وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات	امتحانات الشهادة الثانوية العامة فرعا : الاجتماع والاقتصاد والآداب والإنسانيات	دورة العام 2015 العادية الاربعاء 17 حزيران 2015

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

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

First exercise: (7 points)

Conservation and non-conservation of mechanical energy

A ball considered as a particle of mass m = 0.5 kg, is launched vertically upward from a point O, 1 m above the ground, with a speed V_0 = 6 m/s.
Take:

- ✓ The horizontal plane passing through the ground as a gravitational potential energy reference;
- ✓ g = 10 m/s^2.

1) Calculate at the point O:
- **a)** the kinetic energy of the ball ;
- **b)** the gravitational potential energy of the system (S) [ball , Earth] ;
- **c)** the mechanical energy of (S).

2) Neglecting air resistance. The ball reaches its maximum height h_{max} at a point A above the ground (Fig.1).
- **a)** Specify, at A, the value of the mechanical energy of (S).
- **b)** Determine, at A, the gravitational potential energy of (S).
- **c)** Deduce h_{max}.

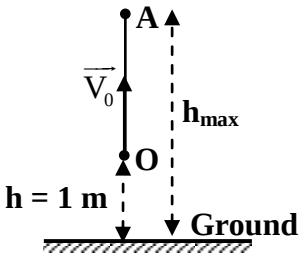

Fig. 1

3) In reality, the ball reaches a point A' of height H = 2.5 m above the ground with a zero speed (Fig.2).
- **a)** Determine, at A', the mechanical energy of (S).
- **b)** Calculate the variation ΔME of the mechanical energy of (S) between O and A'.
- **c)** Calculate OA'.
- **d)** The air resistance acting on the ball is represented by a force $\vec{f}$, of magnitude f supposed constant. Knowing that ΔME = – f × OA', calculate f.

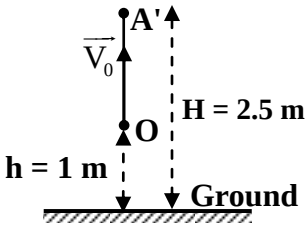

Fig. 2

Second exercise: (7 points)

Nuclear Fusion

The two isotopes of hydrogen, deuterium $^{2}_{1}H$ and tritium $^{3}_{1}H$ fuse according to the following nuclear reaction:

$$^{2}_{1}H + ^{3}_{1}H \longrightarrow ^{4}_{2}He + ^{A}_{Z}x$$

Given: speed of light in vacuum: c = 3×10^{8} m/s; 1 u = 1.66×10^{-27} kg.

1) Define the isotopes of a chemical element.

2) **a)** Calculate A and Z , specifying the laws used.
b) Identify the emitted particle $^{A}_{Z}x$.

3) The mass defect due to this reaction is Δm = 0.0189 u. Determine, in J, the energy liberated by this reaction.

4) Calculate the energy released by the fusion of 1 kg of deuterium according to the above reaction knowing that 1 kg of deuterium contains 3×10^{26} nuclei.

5) The combustion of 1 kg of oil provides 4.3×10^{7} J. Calculate the mass of oil whose combustion provides an energy equivalent to that given by the fusion of 1 kg of deuterium.

<u>Third exercise</u>: (6 points)

A new celestial body in the solar system

Read the following text then answer the questions that follow.

"The astronomy of the solar system is dominated for several years by the results of systematic observations of the planets, comets, asteroids… The method of observation is to take photographs of some parts of the sky which are then compared using a special microscope to detect objects in motion... The glow of the celestial body that I discovered, says C.T. Kowal, allows me to estimate its diameter: between 150 and 600 km. This dimension is higher than that of comets nuclei, but smaller than planets: it is comparable with that of the largest known asteroid, it was clearly a new element "adopted" under the name Chiron. Chiron's orbit, highly elliptical, passes from the level of the orbit of Uranus to the inside of the orbit of Saturn …

Chiron comes sometimes very close to Saturn, which could significantly alter its orbit because of the strong gravitational pull exerted by the giant planet…"

Questions

1) Define astronomy.

