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

يتكوّن هذا الامتحان من خمسة تمارين، موزعة على أربع صفحات. يجب اختيار **ثلاثة تمارين فقط**.
إقرأ الأسئلة كلّها بشكل عام وشامل، ومن ثمّ حدّد اختياراتك.
ملاحظة: في حال الإجابة عن أكثر من ثلاثة تمارين، عليك شطب الإجابات المتعلقة بالتمارين التي لم تعد من ضمن اختيارك، لأن التصحيح يقتصر على إجابات التمارين الثلاث الأولى غير المشطوبة، بحسب ترتيبها على ورقة الإجابة. يمكن الاستعانة بالآلة الحاسبة غير القابلة للبرمجة. تعطى نصف علامة على وضوح الخط والترتيب.

Exercise 1 (6.5 pts)

Mechanical energy

A skier, considered as a particle of mass m = 75 kg, descends a slope following a straight trajectory. During his descent, the skier passes through points A, B, C, and D. Take g = 10 m/s^2.
The table below shows the kinetic energy KE of the skier and the gravitational potential energy GPE of the system (Skier, Earth) at A, B, C and D.

Doc. 1
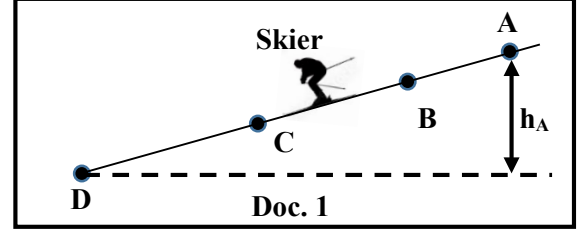
Position	A	B	C	D
KE (J)	375	375	375	375
GPE (J)	75 000	37 500	22 500	0

1) Show that the reference level of the gravitational potential energy of the system (Skier, Earth) is the horizontal plane passing through D.
2) Show that the skier descends the slope at a constant speed V.
3) Calculate V.
4) Determine the altitude h_A of point A .
5) Calculate the mechanical energies ME_A and ME_D of the system (Skier, Earth) at A and D, respectively.
6) Deduce the value of the mechanical energy lost between A and D.
7) Indicate the cause of this loss.
8) In what form does this energy loss appear?

## Exercise 2 (6.5 pts)

Motion of a wheelchair

A patient in a wheelchair is at rest at point A. The total mass of the patient and the wheelchair is M = 100 kg. A nurse pushes the wheelchair over a horizontal distance AB = 40 m, the speed of the wheelchair at point B is V_B = 2.5 m/s.

The nurse exerts a constant force $\vec{F}$ in the horizontal direction of motion with a value F = 50 N (Doc. 2).
Take the horizontal plane containing AB as the reference level for the gravitational potential energy.

Doc. 2
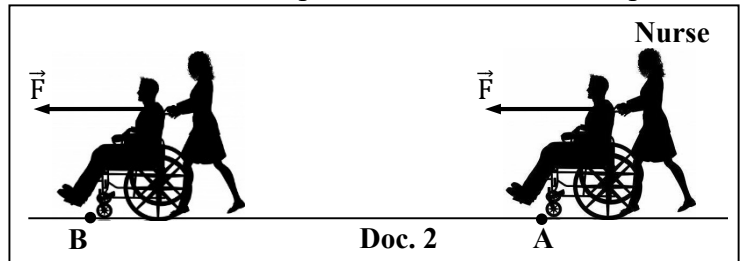
1) Work is done by a force when two conditions are met. Choose from the following expressions the one that correctly describes these two conditions:
   Expression 1: The force applied on the body does not contribute to its movement, and this force is perpendicular to the direction of motion.
   Expression 2: The body on which the force is applied must move, and this force acts on the body completely or partially in the direction of motion.
   Expression 3: The body on which the force is applied must move, and this force acts perpendicular to the direction of motion.

2) Calculate the work done by $\vec{F}$ to displace the wheelchair from A to B.

3) Indicate a source of chemical energy that the nurse needs to accomplish her work.

4) Choose the correct answer:

  4.1) The kinetic energy of the wheelchair is the energy it possesses due to its:
   a) position
   b) motion
   c) dimensions

  4.2) The values of the kinetic energy of the system (wheelchair, patient) at A and at B are respectively:
   a) $KE_A = 312.5$ J and $KE_B = 0$ J
   b) $KE_A = 312.5$ J and $KE_B = 312.5$ J
   c) $KE_A = 0$ J and $KE_B = 312.5$ J

  4.3) If the speed of the wheelchair increases 3 times, its kinetic energy increases:
   a) 3 times
   b) 6 times
   c) 9 times

  4.4) During the motion of the wheelchair from A to B, the value of the gravitational potential energy of the system (wheelchair, patient, Earth):
   a) remains constant
   b) decreases
   c) increases

Exercise 3 (6.5 pts)

Global Warming

Read carefully the selection of document 3 and then answer the questions.

