وزارة التربية والتعليم العالي
المديرية العامة للتربية
دائرة الامتحانات

امتحانات الشهادة الثانوية العامة
فرعا الاجتماع والاقتصاد والإنسانيات

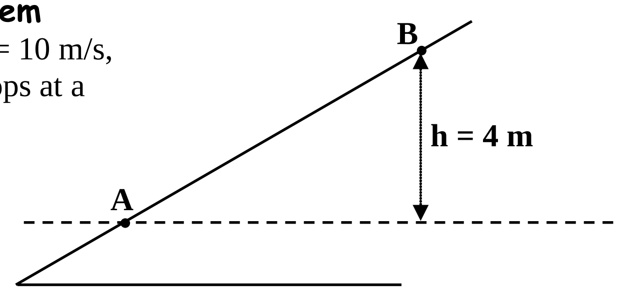
دورة سنة ٢٠٠٧ الإكمالية الاستثنائية

مسابقة في الثقافة العلمية: مادة الفيزياء
المدة: ساعة واحدة

الاسم:
الرقم:

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

First exercise (6 ½ pts) Mechanical energy of a system



A solid (S), of mass m = 0.1 kg, is launched with an initial speed V_A = 10 m/s, from point A up the line of greatest slope of an inclined plane. (S) stops at a point B and then moves back downwards.
The height of point B is h = 4 m, above the horizontal plane passing through A, this plane being taken as a gravitational potential energy reference [$P.E_g = 0$] .
Take : g = 10 m/s^2.

1) (S) rises from A to B.
- ***a)*** The system [(S), Earth] gains gravitational potential energy. Why?
- ***b)*** Calculate the values $M.E_A$ and $M.E_B$ of the mechanical energy of the system [(S), Earth] at A and B respectively.
- ***c)*** Calculate the decrease in the mechanical energy of the system [(S), Earth] when (S) passes from A to B.
- ***d)*** In what form of energy, does this decrease appear?

2) (S) descends from B and passes through A. Knowing that the decrease in the mechanical energy is the same during the upward motion and the downward motion, calculate, upon returning to point A :
- ***a)*** The mechanical energy of the system [(S), Earth];
- ***b)*** The speed of (S).

Second exercise (6 pts) The solar system

Read carefully the following selection then answer the questions that follow.
« Our solar system has a relatively simple structure. If we could see it from outside, we would notice that the different objects that form our solar system rotate around a central star, our Sun, in a disk, called the average plane of the solar system...The Terrestrial planets are the four planets that are nearest to the Sun.
Jupiter, Saturn, Uranus and Neptune are known as the Jovian planets, because they are huge as compared to the Earth and being gaseous like Jupiter.
The development in astronomy during the XVIth and the XVIIth centuries came up with a new theory: the heliocentric theory. This theory replaced the theory of Plato and Aristotle… »

Questions

1) Pick up from the text the statement that refers to the heliocentric theory.
2) In the text, we read: « the average plane of the solar system…».Give the scientific name of this plane.
3) ***a)*** Why do we call the four planets nearest to the Sun as Terrestrial?
b) Give the names of three Terrestrial planets not mentioned in the text.
4) ***a)*** One planet is neither Terrestrial nor Jovian. Which one?
b) This planet belongs to a group of planets. Which one?
c) Give two differences between this planet and the other planets of its group.
5) Give the name of the theory proposed by Plato and Aristotle.
6) Give the difference, concerning the trajectories of the planets, between the heliocentric theory of Copernicus and that of Kepler.

Third exercise (7 ½ pts) Pacemaker

A pacemaker, used to regulate the heart beats, contains, at the instant $t_0 = 0$, plutonium ${}^{238}_{94}Pu$ of mass $m_0 = 150$ mg. The plutonium ${}^{238}_{94}Pu$ is an α emitter.

This source of plutonium, being very small, is placed in a tightly closed container.

Starting from the energy liberated by each disintegration (decay), the pacemaker produces an electric energy.

The object of this exercise is to calculate the average energy produced in one second by this pacemaker.

Given: Mass of a plutonium ${}^{238}_{94}Pu$ nucleus : 3.84×10^{-25} kg

Mass of a helium ${}^{4}_{2}He$ nucleus : 0.0664×10^{-25} kg

Mass of a uranium ${}^{A}_{Z}U$ nucleus : 3.77×10^{-25} kg.

Speed of light in vacuum: $c = 3 \times 10^{8}$ m/s.

1year = 31536×10^{3} seconds.

1 mg = 10^{-6} kg.

1) The daughter nucleus produced by the decay of ${}^{238}_{94}Pu$ is a uranium nucleus represented by ${}^{A}_{Z}U$.

a) Write down the equation of this decay.

b) Calculate Z and A specifying the laws used.

