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 calculator is recommended.

Exercise 1 (6 points) Solar energy

Energy from solar radiation converted into heat, electrical or chemical energy, for our uses, is commonly called "Solar Energy".
The warming, provoked by the absorption of solar radiation on the ground or in the atmosphere, induces a certain number of phenomena:

- evaporation of water and then re-condensation of it in the atmosphere to create clouds and rain;
- movement of air, related to temperature differences from one place to another in the atmosphere;
- emission of this absorbed energy in space in the form of infrared radiation.

The main renewable energies, hydraulic energy and wind energy, result from these interactions of radiation with the atmosphere. The energy of solar radiation is converted into mechanical energy either by rising masses of water or by the movement of masses of air. Whereas for biomass, it is a direct conversion of solar radiation into chemical energy by transforming atmospheric CO_2 into organic material.

According to the website "encyclopédie de l'énergie" **(March 26, 2018)**

Doc. 1

1) Indicate the origin of the radiation of the Sun and the stars.
2) Indicate two advantages of the solar energy.
3) Document 1 mentions three renewable energies originating from solar energy.
Pick out from document 1 the statement that explains how solar energy is at the origin of:
- hydraulic energy;
- wind energy;
- biomass.

4) The solar power received by 1 square meter on a surface of the Earth is P = 100 W. This power can be collected by solar cells and converted into electrical power.
4-1) Calculate the solar power received $P_{received}$ by one solar cell of surface area S =1.5 m^2.
4-2) Calculate the electric power $P_{electric}$ produced by each of these cells, knowing that the efficiency r of each of these cells: $r = \frac{P_{electric}}{P_{received}} = 14\ \%$.

Exercise 2 (7 points) Smoke detector

From 1st January 2020, it will be prohibited to use smoke detectors operating on the basis of a radioactive source at home. These smoke detectors don't have health risk when used in the normal way. It is completely safe to install, remove, store or transport them. However, if the smoke detector is damaged, there is a minimal risk of radioactive contamination.
To eliminate any risk, it is advisable to wear plastic gloves when removing the device, then throw the gloves in a plastic bag with the smoke detector and take them to the recycling park.

According to the website "AFCN" **(October 29, 2019)**

Doc. 2

1) Document 2 mentions smoke detectors operating on the basis of a radioactive source.
1-1) Define «radioactive source».
1-2) Pick out from document 2 the reason for which it will be forbidden to use this type of home detectors.

2) Americium 241 is the radioactive source commonly used in such detectors. Americium $^{241}_{95}Am$ disintegrates into a neptunium $^{237}_{93}Np$ nucleus by emitting a particle $^{A}_{Z}X$ according to the following equation:

$$^{241}_{95}Am \rightarrow {}^{237}_{93}Np + {}^{A}_{Z}X .$$

2-1) Calculate Z and A, indicating the laws used.

2-2) Indicate the name and the symbol of the particle $^{A}_{Z}X$

2-3) Indicate the cause for which the emitted particle does not present a risk for a person passing at few meters away from the detector.

3) The nucleus of neptunium is sometimes obtained in an excited state. It drops to its ground state by emitting a certain radiation.

3-1) Indicate the nature of the emitted radiation.

3-2) This radiation is able to reach people who are near such detectors. Why?

3-3) A person of mass M = 75 kg working nearby such detectors receives, during an hour, an energy $E = 4 \times 10^{-7}$ J from this radiation. Calculate, in Gy, the absorbed dose by this person during an hour.

Exercise 3 (7 points) Terrestrial planets and Gaseous planets

Document 3 shows some characteristics that distinguish two groups of planets in our solar system.

	Group 1	**Group 2**
Distance from the Sun	Close to Sun	Far away from the Sun
State of matter	Solid, formed of rocks, metals and ice	Gaseous, formed of gas that surrounds a rocky nucleus.
Size	Small size, similar or smaller than that of the Earth	Large size, much larger than that of the Earth
Chemical composition		
Density		

According to the site « wikibooks »

Doc. 3

1) Group 1 corresponds to terrestrial planets.