> Climate changes have now become a global concern. The massive production and consumption of fossil fuels, methane emissions, and deforestation contribute to the increase of greenhouse gases, causing a rise in temperature.
>
> Climate changes due to global warming have numerous consequences, including rising sea levels, disruption of precipitation patterns, and other effects.
>
> Renewable energy sources are among the alternatives to fossil fuels in the coming years. Individual behavior and eco-consumption can also have a significant impact on greenhouse gas emissions, thus slowing the rise in temperatures. However, this awareness is meaningless without real involvement from states and concrete measures to combat global warming.
>
> www.planete-energies.com
>
> **Doc. 3**

Questions:

  1) The text of document 3 discusses climate changes. Pick out from document 3:
   1.1) two causes that contribute to these changes;
   1.2) two consequences of these changes on our planet.
  2) Global warming is related to the increase in greenhouse gases.
   2.1) Name two gases responsible for this effect.
   2.2) Explain briefly this effect.
  3) The text of document 3 mentions fossil fuels.
   3.1) Name two kinds of fossil fuels.
   3.2) Are these sources of energy renewable or non-renewable?
  4) Pick out from document 3 one solution that helps to reduce the danger of global warming.
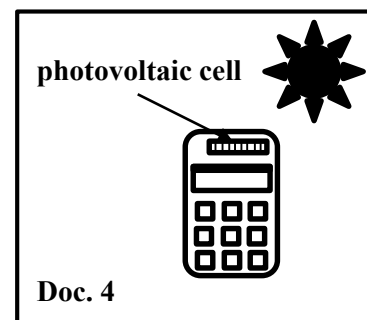
Exercise 4 (6.5 pts)
Solar calculator

A solar calculator is equipped with a photovoltaic cell with a surface area $S = 5\times10^{-4}\,m^2$. This cell generates enough energy to operate the calculator without using traditional batteries (Doc. 4).

1) Indicate one advantage of using a solar calculator.
2) Indicate the form of the received energy and the form of useful energy produced by the photovoltaic cell of the solar calculator.
3) The cell is exposed to the sunlight in a sunny day. The average power of sunlight is $800\,W/m^2$.
   Show that the energy received by the cell during 2 hours of operation is $E_{received} = 0.8$ Wh.
4) Calculate, in Wh, the useful energy produced by the cell during 2 hours knowing that the efficiency « r » of the cell is r = 20 %. Given : $r = \dfrac{\text{useful energy}}{\text{received energy}}$.
5) Part of the received energy by the cell is not converted into useful energy. Calculate the value of this energy during 2 hours of operation.

Doc. 4

photovoltaic cell

Exercise 5 (6.5 pts)
Formation of Lead-206 from Bismuth-209

The transformation of bismuth into lead occurs through several steps.

Step 1:

Stable bismuth-209 irradiated with thermal neutrons, produces radioactive bismuth-210 ($^{210}_{83}Bi$).

Step 2:

Bismuth-210, decays into polonium-210 by emitting an electron. This disintegration is accompanied by the emission of a gamma radiation.

Step 3:

Polonium-210 ($^{210}_{84}Po$), with a half-life of 138 days, emits alpha particles and transforms into lead ($^{206}_{82}Pb$).

1) Consider the following three equations:

Equation 1	Equation 2	Equation 3
$^{210}_{83}Bi \rightarrow\ ^{210}_{84}Po\ +\ ^{0}_{-1}e\ +\gamma$	$^{210}_{84}Po \rightarrow\ ^{206}_{82}Pb\ +\ ^{A}_{Z}X$	$^{209}_{83}Bi\ +\ ^{1}_{0}n\ \rightarrow\ ^{210}_{83}Bi$

Match each step of the transformation of bismuth into lead to the corresponding equation.

2) The nuclei $^{209}_{83}Bi$ and $^{210}_{83}Bi$ are isotopes. Why?
3) Due to what is the emission of γ radiation during step 2?
4) Consider equation 2, the decay equation of polonium-210.
   4.1) Calculate Z and A by indicating the laws used.
   4.2) Indicate the name and symbol of the particle emitted during the decay of polonium-210.
5) Define the half-life of a radioactive substance.
6) Given that at $t_0 = 0$, the initial mass of polonium-210 is $m_0 = 100$ g.
   Determine the time required for the mass of polonium to become m = 25 g.

