Answer Key 106 Nuclear Questions

1. 2 neutrons	6. 3 mass + charge	11. 3 16-N	16. 3 3 x 12.4 hours
2. 4 gamma	7. 3 $n^\circ : p^+$	12. $9n^\circ : 10p^+$	17. 3 remains the same
3. 1 Sr-90	8. 1 alpha	13. skip	18. 3 phosphorous-32
4. 3 +1/less mass	9. 3 gamma	14. It has a $1n^\circ : 1p^+$	19. 1 eight days
5. 4 gamma	10. no mass, no charge	15. $9n^\circ : 7p^+$	20. 2 one half

21. Radium bonds like calcium does, so it replaces the calcium in the bones, putting radioactive isotopes in your body long term, which will lead to long term exposure to radiation, leading to illness or death.

22. $^{226}_{88}Ra \rightarrow {}^{4}_{2}He + {}^{222}_{86}Rn$

23. Radium has 2 valence electrons, just like calcium, so it will form the same sort of ionic bonds (+2).

24. 1599 years
25. 2 one quarter
26. 3 3.82 days and alpha decay
27. 2 59.3 seconds

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separate sheets out back for questions 28-39, and for 40-50

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51. $^{210}_{84}Po \rightarrow {}^{4}_{2}He + {}^{206}_{82}Pb$

52. 75 minutes
53. 1/32 or 0.32 x 1,000,000 atoms = 320,000 atoms left
54. 3 it's the only one without neutral neutrons
55. 2 C-14 undergoes beta decay β^-

56. 1 nucleus
57. 2 artificial transmutation
58. 4 transmutation
59. 4 natural transmutation
60. positron β^+

61. positron β^+
62. beta β^-

63. $^{30}_{15}P$

64. $^{0}_{-1}e$ 65. $^{1}_{0}n$ 66. $^{0}_{-1}e$ Or β^-

67. 1 potassium-37
68. 4 C-14 and N-16 are the only pair both on Table N
69. 3 both positively charged and will repel each other
70. 3 neutron

71. $^{214}_{82}Pb$

72. Pb-206 has a stable nucleus, a “normal” neutron:proton ratio exists, no more transmutation necessary
73. 2 fusion
74. 2 nuclear fission
75. mass is converted into energy in nuclear reactions

76. nuclear fusion
77. 1 form heavier isotopes from lighter isotopes
78. 1 less than the mass of the reactants because some of the mass is converted into energy
79. 1 matter is converted into energy
80. 4 transmutation

81. burning fossil fuels creates much CO2, warming the planet. Nuclear reactions do not produce any CO2
82. Wastes emit radioactive particles for long periods of time, and are dangerous if terrorists capture them. Watching them and protecting the environment from them for such long time frames is difficult
83. Long term exposure to radioactive material can cause tumors and genetic mutations.

84. 1 it has the longest half life (by far)
85. 4 long half lives leaving radioactive dangers for extended time frames

86. $^{226}_{88}Ra \rightarrow {}^{4}_{2}He + {}^{226}_{86}Rn$

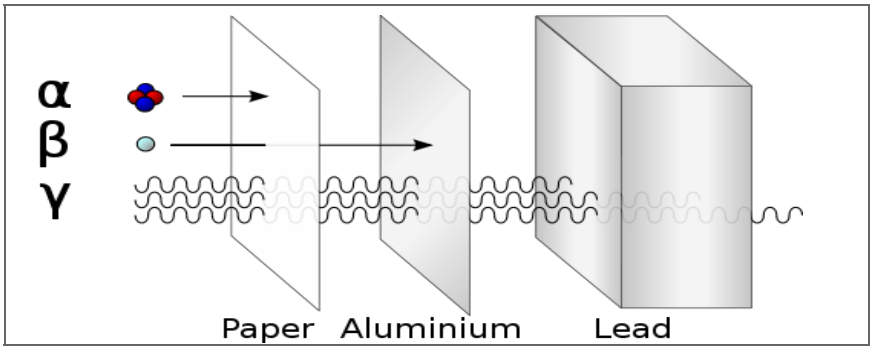
87. Radioactive particles have high energy, they can literally knock out atoms from molecules (in DNA) which can lead to genetic mutations, or even initiate tumor growth in previously healthy tissues.
88. Radium &calcium are both in group 2, both make +2 cations, both bond the same. Ra can substitute Ca

89. $^{241}_{95}Am \rightarrow {}^{4}_{2}He + {}^{237}_{93}Np$

90. Kr-85 emits beta radiation while Am-241 emits alpha radiation.
91. Radiation is used medically. Co-60 emits beta radiation, which is used to kill tumors. I-131 is used to diagnose thyroid gland malfunctions.

