Name……………………………

Nuclear Physics and radioactivity – Data analysis /32

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:					
	1mm air only	0.1mm paper	0.02mm Aluminium	2mm Aluminium	10 mm Lead	
A	475	449	397	199	150	β and γ
B	1037	998	901	415	325	β and γ
C	1163	94	16	13	16	α
D	584	573	523	312	17	β
E	604	612	590	588	540	γ
F	591	279	282	302	262	α and γ

A Geiger counter normally picks up a background count.

Question 1.

a) What causes this background count?

Radiation from the sun/the universe. Radiation from radioactive material in the air (eg Carbon 14 in carbon dioxide), Radiation from the Earth / radiation from dust (volcanic erruptions) (1 mark one or more specific suggestion)

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

13-17 (1 mark)

c) Explain how you decided on this value?

These are the lowest values on the table and sample C shows fluctuations between these values regardless of the shielding / C appears to be a radiation source (of alpha) which is reduced by over 90% by paper and completely by aluminium. The remaining count must be background.(1 mark)

Question 2.

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

b) Calculate the activity of this sample. **19(.38)** Bq (1 mark)

Question 3 .

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

Sample	Type of decay	Explanation (explain clearly how you know)
A	**β and γ**	Shows a decrease when shielded with aluminium and Lead indicating Beta, but still quite a high count with thick lead indicating gamma
B	**β and γ**	Shows a decrease when shielded with aluminium and Lead indicating Beta, but still quite a high count with thick lead indicating gamma
C	**α**	Shows a significant drop after shielded with paper. Drops to background count with thin aluminium indicating alpha
D	**β**	Shows a decrease when shielded with aluminium and drops to background when shielded with lead indicating Beta
E	**γ**	Shielding does not have much effect on count /still quite a high count with thick lead indicating gamma
F	**α and γ**	Significant drop when shielded with paper indicating alpha. Still quite a high count with thick lead indicating gamma

(12 marks)

Part B

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)**

Graph must have labels with units on each axis. **- 1 mark**

Uniform sensible scale **- 1 mark**

All points clearly drawn in correct places **- 1 mark**

Points joined up to produce a smooth half life curve. **- 1 mark**

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

7.5 hours (accept between7 and 8 hours) **- 1 mark**

Show working on graph **- 1 mark**

(2 mark)

c) What percentage is left after 4 half lives?

Either: 6.25 %

Or Read from graph and calculate percent

(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

45/ 7.5 = 6 half lives

Either read from graph or calculate from formula

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

$$N = \frac{800}{2^6}$$

N = 12.5g

ii)1350 minutes

1350/ 60 x7.5 = 3 half lives

Either read from graph or calculate from formula

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

$$N = \frac{800}{2^3}$$

N = 100g

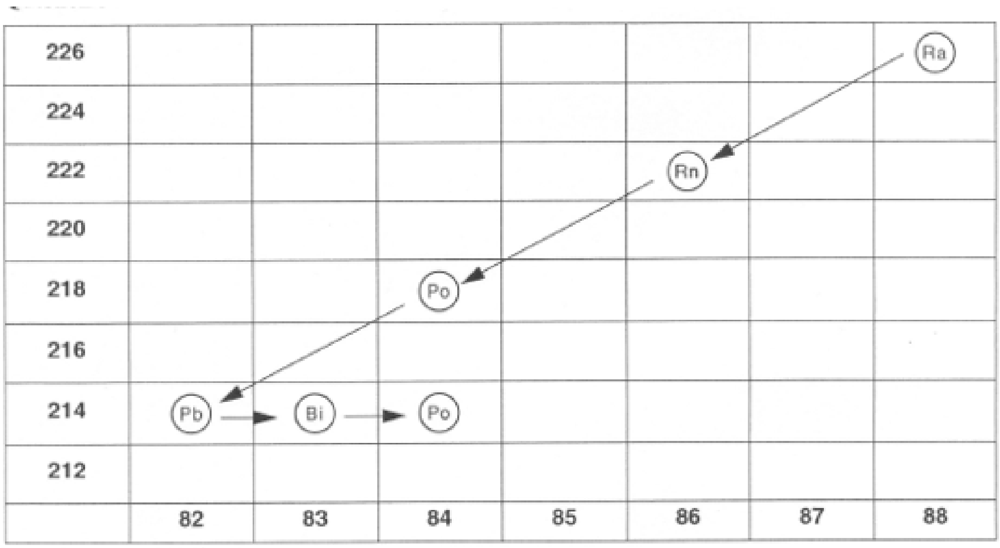
(2+ 2 = 4 marks)

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	Francium	Radium
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)	Fr 223 (α)	Ra 226 (α)
81	**82**	**83**	**84**	**85**	**86**	**87**	**88**

The decay of radium-226 into radon-222 is shown in the grid below:



4 marks
1 mark for each correct transition

Draw the next four stages of this decay series on the grid (above) by referring to the data on the table at the beginning of this question. Label each entry with the element's symbol and an arrow indicating the decay step.

(4 marks)