IUPAC Periodic Table of the Isotopes

IUPAC project 2007-038-3-200 with CCE

Update for CCE for August 2010

N. E. Holden, Chairman

Request to CCE

- This task group needs input from CCE to make the IUPAC Periodic Table of the Isotopes as useful as possible in the classroom.
- The task group needs responses relatively soon so that we can complete this product by the end of the year.
- At the end of this PowerPoint presentation are a few questions for CCE.

IUPAC Periodic Table of the Isotopes

We envision that the table of isotopes paper will consist of the following (We are not yet authorized by IUPAC to produce a web product):

1. A color-coded periodic table that explains:
   - all elements are made up of radioactive isotopes, and that many of these elements have stable isotopes
   - what are atomic weights, and why atomic weights may not be constants of nature
   - isotope processes and principles, including radioactive decay, fractionation of isotopes, nucleosynthesis, etc.
   - practical uses of isotopes, a few of which include:
     - isotopes in medical diagnosis and treatment
     - isotopes in industry
     - geochronology
     - isotopes in forensic sciences
     - stable isotope variation and Earth-system processes, e.g., climate change
2. A “basic” data page and an “applications” page for each of the 118 elements

What follows?

Following are early drafts of basic data pages and application pages for three elements:

- mercury
  - example of an element that has two or more stable isotopes and the atomic weight is not a constant of nature
  - atomic weight depends upon the mole fractions of the isotopes in a particular sample
- arsenic
  - example of an element with a single stable isotope
  - atomic weight is a constant of nature because the mole fraction of the stable isotope is 1
- americium
  - example of an element with no stable isotopes
  - has no standard atomic weight

Draft main page

IUPAC Periodic Table of the Isotopes (Main page)

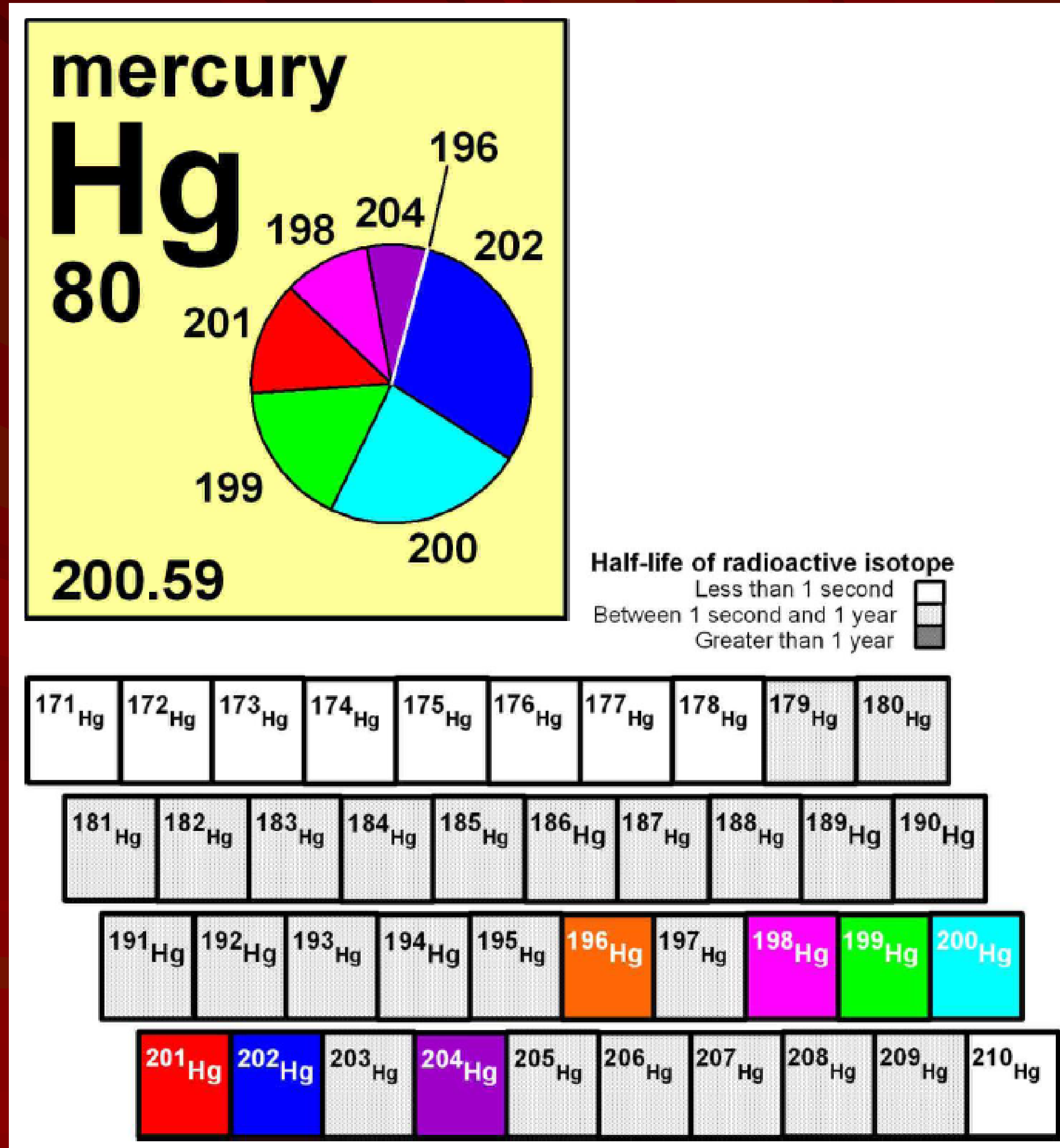
- elements with 2 or more stable isotopes
- elements with a single stable isotope
- elements with no stable isotopes

