Video

2011.Radio.01

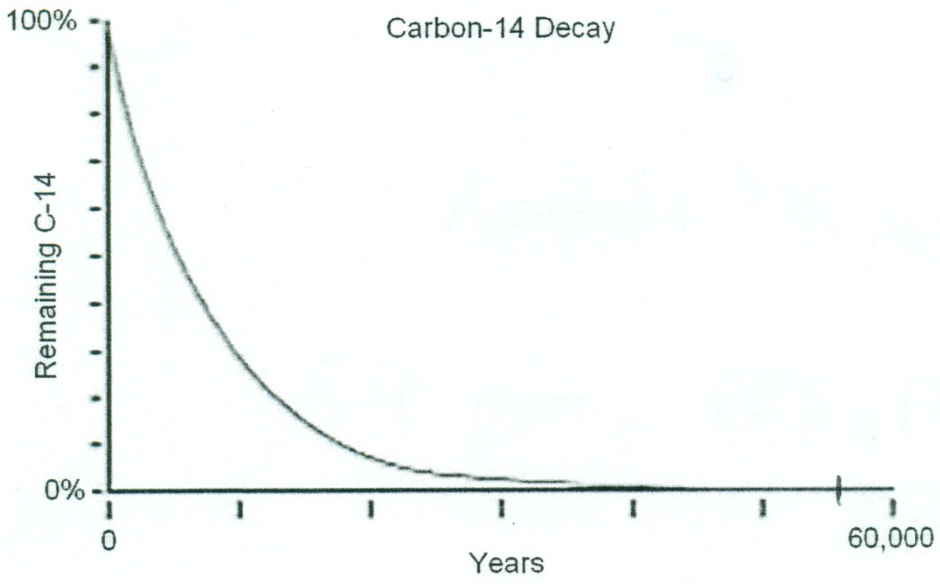
SECTION EUROPEENNE

Épreuve spécifique de sciences physiques en anglais

CARBON-14 DECAY

DOCUMENTS

Play the video : Carbon-14_decay.flv
Use your knowledge, the content of the video and the picture below to answer the questions.



TASK : You need to explain the decay of a radioactive sample and its use for dating.
You can use the topics below and the video ***"carbon-14 decay"*** *to organize or support your presentation, but feel free to use them in any order you like.*

- ✓ What are the differences and common points between carbon-14 and carbon-12?
- ✓ What do you know about the beta radioactivity?
- ✓ What are the other types of radioactivity?
- ✓ Could you explain simply what percentage of carbon-14 is left after 57300 years? Does that explain that "carbon-14 samples can be accurately dated up to 60000 years old"?
- ✓ What other uses of radioactivity do you know?

Correction Radiocarbon dating Test

1. Carbon 12 and carbon 14 belong to the same chemical element called carbon characterised by its atomic number Z or number of protons in the nucleus that is 6. The difference between these two isotopes lies in the number of neutrons in their nucleus: 6 in carbon 12 and 8 in carbon 14. The ratio of the number of neutrons to the number of protons is related to the stability of the nucleus; in a carbon 12 nucleus this ratio is 1 and this makes it very stable while in carbon 14 this ratio is greater than one and this is responsible for the **instability** of the nucleus.
2. Beta radioactivity is either **beta +**: it is the emission of a positron (from the transformation of a proton of the nucleus into a neutron) or **beta -** : it is the emission of an electron (from the transformation of a neutron of the nucleus into a proton).
3. There is also **alpha radioactivity** which is the emission of a helium nucleus and **gamma radioactivity** which is the emission of a very energetic photon or electromagnetic wave with an extremely small wavelength (smaller than the diameter of an atom) following the return of an excited nucleus to its ground state.
   In any case, radioactivity results from the transformation of an unstable nucleus into a more stable one. Moreover it's a spontaneous process (a radioactive nucleus decays on its good time) and it's a random process (nobody can predict when a single nucleus is going to decay).
4. The **half-life** of carbon 14 equals 5,730 years. It means that every 5,730 years the amount of carbon 14 in the sample or its activity (number of **disintegrations** per second) is halved. After 57,300 years which represents exactly 10 half-lives, the percentage of carbon 14 left is only $100 \times 1/2^{10}$ that is approximately 0.1%. The amount of carbon 14 in such an old sample is so low that physicists are unable to accurately date it; as a conclusion, physicists can only date **up to** 60,000 years with this technique.
5. Dating an **archaeological finding** (such as a bone amulet or any other artefact) is not the only application of radioactivity. Radioactivity is also very common in medicine; it can be used in **radiotherapy** or in **imaging**.
   In radiotherapy, gamma rays are **targeted to** cancer cells to destroy them.
   In imaging, radioactive materials are used as **radioactive tracers** which are ingested by the patient and can be followed during their absorption by the organism with special cameras or gamma probes.
   Radioactivity is also used in food industry: **food irradiation** can be used as a bactericide for eliminating the **bacteria** that might be present in food.
   N.B1: chemotherapy is the use of special drugs and must be distinguished from radiotherapy.
   N.B2: the energy released by the decay of radioactive materials is not used to generate heat in nuclear power plants; radioactivity is a by-product of the fission reaction which takes place in the reactor and which is used as the source of energy to turn water into steam.