Exploring radioactivity in the classroom

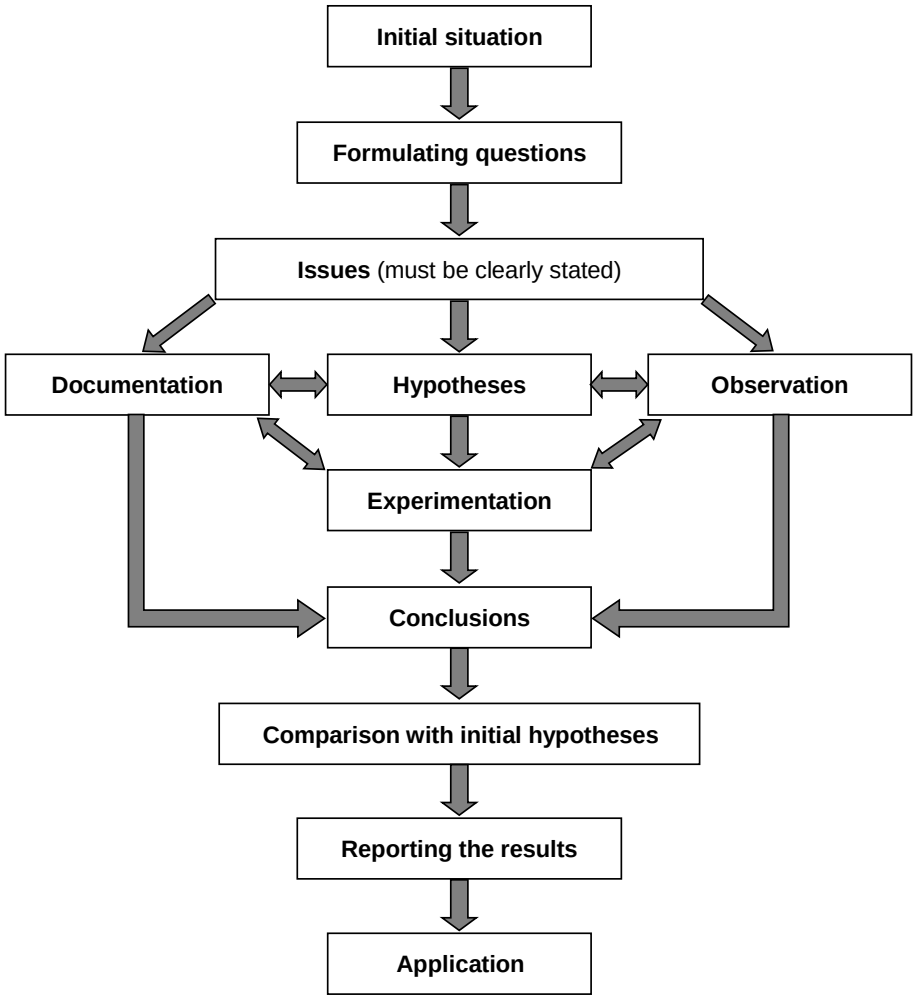
Conducting the workshop

The workshop involves a hands-on approach in accordance with an operation promoted by Nobel laureate Georges Charpak to foster scientific investigation in the classroom (“la main à la pâte “ web site : http://www.inrp.fr/lamap/accueil.html)

- Overview
- Introductory experiments
  - Experiment series 1
  - Experiment series 2
- Formulating the question
- Hypotheses
- Testing the hypotheses (individual challenge for each pupil)
- Final discussion

