وزارة التربية والتعليم العالي
المديرية العامة للتربية
دائرة الامتحانات

امتحانات الشهادة الثانوية العامة
فرعا: الاجتماع والاقتصاد
والآداب والإنسانيات

دورة سنة 2007 العادية

مسابقة في الثقافة العلمية- المادة: الفيزياء
المدة: ساعة واحدة

الاسم:
الرقم:

This exam is formed of three exercises in two pages numbered from 1 to 2

<u>The use of non-programmable calculator is recommended</u>

<u>First exercise</u> (7½ pts) The Carbon 14

The object of this exercise is to show evidence of certain characteristic properties of the radioelement $^{14}_{6}C$.

Given:

Mass of a $^{14}_{6}C$ nucleus = 14.0065 u	1u = 1.66 $\times 10^{-27}$ kg
Mass of a $^{14}_{7}N$ nucleus = 14.0031u	Speed of light in vacuum c = 3×10^{8} m/s
Mass of an electron ($^{0}_{-1}e$) = 0.00055 u	Half-life (period) of the radioelement $^{14}_{6}C$ is T = 5700 years

A – Formation of Carbon 14

In the higher atmosphere, a nitrogen $^{14}_{7}N$ nucleus is transformed into $^{14}_{6}C$, an isotope of carbon $^{12}_{6}C$, under the impact of a particle $^{A}_{Z}X$, according to the following reaction:

$$^{14}_{7}N + {}^{A}_{Z}X \longrightarrow {}^{14}_{6}C + {}^{1}_{1}Y$$

1) The nuclides $^{14}_{6}C$ and $^{12}_{6}C$ are isotopes. Why?

2) Calculate Z and A specifying the laws used.

3) Identify the particles $^{A}_{Z}X$ and $^{1}_{1}Y$.

B – Disintegration of carbon 14

The disintegration of a carbon 14 nucleus takes place according to the following reaction:

$$^{14}_{6}C \longrightarrow {}^{14}_{7}N + {}^{0}_{-1}e$$

1) Specify, with justification, the type of this disintegration.

2) ***a)*** Calculate, in u then in kg, the mass defect in this reaction.

b) Deduce, in J, the energy liberated by this reaction.

C – Dating by carbon 14

The carbon 14 is used to determine the approximate age of fossils.

A piece of wooden fossil, found in a prehistoric cave, contains a mass of m = 2×10^{-12} g of carbon 14.

Another piece, of the same mass, freshly cut from a living tree of the same type of wood, contains a mass of $m_0 = 8\times 10^{-12}$ g of carbon 14.

1) Define the period (half-life) T of a radioelement.

2) Deduce that the age of the piece of wooden fossil is 11400 years.

<u>Second exercise</u> (6 pts) Energy and Transformations

Read carefully the following selection then answer the questions that follow

"…Using different forms of energy , we can observe a wide historical development which led, in the past, to prefer using coal instead of wood as it leads today to prefer petroleum instead of coal…The radiant energy, apparently rarely used, is however one of the most important forms. Sun rays, heating up Earth, make life, and especially the growth of plants possible…Nowadays, we use the solar cells to produce electric energy…But natural resources that were accumulated during the past geological ages are

becoming rare or drying up ...That is why researches on nuclear energy are developing. This latter form gives rise to a very large amount of energy in a relatively short time. More precisely, if a mass m of matter disappears, an amount of energy E appears...".

Questions

1) Out of the sources of energy mentioned in the above text, give the name of:
   a) The oldest used source;
   b) One renewable source, one non-renewable source and one secondary source.
2) The industrial revolution towards the end of the 18^{th} century started with the development of a certain machine that required the use of coal instead of wood. What is the name of this machine?
3) Plants convert radiant energy into another form of energy. What is that form?
4) Pick up from the text:
   a) The statement that indicates the transformation of radiant energy into thermal energy;
   b) The name of the converter that converts radiant energy into electric energy;
   c) The statement referring to Einstein's principle of equivalence between mass and energy.
5) A relation expresses the principle of equivalence between mass and energy.
   Write down this relation. What does each term of this relation represent ?

