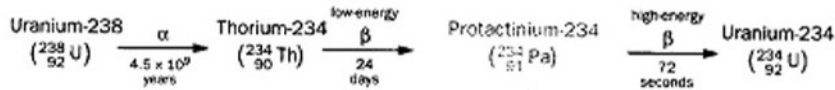


# Half-life

## Introduction

The time taken for the activity of a radioactive source to reduce by half is called the half-life of the source.

You are going to measure the half-life of protactinium 234. This is a beta-emitting decay product in the decay of uranium-238; part of the series is given above:



Decay series of uranium-238

The protactinium-234 is extracted almost completely by an organic solvent, such as amyl acetate, from an acidified aqueous solution of uranyl nitrate (which contains proportionally, 1g uranyl nitrate, to 3 cm<sup>3</sup> water, to 7 cm<sup>3</sup> concentrated hydrochloric acid). Only the high-energy beta particles from the decay of protactinium-234 are detected by a G-M tube.

## Apparatus

Datadisc Au  
Radioactive Count Rate sensor  
Logbook XD, ML or SE



A serial lead or USB-serial lead



Protactinium

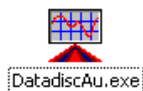
## Duration

30 minutes

## Method

1. Plug the Logbook into the PC using a serial lead or USB-serial lead.
2. Plug the Radioactive Count Rate sensor into port 1 or 3 according to the Logbook you are using.

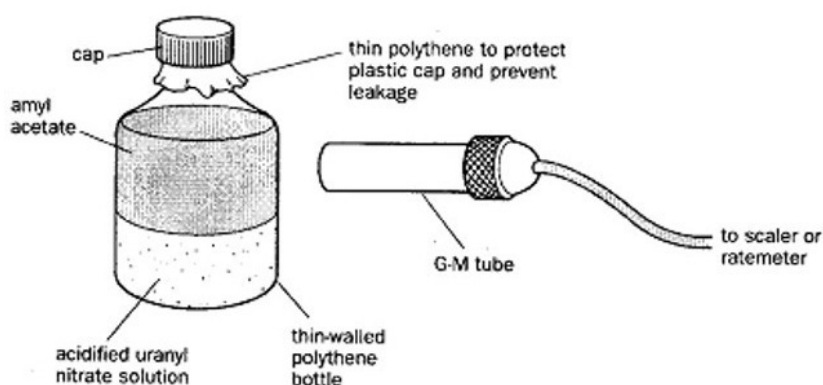
3. Start Datadisc Au.



4. Click on "Measure".
5. Click on "Auto time". Then the recording window will open.
6. Choose the channel you want to measure on the toolbar if you are using Logbook ML or SE.
7. To make the recording:

Equal volumes of the organic and aqueous solutions are contained in a thin-walled, stoppered, polythene bottle so that each layer is as deep as the width of the G-M tube window.


- a. Well shake the bottle and then arrange it as in the figure below with the G-M tube opposite the top half of the bottle.



Measuring the half-life of protactinium-234

- b.  Click on the green recording icon on the toolbar: this starts the recording.

As soon as the layers have separated, the scaler or ratemeter connected to the G-M tube is started and counts taken at ten-second intervals without stopping the counter. After allowing for the background count, a graph of count-rate against time can be plotted.

- c.  Stop recording by clicking on the red hand about 10 minutes after starting. You can see the time on the X-axis.

8. Click on "Keep this data".



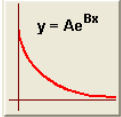
## How to save your recording

1. Click on "File".
2. Click on "Save as...".
3. Choose the directory you want to save in and type the name of your file.

- Click on "Save".