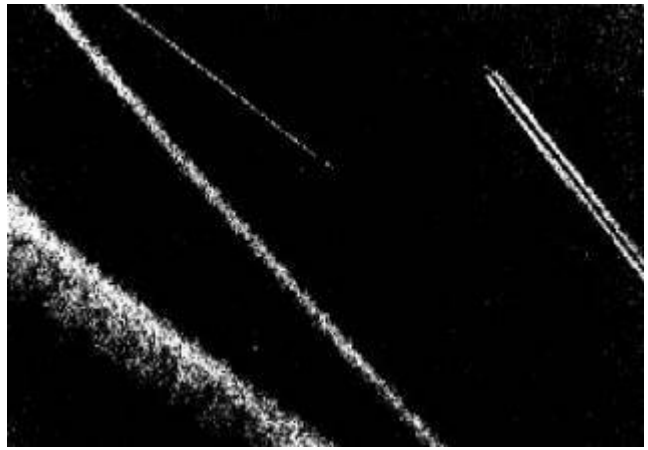
Radioactivity in the classroom

THE SCIENTIFIC APPROACH



Radioactivity in the classroom

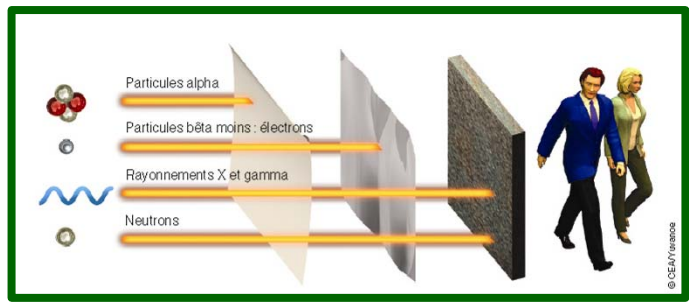
- Overview
  - What is radioactivity?
  - How is it expressed?
  - Where is it?



Radioactivity in the classroom

- **Introductory experiments: Series 1**
  - The first series of experiments makes the pupils aware of the different types of radioactivity despite its invisibility, and provides a simplified overview of their interaction with matter.

- **Material necessary**
  - MIP detector (alpha probe and beta-gamma probe)
  - Fragment of uranium ore, camping gas lantern mantle (optionally a luminous watch dial)



Radioactivity in the classroom

- **Introductory experiments: Series 2**

  The scientific concepts behind these experiments are :

  – *Background noise* due to environmental radioactivity

  – The *randomness* of radioactivity on different types of samples

  Pupils are introduced to *histograms*, notably through a discussion of “normal” (Gaussian) distributions

- **Material necessary**

  – Radon kit (+NaI)

  – Piece of granite, potash

Radioactivity in the classroom

Formulating the questions

How to explain all the observations of experiments 1 & 2?
What is the phenomenon involved?
Why are two measuring instruments used?
Why are the observations different for the two samples?
Why does the signal vary with the distance?
Why is nothing detected behind a sheet of paper or aluminum foil?
Why does the radon + NaI kit measure beta and gamma radioactivity even in the absence of any source?
Why are the measured values not repetitive?

As many questions as necessary to understand the phenomenon.

Radioactivity in the classroom

- **Hypotheses (examples)**

1: Radioactivity exists in nature
even in the absence of any potential source.

2: Radioactivity is a random phenomenon.

3: The material penetrating power is not the same for different types of radiation.

Note: This property is important for radiation protection.