1-1) Why is it called terrestrial?

1-2) How many planets do we have in this group?

1-3) Name two planets belonging to this group.

2) Group 2 is that of gaseous planets.

2-1) Pick out from document 3 an indicator that justifies this name.

2-2) Name the largest planet in the solar system belonging to this group.

2-3) Pick out from document 3 the reason that makes all the planets belonging to this group cold.

3) Copy the last two rows of document 3 and then use the four expressions below to properly complete this document.

- Low, close to that of water.
- Between 3 and 5.5 g/cm^3.
- Rich in silicon, oxygen, iron and magnesium.
- Rich in hydrogen and helium.

4) Indicate two common characteristics between these two groups of planets.

Exercise 1 (6 points) Solar energy

Part		Answers	Note
1		Nuclear fusion	1
2		Renewable energy Non polluting energy Or Economical energy	0.75 0.75
3		hydraulic energy: evaporation of water and then re-condensation of it in the atmosphere to create clouds and rain solar energy : movement of air, related to temperature differences from one place to another in the atmosphere biomass: it is a direct conversion of solar radiation into chemical energy by transforming atmospheric CO_2 into organic material	1.5
4	4-2	$P_{received} = 100 \times 1.5 = 150$ W	1
	4-3	$r = \frac{P_{produced}}{P_{received}} = 0.14$ So $P_{produced} = P_{electric} = 0.14 \times 150 = 21$ W	1

Exercise 2 (7 points) Smoke detector

Part		Answers	Note
1	1-1	Radioactive source: it is the spontaneous transformation of an unstable nucleus into another more stable nucleus with the emission of radioactive radiation.	1
	1-2	if the smoke detector is damaged, there is a minimal risk of radioactive contamination.	0.5
2	2-1	Conservation of mass number A : 241 = 237 + A so A = 4 Conservation charge number Z : 95 = 93 + Z ; Z = 2	2
	2-2	Name : Helium ; Symbol : ^4_2He	1
	2-3	Weak penetrating power	0.5
3	3-1	electromagnetic radiation	0.5
	3-2	Gamma radiations is very penetrating	0.5
	3-3	Absorbed dose $= \frac{E_{received}}{M} = \frac{4 \times 10^{-7}}{75} = 5.3 \times 10^{-9}$ Gy	1

Exercise 3 (7 points) Terrestrial planets and Gaseous planets

<table>
<tr><th colspan="2">Part</th><th>Answers</th><th>Note</th></tr>
<tr><td rowspan="3">1</td><td>1-1</td><td>The planets of this group have similar properties (dimensions, mass, etc..) to those of the Earth</td><td>1</td></tr>
<tr><td>1-2</td><td>4 planets</td><td>0.5</td></tr>
<tr><td>1-3</td><td>Two planets : Mercury, Venus, Earth, Mars</td><td>1</td></tr>
<tr><td rowspan="3">2</td><td>2-1</td><td>State of matter : Gaseous, formed of gas that surrounds a rocky core</td><td>1</td></tr>
<tr><td>2-2</td><td>Jupiter</td><td>0.75</td></tr>
<tr><td>2-3</td><td>Far away from the Sun</td><td>0.75</td></tr>
<tr><td colspan="2">3</td><td><table><tr><th></th><th>Terrestrial Planets</th><th>Gaseous Planets</th></tr><tr><td>Chemical Composition</td><td>Rich in Silicon, Oxygen, Iron and Magnesium</td><td>Rich in Hydrogen and Helium</td></tr><tr><td>Density</td><td>Between 3 and 5.5 g/cm^3</td><td>Low, close to that of water</td></tr></table></td><td>1</td></tr>
<tr><td colspan="2">4</td><td>• The planets of these two groups revolve around the Sun
• The planets of these two groups belong to the same solar system
• The planets of these two groups revolve around themselves and around the Sun
• The trajectory of all the planets is elliptical
• The planets of these two groups are in the same plane "ecliptic plane"</td><td>1</td></tr>
</table>