Key: atomic number / Symbol

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57-71 lanthanoids	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-103 actinoids	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn						

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

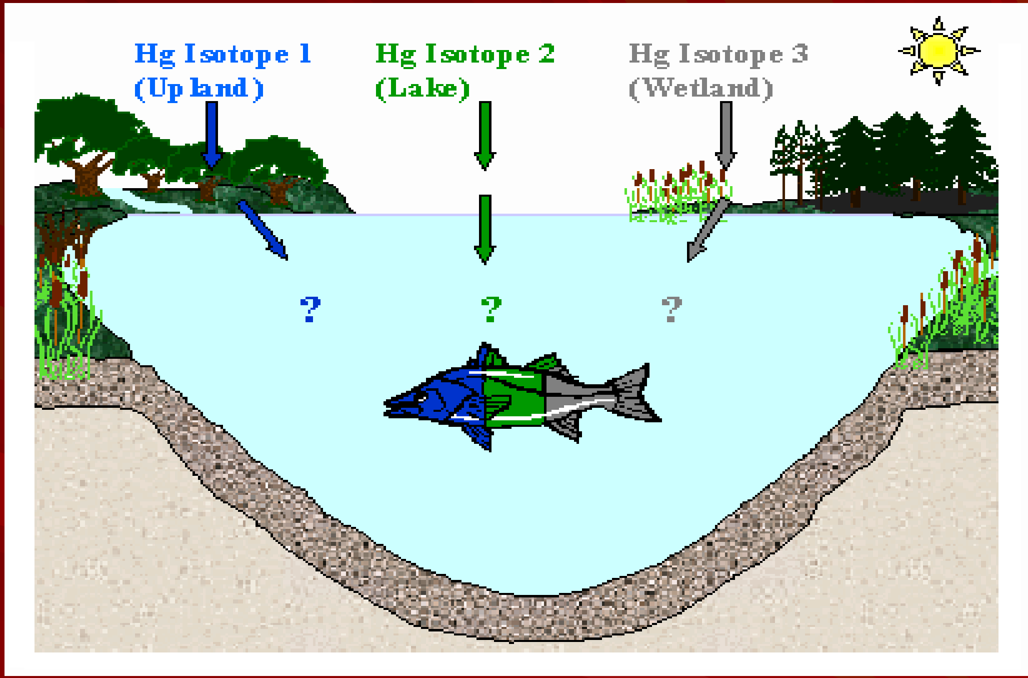
Hg basic data page



Application page example for mercury

Isotopes in the **environment:**

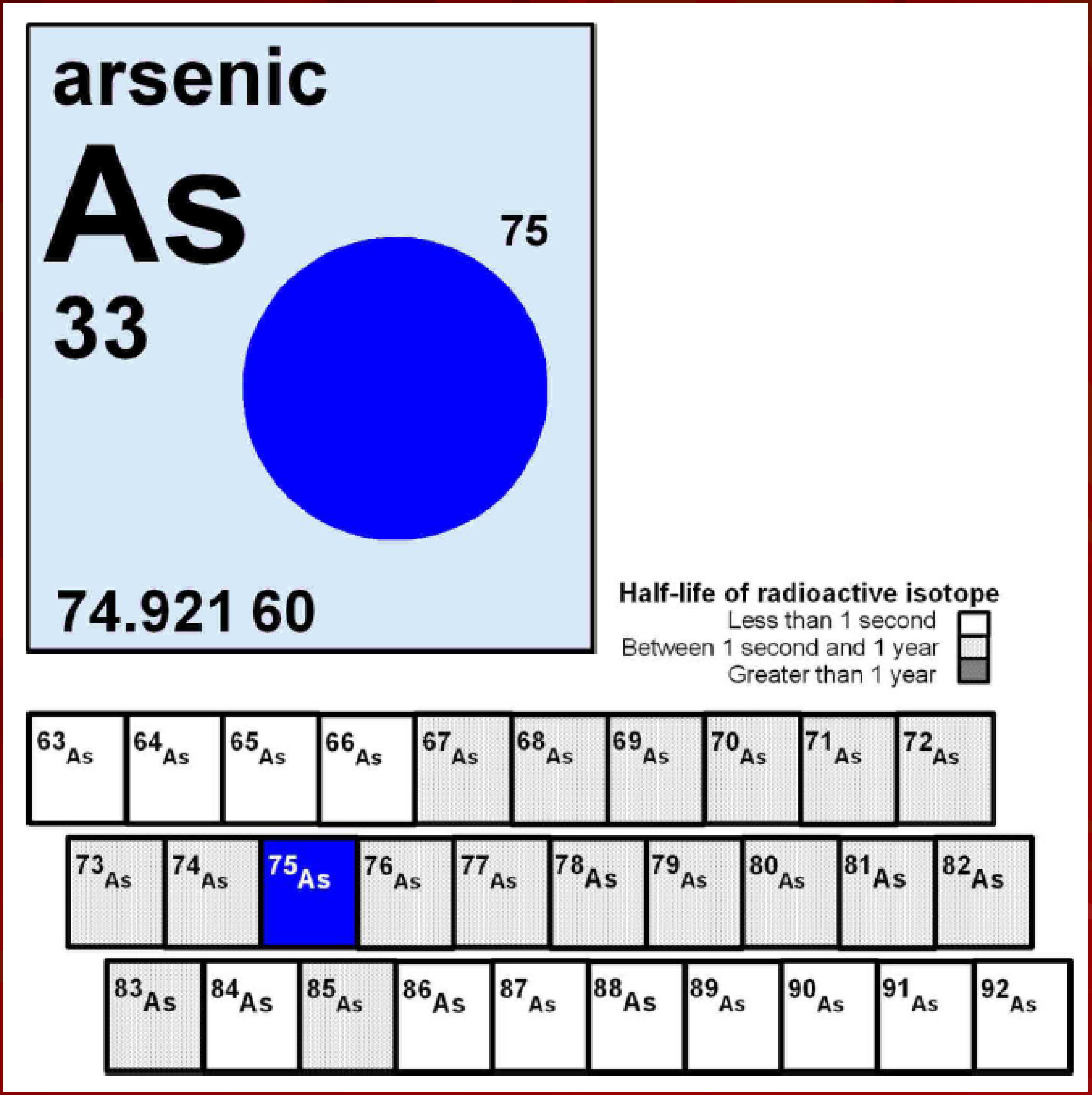
- ^{198}Hg, ^{200}Hg, and ^{202}Hg are stable isotopes that can be used in emission and deposition studies of Hg in aquatic and terrestrial ecosystems. For example, different isotopes of mercury are added to the upland for run-off evaluation, to the lake for direct deposition analysis, and to the wetland for outflow-contribution analysis to determine the entry route of mercury to an ecosystem and to show these different entry routes can affect Hg accumulation in local fish populations.