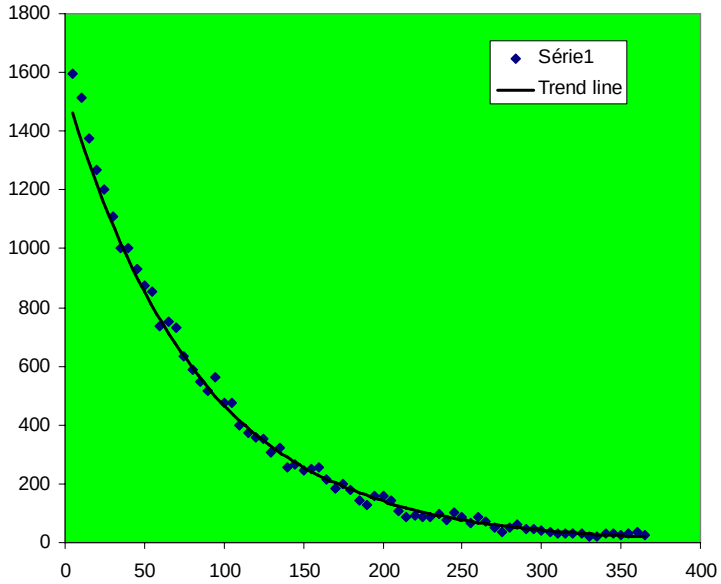
Radioactivity in the classroom

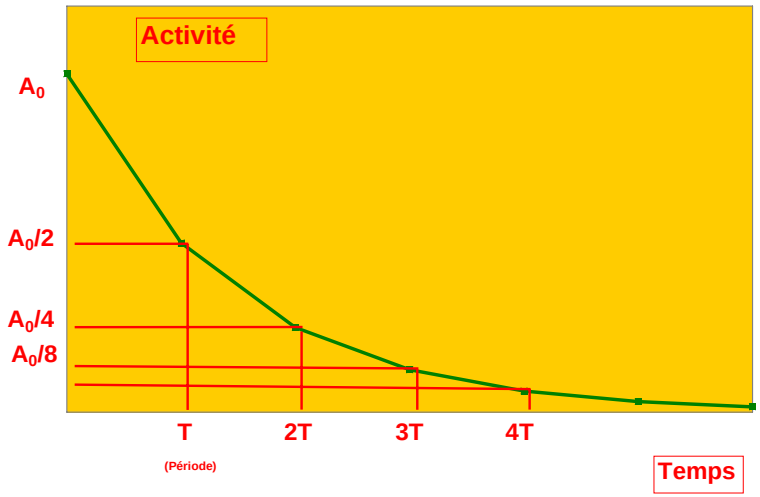
Testing the hypotheses

(Individual challenge for each pupil)

- Example 1:

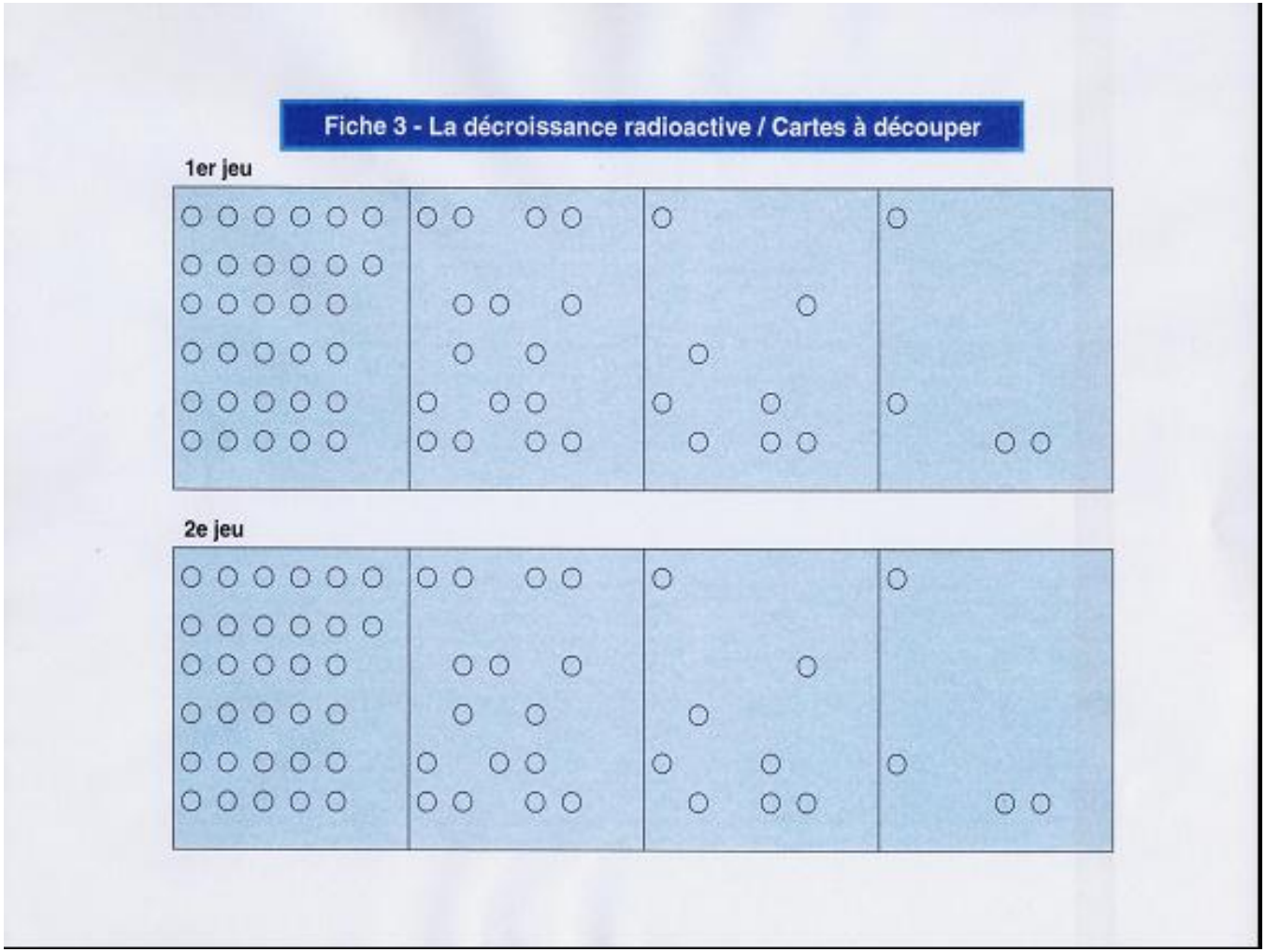
  Study the randomness of natural radioactivity with the “Radon kit” developed by Algade and marketed by Jeulin