Third exercise (6½ pts) Chiron: an Object of our Solar System

Read carefully the following selection then answer the questions that follow

"...The brightness of the celestial object I just discovered allows me to estimate its diameter: between 150 and 600 km. This size is greater than that of the nuclei of comets, but much smaller than that of planets: it is comparable with that of the greatest asteroids. Being much farther than any known asteroid, it was considered as a new element ...Due to this long series of observations, it was possible to determine the orbit of this element with high precision. Extremely elliptic, it passes from the level of the orbit of Uranus to the inside of that of Saturn; the maximum distance of this object from the Sun is 19 AU…
This is Chiron, the most famous of Centaurs, the son of Saturn and the grandson of Uranus….
Many journalists named Chiron as the « tenth planet » but in fact, it is too small to be a real planet…
One of the conceptions about the origin of Chiron predicts that it is a comet, captured on its actual orbit under the influence of gravitational attraction exerted by Saturn and Uranus…"

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Astronomy and space (Pluri sciences).

Given: 1 AU = 150×10^6 km.

Questions

1) a) Define an asteroid.
   b) Give the names of two parts of a comet.
2) Saturn and Uranus belong to the same group of planets. Which one?
3) Calculate in km the maximum distance between Chiron and the Sun.
4) Pick up from the text :
   a) The statement referring to Kepler's first law ;
   b) The order of magnitude of the diameter of the largest asteroid ;
   c) The reason for which Chiron cannot be considered as a real planet;
   d) The statement indicating that Uranus is «older» than Saturn.
5) a) Give the name of the scientist who formulated the law of universal gravitation.
   b) Give the statement of this law.

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First exercise (7 ½ pts)

A - 1) Because they have same value of Z. **(½ pt)**

2) Conservation of charge number:
$7 + Z = 6 + 1 \Rightarrow Z = 0$.
Conservation of mass number:
$14 + A = 14 + 1 \Rightarrow A = 1$ **(1 ½ pt)**

3) ${}^{A}_{Z}X$ is a neutron; ${}^{1}_{1}Y$ is a proton**. (½pt)**

B- 1) Since there is an emission of electr then this is a β^- disintegration. **(½ pt)**

2) a) $\Delta m = 2.95 \times 10^{-3}$ u
$= 4.9 \times 10^{-30}$ kg. **(1½ pt)**

b) $E = \Delta m \times c^2 = 4.4 \times 10^{-13}$ J. **(1 pt)**

C-1) It is the time at the end of which half of the substance is disintegrated. **(1 pt)**

2) $N_0 \xrightarrow{T} \frac{N_0}{2} \xrightarrow{T} \frac{N_0}{4}$

$\Rightarrow$ t = 2T = 11400 years. **(1 pt)**

Second exercise (6 pt)

1) a) The wood **(½ pt)**

b) The Sun
Coal (petroleum or wood)
Electricity. **(1 ½ pt)**

2) Steam engine. **(½ pt)**

3) Chemical energy. **(3/4 pt)**

4) a) " the rays that are coming from the Sun**,** warming the Earth ... " **(½ pt)**

b) Solar cell. **(3/4 pt)**

c) " If a mass m of matter disappears, an amount of energy E appears … " **(½ pt)**

5) $E = m.c^2$. **(½ pt)**
m: mass of the matter**(1/4 pt)**
c: speed of light in vacuum **(1/4 pt)**

Third exercise (6 ½ pts)

1) a) An asteroid is a rocky object of irregular form that orbits the Sun. **(1 pt)**

b) The nucleus – coma – tail. **(1 pt)**

2) Group of outer planets. **(½ pt)**

3) The distance:
$19 \times 150 \times 10^6 = 285 \times 10^7$ km **(3/4 pt)**

4) a) « it has been possible to determine the **orbit** of this element with high precision. Extremely **elliptic»**
(½ pt)

b) 600 km, because it is mentioned in the text : **«** it is comparable to that of the bigger asteroids **» (½ pt)**

c) « it is **very small** to be considered as a real planet **» (½ pt)**

d) Chiron, son of Saturn and grandson of Uranus …**(½ pt)**

5) a) Newton. **(½ pt)**

b) Any two bodies attract each other wi a force that varies with the inverse o the square of the distance between them and with the product of their masses. **(3/4 pt)**