Stable mercury isotopes are being used to evaluate direct deposition, upland runoff, and wetland outflow contributions to fish mercury levels.

Reference:
http://www.tracesciences.com/hg.htm
http://www.biology.ualberta.ca/metaalicus/metaalicus.htm

As basic data page



Application page example for arsenic

Isotopes in **medicine:**

- ^{72}As and ^{74}As are positron emitters that have long half-lives (26 hr and 17.77 d, respectively) and are a valuable asset in molecular imaging in vivo. These isotopes can be designed to bind to monoclonal antibodies (mab), which attach to and accumulate in tumors of interest. Once the mabs attach to the tumor, the ^{72}As or ^{74}As labeled ligands bind to the mabs and positron emission tomography (PET) is used to visualize the exact location of the tumor.

  PET is a method of imaging where a positron-emitting radioisotope is injected and accumulates in the target tissue. Positrons are emitted as the isotope decays, immediately bombarding nearby electrons, resulting in two identifiable gamma particles emitted in opposite directions. These gamma particles can be detected by a PET camera to provide precise information about their origin and the location of the tumor.

PET scan of a rat with tumors. An x-ray image of the rat is overlaid on the scan.
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Reference:
http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TJM-4KXF23G-2&_user=696292&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1095311718&_rerunOrigin=google&_acct=C000038819&_version=1&_urlVersion=0&_userid=696292&md5=1e804ab8d7f29545283868cde5615c33
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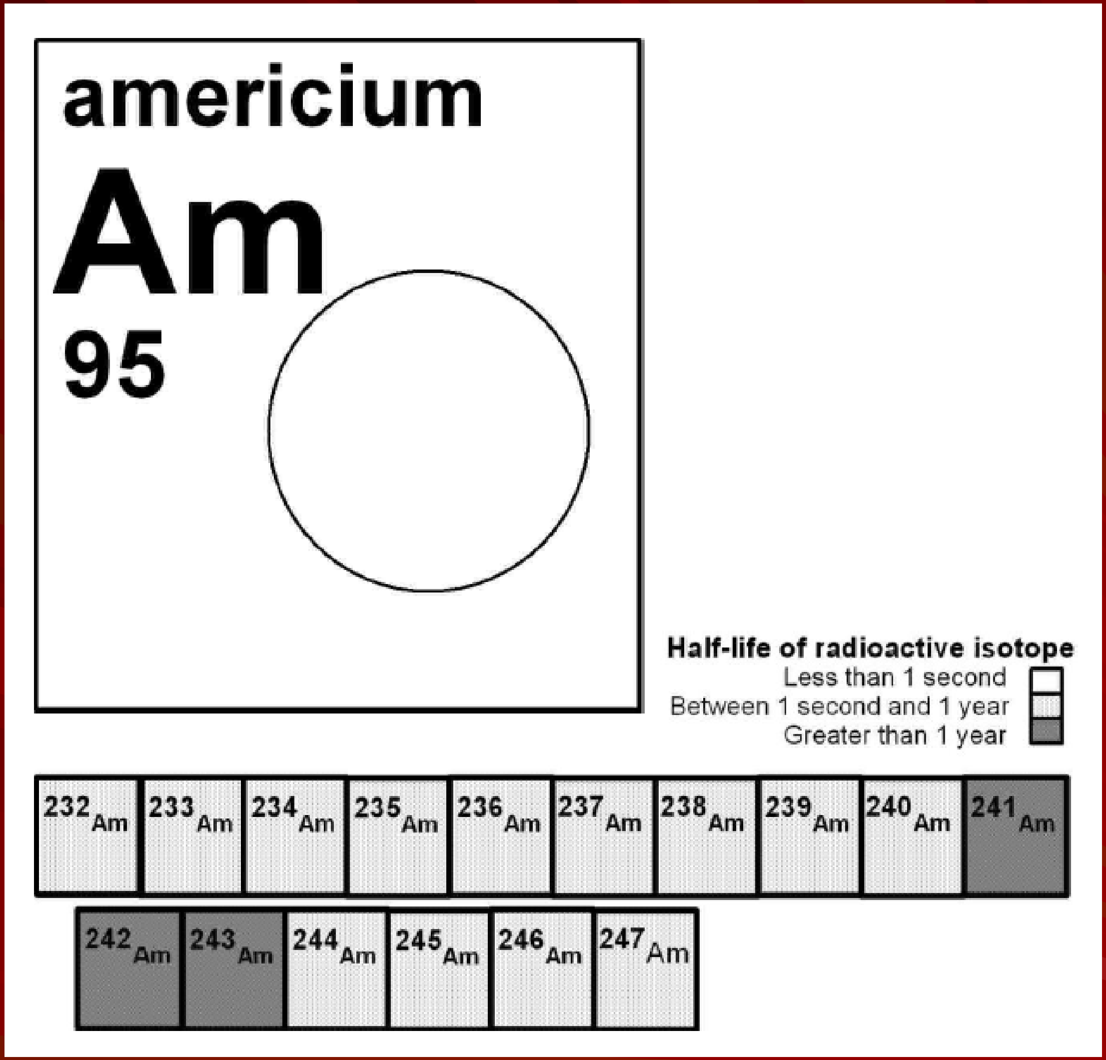
http://www.ne.doe.gov/isotopes/neIsotopes2eMedical.html
http://toxsci.oxfordjournals.org/cgi/reprint/34/2/240.pdf

