الاسم:	مسابقة في مادة الفيزياء
الرقم:	المدة: ساعة واحدة

The exam is formed of three exercises.
The use of non-programmable calculators is recommended.

I-(07 points)
Various Forms of Energy
Read carefully the following selection. Then, answer the questions that follow.

"Our forefathers had only that energy of their muscles to use. Today, we use the energy of falling water, that of the Sun, or that of the atom..." Certain bodies possess one form of energy that is function of their speed, other possess a form of energy due to their position in space…. However, the most interesting is the energy of flowing water (torrent) or that of lake at a high attitude.

Water is forced to fall, from a height of a few hundreds of meters, into a definite path; at the end of its run, it is able to turn the blades of the shaft of a turbine that runs an alternator thus producing electricity…"

Questions:
1. In order to do work, man needs muscular energy. What is the source of this energy?
2. a) Pick up two statements from the text, one denoting kinetic energy and another denoting gravitational potential energy.
   b) The combination of these two forms of energy gives another energy. Name this energy.
3. The water in a lake is $100m$ above the turbine-alternator system and its rate of flow is $2.5 \times 10^5 kg/s$. **Take:** $g = 10m/s^2$.
   a) What are the different forms of energy existing between the water in the lake and the output of the alternator?
   b) Calculate the average energy E received by the turbine in one second.
   c) 40% of E is converted into electrical energy E_e. Calculate E_e.
4. Indicate, for each of these energies mentioned in the text, whether or not this energy is polluting.

II-(07 points)
Nuclear Power Stations
Electricity is produced in a power plant after using different sources of energy. We consider nuclear power plants that utilize the energy liberated by a «fuel» in the form of heat. This «fuel» is uranium. In a nuclear power plant, a nucleus of uranium 235 undergoes fission upon impact with a neutron thus producing a considerable amount of energy.

One of these fission reactions is the following: $^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{92}_{40}Zr + ^{142}_{x}Te + y^{1}_{0}n$

Given: $1u = 1.66 \times 10^{-27} kg;$

Speed of light in vacuum $c = 3 \times 10^8 m/s;$

Mass of one nucleus of uranium $m(^{235}_{92}U) = 3.9 \times 10^{-25} kg.$

1. Calculate:
   a) x and y, indicating the laws used.

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b) the amount of energy, in joule, liberated energy by the fission of one nucleus of uranium 235 knowing that the corresponding mass defect is $\Delta m = 0.198u$.

c) the energy produced by the fission of one gram of uranium.

2. The presence of a nuclear power plant may lead to serious consequences:

   a) Name one of these consequences on health.

   b) What is the major problem due to this presence?

   c) Two accidents took place in a nuclear reactor.

   Name the location of one of these two accidents.

III-(06 points)
Development of Astronomy
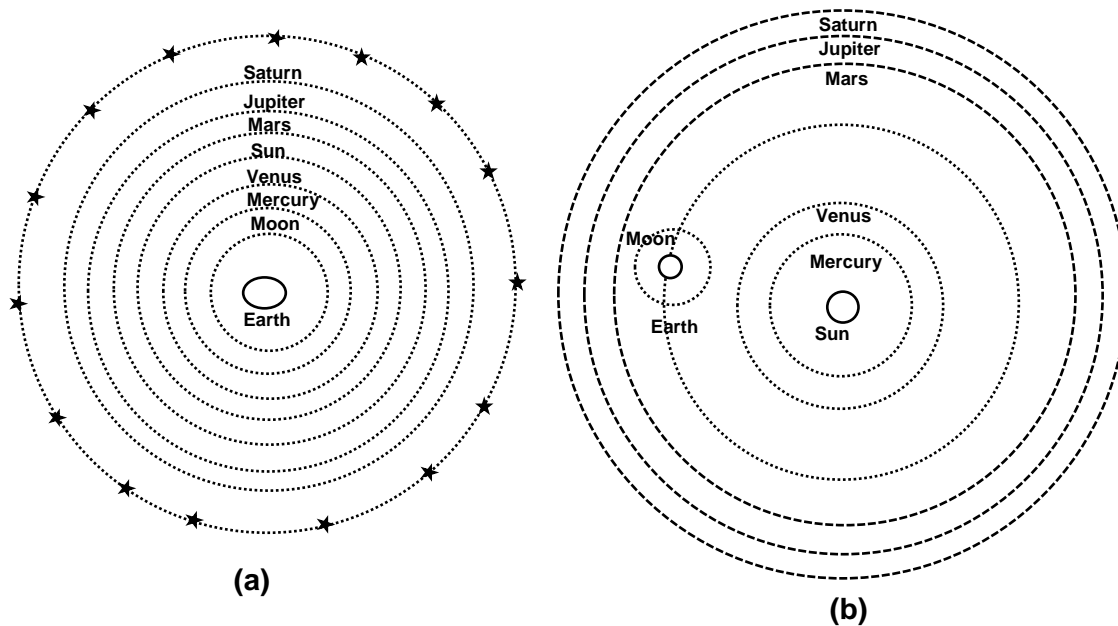*Read carefully the following selection. Then, answer the questions that follow.*

Since the ancient Greek, astronomy has developed with the time, starting with observations, researches and theories elaborated by many geniuses.