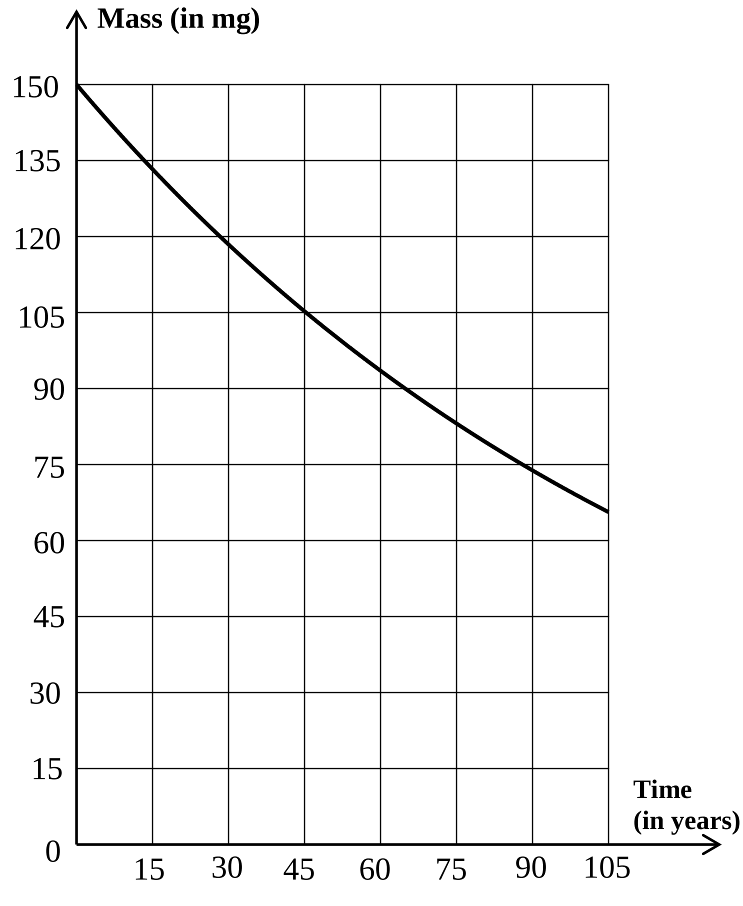
2) Calculate the mass defect as a result of the decay of a ${}^{238}_{94}Pu$ nucleus.

3) Deduce, in joule, the energy liberated by each decay.

4) Show that the number of plutonium nuclei, initially present in the pacemaker, is $N_0 = 39 \times 10^{19}$ nuclei.

5) The adjacent curve shows the variations of the mass of plutonium during the decay as a function of time expressed in years.

The pacemaker keeps functioning in a satisfactory way until the mass of plutonium decreases by 30% of its initial value $m_0 = 150$ mg.



a) Using the adjacent graph, determine the time interval t_1 during which the pacemaker functions in a satisfactory way.

b) Calculate the number of decays during the time interval t_1.

c) Deduce :

i) The energy E provided by the pacemaker by the end of the time interval t_1.

ii) The average energy produced in one second by the pacemaker.

أسس التصحيح لشهادة الثانوية العامة. لفرعاالاقتصاد والاجتماع والانسانيات. مادة الفيزياء. دورة ٢٠٠٧ الإكمالية الإستثنائية

First exercise (6 ½ pts)

1)

a) The gravitational potential energy of (S) increases with height. **(¾ pt)**

b) $M.E_A = P.E_A + K.E_A = 0 + ½ m(V_A)^2$
$\Rightarrow M.E_A = 5$ J. **(1pt)**

$M.E_B = P.E_B + K.E_B = mgh + 0$
$\Rightarrow M.E_B = 4$ J. **(1pt)**

c) $M.E_A – M.E_B = 1$ J. **(½ pt)**

d) Thermal energy **(¾pt)**

2)

a) $M.E_A = 5 - 2 = 3$ J. **(1 pt)**
(Where $M.E_A = 4 -1= 3$ J.)

b) $½ mV^2 + 0 = 3 \Rightarrow V^2 = 60$
$\Rightarrow$ V = 7.74 m/s. **(1½ pt)**

Second exercise (6 pts)

1) « rotate around a central star, our Sun, in a disk ». **(¾ pt)**

2) Ecliptic Plane. **(¾ pt)**

3)

a) Because they have some properties similar to that of Earth **(¾ pt)**

b) Mercury, Venus , Mars. **(¾ pt)**

4)

a) Pluto. **(½ pt)**

b) Outer Group **(½ pt)**

c) Pluto is not a gaseous planet; the volume and the mass of Pluto are smaller than those of other outer planets. **(½ pt)**

5) The Geocentric Theory. **(½ pt)**

6) According to Copernicus theory the trajectories are circular; according to Kepler theory the trajectories are ellipses. **(1 pt)**

Third exercise (7 ½ pts)

1)

a) ${}^{238}_{94}Pu \rightarrow {}^{4}_{2}He + {}^{A}_{Z}U$ **(½ pt)**

b) The conservation of mass number gives :
$238 = 4 + A \Rightarrow A = 234$ **(¾ pt)**
The conservation of charge number gives
$94 = 2 + Z \Rightarrow Z = 92$ **(¾ pt)**

2) $\Delta m = m(Pu) – m(U) – m(H_e)$
$= 3.84\times10^{-25} - 3.77\times10^{-25} - 0.0664 \times10^{-25}$
$= 3.6\times10^{-28}$ kg. **(1 pt)**

3) $E = \Delta m \times c^2 = 3.6\times10^{-28} \times 9\times10^{16} = 32.4\times10^{-12}$ J. **(1 pt)**

4) $N_0 = \dfrac{150\times10^{-6}}{3.84\times10^{-25}} = 39\times10^{19}$ nuclei. **(½ pt)**

5)

a) The time interval taken by the mass to decreases by $0.3\times150 = 45$ mg, is found from the graph :
$t_1 = 45$ years. **(¾ pt)**

b) The number of disintegrated nuclei during 45 years is $n = 39 \times10^{19}\times0.3 = 11.7\times10^{19}$ nuclei. **(¾ pt)**

c) **i)** $E = 11.7\times10^{19}\times32.4\times10^{-12} = 380\times10^{7}$ J. **(¾ pt)**

ii) $P = \dfrac{E}{t_1} = \dfrac{380\times10^{7}}{45\times31536000} = 2.7$ W. **(¾ pt)**