

Physics 100 - Fall 2007 - Recitation 7

① Determine the nuclear product remaining after

i) β^- decay of ^{211}Pb

ii) α decay of ^{247}Cm

iii) γ decay of ^{131}I

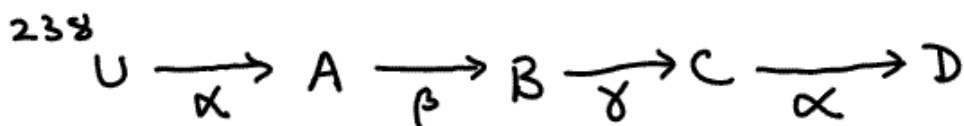
② Which is safer overall -

a coal power plant or a nuclear power plant?

what do you mean by "safe"?

what are all the factors you should consider?

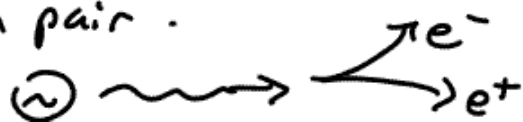
③ Sometimes radioactive isotopes decay to other isotopes that are also radioactive ... which decay to other isotopes that are radioactive, etc. This is called a "decay series". Here is the beginning of one such series:



What are nuclei A, B, C, D? (Z , A and symbol)

Radiation such as α , β and γ rays are potentially harmful to living things because the $\alpha/\beta/\gamma$ particles can ionize (rip apart) the molecules in human tissue, killing cells and causing long-term DNA damage. If the radiation dose is high enough the cell damage can kill the living thing. If the damage is not that severe, the DNA damage can lead to cancer and/or birth defects many years later.

Only particles that are charged can cause ionizing damage as they pass through tissue. The larger the electrical charge of the ionizing radiation, the heavier is the ionizing damage and the shorter the range of the radiation in the material. γ -rays pass harmlessly through materials except when they pair-produce into an electron-positron pair.



This is what happens to γ -rays when they eventually interact with matter.

α particles can be stopped by a sheet of paper.

β particles are stopped by the outer layers of skin.

γ -rays can pass through living tissue and other materials. Typically they are stopped by a thick layer of lead.

④ If I told you that you had to spend the night sleeping in a bed laced with an α source, a β source or a γ source ... which would you choose? Why? (Assume similar activities for the sources)

⑤ Suppose you had 3 stupid friends ...
friend 1 drinks a glass of water laced with an α source.
friend 2 " " " " " " β source.
friend 3 " " " " " " γ source.

Assume similar activities for the materials in the drinks.

Which friend should you be most worried about? Why?

In quantum mechanics we usually cannot predict the outcome of a single measurement, but we can often predict the correct average of many measurements.

⑥

Quantum Dice 1 :

Do in groups of 2 to 4

One person (The experimentalist) should Toss a single die 48 times keeping track of the values on top face of the die for each toss.

A different person (the oracle) should move where they cannot see the die being thrown and they should predict the value seen for each of the 48 throws and record their predictions

How often does the oracle correctly predict what the experimentalist measures?

How often would you expect the oracle to get it right just due to random luck?

How much variation is there among all the oracles in your section in terms of the number of correct predictions they make?

What is the average value of all the measurements made by the experimentalist?

What would you expect to find for the average value of all 48 measurements?

⑦ Quantum Dice 2:

Do in groups of 2 to 4

Throw two Dice sequentially 50 times.

When the 1st Die comes up as a one or a two, record the value of the second die.

Compare the distribution and average values of your measurements with what you observed in the Quantum Dice 1 exercise.

What do you see from this comparison?

Now repeat the exercise ... but instead of throwing the second die take as your measured value the number on the bottom face of the first die (remember ... only take those where the 1st die comes up one or two). Compare the distribution and average of your measurements with what you saw earlier.

Can you explain the difference you see?

How might this situation be similar to what is meant by "quantum entanglement"?

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A small sample of charcoal from an archaeological site is measured to have an activity of 38000 decays/second

Approximately how many ^{14}C nuclei remain in the sample?

($t_{1/2}$ for ^{14}C = 5730 years)

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Periodic Table of the Elements

1A	2A	3B	4B	5B	6B	7B	8B	11B	12B	3A	4A	5A	6A	7A	8A																																																																																				
1 H hydrogen 1.008	4 Be beryllium 9.012	21 Sc scandium 44.956	22 Ti titanium 47.88	23 V vanadium 50.94	24 Cr chromium 52.00	25 Mn manganese 54.94	26 Fe iron 55.85	27 Co cobalt 58.93	28 Ni nickel 58.69	29 Cu copper 63.55	30 Zn zinc 65.38	31 Ga gallium 69.72	32 Ge germanium 72.64	33 As arsenic 74.92	34 Se selenium 78.96	35 Br bromine 79.90	36 Kr krypton 83.80	37 Rb rubidium 85.47	38 Sr strontium 87.62	39 Y yttrium 88.91	40 Zr zirconium 91.22	41 Nb niobium 92.91	42 Mo molybdenum 95.94	43 Tc technetium (99)	44 Ru ruthenium 101.1	45 Rh rhodium 101.07	46 Pd palladium 106.42	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.76	52 Te tellurium 127.6	53 I iodine 126.90	54 Xe xenon 131.3	55 Cs cesium 132.91	56 Ba barium 137.33	57 La* lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium (145)	62 Sm samarium 150.36	63 Eu europium 151.96	64 Gd gadolinium 157.25	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.05	71 Lu lutetium 174.96	72 Hf hafnium 178.49	73 Ta tantalum 180.95	74 W tungsten 183.85	75 Re rhenium 186.21	76 Os osmium 190.23	77 Ir iridium 192.22	78 Pt platinum 195.08	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.38	82 Pb lead 207.2	83 Bi bismuth 208.98	84 Po polonium (209)	85 At astatine (210)	86 Rn radon 222	87 Fr francium 223	88 Ra radium 226	89 Ac~ actinium (227)	90 Th thorium 232.04	91 Pa protactinium 231	92 U uranium 238.03	93 Np neptunium 237	94 Pu plutonium 244	95 Am americium 243	96 Cm curium 247	97 Bk berkelium 247	98 Cf californium 251	99 Es einsteinium 252	100 Fm fermium 257	101 Md mendelevium 258	102 No nobelium 259	103 Lr lawrencium 260	104 Rf rutherfordium 261	105 Db dubnium 262	106 Sg seaborgium 263	107 Bh bohrium 264	108 Hs hassium 265	109 Mt meitnerium 266	110 Ds darmstadtium 268	111 Uuu unununium 269	112 Uub ununbium 270	113 Nh nihonium 271	114 Uuq ununquadium 272	115 Uuh ununhexium 273	116 Uuq ununhexium 274	117 Uue ununseptium 275	118 Uuo ununoctium 276

element names in **blue** are liquids at room temperature
 element names in **red** are gases at room temperature
 element names in **black** are solids at room temperature

