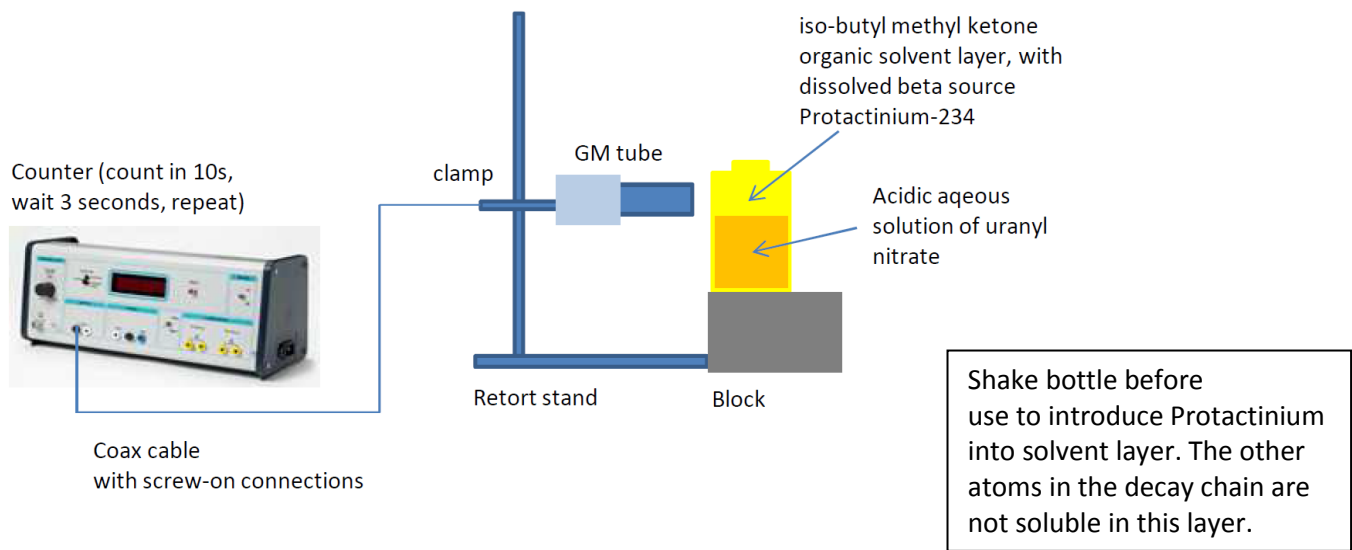


Half life of Protactinium experiment

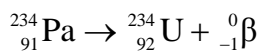
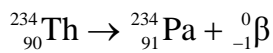
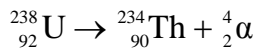
NAME: HOUSE: DATE:

Experimental setup



Radioactive decay chain

Protactinium-234 decays via beta emission. Compared to the other isotopes in the decay chain it has a very short (and therefore easily measurable) half life.



Isotope	Half-life
${}_{92}^{238}\text{U}$	4.5 billion years
${}_{90}^{234}\text{Th}$	24 days
${}_{92}^{234}\text{U}$	246,000 years

Half life

A model of count-rate is *exponential decay* with time

$$\frac{dN}{dt} = \frac{dN}{dt} \Big|_{t=0} e^{-\lambda t}$$

$$\frac{dN}{dt} \Big/ \frac{dN}{dt} \Big|_{t=0} = \frac{1}{2}$$

$$\Rightarrow \exp(-\lambda T_{\frac{1}{2}}) = \frac{1}{2}$$

$$\therefore T_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$$

Calculate *half-life* from the gradient of (t, ln(count-rate)) graph

$$T_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$$

$$\ln\left(\frac{dN}{dt}\right) = \ln\left(\frac{dN}{dt} \Big|_{t=0}\right) - \lambda t$$

Collect experimental data

time/s	time/min	Count/10s	Count rate (sans background) (counts per second)	ln of count rate *
0	0.00			
13	0.22			
26	0.43			
39	0.65			
52	0.87			
65	1.08			
78	1.30			
91	1.52			
104	1.73			
117	1.95			
130	2.17			
143	2.38			
156	2.60			
169	2.82			
182	3.03			
195	3.25			
208	3.47			
221	3.68			
234	3.90			
247	4.12			
260	4.33			
273	4.55			
286	4.77			
299	4.98			
312	5.20			
325	5.42			
338	5.63			
351	5.85			
364	6.07			
377	6.28			
390	6.50			
403	6.72			
416	6.93			

* ln means Natural Logarithm. Use the ln button on your calculator.

BACKGROUND COUNT (100s) :

BACKGROUND COUNT RATE :

