وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات	امتحانات الشهادة الثانوية العامة فرعا الاجتماع والاقتصاد والآداب والإنسانيات	دورة سنة 2014 العادية
	مسابقة في 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

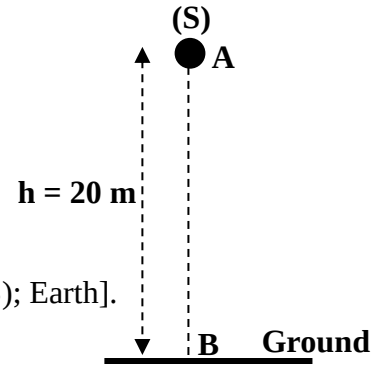
First exercise: (7 points)

Fall of a body

A marble (S) considered as a particle of mass m = 100 g, is released from rest at the instant $t_0 = 0$ from a point A, 20 m above a point B on the ground. The horizontal plane passing through B is taken as a gravitational potential energy reference. Take g = 10 m/s^2.

A- Study of the motion in vacuum

We neglect air resistance during the fall.



1) The marble (S) is at A, calculate the value of:
   a) the kinetic energy of (S);
   b) the gravitational potential energy of the system [(S); Earth];
   c) the mechanical energy of the system [(S); Earth].
2) The marble (S) is at B.
   a) Indicate the value of the gravitational potential energy of the system [(S); Earth].
   b) The mechanical energy of the system [(S); Earth] is conserved. Justify.
   c) Deduce the value of mechanical energy of the system [(S); Earth].
   d) i) Determine the value of the kinetic energy of (S) as it reaches B.
      ii) Deduce the value of the speed of (S) as it reaches B.

B- Study of the motion in air

The marble (S) falls now in air where air resistance is no more negligible. Thus, (S) reaches B with a speed 18m/s.

1) The mechanical energy of the system [(S); Earth] is no longer conserved. Justify.
2) Determine the mechanical energy of the system [(S); Earth] as (S) reaches B.
3) Calculate the variation of the mechanical energy of the system [(S); Earth] between A and B.
4) The loss in the mechanical energy appears in a certain form. Name this form

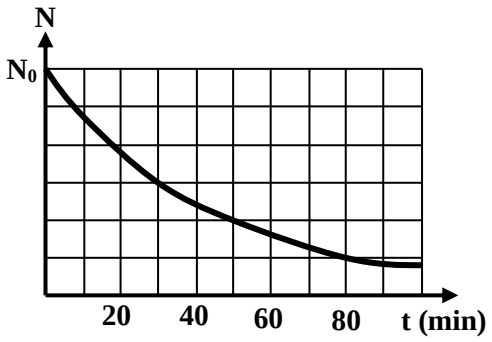
Second exercise: (7 points)

Obtaining mendelevium

Read carefully the following selection then answer the questions the follow.

"The mendelevium $(^{257}_{101}Md)$ is radioactive substance. A mendelevium nucleus is prepared in laboratory, by bombarding an einsteinium nucleus $^{253}_{99}Es$ with $^{A_1}_{Z_1}X$ particle.

Half of the entire nuclei will decay in about half an hour and become a fermium isotope $(^{257}_{100}Fm)$ according to a spontaneous disintegration reaction."



Questions

1) Indicate the name and the number of each constituents of the mendelevium nucleus $^{257}_{101}Md$.

2) The equation of preparing ${}^{257}_{101}Md$ is given by: ${}^{A_1}_{Z_1}X + {}^{253}_{99}Es \rightarrow {}^{257}_{101}Md$
   a) Determine A_1 and Z_1, indicating the used laws.
   b) Identify the particle ${}^{A_1}_{Z_1}X$.
3) a) Pick out from the text the value of the half-life (period) of the mendelevium.
   b) Verify from the graph this value.
4) The nuclear disintegration of the mendelevium is:

$$ {}^{257}_{101}Md \rightarrow {}^{257}_{100}Fm + {}^{A_2}_{Z_2}Y. $$

   a) Calculate A_2 and Z_2.
   b) Name the emitted particle ${}^{A_2}_{Z_2}Y$.
5) At $t_0 = 0$, the sample of the prepared mendelevium has N_0 nuclei.
   a) Determine in terms of N_0, the remaining number of mendelevium nuclei after one hour of disintegration.
   b) The remaining number of mendelevium nuclei after one day is practically zero. Justify.

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

The astronomical revolution

Read carefully the following text then answer the questions that follow.