Am basic data page



Application page example for americium

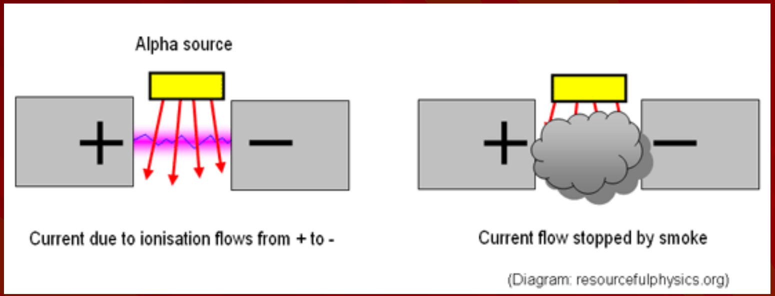
Isotopes in the **home**:

Americium-241 is used in smoke detectors as an ionization source to detect smoke.

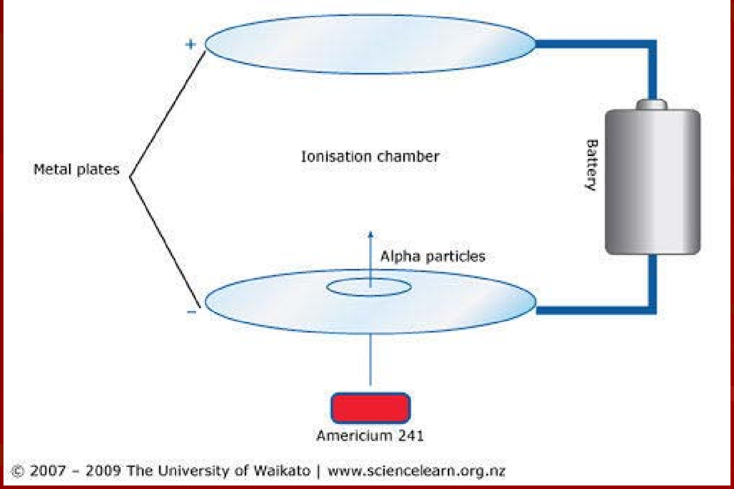
A small piece of americium-241 oxide is inside all such smoke detectors. The americium compound gives off alpha particles that strike air molecules, causing them to break apart into electrically charged pieces called ions. These ions help carry a current from one side of the detector to the other, flowing continuously when only air is present. The alarm sounds if the current is disrupted by smoke in the detector, which absorbs the americium-241 alpha particles, resulting in an incomplete circuit.

