مسابقة في الثقافة العلمية: مادة الفيزياء
المدة: ساعة واحدة

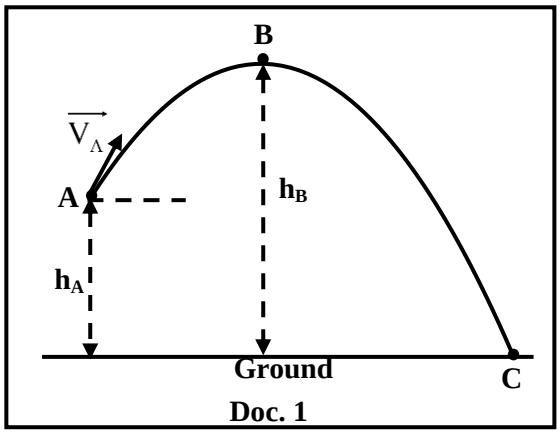
الاسم:
الرقم:

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

Exercise 1 (7.5 pts)

Launching a ball

A ball (S), considered as a particle, of mass m = 2 kg is launched with an initial speed V_A = 12 m/s from point A at a height h_A = 3 m above the ground.
The path of the motion of (S) is shown in document 1.
(S) reaches the ground at point C with a speed V_C.
Neglect air resistance.



Doc. 1

Take:

- the ground as the reference level for gravitational potential energy of the system [(S) , Earth];
- g = 10 m/s^2.

1) Calculate at the instant of launching (S) at A:
1.1) the kinetic energy of (S);
1.2) the gravitational potential energy of the system [(S) , Earth].
2) Deduce that the mechanical energy of the system [(S) , Earth] at A is ME_A = 204 J.
3) The mechanical energy of the system [(S) , Earth] is conserved. Why?
4) The table below shows the speed of (S) and its height above the ground at three different positions.

Position	A	B	C
V (m/s)	12	10	V_C
h (m)	3	h_B	0

4.1) Show that the kinetic energy of (S) at B is 100 J.
4.2) Deduce the value of the gravitational potential energy of the system [(S) , Earth] at B.
4.3) Calculate the value of h_B.
4.4) (S) reaches the ground at C. Its speed just before reaching the ground is V_C.
Specify the correct statement.
a) V_C is smaller than V_A.
b) V_C is greater than V_A.
c) V_C is equal to V_A.

Exercise 2 (6 pts)

Solar power in Lebanon

Read carefully the following selection, and then answer the questions.

"... Electricity provided by the state-owned "Electricité du Liban" has dwindled (dropped) to a few hours per day, and has been shut off completely in some areas of the country, due to the lack of heavy fuel oil for power plants.

As a result, there has been an explosion in interest in alternative energy, and thousands of mostly wealthy people are now turning to solar power.

Solar power works by converting energy from the sun into another forms of energy via photovoltaic panels. There are two forms of energy generated from the sun for our use – electricity and heat …"

SOURCE: AL JAZEERA

Doc. 2

Questions

1) Pick out from document 2:
- **1.1)** the reason behind the booming of solar power in Lebanon;
- **1.2)** a converter of solar energy.

2) The text mentions solar energy as an alternative energy.
- **2.1)** Is solar energy renewable or non-renewable?
- **2.2)** Give the names of two other clean sources of energy that can be used in Lebanon as an alternative of heavy fuel oil.

3) A photovoltaic panel is formed of solar cells.
- **3.1)** Indicate the form of the energy received and the form of the useful energy furnished by solar cells.
- **3.2)** Suppose that l m^2 of a photovoltaic panel receives from the sun an average power of 1 kW and furnishes a useful power of average value 0.2 kW.

  Calculate the efficiency "r" of this photovoltaic panel. Given: $r = \frac{\text{Average useful power}}{\text{Average received power}}$.
- **3.3)** How can we store the useful energy furnished, during the day, by a photovoltaic panel for use at night?

Exercise 3 (6.5 pts)

Carbon dating

For many years, scientists have been able to determine the age of a fossil through carbon-14 dating. Carbon-14 ($^{14}_{6}C$) is a β^- emitter, and its half-life (period) is T = 5730 years.

