



**Radioactivity - Radionuclides - Radiation**  
**8th Multi-Media Training Course with Nuclides.net**  
**(Institut Jozef Stefan, Ljubljana, 13<sup>th</sup>-15<sup>th</sup> September 2006)**

Wednesday, 13<sup>th</sup> September 2006

**Case Study: Nuclide Charts-Nuclear Data-Searchable database**

**Exercises**

Veronique BERTHOU

European Commission  
Institute for the Protection and the Security of the Citizen  
Nuclear Safeguards Unit  
Via E.Fermi 1, 21020 Ispra, Italy  
E-mail: [veronique.berthou@jrc.it](mailto:veronique.berthou@jrc.it)



# Computer exercise

- *Decay Heat Calculation:*

A transport package contains 10 g of H3 and  $10^{-2}$  g of U237

The safety officer wants to evaluate the heat from the package

- Step 1:

- 1) What daughters can we expect in the package?
- 2)  $\gamma$  spectrometry is used to check the contains of the package. Which main  $\gamma$  lines will be measured?

Use the Datasheets



File Navigation Charts Data Search Applications Information

Periodic Zoom Chart Data Search Decay Dosimetry Virtual UNC Forum News Help

**nuclides.net** **237 U** **DataSheet**

Print	FactSheets	Notes	Averaged Cross sections
<b>Mass Excess</b> 45386.1 (± 20) keV	<b>Mass</b> 237.0487240 (± 21) u	<b>Half-life</b> 6.75 (± 1) d	<b>Abundance</b> -
<b>Spin</b> 1/2	<b>Parity</b> +	<b>Binding Energy</b> 7.576 MeV	<b>Daughters</b> 93 Np 237
<b>Type of decay</b> β-	<b>Branching ratio</b> 1.00E+00	<b>Decay Energy, Q(MeV)</b> 0.52	<b>Photon(keV)</b> 143
<b>Mean Decay Energies</b>	<b>Alpha(MeV)</b> 0	<b>Electron(keV)</b> 199	
<b>Effective Dose Coefficient Ingestion (Sv/Bq)</b> 7.7000E-10	<b>Effective Dose Coefficient Inhalation (Sv/Bq)</b> 1.900E-09	<b>Reference Annual Dose Workers</b> 20 mSv	<b>Reference Annual Dose Public</b> 1 mSv
<b>Gamma</b>	<b>Beta -</b>	<b>e-</b>	<b>X</b>
<input type="checkbox"/> Null <input checked="" type="checkbox"/> stable	<b>AC231</b> 7.5 m	<b>AC232</b> 1.98 m	<b>AC233</b> 2.42 m
<input type="button" value="Select all"/> <input type="button" value="Select none"/>	<b>AC234</b> 44 s	<b>AC235</b> 40 s	<b>AC236</b> 2 m

nuclides.net **237 U** DataSheet

Print FactSheets Notes Averaged Cross sections

**Gamma Rays <sup>237</sup>U**

Number of spectra: 23      ΣE.P(eV per disintegration): 7.7274E+04      [Graph](#)

Energy(eV)	Emission probability
59536	3.4500E-01
208000	2.1600E-01
26340	2.2200E-02
164580	1.8700E-02
64832	1.3100E-02
332354	1.2100E-02
267540	7.3000E-03
51005	4.5000E-03
33190	1.1200E-03
370934	1.1000E-03
335405	9.7000E-04
13810	6.1000E-04
368605	4.2000E-04

Daughter Np237

Main γ lines:

59 keV & 2.08 MeV

nuclides.net **<sup>3</sup>H** DataSheet

Print FactSheets Notes Averaged Cross sections

<b>Mass Excess</b> 14949.794 (± 1) keV	<b>Mass</b> 3.016049282 (± 1) u	<b>Half-life</b> 12.33 (± 6) y	<b>Abundance</b> -
<b>Spin</b> 1/2	<b>Parity</b> +	<b>Binding Energy</b> 2.827 MeV	
<b>Type of decay</b> β-	<b>Branching ratio</b> 1.00E+00	<b>Decay Energy, Q(MeV)</b> 0.02	<b>Daughters</b> 2 He 3
<b>Mean Decay Energies</b>	<b>Alpha(MeV)</b> 0	<b>Electron(keV)</b> 5.71	<b>Photon(keV)</b> 0
<b>Effective Dose Coefficient Ingestion (Sv/Bq)</b> 1.8000E-11	<b>Effective Dose Coefficient Inhalation (Sv/Bq)</b> 2.600E-10	<b>Reference Annual Dose Workers</b> 20 mSv	<b>Reference Annual Dose Public</b> 1 mSv

Beta -

Daughter He3

No γ lines:



# Computer exercise

- *Decay Heat Calculation:*

A transport package contains 10 g of H3 and  $10^{-2}$  g of U237

The safety officer wants to evaluate the heat from the package

- Step 2:

1) What is the heat generated by 10g of H3 and 0.01 g of U237? (Use Factsheets)

2) What is the total dose rate at 1 m ?

