Physics 100 - Spring 2007 - Recitation 8

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:

$$^{238}U \xrightarrow{\alpha} A \xrightarrow{\beta} B \xrightarrow{\gamma} C \xrightarrow{\alpha} D$$

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

(4) What fraction of a sample of ^{68}Ge will remain after 3 years?
($t_{1/2}$ of ^{68}Ge is ~9 months)

(5) A small sample of charcoal from an archeological 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)

(6)

When the atomic (fission) bomb was being developed, one of the scientists on the Manhattan project suggested that the detonation of the bomb might trigger fusion reactions in the atmosphere, causing a fusion chain reaction that could burn up the entire atmosphere of the earth. Other scientists calculated that under worst-case scenario assumptions the temperature needed to ignite fusion reactions in the atmosphere was a factor of 100 higher than that expected to occur in the midst of the fission explosion. So, these scientists were confident that the atmosphere would not be destroyed. This issue and the potential risk was not made public at the time.

What do you think about this?

Was the risk justified?

How certain should the science be to make you comfortable with such a risk?

What would you have done in such a situation if you were one of the scientists?

... what would you have done if you were the President at the time?

(7) Each member of the class should wad up 3 sheets of paper.

All the Students should bunch together in the center of the room holding their paper wads. Whenever a student is hit by a wad of paper they are to toss all three of their paper wads up into the air.

The TA now tosses one wad of paper into the center of the group of students.

→ Watch the "chain reaction"

Next, have ~2/3 of the students carry 3 wads of paper while ~1/3 of the students remain without wads of paper. These folks act as "control rods" in a nuclear reactor. Now the TA tosses a wad of paper into the center of the group. . . . can you see the difference in the "chain reaction"?

(8) An α-particle fuses with $^{16}_{8}O$. What is the nuclear product of this reaction?
Is energy released or absorbed when this reaction occurs? Is it easier or harder to remove a nucleon from the product nucleus than from the ^{16}O before the reaction takes place?

(9) When an atom of uranium undergoes fission, approximately 1% of the mass is lost (converted to energy). In a uranium bomb similar to that dropped on Hiroshima, suppose that 10 kg of uranium undergoes fission. How much energy is released?

Express your answer in equivalent tons of TNT, where one ton of TNT releases 4.2×10^9 J when it explodes.

Los Alamos National Laboratory Chemistry Division

Periodic Table of the Elements

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	11B	12B	3A	4A	5A	6A	7A	8A
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac~	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Uuu	112 Ub		114 Uuq		116 Uuh		118 Uuo

Lanthanide Series*	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
Actinide Series~	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

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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