### How to find the half life

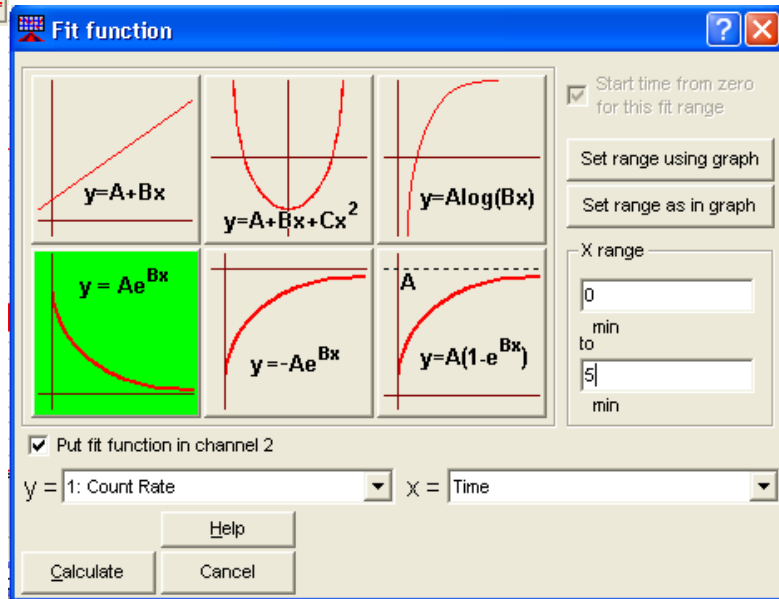
- Click on "Data".
- Click on "Fit".
- Click on "Auto". The "Fit function" dialogue will open.

- Click on .

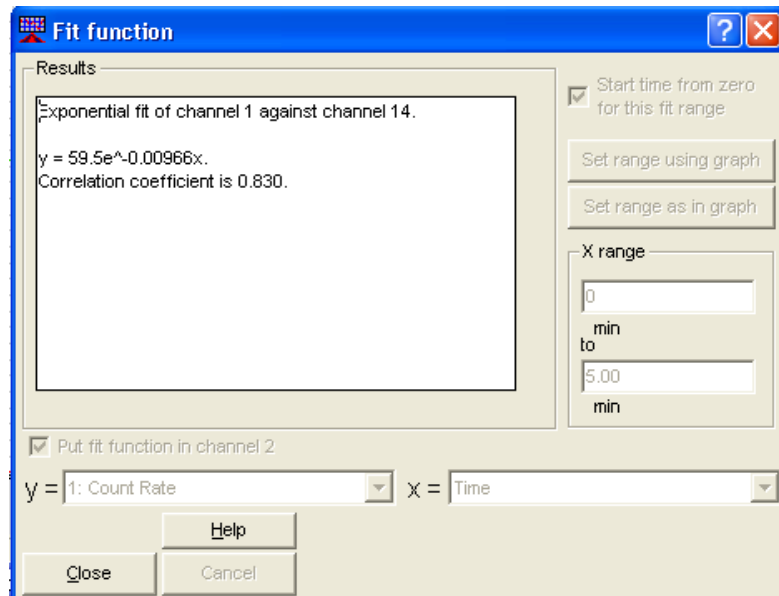
- The X range chosen is, automatically, the whole range of the recording. You can amend it by choosing only the first minutes.

- Choose the function you want to fit: Count Rate against time.

- Click on "Calculate".



- A new window will appear, giving the function. You can then calculate the half life.



Here, you can read:

$$\text{Activity} = 59.5 * e^{-0.00966 * t}$$

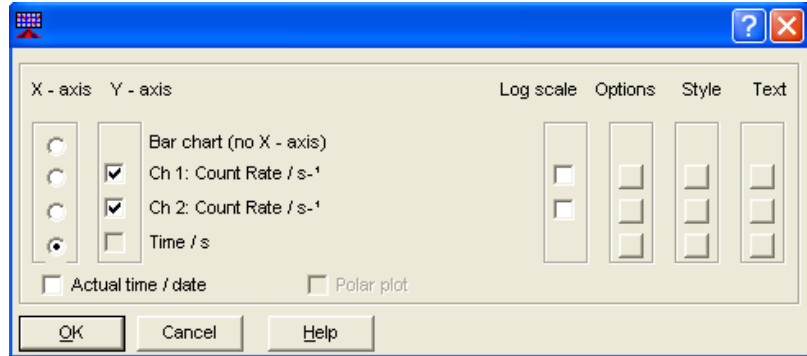
So, half-life =  $\ln 2 / 0.00966$  = 71.7s.