مسابقة في مادة الفيزياء
أسس التصحيح – إنكليزي

Exercise 1 (6.5 pts)	Mechanical energy	
part	**Answers**	**Mark**
1	The gravitational potential energy is zero at D	1
2	$KE_A = KE_B = KE_C = KE_D = \frac{1}{2}\,mV^2$ Since same mass and same speed	1
3	$KE_C = \frac{1}{2}\,mV^2$ $375 = \frac{1}{2}\,75\,V^2$ $V^2 = 10$ Then $V = 3.16$ m/s $= \sqrt{10}$ m/s	0.5
4	$GPE_A = mgh_A$ $75\,000 = 75 \times 10 \times h_A$ $h_A = 100$ m	1
5	$ME_A = 375 + 75000 = 75375$ J $ME_D = 375 + 0 = 375$ J	1
6	$E_{lost} = 75375 - 375 = 75000$ J	1
7	The skier is submitted to a friction force.	0.5
8	Thermal energy	0.5

Exercise 2 (6.5 pts)	Motion of a Wheelchair	
Part	**Answers**	**Mark**
1	Expression 2	1
2	$W = F \times d$ $W = 50 \times 40 = 2\,000$ J	0.5 0.5
3	Food	0.5
4.1	The kinetic energy of the wheelchair is the energy it possesses due to its: **a) motion**	1
4.2	The values of the kinetic energy of the system (wheelchair, patient) at A and at B are respectively: **a) $KE_A = 0$ J and $KE_B = 312.5$ J**	1
4.3	If the speed of the wheelchair increases 3 times, its kinetic energy increases: **c) 9 times**	1
4.4	During the motion of the wheelchair from A to B, the value of the gravitational potential energy of the system (wheelchair, patient, Earth): **a) remains constant**	1

Exercise 3 (6.5 pts)	Global Warming	
Part	**Answers**	**Mark**
1.1	**Two causes**: • The massive production and consumption of fossil fuels; • methane emissions; • deforestation.	**0.5** **0.5**
1.2	**Two consequences**: • rising sea levels; • disruption of precipitation patterns.	**0.5** **0.5**
2.1	**Two** greenhouse gases: Water vapor (H_2O), Carbon dioxide (CO_2), Methane (CH_4), Ozone (O_3), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulfur hexafluoride (SF_6).	**0.5** **0.5**
2.2	Some gases in the atmosphere trap the Earth's heat without blocking the radiation coming from the Sun. **or** : Some gases form a layer in the atmosphere that prevents the infrared radiation emitted by the Earth's surface from passing through, which results in warming the Earth's surface. **or** …	**1**
3.1	**Two sources** of fossil energy: Coal – oil – fuel – diesel …	**0.5** **0.5**
3.2	Non-renewable	**0.5**
4	According to the document, **a solution** to reduce the risk of global warming includes: • Using renewable energy sources • Individual behavior and eco-consumption • real involvement from states and concrete measures to combat global warming	**1**

Exercise 4 (6.5 pts)	Solar calculator	
Part	**Answers**	**Mark**
1	**One advantage** of using a solar calculator: • Utilizes a clean source; • Uses a renewable source; • Does not require traditional batteries, which reduces the environmental impact associated with the production and disposal of batteries.	**1**
2	Received Energy: Solar energy Useful Energy: Electrical energy	**1** **1**
3	Received Energy = $800 \times 2 \times 5 \times 10^{-4}$ = 0.8 Wh.	**1.5**
4	Useful Energy = r $\times$ Received Energy = 0.16 Wh.	**1**
5	Dissipated energy = 0.8 – 0.16 = 0.64 Wh.	**1**

Exercise 5 (6.5 pts)	Formation of Lead-206 from Bismuth-209	
Part	**Answers**	**Mark**
1	Step 1 → Equation 3 Step 2 → Equation 1 Step 3 → Equation 2	0.5 0.5 0.5
2	These two nuclei are of the same element, bismuth, having the same atomic number Z and different mass numbers A.	0.5
3	Gamma radiation is emitted during the de-excitation of the nucleus formed by polonium-210.	0.5
4.1	$^{210}_{84}\text{Po} \rightarrow \,^{206}_{82}\text{Pb} + \,^{A}_{Z}\text{X}$ the law of conservation of charge number: $84 = 82 + Z$; $Z = 2$ the law of conservation of mass number: $210 = 206 + A$; $A = 4$	1 1
4.2	Name of the emitted particle: helium nuclei Symbol $^{4}_{2}\text{He}$	0.25 0.25
5	The half-life of a radioactive substance (or the radioactive period) is the time it takes for half of the radioactive substance to decay.	0.75
6	$m_0 = 100$ g $\dfrac{m}{m_0} = \dfrac{1}{2^n} = \dfrac{25}{100}$; $n = 2$ Then time is $t = 2\,T = 276$ days **Or**: $m_0 = 100$ g after one half-life $m = 50$ g and after another half-life $m = 25$ g Therefore, two half-lives have elapsed, which corresponds to $t = 2\,T = 276$ days.	0.75