

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

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

**Exercise 1 (6 points)**

**Solar Snake**

The Swedish architect Mans Tham had brilliant idea to cover roads with photovoltaic panels (solar cells). The concept was adopted at Montpellier, Belgium, and Lebanon.

The concept "solar snake" is a huge umbrella composed of photovoltaic panels that is placed over roads or highways. This solar snake, in addition to produce electrical energy, reduces water pollution, noise and fine particles...

Belgium was the first country to express its interest in this revolutionary concept and to adopt it. The first solar snake was built above the ultra-fast train line (TGV)... The solar snake was also installed on the parking of Montpellier airport.

In Lebanon, a similar project was carried out over the river that runs through Beirut. This gigantic umbrella of 325 meter long and 32 meter width gives shadow to the running water, avoiding it from evaporating.

Doc. 1

Ref: <http://www.agexis.com>

- 1) The text of document 1 mentioned photovoltaic panels.
  - 1-1) Indicate the forms of energy received and furnished by these panels.
  - 1-2) Name the source of energy that supplied these panels. Is it nonrenewable or renewable?
  - 1-3) Name another converter that receives the same form of energy to produce thermal energy.
- 2) Pick out from the text of document 1:
  - 2-1) the advantages of covering roads with photovoltaic panels;
  - 2-2) the advantage of covering river that runs through Beirut by a solar snake.
- 3) Currently, the solar panels project in Beirut consists of 3600 photovoltaic panels that produce an electric power of 1MW.

At the end of the project, photovoltaic panels are expected to generate an electric power of 10 MW to supply 10000 residents in Beirut. Determine:

  - 3-1) the number of residents benefiting from the production of electric power of 1MW;
  - 3-2) the number of photovoltaic panels that should be installed to generate 10 MW.
- 4) The solar snake was constructed in Beirut to reduce the usage of fossil fuels in producing electricity.

Name two non-polluting sources used to produce electricity in Lebanon.

**Exercise 2 (7 points)**

**Nuclear power plant**

- 1) In a nuclear power plant, uranium 235 nucleus undergoes under the impact of a slow neutron (thermal neutron) the following reaction:  ${}_0^1n + {}_{92}^{235}\text{U} \rightarrow {}_{38}^{94}\text{Sr} + {}_{54}^A\text{Xe} + 2{}_0^1n$ 
  - 1-1) Determine Z and A indicating the used laws.
  - 1-2) Is the above reaction spontaneous or provoked? Justify.
  - 1-3) The above reaction is nuclear fission. Why?
  - 1-4) Calculate, in u and in kg, the mass defect «  $\Delta m$  » of the above reaction.
  - 1-5) Calculate, in joules, the energy liberated by the fission of one nucleus of uranium 235.

**Given:**  $m({}_{92}^{235}\text{U}) = 235.0439 \text{ u}$  ;  $m({}_{38}^{94}\text{Sr}) = 93.9145 \text{ u}$  ;  $m({}_{54}^A\text{Xe}) = 139.9252 \text{ u}$  ;  $m({}_0^1n) = 1.0087 \text{ u}$  ;  
 $c = 3 \times 10^8 \text{ m/s}$  ;  $1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$ .

- 2) A man of mass  $M = 80$  kg and a child of mass  $m = 20$  kg, are exposed to neutrons emitted by the fission of uranium 235. Each one of them receives energy of 20 J.

Given: Relative biological efficiency of a neutron R.B.E = 5.

2-1) Show that the dose absorbed by the man is equal to 0.25 Gy.

2-2) Calculate, in Sv, the physiological equivalent of dose (E.D) received by the man.

2-3) Deduce, referring to the table of document 2, the effect of the fission of  ${}^{235}_{92}\text{U}$  on the man.

2-4) Calculate, in Sv, the physiological equivalent of dose (E.D) received by the child, knowing that the absorbed dose by the child is 1 Gy.

2-5) Deduce how the physiological equivalent of dose varies with the mass of the person exposed to neutrons emitted by the fission of uranium 235.

| E.D (Sv) | Effect                        |
|----------|-------------------------------|
| > 10     | Death                         |
| 5        | 50 % mortality                |
| 1.25     | Digestive problems            |
| 0.05     | Modification of blood formula |
| Doc. 2   |                               |

### Exercise 3 (7 points)

### Solar system

In the table of document 3 certain characteristics of planets of the solar system are grouped.

| Planet  | Average distance from the Sun (A.U) | Period of revolution (years) | Density ( $\text{g/cm}^3$ ) | Surface temperature ( $^{\circ}\text{C}$ ) |
|---------|-------------------------------------|------------------------------|-----------------------------|--|
| Jupiter | 5.20                                | 11.86                        | 1.33                        | -150                                       |
| Uranus  | 19.19                               | 84                           | 1.30                        | -200                                       |
| Venus   | 0.72                                | 0.61                         | 5.24                        | 480  |
| Earth   | 1                                   | 1                            | 5.51                        | 22   |
| Saturn  | 9.53                                | 29.45                        |                             | -180                                       |
| Mars    | 1.52                                | 1.88                         |                             | -170 to 35                                 |
| Mercury | 0.38                                | 0.23                         | 5.43                        | -170 to 400                                |
| Neptune | 30                                  | 164                          | 1.76                        | -210                                       |
| Doc. 3  |                                     |                              |                             |  |

- 1) The planets of the solar system are classified in two groups:

1-1) Name these two groups.