le VISIATOME Marcoule

Radioactivity in the classroom



Radioactivity in the classroom

Final discussion : radioactivity applications (examples)

1 : In Earth sciences - dating of the rocks

2 : In Archaeology - dating of the bones, paintings

3 : In Medecine

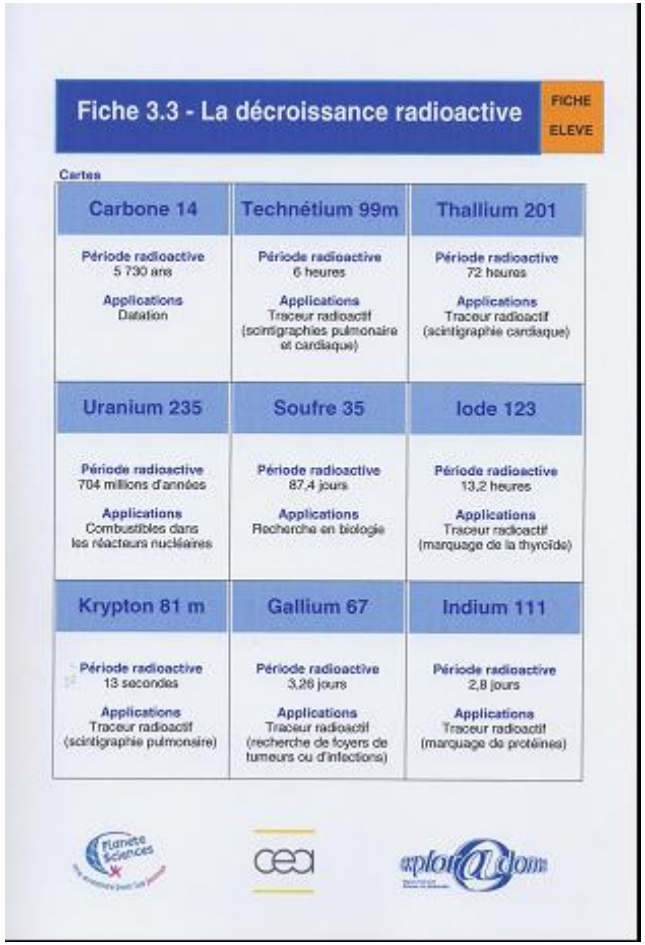
- **radioactive marker**
- **search for cancerous tumour**

Final discussion : radioactivity applications

Example 1 :

The pupils have to classify the elements by chronological order regarding to their half-life time.