*Hints: Heat = Isotopic Power x Mass*

*Dose = Mass x Specific Activity x Specific Dose Rate*



Nuclide :<sup>3</sup> H

Half-Life =	1.23E+01 y
Average or mean lifetime =	1.78E+01 y
Specific Activity =	3.56E+14 Bq/g
<b>Heat Generation:</b>	
Isotopic Power( $\alpha$ ) =	0.0E+00 W/g
Isotopic Power( $\alpha+\beta$ ) =	3.25E-01 W/g
Isotopic Power( $\alpha+\beta+\gamma$ ) =	3.25E-01 W/g
<b>Radiotoxicity:</b>	
Annual Limit of Intake (ALI) for Inhalation* =	7.69E+07 Bq
Annual Limit of Intake (ALI) for Ingestion* =	1.11E+09 Bq
Derived air concentration (DAC)* =	3.21E+04 Bq/m <sup>3</sup>
Derived water concentration (DWC)* =	1.22E+06 Bq/litre
<b>Packaging &amp; Transport:</b>	
Activity limits for special form materials, A1 =	40 TBq
Activity limits for normal form materials, A2 =	40 TBq
Notes: all forms	
Mass(A1) =	1.12E-13 g
Mass(A2) =	1.12E-13 g

stable     Select none

Heat = Isotopic Power x Mass

For U237: Heat = 166x0.01 = 1.66 W

For H3: Heat = 0.325x10 = 3.25 W



Nuclide :<sup>237</sup> U

	Half-Life =	6.75E+00 d
	Average or mean lifetime =	9.72E+00 d
	Specific Activity =	3.02E+15 Bq/g
<b>Heat Generation:</b>		
	Isotopic Power(α) =	0.0E+00 W/g
	Isotopic Power(α+β) =	9.65E+01 W/g
	Isotopic Power(α+β+γ) =	1.66E+02 W/g
<b>Gamma Emission:</b>		
	Specific Gamma Dose Rate at 1m =	2.39E-01 μSv/MBq.h
<b>Radiotoxicity:</b>		
	Annual Limit of Intake (ALI) for Inhalation* =	1.05E+07 Bq
	Annual Limit of Intake (ALI) for Ingestion* =	2.6E+07 Bq
	Derived air concentration (DAC)* =	4.39E+03 Bq/m <sup>3</sup>
	Derived water concentration (DWC)* =	2.84E+04 Bq/litre

Dose = Mass x Specific Activity x Specific Dose Rate

For U237: Dose = 0.01x3.02x10<sup>12</sup>x0.239 = 7.2x10<sup>9</sup> μSv/h

For H3: No γ Dose Rate



# Computer exercise

- *Decay Heat Calculation:*

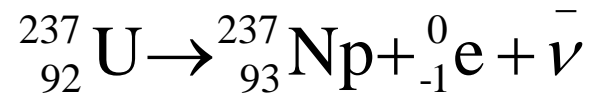
A transport package contains 10 g of H3 and  $10^{-2}$  g of U237

The safety officer wants to evaluate the heat from the package

- Step 3:

1) In the decay of U237 what's the total decay energy (Q value) ? (use Datasheets)

2) What's the energy of the anti-neutrino?



3) What is the total energy (and thus heat) carried away by the anti-neutrino?



nuclides.net		237 U		DataSheet	
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<b>Gamma</b>	<b>Beta -</b>	<b>e-</b>	<b>X</b>		

$$Q \text{ value} = 0.52 \text{ MeV}$$

$$E_{\nu} = 520 - 199 - 143 = 178 \text{ keV}$$

$$\%E_{\nu} = 178 / 520 = 34\%$$

If one calculates the decay heat using the Q value:

$$\begin{aligned} \text{Heat} &= Q(\text{eV}) \times \text{Activity (Bq)} \times 1.6 \times 10^{-19} \\ &= 0.52 \times 10^6 \times 3 \times 10^{13} \times 1.6 \times 10^{-19} \\ &= 2.5 \text{ W} \end{aligned}$$

(Exact calculation 1.66 W i.e. false by 34% carried away by the anti-neutrino)