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

**First exercise:** (7 points)

### Human activities and wastes

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

"Most human activities produce wastes; when you prepare to eat, when you drive a car, or when you wash your clothes, … Also, the production of any form of energy yields wastes; when you use solar energy, nuclear energy, wind energy, or fossil fuel, … Furthermore wastes occupy large areas on Earth and emit harmful and dangerous gases. Simply wastes belong to our life and the only way to confront them, is to find solutions of this challenge.

In the case of nuclear energy or its technological industry, wastes come from the use of radioisotopes in research, in medicine, … As secondary products; wastes are produced during the production of electricity in a nuclear or thermal power plant.
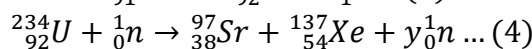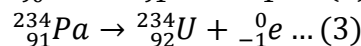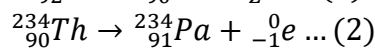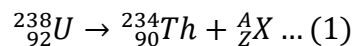
**Questions:**

1) Wastes are the origin of a phenomenon called "pollution". Define pollution.

2) Pick up from the text:
   a) three human activities that produce waste;
   b) the sentence which tells that wastes can cause soil and air pollution;
   c) an example that shows that the production of energy is always accompanied with wastes;

3) Name two:
   a) renewable sources of energy;
   b) non-renewable sources of energy.

4) During the production of electricity in a nuclear power plant nuclear wastes are produced.
   a) Define nuclear wastes.
   b) Name their two types.
   c) Tell how can we get rid of nuclear wastes.

**Second exercise:** (7 points)

### Nuclear reactions

At the end of a number of nuclear reactions, a uranium 238 nucleus $^{238}_{92}U$ becomes a uranium 234 nucleus $^{234}_{92}U$ that can undergo a nuclear fission reaction.

Consider the following four nuclear reaction:

$$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{Z}X \dots (1)$$
$$^{234}_{90}Th \rightarrow {}^{234}_{91}Pa + {}^{0}_{-1}e \dots (2)$$
$$^{234}_{91}Pa \rightarrow {}^{234}_{92}U + {}^{0}_{-1}e \dots (3)$$
$$^{234}_{92}U + {}^{1}_{0}n \rightarrow {}^{97}_{38}Sr + {}^{137}_{54}Xe + y{}^{1}_{0}n \dots (4)$$

1) There are two types of nuclear reactions: spontaneous and provoked.
   a) Distinguish between these two types.
   b) Indicate the type of each of the above four nuclear reactions.

2) a) Calculate A and Z in reaction (1), specifying the laws used.
   b) Identify the emitted particle X.

3) Reaction (4) is a nuclear fission reaction.
   a) Define nuclear fission reaction.
   b) Calculate y in reaction (4).
   c) The mass defect of this reaction is $\Delta m = 0.203u$. knowing that $1u = 1.66 \times 10^{-27}kg$ and $c = 3 \times 10^8 m/s$, determine the energy liberated by this reaction.

**Third exercise: (6 points)**

**The solar system**

The following table gives some of the characteristics of some planets of our solar system:

| Planet | d: average distance from the Sun (A.U) | T: period of revolution around the Sun (year) | Chemical composition of its atmosphere | Surface temperature (°C) |
|---|---|---|---|---|
| Jupiter | 5.20 | | $H_2$, He | -150 |
| Earth | 1 | 1 | $N_2$, $O_2$ | 22 |
| Venus | 0.72 | | $CO_2$ (95%) | 480 |
| Pluto | 39.80 | 247.7 | $N_2$ | -230 |
| Mars | 1.52 | | $CO_2$ (96%) | -170 to 35 |
| Mercury | 0.38 | 0.24 | $H_2$, He | -170 to 450 |

**Questions:**
1) Scientists classify the planets into two groups.
   a) Indicate these two groups.
   b) Jupiter and Pluto belong to the same group. What is that group?
   c) Indicate the differences between these two planets.
2) a) Venus is further from the Sun than Mercury however its temperature is higher. Justify referring to the table.
   b) Pick up from the table an indicator that shows there are no oceans on Venus.
3) The term "average distance from the Sun" indicates that the trajectory of a planet is not circular.
   a) Indicate the shape of the trajectory of a planet.
   b) Give the name of the scientist who stated the law concerning this trajectory.
4) The missing values of T in the table are: 0.61; 1.88 and 11.86. To which planet does each of these periods correspond?

## First Exercise (7 points)

| Part | Answer | Mark |
|---|---|---|
| 1 | Pollution is the contamination of the Earth's environment with materials that interfere with human health. | 0.5 |
| 2.a | When you prepare to eat – when you drive a car – when you wash your clothes. | 0.75 |
| 2.b | Furthermore waste occupies space on ground and emits harmful and dangerous gases. | 0.75 |
| 2.c | The production of electricity in a nuclear or thermal power plant. | 0.5 |
| 3.a | Sun; wind | 1 |
| 3.b | Radioactive material; fossil fuel. | 1 |
| 4.a | The unused fuel and products of fission are collectively named nuclear wastes. | 1 |
| 4.b | Wastes of short radioactive periods; wastes of long radioactive period. | 1 |
| 4.c | These wastes are put in concrete containers underground. | 0.5 |

## Second Exercise (7 points)

| Part | Answer | Mark |
|---|---|---|
| 1.a | Provoked reaction needs an external intervention.<br>Spontaneous reaction occurs with any external intervention. | 1 |
| 1.b | Reaction (4): Provoked.<br>(1), (2), and (3): Spontaneous. | 1 |
| 2.a | Conservation of mass number: $238 = 234 + A \Longrightarrow A = 4$<br>Conservation of charge number: $92 = 90 + Z \Longrightarrow Z = 2$ | 1.5 |
| 2.b | $_Z^A X = _2^4 He$ which is an $\alpha$ particle (Helium nucleus) | 0.5 |
| 3.a | Fission is a stimulated nuclear reaction during which a heavy nucleus is divided into two lighter nuclei under the impact of a neutron. | 1 |
| 3.b | $234 + 1 = 97 + 137 + y \Longrightarrow y = 1$ | 0.5 |
| 3.c | $E = \Delta mc^2 = 0.203 \times 1.66 \times 10^{-27} \times (3 \times 10^8)^2 = 3.03 \times 10^{-11} J$ | 1.5 |

## Third Exercise (6 points)

| Part | Answer | Mark |
|---|---|---|
| 1.a | Inner planets (or terrestrial); outer planets | 1 |
| 1.b | Outer planets. | 0.5 |
| 1.c | Jupiter is a gaseous planet whereas Pluto is not gaseous.<br>Pluto is the smallest planet and Jupiter is the largest. | 1 |
| 2.a | Due to the existence of $CO_2$ in the atmosphere of Venus. | 0.75 |
| 2.b | The temperature on the surface of Venus is 480ºC, this temperature cannot keep water in liquid state thus oceans do not exist on the surface of Venus. | 0.75 |
| 3.a | Elliptic. | 0.5 |
| 3.b | Kepler. | 0.5 |
| 4 | Jupiter: 11.86<br>Venus: 0.61<br>Mars: 1.88 | 1 |