"Kepler, Galileo and Newton are in favor for heliocentric theory of Copernicus…
Kepler shows that the planetary motion can be described by numerical relations. He also establishes three laws known as the fundamental laws of astronomy, because they provide the means to know the form of the orbits and the necessary times to describe them as a function of the distance to the Sun.
During the autumn 1609, Galileo has the idea to turn for the first time a small telescope he makes up towards the sky… He claims that he has the proof of the rotational motion of the Earth around the Sun…
Newtons makes up, in 1671, the first telescope using a mirror as objective rather than a lens…
Newton also founds mechanics. He manages to give the expression of the force which is as well as the origin of the motion of the planets and the phenomenon of falling of bodies…"

Questions:

1) In the text, we talk about the heliocentric theory of Copernicus. Indicate the main difference between the heliocentric theory and the geocentric theory of Plato and Aristotle.
2) a) Pick out from the text the expression that shows why the three laws of Kepler are considered as fundamental for astronomy.
   b) Give the statement of Kepler's 2nd law.
3) Galileo proved, using his telescope, the main idea of the heliocentric theory. Pick out form the text the expression that supports this idea.
4) In the text, we talk about a force that is the origin of the motion of the planets. The magnitude of this force is given by: $F = \frac{GmM}{d^2}$.
   a) State the law related to this force (law of universal gravitation).
   b) Calculate the distance between Earth and the Moon knowing that M = 6×10^{24} kg; m = 7.35×10^{22} kg; F = 2×10^{20} N; G = 6.67×10^{-11}SI.
5) The 19th century had been marked by the application of laws and principles of physics in order to determine the composition, the speed, … of stars, thus a science was born. Name this science.

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First Exercise (7 points)

Part	Answer	Mark
A.1.a	$K.E = \frac{1}{2}mv^2, but\ v = 0 \Longrightarrow K.E = 0$	0.5
A.1.b	$G.P.E = mgh_A = 0.1 \times 10 \times 20 = 20J$	0.5
A.1.c	$M.E = K.E + G.P.E = 20J$	0.5
A.2.a	$G.P.E = 0$ since $h = 0$	0.5
A.2.b	M.E is conserved since air resistance is neglected.	0.25
A.2.c	$M.E_A = M.E_B = 20J$	0.5
A.2.d.i	At B; $M.E_B = K.E_B + G.P.E_B \Longrightarrow 20 = K.E_B + 0 \Longrightarrow K.E_B = 20J$	0.75
A.2.d.ii	$K.E_B = \frac{1}{2}mv_B^2 \Longrightarrow 20 = \frac{1}{2} \times 0.1 \times v_B^2 \Longrightarrow v_B = 20m/s$	1.25
B.1	M.E is not conserved since air resistance exists.	0.25
B.2	$M.E_B = K.E_B + G.P.E_B \Longrightarrow M.E_B = \frac{1}{2}mv_B^2$ $M.E_B = \frac{1}{2} \times 0.1 \times 18^2 = -3.8J$	1
B.3.a	$\Delta M.E = M.E_B - M.E_A = 16.2 - 20 = -3.8J$	0.5
B.3.b	The energy is transformed into heat.	0.5

Second Exercise (7 points)

Part	Answer	Mark
1	Proton: 101 and neutron: 156	1
2.a	Conservation of mass number: $A_1 = 4$; Conservation of charge number: $Z_1 = 2$	1
2.b	Helium (α particle)	0.5
3.a	T = 30 minutes	0.5
3.b	From the graph $\frac{N_0}{2}$ corresponds to t = 30 min.	1.25
4.a	$A_2 = 0 \qquad Z_2 = 1$	0.5
4.b	Positron	0.5
5.a	$N_0 \rightarrow \frac{N_0}{2} \rightarrow \frac{N_0}{4} \Longrightarrow$ the remaining number of nuclei after one hour is: $\frac{N_0}{4}$ Or from the graph, at t = 1h $\Longrightarrow N = \frac{N_0}{4}$	1.25
5.b	Because it has very short half-life (30min) with respect to 1 day.	0.5

Third Exercise (6 points)

Part	Answer	Mark
1	Geocentric theory: The Earth is the center of the universe and all the celestial bodies revolve around it. Heliocentric: The Sun is the center of universe and all the celestial bodies revolve around it.	1
2.a	"…Because they provide the means of knowing the form of the orbits and the necessary time to describe them according to the distance to the Sun…"	0.75
2.b	The second law of Kepler: the second links the planet velocity to its distance from the Sun: the velocity decreases as the distance increases.	1
3	"…He claims that he has the proof of the rotational motion of the Earth around the Sun…"	0.75
4.a	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.	1
4.b	$F = \frac{GmM}{d^2} \Longrightarrow 2 \times 10^{20} = \frac{6.67\times10^{-11}\times7.35\times10^{22}\times6\times10^{24}}{d^2}$ $d^2 = 147.0735 \times 10^{15} m^2$ $d = 38.35 \times 10^{7} m$	1
5	The astrophysics (astronomy)	0.5