

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

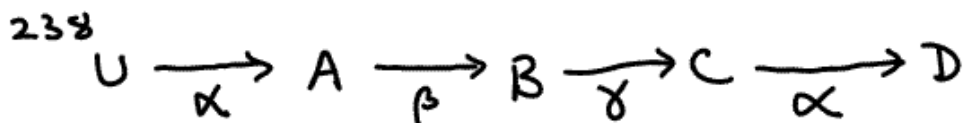
② Which is safer overall -

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:



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?

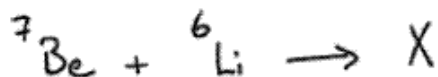
What would you have done in such a situation if you were one of the scientists?

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

- 5) A small sample of charcoal from an 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)

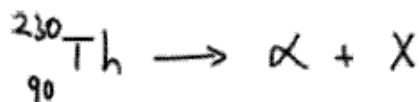
- 6) The source of energy for the creation of most gold atoms (a gold atom is heavier than an iron atom) used in jewelry is
- the gravitational collapse of a star.
 - a goldsmith's smelter.
 - The fission of a heavier element such as radium or hafnium.
 - the shock wave of a supernova explosion at the end of the stellar life cycle for a large star.
 - 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.



Problem 9 (6 points):

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



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

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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 electronvolts.
- 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 electron's 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	1 H Hydrogen 1.008	2A	3B	4B	5B	6B	7B	8B	11B	12B	3A	4A	5A	6A	7A	8A
	3 Li Lithium 6.941	4 Be Beryllium 9.012	11 Na Sodium 22.99	12 Mg Magnesium 24.31	19 K Potassium 39.10	20 Ca Calcium 40.08	37 Rb Rubidium 85.47	38 Sr Strontium 87.62	55 Cs Cesium 132.9	87 Fr Francium 223	5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 18.99	10 Ne Neon 20.18
	21 Sc Scandium 44.96	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 65.39	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 98.91	45 Rh Rhodium 101.07	46 Pd Palladium 106.4	47 Ag Silver 107.87	48 Cd Cadmium 112.4	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
	57 La* Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 196.97	80 Hg Mercury 200.6	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
	89 Ac~ Actinium 227	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 (271)	111 Uuu Unununium (272)	112 Uub Ununbium (277)	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon 222
	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 174.9	88 Ra Radium 226	118 Uuo Ununoctium (284)
	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	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)	114 Uuq Ununquadium (289)	115 Uuh Ununhexium (288)
	98 Ce Cerium 140.1	99 Pr Praseodymium 140.9	100 Nd Neodymium 144.2	101 Pm Promethium (145)	102 Sm Samarium 150.4	103 Eu Europium 152.0	104 Gd Gadolinium 157.3	105 Tb Terbium 158.9	106 Dy Dysprosium 162.5	107 Ho Holmium 164.9	108 Er Erbium 167.3	109 Tm Thulium 168.9	110 Yb Ytterbium 173.0	111 Lu Lutetium 174.9	112 Uuq Ununquadium (289)	113 Uuh Ununhexium (288)

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

Lanthanide Series*

Actinide Series*