Ask them which are the advantages of short-live elements (as they disintegrate quickly, they are used for medical applications)



Fiche 3.3 - La décroissance radioactive — FICHE ELEVE

Cartes

Carbone 14	Technétium 99m	Thallium 201
Période radioactive 5 730 ans **Applications** Datation	**Période radioactive** 6 heures **Applications** Traceur radioactif (scintigraphies pulmonaire et cardiaque)	**Période radioactive** 72 heures **Applications** Traceur radioactif (scintigraphie cardiaque)
Uranium 235	**Soufre 35**	**Iode 123**
Période radioactive 704 millions d'années **Applications** Combustibles dans les réacteurs nucléaires	**Période radioactive** 87,4 jours **Applications** Recherche en biologie	**Période radioactive** 13,2 heures **Applications** Traceur radioactif (marquage de la thyroïde)
Krypton 81 m	**Gallium 67**	**Indium 111**
Période radioactive 13 secondes **Applications** Traceur radioactif (scintigraphie pulmonaire)	**Période radioactive** 3,26 jours **Applications** Traceur radioactif (recherche de foyers de tumeurs ou d'infections)	**Période radioactive** 2,8 jours **Applications** Traceur radioactif (marquage de protéines)

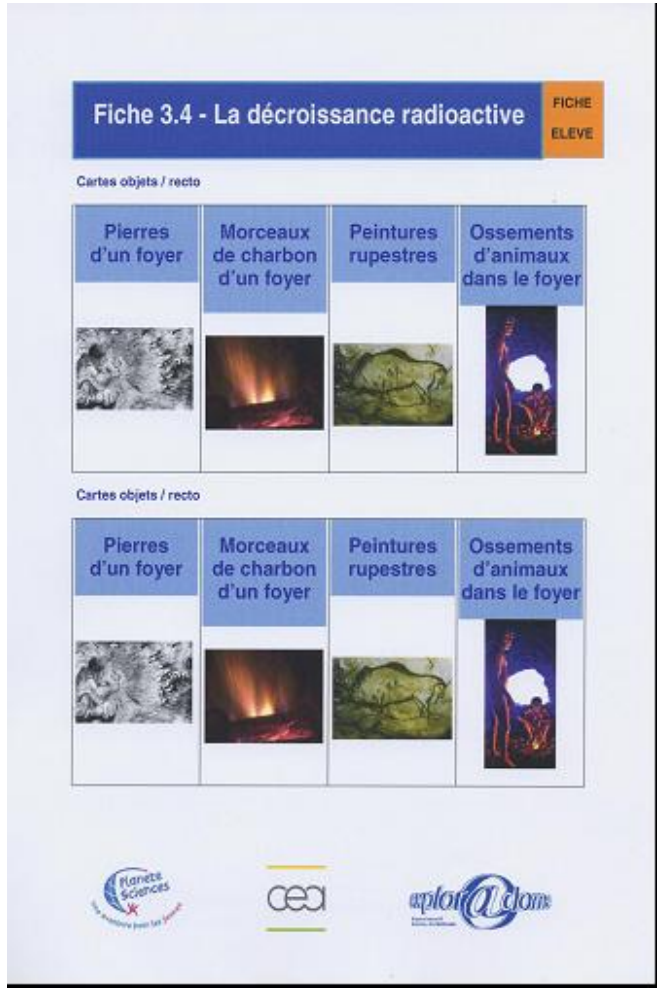
Radioactivity in the classroom

Final discussion : radioactivity applications

Example 2 :

From the table of C^{14} radioactive decrease , ask the pupils to find the age of the various objects shown

Disintegration per minut per gram (DPM/g)	Time (My)
13.6	0
6.8	5568
3.4	11136
1.7	16704
0.85	22272
0.425	27840
0.2125	33408



Radioactivity in the classroom

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