92. Long term dangerous radiation emission means you must guard it from bad guys for a really long time. You must make sure it never leaks into the water or food chain. You must stay away from it. You can never, ever forget where you put it, even if the people who put it there die. New people can never forget to keep it away from everyone, or else.

93. In the core the nuclear fission reaction is happening. It's controlled by the control rods that can absorb neutrons to slow the reaction down, or they are pulled out some, allowing more neutrons to fly and a faster chain reaction happens, creating more heat. The inner heat exchanger allows very radioactive water (steam) to carry heat from the core and to transfer the heat to the "outer" water. That water boils as well, and turns the turbine, which is a bunch of really strong magnets. Moving magnets around copper wires creates current (electricity) which is sent to the people. The super heated steam is cooled in the cooling tower, before it's sent back to absorb more heat from the inner radioactive water. The whole system is a heat exchange. A fission reaction creates heat, the double heat exchange hopefully keeps the radiation inside, the heat turns water to steam, the steam turns the turbine. When all goes well only hot water is released. Not shown in the diagram is a cool water pump (from a huge lake or the ocean) bringing in cool water to the tower to condense the steam (remove the heat) so it can then re-absorb more heat, so the turbine keeps spinning. This contraption could also be powered by a river, water turning the turbine, but this is much more powerful, and creates much more electricity. Any leaks are really bad. The pumps keep the water moving, and the heat transferring. Major problems if they fail.

94. Half life is 5.271 years
95. cobalt-60 emits beta radiation
96. gamma is the strongest, alpha is the weakest. Alpha radiation is deadly to humans
97. 

98. All living things are made up of carbon, and they eat food (plants absorb CO_2) containing carbon. The Sun's rays constantly are changing a small measurable percentage of stable carbon into radioactive carbon. All living things contain the same ratio of C-12 to C-14. Since the radioactive C-14 decays at a constant rate, once some thing dies, and stops eating, the change in this ratio is measurable. It takes only some fancy math which you could do to calculate how long ago something died (stopped eating) from this ratio, which means you can accurately date this due to the change in the carbon ratios. It is accurate to about 70,000 years. Older material has such small amounts of radioactive carbon the dating becomes much less accurate, or even impossible.

99. Dinosaurs died millions of years ago, way too long for the amount of radioactive carbon in them (or rather, left in them now) could be measured accurately. Mastodons died out only tens of thousands of years ago, which allows for very accurate readings of how long ago they stopped eating, and stopped replacing their radioactive carbon. Dinosaur bones can be accurately measured if the rocks they are found in contain other radioactive elements (uranium, for example). The ratio of uranium to the decay products can be measured because it has a much longer half life.

100. fusion

101. it's nuclear chem because all of the "action" happens in the nucleus. It's not about the electrons, like the rest of the chem we have studied all year.

102. In nuclear reactions some matter is lost as it's converted into energy. According to the Einstein equation e=mc2, energy equals mass (times the speed of light squared, which is just a constant). The important part of that equation is that energy equals mass.

103. Natural transmutation occurs because it does. You can't control it in any way. The isotopes are unstable and in their attempt to become more stable they emit parts of their own nucleus, changing into other elements. Artificial transmutation is caused by people bombarding nuclei with particles (usually neutrons) to force a transmutation reaction. It does not happen naturally.

104. Thyroid glands absorb iodine to make hormones. Any iodine can be absorbed, even radioactive iodine. If a doctor injects you with a small but measured dose of radioactive iodine, your gland should absorb a certain amount of it over a certain time frame if it's working well. A special photograph is taken of your neck to see how much iodine was absorbed. If it's all there, your gland is well. If not, they need to see how to help you. Even though I-131 is radioactive, you get a small dose, and with an 8 day half life, it decays quickly, before you get ill.

