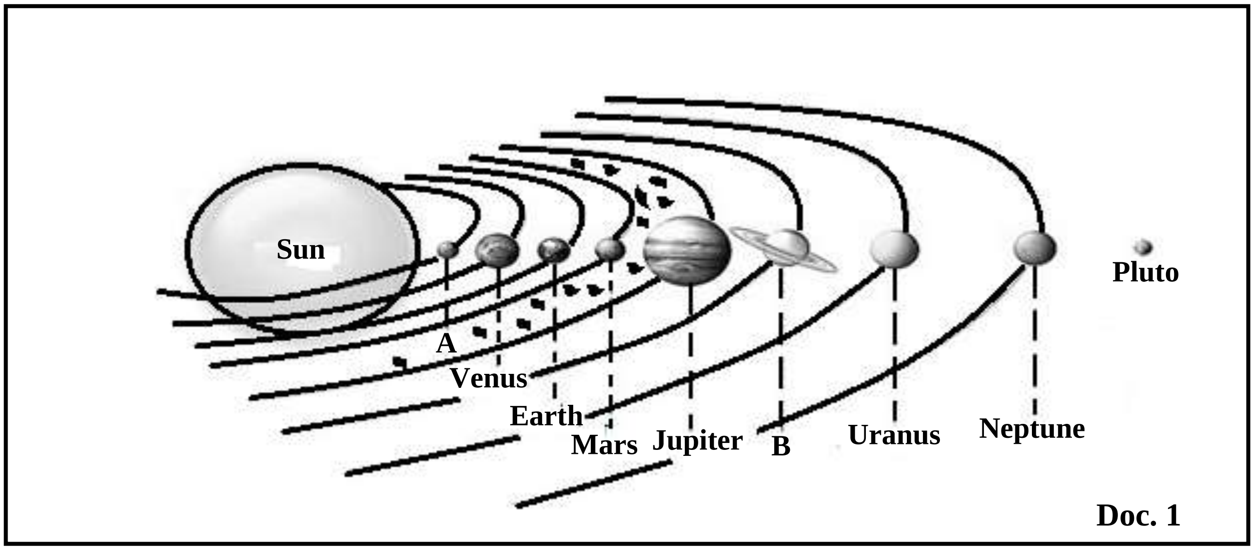
4) The energy liberated by the fission of 1 g of uranium-235 is $E_2 = 8.2 \times 10^{10}$ J. Deduce an advantage of nuclear fusion over nuclear fission.

5) Give another advantage of nuclear fusion over nuclear fission.

<u>Exercise 3</u> (6.5 points)

The solar system

Document 1 represents a simplified figure of our solar system.



1) The planet "A" is the closest planet to the Sun.

1-1) Name this planet.

1-2) Indicate the group of planets to which this planet belongs.

1-3) Indicate two common properties among the planets of this group.

2) The planets "B" and "Neptune" belong to the same group of planets.

2-1) Name the planet "B".

2-2) Indicate the group of planets to which these two planets belong.

3) The period of revolution of planet "A" around the Sun is T_A and that of planet "B" is T_B. Compare T_A and T_B. Justify by stating the convenient law.

4) A belt of solid objects exists between the orbits of Mars and Jupiter. Name these objects.

5) Document 1 shows that most of the planets orbit the Sun in almost the same plane. Name this plane.

6) Document 1 shows that the trajectories of the planets around the Sun are not circular.

6-1) Indicate the shape of the trajectories described by the planets.

6-2) Name the scientist who set out the law related to the shape of these trajectories.

Exercise 1 (7 points) **Mechanical energy**

Question		Answer	Mark
1	1-1	$KE(A) = \frac{1}{2} m V_A^2 = \frac{1}{2} \times 0.1 \times 0 = 0$ J	0.5
	1-2	$PEg_{(A)} = m g h$ $PEg_{(A)} = 0.1 \times 10 \times 1.5 = 1.5$ J	0.5 0.5
	1-3	$ME_{(A)} = PEg_{(A)} + KE_{(A)}$ $ME_{(A)} = 1.5 + 0 = 1.5$ J	0.5 0.5
2	2-1	The mechanical energy is conserved between A and B since there is no friction.	0.5
	2-2	$ME_{(B)} = ME_{(A)} = 1.5$ J	0.5
	2-3	$ME_{(B)} = PEg_{(B)} + KE_{(B)}$ $PEg_{(B)} = 0$ J since B is at the reference level of gravitational potential energy. $ME_{(B)} = 0 + \frac{1}{2} m V_B^2$, so $V_B = \sqrt{\frac{2ME_{(B)}}{m}}$, then $V_B = \sqrt{\frac{2 \times 1.5}{0.1}} = 5.5$ m/s	0.5 0.5 0.5
3	3-1	$ME_{(C)} = PEg_{(C)} + KE_{(C)}$ $PEg_{(C)} = 0$ J ; since C is at the reference level of gravitational potential energy and $KE_{(C)} = 0$ J since $V_C = 0$. $ME_{(C)} = 0 + 0 = 0$ J	 0.5 0.5
	3-2	$ME_{(B)} - ME_{(C)} = f \times BC$, so $f = \frac{ME_{(B)} - ME_{(C)}}{BC}$, then $f = \frac{1.5 - 0}{2} = 0.75$ N	1

Exercise 2 (6.5 points) **Nuclear Fusion**

Question		Answer	Grade
1		These nuclei have same charge number but different mass number.	**1**
2		100 million degrees	**0.5**
3	**3.1**	Conservation of mass number: $2 + 3 = 4 + A$, then $A = 1$ Conservation of the charge number: $1 + 1 = 2 + Z$, then $Z = 0$ (or student can say Soddy's laws)	**1**
	3.2	Neutron	**0.5**
	3.3	$\Delta m = \Delta m = m_{before} - m_{after}$ $\Delta m = m({}_1^2H) + m({}_1^3H) - m({}_2^4He) - m({}_0^1n)$ $\Delta m = (2.0134 + 3.0160) - (4.0015 + 1.0087) = 0.0192$ u	**0.75**
	3.4	$E = \Delta m c^2$ But $\Delta m = 0.0192 \times 1.66 \times 10^{-27}$ kg $= 3.1872 \times 10^{-29}$ kg $E = 3.1872 \times 10^{-29} \times 9 \times 10^{16} = 2.86848 \times 10^{-12}$ J	**1**
	3.5	8.35×10^{-24} g $\rightarrow$ 2.86848×10^{-12} J 1 g $\rightarrow$ E_1 Therefore $E_1 = 3.4353 \times 10^{11}$ J	**0.75**
4		$E_1 > E_2$, then nuclear fusion yields more energy than nuclear fission	**0.5**
5		Hydrogen is more abundant than uranium in nature Or: Nuclear fusion does not produce radioactive nuclei	**0.5**

Exercise 3 **(6.5 points)** **Solar System**

Part		Answer	Mark
1	1-1	A : Mercury	0.5
	1-2	Group of the inner planet	0.5
	1-3	They are solid planets They have similar dimensions (volume) They have similar mass They have almost same density (similar composition)	0.5 0.5
2	2-1	B :Saturn	0.5
	2-2	Group of the outer planets	0.5
3		$T_A < T_B$, since planet A is closer to the Sun than planet B. Kepler's third law: The period of revolution of a planet increases with the distance separating it from the Sun.	0.5 1
4		Asteroids	0.5
5		The plane of the ecliptic	0.5
6	6-1	The form is elliptical	0.5
	6-2	Kepler	0.5