وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات	امتحانات الشهادة الثانوية العامة الفروع : إجتماع و إقتصاد و آداب و إنسانيات	الدورة العادية للعام 2011
	مسابقة في مادة الفيزياء المدة ساعة	الاسم: الرقم:

<u>This Exam is formed of three exercises in two pages</u>
<u>Using a non-programmable calculator is allowed.</u>

First Exercise (7 points)

Nuclear Fission

A nuclear power plant is used to produce electric energy. This power plant uses the heat liberated by the fission reactions of uranium 235 in order to change water into steam. The pressure of the steam helps to run, with a high speed, a turbine that drives an alternator thus producing electricity. Certain products of the fission are radioactive nuclei having very high activity.

Given :

Particle or nucleus	Neutron $^{1}_{0}n$	Uranium 235 $^{235}_{92}U$	Xenon $^{A}_{54}Xe$	Strontium $^{94}_{Z}Sr$
Mass in u	1.00866	234.9942	138.8892	93.8945

$1\ u = 1.66\times10^{-27}$ kg ; speed of light in vacuum : $c = 3\times10^{8}$m/s.

Questions

1) Give the definition of :
- ***a)*** A nuclear fission;
- ***b)*** The activity of a radioactive source.

2) Pick up, from the text, the statement that indicates the transformation :
- ***a)*** of nuclear energy into thermal energy ;
- ***b)*** of thermal energy into kinetic energy ;
- ***c)*** of kinetic energy into electric energy.

3) Pick up, from the text, the statement indicating that nuclear wastes are produced in a nuclear power plant.

4) One of the possible nuclear reactions in a nuclear reactor is the following:

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{94}_{Z}Sr + {}^{A}_{54}Xe + 3\ {}^{1}_{0}n$$

- ***a)*** Determine Z and A specifying the laws used.
- ***b)*** Calculate, in u then in kg, the mass defect during this reaction.
- ***c)*** Calculate, in J, the energy liberated by this fission reaction.

Second Exercise (6 points)

From Ptolemy to Newton

Read carefully the following selection and answer the questions that follow.

During the Middle Ages and longtime before that, the Earth was considered the center of the universe. The phenomena observed in the sky were explained by assuming the Earth at the center, and admitting that the Sun, the Moon and the planets are moving around it. This theory was described by Ptolemy (70-147) in the *Almagest.*

Nicolas Copernicus (1473-1543), a Polish astronomer, came up, in 1543, in his work «*De revolutionibus orbium cœlestium*» with another theory: the Earth and the other planets turn around the Sun. This theory, confirmed by Kepler, Galileo and Newton, has finally dominated.

Questions

1) In the text, we read about two theories concerning the universe.
- ***a)*** Give the name of these two theories.
- ***b)*** Draw, from the text, the statement related to each of these two theories.

2) ***a)*** Specify the shape of the trajectories described by the centers of the planets,
- ***i)*** according to Copernicus.
- ***ii)*** according to Kepler.

b) According to Copernicus, the motion of each planet around the Sun is uniform. How, according to Kepler, does the speed of each planet vary with its distance from the Sun?

c) How, according to Kepler, does the period of revolution of a planet around the Sun vary with its distance from the Sun?

3) Tycho Brahé, an astronomer of the Middle Ages, contributed to the development of astronomy. What was his major contribution?

4) The text mentions the name of a scientist who invented an instrument that contributed to the development of astronomy.
- ***a)*** Give the name of this scientist.
- ***b)*** What was the invented instrument?

5) The two planets Mars and Venus, of respective masses m_1 and m_2 ($m_1 < m_2$), turn around the Sun at distances d_1 and d_2 respectively ($d_1 > d_2$). The Sun attracts Mars and Venus with the forces F_1 and F_2 respectively. Compare F_1 and F_2 using Newton's law of universal gravitation.

Third Exercise (7 points)

Energy conversion

Consider a system (S) formed of a solar cell and an electric pump. The cell is used to feed the pump under a constant electric voltage. The pump is used to raise, from a well of depth of 2 m, an amount of water of mass 10 kg during a time t.

Recall that the efficiency of a system is the ratio of the energy furnished to the energy received by this system during the same time.

Given: $g = 10\ m/s^2$. We neglect all forces of friction.

1) Indicate the energies furnished and received by,
- ***a)*** the solar cell .
- ***b)*** the pump.

2) ***a)*** Calculate the work done by the weight of water during t.
- ***b)*** Deduce the energy furnished by the pump during t.

3) Determine the energy received by the pump during t knowing that its efficiency is 80 %.

4) The cell receives during t an amount of energy of 2500 J.
- ***a)*** Give the name of one form of energy lost in the cell.
- ***b)*** Calculate the efficiency of this cell.

5) Specifying the energy received and that furnished by the system (S), deduce its efficiency.

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First exercise (7 points)

Part of the Q	Answer	Mark
1.a	Fission is a stimulated nuclear reaction during which a heavy nucleus is divided into two lighter nuclei under the impact of a neutron	1
1.b	The activity is the number of disintegrations that occurs per unit time	1
2.a	"these power plants use the heat released by fission reactions of uranium 235."	0.5
2.b	"The pressure of the steam helps to run a high-speed turbine"	0.5
2.c	"turbine that drives an alternator producing electricity"	0.5
3	"Some fission products are nuclei having very high radioactive activity"	0.5
4.a	The conservation of mass number gives: $235 + 1 = 94 + A + 3 \quad A = 139$. The conservation of charge number gives: $92 = Z + 54 \Rightarrow Z = 38$.	1
4.b	$\Delta m = m_{(before)} - m_{(after)}$ $\Delta m = 234.9942 + 1.00866 - 93.8945 - 138.8892 - 3\times1.00866 = 0.19318$ u $\Delta m = 0.19318\times1.66\ 10^{-27}$ kg $= 0.321\times10^{-27}$ kg	1
4.c	$E = \Delta m\times c^2 = 0.321\times10^{-27}\times(3\times10^8)^2 = 2.889\times10^{-11}$ J.	1

Second exercise (6 points)

Part of the Q	Answer	Mark
1.a	Geocentric and Heliocentric.	0.5
1.b	Geocentric: the Sun, the Moon and the planets are moving around it Heliocentric: the Earth and the other planets turn around the Sun	0.5 0.5
2.a.i	Circular	0.25
2.a.ii	Elliptic	0.25
2.b	The speed decreases as the distance increases	0.75
2.c	T increases as d increases	0.75
3	He collected measurements about the motion of the planets. Or He invented several measuring instruments.	0.5
4.a	Galileo	0.5
4.b	Telescope	0.5
5	The force of attraction is proportional to M_S , m_P and inversely proportional to d^2 $F_1 < F_2$ since $m_1 < m_2$ and $d_1 > d_2$	1

Third exercise (7 points)

Part of the Q	Answer	Mark
1.a	The cell converts solar energy into electric energy	1
1.b	The pump converts electric energy into gravitational potential energy	1
2.a	$W = mgh = 10 \times 10 \times 2 = 200$ J.	1
2.b	$E = W = 200$ J	0.5
3	$k_{pump} = \frac{E_{furnished}}{E_{received}} \Rightarrow 0.8 = \frac{200}{E_{received}} \Rightarrow E_{received} = 250$ J	1
4.a	Thermal energy or reflected luminous energy	0.5
4.b	$k_{cell} = \frac{250}{2500} = 10$ %.	1
5	Received energy: solar energy Furnished energy: gravitational potential energy $k_{(S)} = \frac{200}{2500} = 0.08 = 8\%$	1