The Greek Ptolemy, "prince of astronomers" was a supporter of the geocentric theory that ruled up to the middle of the sixteenth century when Copernicus proposed the heliocentric model that replaced the preceding theory.

Galileo, convinced by the theory of Copernicus, constructed the first astronomical telescope. Johannes Kepler, using Tycho Brahe's observations, came up with three laws about planetary motion. Isaac Newton, by his study of gravitation, may be considered as the greatest astronomer.

Questions:

1. With what is astronomy interested?
2. Which of the two diagrams (a) or (b) represent the system of Copernicus? Why?
3. How did **Galileo** contribute to the development of astronomy?
4. Tell, based on **Kepler's** laws how do the speed and the period of revolution of a planet vary with its average distance from the Sun.
5. Give the statement of **Newton's** law of gravitation.

(a)

(b)

First Exercise (7 points)

Part	Answer	Mark
1	The muscular force that is necessary for man is found in food.	0.5
2.a	The statement concerning the kinetic energy "some bodies possess a form of energy that is a function of their speed" The statement concerning the gravitational potential energy is "other bodies possess a form of energy depending on their position"	1
2.b	Mechanical Energy.	0.5
3.a	The energy in the lake's water, is stored in the form of potential energy. During the fall of water, this energy is transformed into kinetic energy In its turn, this kinetic energy is transformed into kinetic energy of rotation in the turbine. At the end, the alternator transform the kinetic energy into electric energy	1.5
3.b	Consider that the gravitational potential energy of the system (water, earth) is zero at the level of the alternator and we suppose that the forces of friction are negligible. $M.E = K.E + G.P.E = 0 + mgh = mgh$ (at the level of lake) $E = K.E + G.P.E = K.E + 0 = K.E$ (at the level of alternator) Conservation of energy $E = K.E = mgh$ $m = $ flow rate x time $ = 25 \times 10^4 kg/s \times 1s = 25 \times 10^4 kg$ $E = 25 \times 104 \times 10 \times 100 = 25 \times 10^7 J$	1.5
3.c	$E_e = 40\%E = 0.4 \times 25 \times 10^7 = 10^8 J$	1.5
4	According to the text The non-polluting energies are: muscular, potential, kinetic, solar, and electrical The polluting energy is fuel (fossil) energy.	1

Second Exercise (7 points)

Part	Answer	Mark
1.a	The law of conservation of mass number gives: $235 + 1 = 92 + 142 + y \Rightarrow y = 2$ The law of conservation of charge number gives $92 + 0 = 40 + x \Rightarrow x = 52$	2
1.b	$E = \Delta mc^2 = (0.198 \times 1.66 \times 10^{-27} kg)(3 \times 10^8)^2 = 2.958 \times 10^{-11} J$	2
1.c	$N = \frac{m(sample)}{m(U)} = \frac{10^{-3}}{3.9 \times 10^{-25}} = 2.564 \times 10^{21}$ nuclues. $E' = NE = (2.564 \times 10^{21})(2.958 \times 10^{-11}) = 0.7585 \times 10^{11} J$	1.5

2.a	The nuclear power plants leave radioactive wastes.	0.5
	The radioactive wastes are dangerous on health. They may cause cancer	
2.b	The major problem that is due to this presence in the difficulty to get rid of the wastes or storing them	0.5
2.c	One of the two accident of nuclear power stations is that of Tchernobyl in Ukraine in 1986	0.5
	The other nuclear accident took place in the United-States in Pensylvenia.	

Third Exercise (6 points)

Part	Answer	Mark
1	Astronomy is a science that studies the motion, position, evolution and structure of celestial bodies.	1
2	In the system of Copernicus, called heliocentric, the Sun is taken as center and all planets turn around it.	1
	In the geocentric system, Earth taken as the center and all planets (as well as Sun) rotate around Earth.	
	Thus, diagram (b) represents the heliocentric system of Copernicus.	
3	The construction of the first telescope by Galileo has contributed to the development of astronomy	1
4	Law that is related to the speed of the planet:	2
	"The speed of revolution of the planet decreases when its distance from sun increases and vice versa".	
	Law that is related to the period of revolution of the planet	
	"The period of a planet around the Sun increases when its distance from sun increases and vice versa".	
	Based on these two laws of Kepler, we can deduce that, by moving away from the Sun, the speed of revolution of a planet decreases where as its period increases	
5	Two masses m and m' separated by a distance r, attract each other by a force that:	1
	- is proportional to the product m.m' of the masses,	
	- and the inversely proportional to square of the distance r.	