

Nuclear Physics and radioactivity – Data analysis

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Part A**Question 1-3 are all based around the data in the table below**

The table below shows results of the number of 'clicks' on a Geiger counter taken in one minute intervals when placed next to a number of unknown samples

Sample	Geiger counter count (counts per minute) when sample and Geiger counter are separated by:				
	1 mm air only	0.1mm paper	0.02mm Aluminium	2mm Aluminium	10 mm Lead
A	475	449	397	199	150
B	1037	998	901	415	325
C	1163	94	17	13	16
D	584	573	523	312	17
E	604	612	590	588	540
F	591	279	282	302	262

A Geiger counter normally picks up a background count.

Question 1.

- a) What causes this background count?

.....
 (1 mark)

- b) Using the data in the table above, suggest a possible range of values for the background count in this experiment.

..... (1 mark)

- c) Explain how you decided on this value?

.....
 (1 mark)

Question 2.

- a) Which sample has the greatest activity? (1 mark)

- b) Calculate the activity of this sample. Bq (1 mark)

Question 3.

Look carefully at the data and try to determine what sort of radioactive decay is occurring for the samples below. The samples may be emitting alpha, beta, gamma radiation or a combination of two of these (but not all three). For each sample below, state what type radiation the samples are emitting and how you worked this out.

Sample	Type of decay	Explanation (explain clearly how you know)
C		
D		
F		

(6 marks)

Part B

Let N_0 = the original number of atoms of radioactive material.

Let N = the number of atoms of radioactive material present after n half-lives have passed.

Therefore, $N = \frac{N_0}{2^n}$

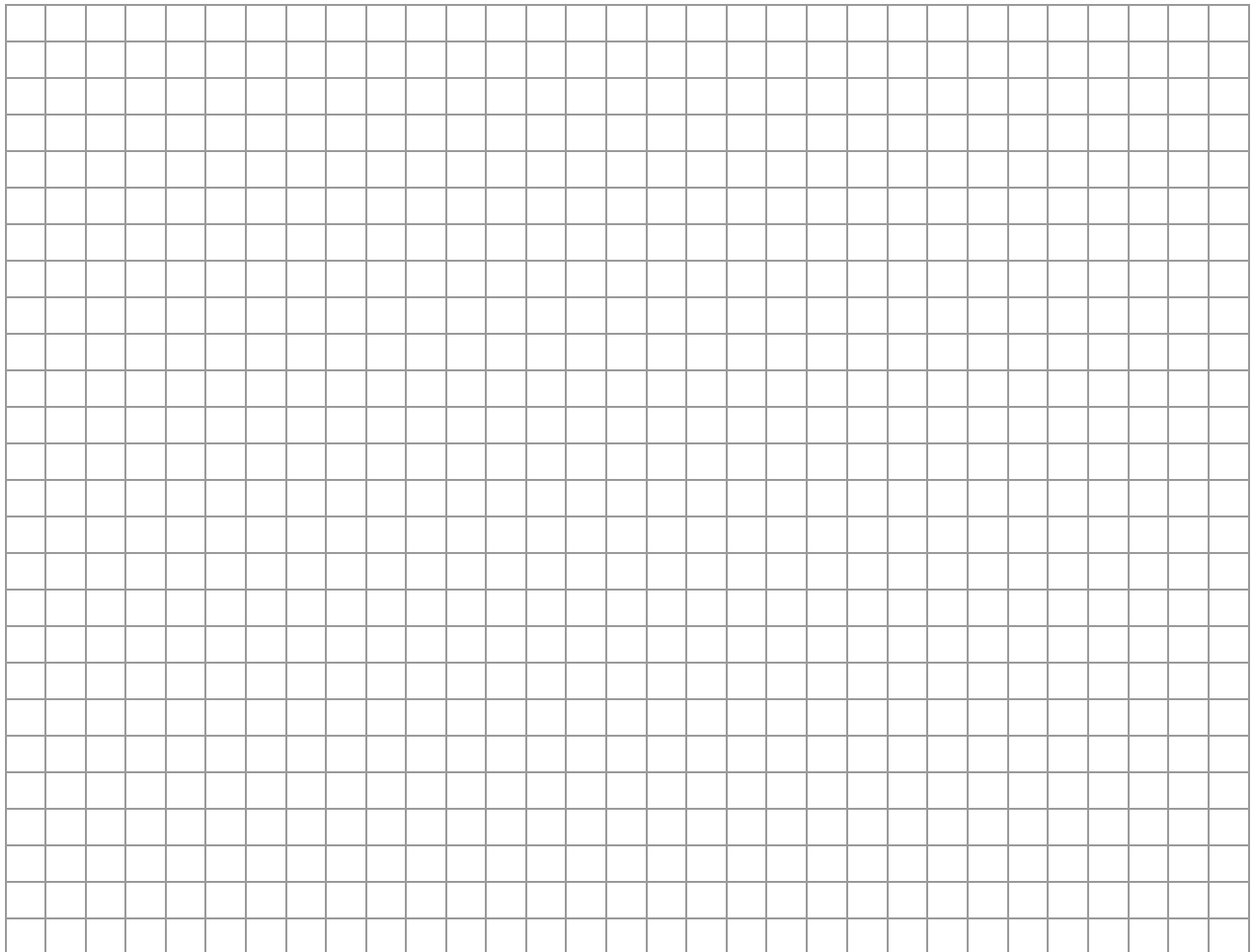
Question 4

The following table shows measurements taken to determine the fraction of parent nuclei remaining as a function of time elapsed for a sample of lead-214 (^{214}Pb).

Time (hours)	0	5	10	15	20	25	30	35	40
Activity (Bq)	398.0	242.0	154.0	104.0	66.0	39.0	21.5	16.0	9.5

a) Plot a graph of these results

(4 marks)



b) Estimate the half-life for ^{214}Pb from the graph (show your working on the graph).

(2 mark)

c) What percentage is left after 4 half lives?

(1 mark)

d) With reference to your graph, or otherwise, determine how much of a sample of 800g of ^{214}Pb would be left after

i) 45 hours

ii) 1350 minutes

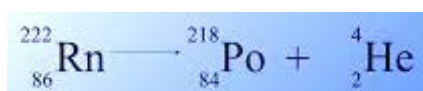
(2 + 2 = 4 marks)

Question 5

The table below provides the name of the elements, the atomic number and the mass number of common isotopes relating to this question. It also give the decay modes (in brackets) for each isotope.

Titanium	Lead	Bismuth	Polonium	Astatine	Radon
Ti-203 Ti-205	Pb-210 (β) Pb-214 (β)	Bi 209 (α) Bi 214 (β)	Po 214 (α) Po 218 (α)	At 218 (α)	Rn 220 (α) Rn 222 (α)
81	82	83	84	85	86

Radon-222 undergoes alpha decay to form Polonium-218. The decay equation is shown below and also represented on the grid below.



- a) Write two equations to show the next two stages of the decay series by referring to the data on the table at the beginning of this question.

(2 marks)

Radon-222 Decay Series Grid

Mass number	222						Rn
	220						
	218				Po		
	216						
	214						
	212						
		81	82	83	84	85	86
Atomic number							

- b) Draw the same two stages of this decay series on the grid (above). Label each entry with the element's symbol and an arrow indicating the decay step.

(2 marks)