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

2) Calculate the number of neutrons in a carbon-14 nucleus.

3) Give the name of the emitted β^- particle.

4) The decay equation of carbon-14 is given by: $^{14}_{6}C \rightarrow {}^{A}_{Z}X + {}^{0}_{-1}e$.

Calculate Z and A, indicating the laws used.

5) Scientists take a specimen of a fossil of an animal.

The mass of carbon-14 in this specimen at the instant of discovery of the fossil is $m = 2\times10^{-8}$ g.

The mass of carbon-14 in this specimen at the instant of death of this animal is $m_0 = 8\times10^{-8}$ g.
- **5.1)** Define the half-life of a radioactive substance.
- **5.2)** Deduce the age of this fossil.

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Exercise 1 (7.5pts) **Launching a ball**

Part	Answer	Mark
1.1	$KE_A = \frac{1}{2} m V_A^2 = \frac{1}{2} \times 2 \times 12^2 = 144$ J	1.5
1.2	$GPE_A = m g h_A = 2 \times 10 \times 3 = 60$ J	1.5
2	$ME_A = KE_A + GPE_A = 144 + 60 = 204$ J	0.5
3	The mechanical energy of the system [(S), Earth] is conserved because air resistance is neglected.	0.5
4.1	$KE_B = \frac{1}{2} m V_B^2 = \frac{1}{2} \times 2 \times 10^2 = 100$ J	0.5
4.2	$ME_A = ME_B = KE_B + GPE_B$, then $204 = 100 + GPE_B$, so $GPE_B = 104$ J	1
4.3	$GPE_B = m g h_B$, then $h_B = \frac{104}{20} = 5.2$ m	1
4.4	b) V_C is greater than V_A. $ME_C = KE_C + GPE_C = KE_C$ ($GPE_C = 0$ since S is at the reference level). $ME_A = KE_A + GPE_A = KE_C$ $GPE_A > 0$, then $KE_C > KE_A$; therefore, $V_C > V_A$ **Or**: $ME_C = KE_C + GPE_C = KE_C = \frac{1}{2} m V_C^2$, then $204 = \frac{1}{2}(2) V_C^2$ Therefore, $V_C = 14.28$ m/s > $V_A = 12$ m/s	1

Exercise 2 (6 pts) **Solar power at Lebanon**

Part	Answer	Mark
1.1	This is because electricity has dropped to a few hours per day, and has been shut off completely in some areas of the country. Or: This is due to the lack of heavy fuel oil for power plants	1
1.2	Photovoltaic panel	0.5
2.1	Renewable energy	0.5
2.2	Wind ; Falling water	1
3.1	Received energy: Solar energy or radiant energy Useful furnished energy: Electrical energy	1
3.2	Efficiency: $r = \frac{Avarage\ useful\ power}{Avarage\ received\ power} = \frac{0.2}{1} = 0.2 = 20\ \%$	1
3.3	The furnished energy can be stored in batteries.	1

Exercise 3 (6.5pts) **Carbon dating**

Part	Answer	Mark
1	They are isotopes of the same element since they have the same charge number but different mass numbers.	1
2	Number of neutrons: $N = A - Z = 14 - 6 = 8$	1
3	Electron	0.5
4	The conservation of the mass number: $14 = A + 0$, then $A = 14$ The conservation of the charge number: $6 = Z - 1$, then $Z = 7$	1.5
5.1	The half-life of a radioactive substance is the time it takes for half of the radioactive substance to decay.	1
5.2	At t = 1 T: $m = \frac{m_0}{2} = 4 \times 10^{-8}$ g ; At t = 2 T : $m = \frac{4 \times 10^{-8}}{2} = 2 \times 10^{-8}$ g Therefore, Age = t = 2 T = 2 × 5730 = 11460 y Or : $m = \frac{m_0}{2^n}$, then $2 \times 10^{-8} = \frac{8 \times 10^{-8}}{2^n}$, so $2^n = 4$, hence $n = 2$ Therefore, Age = 2 T = 2 × 5730 = 11460 y	1.5