Physics 102 - Fall 2009 - 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:

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

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

(4) 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?

(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) The source of energy for the creation of most gold atoms (a gold atom is heavier than an iron atom) used in jewelry is

a) the gravitational collapse of a star.
b) a goldsmith's smelter.
c) The fission of a heavier element such as radium or hafnium.
d) the shock wave of a supernova explosion at the end of the stellar life cycle for a large star.
e) the heat at the center of the earth.

(7) A nuclear fusion process occurs and is described by the equation below. Determine and provide the unknown nucleus (symbolized by X) in the equation.

$$^{7}Be + {}^{6}Li \longrightarrow X$$

Problem 9 (6 points):

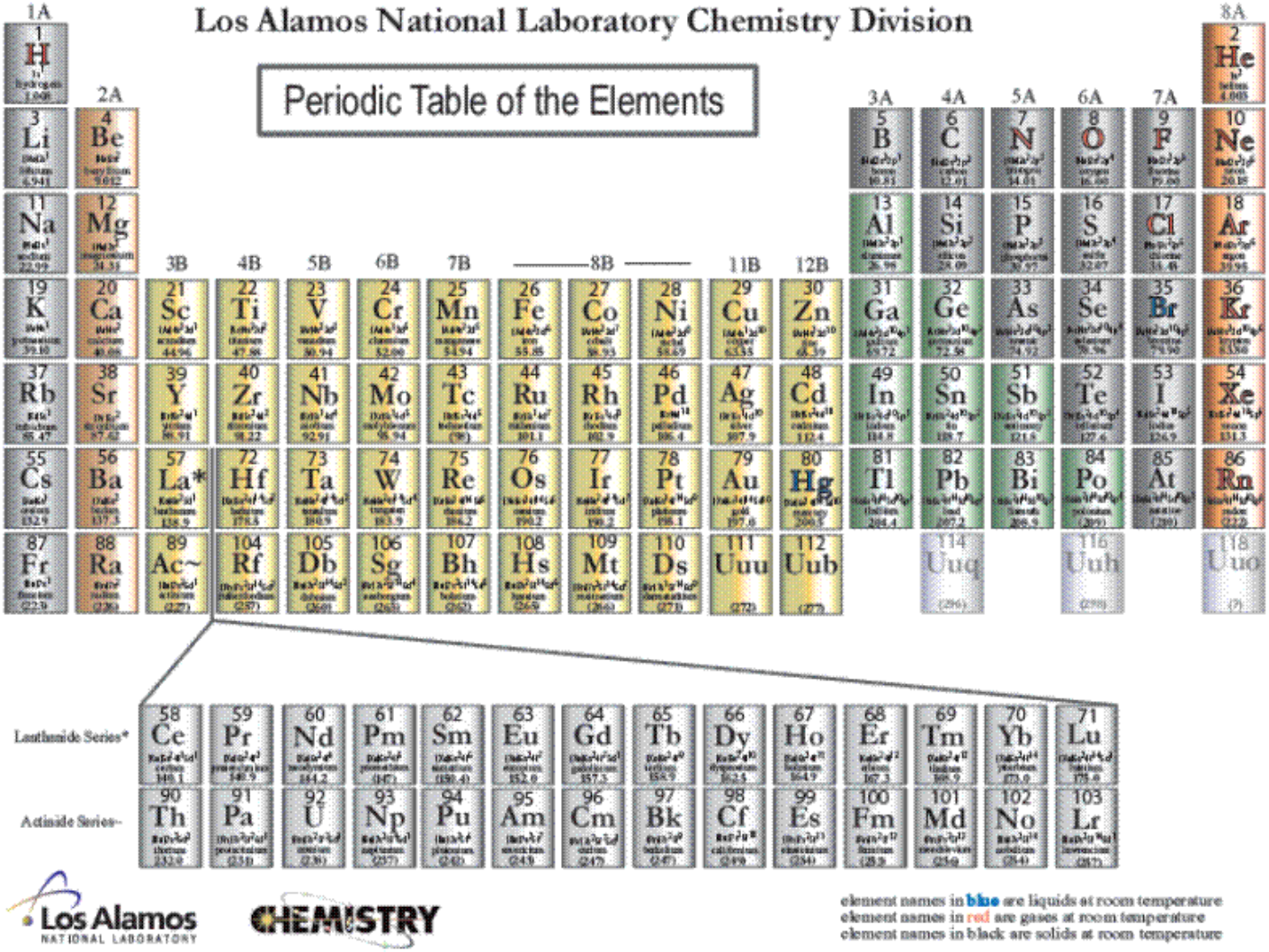
Suppose the nucleus below undergoes alpha decay, what is the nucleus left behind?

$$^{230}_{90}Th \longrightarrow \alpha + X$$

Would you expect this process to release energy or absorb energy?

(8) True-false

a) _____ In typical multi-electron atoms, the electrons all reside in the atom's lowest energy quantum state.
b) _____ If a sample of uranium-235 is subcritical, a nuclear explosion is imminent.
c) _____ According to quantum field theory, the gluon is the virtual particle (gauge boson) responsible for conveying the strong nuclear force.
d) _____ The force of gravity is many times stronger than the weak nuclear force.
e) _____ A typical chemical reaction involves changes in energy of millions of electron-volts.
f) _____ Water is a chemical compound.
g) _____ Carbon dioxide (CO_2) is an isotope of carbon monoxide (CO).
h) _____ According to quantum field theory, the Z particle is the virtual particle (gauge boson) responsible for conveying the strong nuclear force.
i) _____ According to quantum theory, the more precisely the position of an electron is determined the better known is the electrons velocity.
j) _____ The Higgs particle was discovered (first seen) in 2006.
k) _____ A chain reaction refers to the chemical processes that occur when hydrogen is mixed with oxygen and a match.
l) _____ The strong nuclear force is stronger than the electromagnetic force.
m) _____ Nuclear fission is the energy source that powers stars.
n) _____ In quantum mechanics, the wave function specifies the exact position of a particle.
o) _____ Young stars are formed mostly of hydrogen.


Los Alamos National Laboratory Chemistry Division
Periodic Table of the Elements
1A
2A
3B
4B
5B
6B
7B
8B
11B
12B
3A
4A
5A
6A
7A
8A
Lanthanide Series*
Actinide Series~
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
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