The correct answer is 105s.

- Click on "Close".

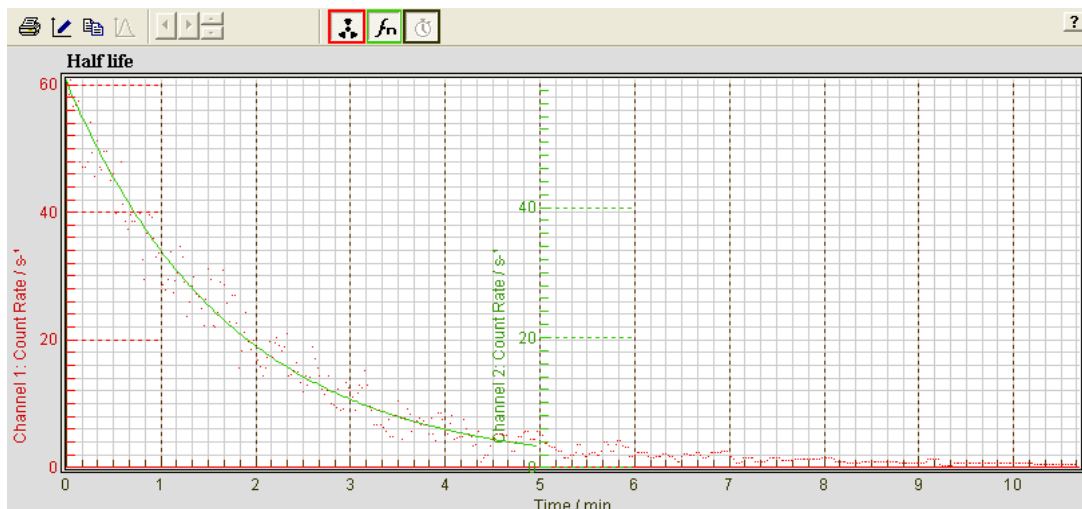
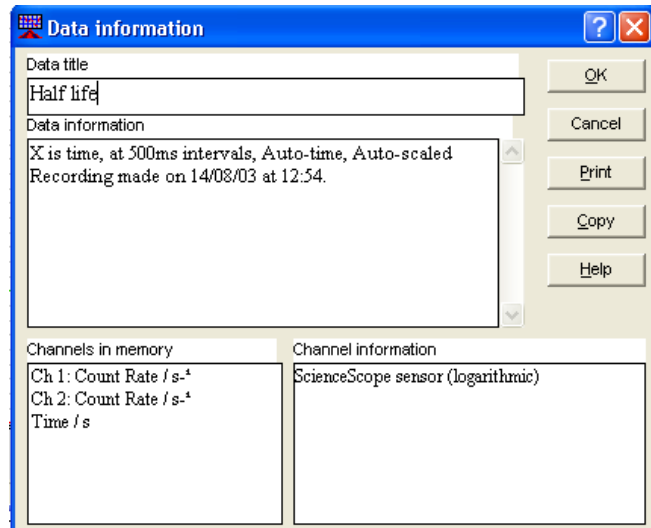
## How to amend the graph

1. Click on "Graph".
2. Click on "Set axes...".
3. Remove all the "Log scale".
4. Click on "OK".



## How to store information about your recording

1. Click on "Data".
2. Click on "Data information".
3. Type all the information you want in "Data title" and "Data information".
4. Click on "OK".



## **How to save your file and exit**

1. Click on "File".
2. Click on "Save".
3. Click on "File".
4. Click on "Exit".