105. The polonium emits alpha particles, which are not strong enough to penetrate your skin. They can get into you through your mucus membranes. Once in your body, they cause all sorts of damage, leading to (a miserable) death.

106. Nothing can be done to alter natural transmutation rate. Heat, cold, pressure, etc. Nothing changes natural transmutation, ever. Never. (Not no way, not no how!, as foretold by the Cowardly Lion, who was a Red-Cat, of course!)

#	nuclide	Decay mode	Transmutes into
28	$^{198}_{79}\mathrm{Au} \rightarrow$	$^{0}_{-1}\mathrm{e} +$	$^{198}_{80}\mathrm{Hg}$
29	$^{37}_{20}\mathrm{Ca} \rightarrow$	$^{0}_{+1}\mathrm{e} +$	$^{37}_{19}\mathrm{K}$
30	$^{222}_{86}\mathrm{Po} \rightarrow$	$^{4}_{2}\mathrm{He} +$	$^{218}_{84}\mathrm{Po}$
31	$^{85}_{36}\mathrm{Kr} \rightarrow$	$^{0}_{-1}\mathrm{e} +$	$^{85}_{37}\mathrm{Rb}$
32	$^{131}_{53}\mathrm{I} \rightarrow$	$^{0}_{-1}\mathrm{e} +$	$^{131}_{54}\mathrm{Xe}$
33	$^{220}_{87}\mathrm{Fr} \rightarrow$	$^{4}_{2}\mathrm{He} +$	$^{216}_{86}\mathrm{At}$
34	$^{19}_{10}\mathrm{Ne} \rightarrow$	$^{0}_{+1}\mathrm{e} +$	$^{19}_{9}\mathrm{F}$
35	$^{53}_{26}\mathrm{Fe} \rightarrow$	$^{0}_{+1}\mathrm{e} +$	$^{53}_{25}\mathrm{Mn}$
36	$^{233}_{92}\mathrm{U} \rightarrow$	$^{4}_{2}\mathrm{He} +$	$^{229}_{90}\mathrm{Th}$
37	$^{235}_{92}\mathrm{U} \rightarrow$	$^{4}_{2}\mathrm{He} +$	$^{231}_{90}\mathrm{Th}$
38	$^{3}_{1}\mathrm{H} \rightarrow$	$^{0}_{-1}\mathrm{e} +$	$^{3}_{2}\mathrm{He}$
39	$^{60}_{27}\mathrm{Co} \rightarrow$	$^{0}_{-1}\mathrm{e} +$	$^{60}_{28}\mathrm{Ni}$

40	The beta decay of uranium 237	$^{237}_{92}U \rightarrow {}^{0}_{-1}e + {}^{237}_{93}Np$
41	The positron emission from Si-26	$^{26}_{14}Si \rightarrow {}^{0}_{+1}e + {}^{26}_{15}P$
42	Polonium-214 undergoes alpha decay	$^{214}_{84}Po \rightarrow {}^{4}_{2}He + {}^{210}_{82}Pb$
43	Es-253 emits an alpha particle	$^{253}_{99}Es \rightarrow {}^{4}_{2}He + {}^{249}_{97}Bk$
44	Ar-37 transmutes into Cl-37	$^{37}_{18}Ar \rightarrow {}^{0}_{+1}e + {}^{37}_{17}Cl$
45	Na-22 transmutes into neon-22	$^{22}_{11}Na \rightarrow {}^{0}_{+1}e + {}^{22}_{10}Ne$
46	Pm-142 transmutes into Nd-142	$^{142}_{61}Pm \rightarrow {}^{0}_{+1}e + {}^{142}_{60}Nd$
47	Cs-137 transmutes into barium 137	$^{137}_{55}Cs \rightarrow {}^{0}_{-1}e + {}^{137}_{56}Ba$
48	Strontium-90 undergoes beta decay	$^{90}_{38}Sr \rightarrow {}^{0}_{-1}e + {}^{90}_{39}Y$
49	Carbon-14 emits a beta particle	$^{14}_{6}Si \rightarrow {}^{0}_{-1}e + {}^{14}_{7}N$
50	Rn-222 and an alpha particle transmute from what radioisotope?	$^{226}_{88}Ra \rightarrow {}^{4}_{2}He + {}^{222}_{86}Rn$