1-2) Name two planets of each group.

1-3) The planets of one of these two groups have similar properties to Earth.

Indicate, referring to the table of document 3, the physical quantity that supports this statement.

- 2) Name:

2-1) the biggest planet of the solar system;

2-2) the closet planet to the Sun;

2-3) a planet that rotates around its axis in the retrograde direction.

- 3) The term "Average distance from the Sun" shows that the trajectory of a planet is not circular.

3-1) Indicate the shape of the trajectory of a planet.

3-2) Name the scientist who stated the law concerning this trajectory.

- 4) In the column "Density in  $\text{g/cm}^3$ " the values "0.69" and "3.94" are missing in the table of document 3. Match, with justification, the missing values for the corresponding planets.

- 5) Referring to the column "Average distance from the Sun" and the column "Period of revolution", indicate how the average distance from the Sun varies with the period of revolution.

| <b>Exercise 1 (6 points) Solar snake</b> |  |               |
|--|--|---------------|
| <b>Q</b>                                 | <b>Answer</b>  | <b>points</b> |
| 1  | Received energy : Solar energy or radiant energy<br>Furnished energy : Electrical energy                     | 0.5<br>0.5    |
|  | Source : Sun<br>Renewable energy   | 0.5<br>0.25   |
|  | Solar panel  | 0.5           |
| 2  | Reduce the pollution of water , noise and fine particles   | 0.5           |
|  | Avoid evaporation of water from the river  | 0.5           |
| 3  | Number of residents = $\frac{10\ 000 \times 1}{10} = 1000$ residents   | 0.75          |
|  | Number of panels that should be installed to generate<br>10 MW = $\frac{10 \times 3600}{1} = 36\ 000$ Panels | 1             |
| 4  | * water  | 0.5           |
|  | * wind   | 0.5           |

| <b>Exercise 2 (7 Points) Nuclear power plant</b> |  |               |
|--|--|---------------|
| <b>Q</b>   | <b>Answer</b>  | <b>points</b> |
| 1  | The conservation laws of mass number and atomic number<br>( Soddy's laws) give: $236 = A + 96$ ; $A = 140$ .<br>$92 = Z + 38$ ; $Z = 54$ . | 1             |
|  | Provoked<br>because the uranium nucleus is bombarded by a neutron  | 0.25<br>0.5   |
|  | The nucleus of uranium ( heavy nucleus) is divided into two lighter<br>after being bombarded by a thermal neutron                          | 0.5           |
|  | $\Delta m = m_U + m_n - m_{Xe} - m_{Sr} - 2m_n = 0.1955\ u = 3.245 \times 10^{-28}\ kg$  | 1             |
|  | $E = \Delta m \times c^2$ .<br>$E = 3.245 \times 10^{-28} \times 9 \times 10^{16} = 2.92 \times 10^{-11}\ j$                               | 1             |
| 2  | $D = E/M = 20/80 = 0.25\ Gy$   | 0.5           |
|  | Physiological Equivalent = Dose x RBE = $0.25 \times 5 = 1.25\ Sv$   | 1             |
|  | Digestive disorders  | 0.25          |
|  | Physiological Equivalent = Dose x RBE = $1 \times 5 = 5\ Sv$   | 0.5           |
|  | Physiological dose equivalent varies inversely to the mass.  | 0.5           |

| <b>Third exercise (7 points)</b> |               | <b>Solar system</b>  |                  |
|----------------------------------|---------------|--|------------------|
| <b>Q</b>                         | <b>Answer</b> |  | <b>Points</b>    |
| <b>1</b>                         | <b>1</b>      | Inner planets or rocky planets   | <b>0.5</b>       |
|                                  |               | Outer planets ( Jovian)  | <b>0.5</b>       |
|                                  | <b>2</b>      | Inner planets : Mars, Venus ,Earth , Mercury   | <b>0.25 0.25</b> |
|                                  |               | Outer planets : Jupiter, Uranus, Neptune , Saturn , Pluto                            | <b>0.25 0.25</b> |
|                                  | <b>3</b>      | Density  | <b>0.5</b>       |
| <b>2</b>                         | <b>1</b>      | <b>Jupiter</b> is the biggest planet   | <b>0.5</b>       |
|                                  | <b>2</b>      | <b>Mercury</b> is the closest planet.  | <b>0.5</b>       |
|                                  | <b>3</b>      | Venus or Uranus or Pluto .   | <b>0.5</b>       |
| <b>3</b>                         | <b>1</b>      | Elliptical.  | <b>0.5</b>       |
|                                  | <b>2</b>      | Kepler.  | <b>0.5</b>       |
| <b>4</b>                         |               | 0.69 g/cm <sup>3</sup> for Saturn since it is gaseous planets                        | <b>0.75</b>      |
|                                  |               | and 3.94 for Mars since it is inner planet and its density is close to that of Earth | <b>0.75</b>      |
| <b>5</b>                         |               | The average distance to the Sun increases with the duration of a revolution          | <b>0.5</b>       |