Post-IGCSE Physics Course: Experimental Physics using Data Loggers and Computers

Radioac Lye decay

Atomic Physics

ast updated April/May 2017

Experimental setup

Transit bucket for radioactive source (from radiation store)

> Geiger-Muller tube sensor for PASCO datalogger

or carrying

(1868-195)

I III WAS INTERNED

Protactinium

generator

66

Retort stand

PASCO datalogger USB hub. Turn it on (switch on the back), *then* run CAPSTONE for maximum enjoyment

Windows PC running CAPSTONE software

(1872-1946)

(1874-1937)



Make sure you point the GM tube in the middle of the *upper* layer of liquid in the Pa generator (it will naturally separate into two layers)

If you don't point the GM tube horizontally you may detect some of the other radiation from the Uranium or Thorium atoms in the mixture.

um Generator en inner bottle

GM tube in operation



Organic solvent layer -the only one which will dissolve molecules with the the beta source Pa-234

Pro

Lower layer which will contain the Uranium and Thorium radioactive atoms. Don't point the GM tube at them!



238 92 $^{234}_{90}$ Th + $^{4}_{2}\alpha$ 234 [,] $^{234}_{91}Pa + ^{0}_{-1}\beta$ $^{234}_{91}$ Pa – $\rightarrow {}^{234}_{92}U + {}^{0}_{-1}\beta$

Acidic aqeous solution of uranyl

> Shake bottle before use to introduce Protactinium into solvent layer. The other atoms in the decay chain are not soluble in this layer.

Note Thorium-234 has a half life of 24 days. Uranium-238 and Uranium-234 have long half lives of 4.5 billion years and 246,000 years respectively, so their activity can be assumed to be constant!

Run the CAPSTONE software and bring up a table and graph.

Check the **GM tube detector** is associated with the USB hub by clicking on **Hardware Setup.** (Click on the active port if a radiation symbol is not present).

The GM tube sensor records **counts per sample.** 10s is appropriate for a 'sample time.' Too small and the exponential decay in activity will be hard to see since the max total activity is only about 20Bq.

To large and you won't construct a smooth decay curve.

10s is goldilocks i.e. 'just right.'

[Graph title here]

e (s)



Click in the table. Ctrl+a to select all Then Ctrl+c to copy to clipboard.

Paste into a text file (e.g. via Notepad)



Edit Workbook

📸 Page #1 😽

Display Journal

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Help

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Drag the text file into an **Excel** window to import the data. It will already be space (or tab?) delimited. Excel is smart enough to put it into columns, so don't edit the text file. Just drag it in.

Plot graphs, work out logarithms etc to work out the background rate and then the half life.

	А	В	С	D	E	F	G	Н	1	J	К	L	М	N		
1																
2	Half life of Protactinium. 2nd May 2017.															
3	Winchester College. Lab P6.							Background	l /Bq	0.5						
4																
			Activity /Bq				Counts /10s (not background adjusted) vs time									
		Geiger Counts	(background		MODEL			counts / 105 (not background aujusted) vs time								
5	Time (s)	(counts/10s)	adjusted)	In(Activity)	of activity		120									
6	10	0	-0.5	#NUM!	18.61		110	++								
7	20	63	5.8	1.758	16.94		_	*								
8	30	89	8.4	2.128	15.43		100									
9	40	114	10.9	2.389	14.04		90	+ +								
10	50	109	10.4	2.342	12.79		80	+++			10					
11	60	113	10.8	2.380	11.64		10	+		Usefi						
12	70	108	10.3	2.332	10.60		0 T			plot d	of the raw	data.				
13	80	82	7.7	2.041	9.65		S 60	+ +		llset	his to dete	rmine				
14	90	76	7.1	1.960	8.79		DO 50	+++		back	background level					
15	100	80	7.5	2.015	8.00		0	-	+	Such	5.04.14.101					
16	110	90	8.5	2.140	7.28		40		+							
17	120	79	7.4	2.001	6.63		30		+++++.							
18	130	54	4.9	1.589	6.04		20		+ +							
19	140	58	5.3	1.668	5.50		20		+#+		т.					
20	150	55	5	1.609	5.01		10		t	+++ + + ++ ++ + +++ +++	++++++++++++++++++++++++++++++++++++++	+++ ++++++++++++++++++++++++++++++++++				
21	160	54	4.9	1.589	4.56		0			· · · · · · +	+ +++ ++	+ + + +	"++			
22	170	50	4.5	1.504	4.15			0	200	400	600	800	1000	1200		
23	180	44	3.9	1.361	3.78					ti	ime/s					
24	190	50	4.5	1.504	3.44											
25	200	20	2.4	1 224	2 1 2											







A nice final graph is the (processed) data overlaid with the model.

clamp

The 'degree of fit' will come from the straight line graph. This one is to summarize your understanding and help communicate your results clearly.



iso-butyl methyl ketone

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MODEL

half life /s 73.9 i.e. background adjusted activity at t0 A0/Bq 8 t0 /s 100

