ACTIVITY AND HALF-LIFE

OCR A LEVEL PHYSICS H556
Module 6: Particles and medical physics
6.4 Nuclear and particle physics
6.4.3 Radioactivity
d) activity of a source; decay constant λ of an isotope; $A=-\lambda N$
e) i) half-life of an isotope $\lambda t_{1/2} = \ln(2)$
f) i) equations describing activity

Outline = how mathematics describes the process of radioactivity

Text book reference = pages 227-234

Independent study = page 229, 232 and 234 questions

What is this lesson all about?

- What is activity?
- What is half-life?
- What determines half-life (affects it)
- How to investigate half-life
- A lot of mathematics (modelling decay)
- Safety

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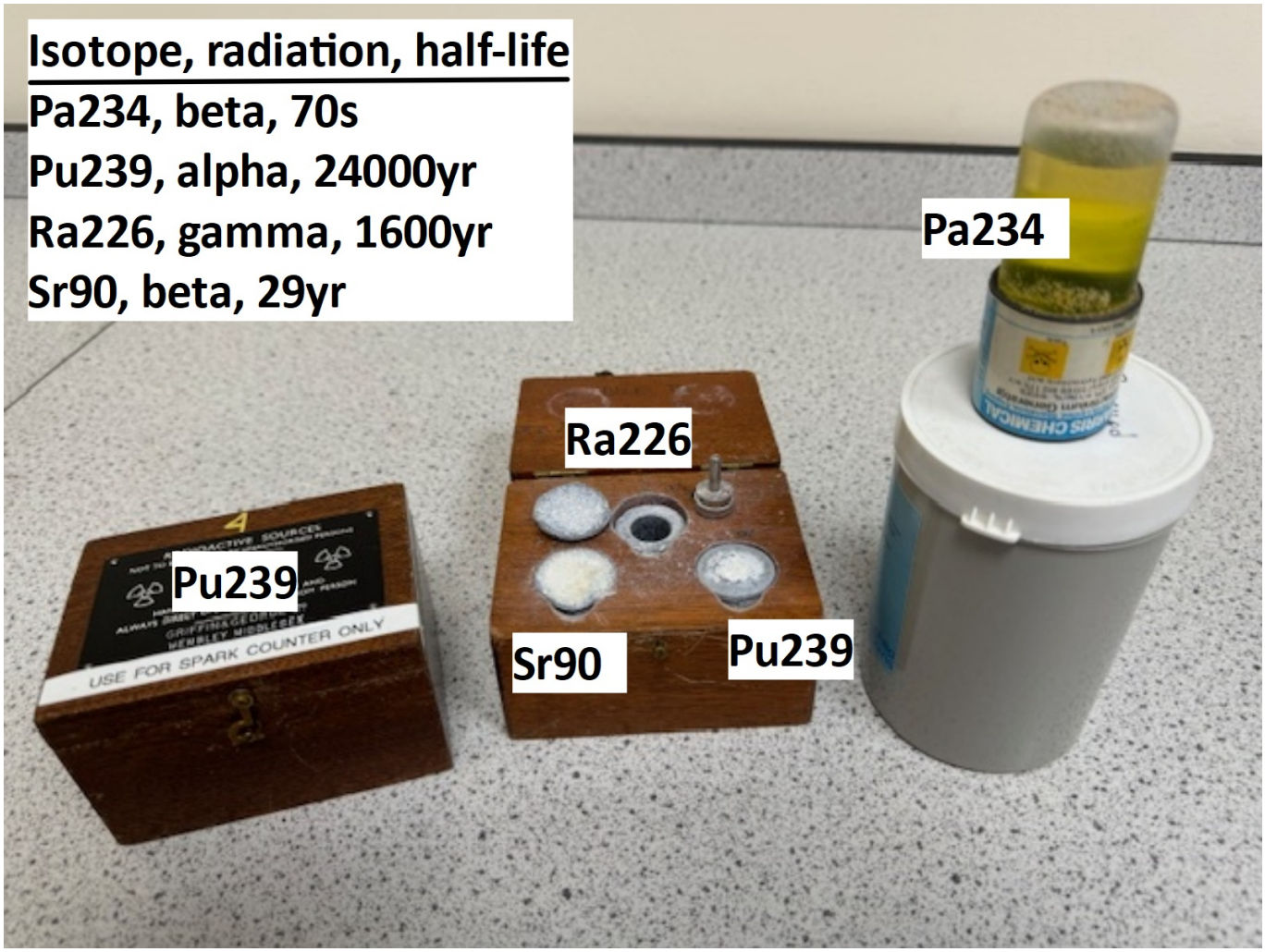
Key concepts

- Radioisotopes = those that can radioactively decay*
- Radionuclide = nucleus of radioisotope
- Radioactivity = spontaneous emission of ionising radiation
- Ionising = can cause particles to become charged
- Activity = emission per unit time
- Activity falls with time as particles decay

*examples of our sources below



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Half-life

- The **time for activity to fall to half of an initial value**
- The **time for half of the radionuclides to decay**

Half-life neat tricks ...

- proportion of nuclei undecayed = $1/2^n$
- number of undecayed = $1/2^n$ x initial counts

... where n is the number of half lives

What affects half-life?

Half-life is determined by the isotope and NOTHING else!

- independent of temperature
- independent of pressure
- independent of chemical reactions

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Mathematical modelling of radioactivity

- $A = dN/dt = -\lambda N$

Where:

A = activity / Bq (bequerel)
N = number of radionucides
t = time / s
λ = decay constant / s^{-1}

Decay constant

The decay constant is a measure of the probabilty of a radionuclide decaying.

Decay constant = decays per particle per unit time

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Mathematical modelling of radioactivity

- $N = N_o e^{-\lambda t}$

Where:

N = number of radionucides
N_o = initial number of radionucides
λ = decay constant / s^{-1}
t = time / s

And it is also true that ...

- $A = A_o e^{-\lambda t}$

Where:

A = activity / Bq
Ao = initial activity / Bq
λ = decay constant / s^{-1}
t = time / s

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Half life and the decay constant

- $\lambda t_{1/2} = \ln(2)$

- Can you work out why?

Where:

λ = decay constant / s^{-1}
$t_{1/2}$ = half-life / s

Independent study

- Page 229, 232 and 234 questions from your text book