2) Name two celestial bodies which are mentioned in the text.

3) Using the text, answer the following questions:
- **a)** Chiron is not a planet. Justify.
- **b)** Indicate the position of the orbit of Chiron in the solar system.
- **c)** Pick up the sentence that refers to Kepler's first law.

4) **a)** Name the scientist who established the law of universal gravitation and state the law.
b) Pick up from the text an effect of the gravitational force on the motion of Chiron.

5) Saturn is described, according to the text, as the "giant" planet. There is another planet in the solar system which is larger than Saturn. Name this planet.

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مشروع معيار التصحيح	مسابقة في الثقافة العلمية: مادة الفيزياء المدة ساعة واحدة	الاسم: الرقم:

First exercise (7 points)

Part of the Q	Answer	Mark
1.a	$KE_O = \frac{1}{2} m V_0^2 = \frac{1}{2} \times 0.5 \times 36 = 9$ J	**1**
1.b	$PE_g = mgh = 0.5 \times 10 \times 1 = 5$ J	**1**
1.c	$ME = PE_g + KE = 14$ J	**½**
2.a	$ME_A = 14$ J , No air resistance $\Rightarrow$ ME is conserved $\Rightarrow ME_O = ME_A$	**¾**
2.b	$ME_A = PE_{g(A)} + KE_A$, but $KE_A = 0$ (maximum height) $\Rightarrow PE_{g(A)} = 14$ J	**¾**
2.c	$PE_{g(A)} = m\ g\ h_{max}$ $\Rightarrow\ h_{max} = 2.8$ m	**½**
3.a	$ME_{A'} = KE_{A'} + PE_{g(A')}$, but $KE_{A'} = 0$ (V = 0) $\Rightarrow ME_{A'} = PE_{g(A')} = mgH = 12.5$ J	**½**
3.b	$\Delta ME = ME_{A'} - ME_O = 12.5 - 14 = -1.5$ J	**1**
3.c.i	$OA' = 2.5 - 1 = 1.5$ m	**½**
3.c.ii	$\Delta ME = -f \times OA' \Rightarrow -1.5 = -f \times 1.5 \Rightarrow f = 1$N	**½**

Second exercise (7 points)

Part of the Q	Answer	Mark
1	They are the nuclides, which have the same value of charge number Z but different mass number A.	**1**
2.a	Conservation of mass number : $2 + 3 = 4 + A \Rightarrow A = 1$ Conservation of charge number: $1 + 1 = 2 + Z \Rightarrow Z = 0$	**1½**
2.a	Neutron	**½**
3	$E = \Delta m\, c^2 = 0.0189 \times 1.66 \times 10^{-27} \times 9 \times 10^{16} = 2.8 \times 10^{-12}$ J.	**1½**
4	Energy released by 1 kg of deuterium: $3 \times 10^{26} \times 2.8 \times 10^{-12} = 8.4 \times 10^{14}$ J.	**1¼**
5	The mass of oil: $m = \frac{8.4 \times 10^{14}}{4.3 \times 10^{7}} \approx 2 \times 10^{7}$ kg .	**1¼**

Third exercise (6 points)

Part of the Q	Answer	Mark
1	Astronomy is the science that studies the position, the motion, the structure and the evolution of celestial bodies; planets, stars, galaxies etc	**1**
2	Comet , asteriods , planets ……	**1**
3.a	No, because its size "much smaller than planets".	**½**
3.b	Between Uranus and Saturn.	**½**
3.c	"it passes from the level of the orbit of Uranus to the inside of the orbit of Saturn"	**½**
4.a	Newton. Any two bodies attract each other with a force that varies with the inverse of the square of the distance between them and with the product of their masses.	**1½**
4.b	" Significantly alter its orbit because of the strong gravitational pull".	**½**
5	Jupiter.	**½**