Smoke detectors in operation

a.



b.



Reference:
http://www.ead.anl.gov/pub/doc/Americium.pdf
http://images.google.com/imgres?imgurl=http://www.iop.org/activity/education/Projects/Teaching%2520Advanced%2520Physics/Atomic%2520and%2520Nuclei/Images%2520500/img_mid_5295.gif&imgrefurl=http://www.iop.org/activity/education/Projects/Teaching%2520Advanced%2520Physics/Atomic%2520and%2520Nuclei/Radioactivity/page_5479.html&usg=__lJnAQNinw6hw5TqfjmJIYf3ISzs=&h=201&w=586&sz=15&hl=en&start=12&tbnid=ItNvZMotTyZ9vM:&tbnh=46&tbnw=135&prev=/images%3Fq%3Damericium%2B241%2Bsmoke%2Bdetectors%2B%252BDiagram%26gbv%3D2%26hl%3Den%26safe%3Dactive
http://www.sciencelearn.org.nz/contexts/just_elemental/sci_media/images/smoke_detector_operation
http://wwwreno.nrc-cnrc.gc.ca/eng/education/elements/el/am.html

Question 1

We want to emphasize why (and which) isotopes of an element are important in everyday life by giving examples. There are 2 possibilities.

1. We can repeat explanations, as needed, on each element page.
2. Alternatively, to avoid repeating techniques that are used for many elements, we can provide explanations of each technique once in the introduction and then refer to specific applications on each element page, as needed.

Would this repetition of subject material (choice #1 above) be preferable for student comprehension, or is #2 the best approach?

Question 2

- Our concern now is that we might be trying to include too much material in a restricted “paper” product.
- We are concerned that we may still suffer from the urge to include “everything” that any “expert” might wish to know rather than what competency or skill the student should retain after being exposed to the material.

How much material should be included in the introduction for students?

Question about the teachers' guide

- How much detail is preferred by the teacher?
- Should mere references to background information be provided?
- We are not planning to indicate uncertainties on the data provided. The use of uncertainties might be beyond the level of information normally presented to students and require additional explanations. Is this a reasonable assumption?
- Where would the learning objectives for students be listed, and where would the competencies and skills that the students would be expected to have after completion of this course of material be provided?
- Would this type of information appear in the teachers' guide or would that information be provided somewhere else?

Question about the pilot study

- What is involved in a pilot study, and do we need to provide anything beyond the material we are now preparing?
- How is the necessary feedback to be obtained?
- Most of our ideas involved the use of a web-site and a response button, but this study must precede any web application. What type of questions should be asked, and how should they be presented?
- Are there things that we should be aware of in designing the feedback mechanism?
- Who from CCE might be willing to guide or assist in this pilot study?

Questions about Face-book pages

The task group has briefly discussed the potential use of a face-book page to provide user interaction. Our concern is not the preparation of such a page, but rather maintenance of the page to keep it current at all times.

You (the Chairman of CCE) had suggested incorporating material on this Periodic Table of Isotopes on the IYC-2011 face-book page.

- Does CCE have any thoughts about this proposal?
- Would students be inclined to make use of a Face-book page, and would the effort be productive time-wise?

Questions about timing and completion date

The task group has been asked by IUPAC Secretary General David Black to try to have our material ready for IYC-2011. I know that your Committee has a group or sub-committee for IYC-2011.

- Is there a method for attempting to incorporate our material within the whole IYC-2011 effort, beyond preparing material for a face-book page?
- Will adjustments be needed to tie-in the material with any IYC-2011 activities?