General Chemistry II Jasperse
Nuclear Chemistry. Extra Practice Problems

Key Equations Given for Test:

$E^\circ_{cell}=E^\circ_{reduction} + E^\circ_{oxidation}$	$\Delta G^\circ = -96.5nE^\circ_{cell}$ (ΔG° in kJ)
$E_{cell} = E^\circ - [0.0592/n]\log Q$	$\log K = nE^\circ/0.0592$
Mol $e^- = [A \bullet$ time (sec)/96,500]	time (sec)= mol e $\bullet$ 96,500/current (in A)
$t = (t_{1/2}/0.693) \ln (A_o/A_t)$	$\ln (A_o/A_t) = 0.693 \bullet t / t_{1/2}$
$E = \Delta mc^2$ (m in kg, E in J, c = $3x10^8$ m/s)	

Radioactivity and Balancing Nuclear Reactions: Balancing Nuclear Reactions and Understanding which Particles are Involves

1. Which of the following statements is true for a ^{14}C?

   a. it has 6 protons and 6 neutrons
   b. it has 12 protons and 12 neutrons
   c. it has 12 protons and 8 neutrons
   d. it has 6 protons and 8 neutrons
   e. none of the above

Protons = Atomic Number
Neutrons = Isotope Mass - Atomic Number
Electrons = Atomic number (protons) adjusted for charge if ionic (anion charge, extra electrons. Cation charge, fewer e's)

2. Which of the following statements is true for a $^{37}Cl^-$ anion?

   a. it has 17 protons, 18 electrons, and 20 neutrons
   b. it has 17 protons, 16 electrons, and 17 neutrons
   c. it has 37 protons, 37 electrons, and 20 neutrons
   d. it has 20 protons, 8 electrons, and 11 neutrons
   e. none of the above

3. Which of the following statements is true for a $^{25}Mg^{+2}$ cation?

   a. it has 12 protons, 14 electrons, and 12 neutrons
   b. it has 12 protons, 10 electrons, and 12 neutrons
   c. it has 12 protons, 10 electrons, and 13 neutrons
   d. it has 24 protons, 12 electrons, and 24 neutrons
   e. none of the above

$\frac{4}{2}$He	α-particle (alpha)	$\frac{0}{0}\gamma$	gamma
$\frac{0}{-1}$e	ß-particle (beta), electron	$\frac{1}{0}$n	neutron
$\frac{0}{+1}$e	positron	$\frac{1}{1}$H	proton

4. Beta emission is associated with _____

a. conversion of a neutron to a proton.
b. conversion of a proton to a neutron.
c. increase in mass number.
d. decrease in mass number by 4 and atomic number by 2.
e. emission of γ rays.

$^{1}_{0}n \rightarrow {}^{0}_{-1}e + {}^{1}_{+1}H$

5. Electron-capture is associated with _____

a. conversion of a neutron to a proton.
b. conversion of a proton to a neutron.
c. increase in mass number.
d. decrease in mass number by 4 and atomic number by 2.
e. emission of γ rays.

$^{0}_{-1}e + {}^{1}_{1}H \rightarrow {}^{1}_{0}n$

6. Alpha emission is associated with _____

a. conversion of a neutron to a proton.
b. conversion of a proton to a neutron.
c. increase in mass number.
d. decrease in mass number by 4 and atomic number by 2.
e. emission of γ rays.

$^{x}_{y}Z \rightarrow {}^{4}_{2}He + {}^{x-4}_{y-2}P$ (α)

7. Positron emission is associated with _____

a. conversion of a neutron to a proton.
b. conversion of a proton to a neutron.
c. increase in mass number.
d. decrease in mass number.
e. emission of γ rays.

$^{1}_{1}H \rightarrow {}^{0}_{+1} + {}^{1}_{0}n$

8. The first step in the disintegration of uranium is $^{238}U \rightarrow {}^{234}Th$. What particle is **emitted** in this reaction?

$^{238}_{92}U \rightarrow {}^{234}_{90}Th + ? \; {}^{4}_{2}He$

Periodic table to find charges

a. α particle
b. neutron
c. proton
d. electron
e. γ ray

9. The isotope Cr–53 is produced by the beta decay of which of the following:

a. ^{53}Mn
b. ^{54}Cr
c. ^{52}Cr
d. ^{53}V
e. ^{54}V

$^{53}_{23}V \rightarrow {}^{53}_{24}Cr + {}^{0}_{-1}e$

$\frac{4}{2}$He	α-particle (alpha)	$\frac{0}{0}\gamma$	gamma
$\frac{0}{-1}$e	ß-particle (beta), electron	$\frac{1}{0}$n	neutron
$\frac{0}{+1}$e	positron	$\frac{1}{1}$H	proton

10. What other particle is **formed** in the fusion of two protons to form deuterium (H-2)?

$^{1}_{1}H + {}^{1}_{1}H \rightarrow {}^{2}_{1}H + ? \; {}^{0}_{+1}$ positron

a. proton
b. neutron
c. electron
d. positron
e. γ ray

11. Which particle is **absorbed** when $^{58}Fe \rightarrow {}^{59}Fe$?

$^{1}_{0}n + {}^{58}_{26}Fe \rightarrow {}^{59}_{26}Fe$

a. α particle
b. neutron
c. proton
d. electron
e. γ ray

12. The isotope Ti–48 is produced by the **alpha decay** of which of the following:

a. ^{53}Mn
b. ^{54}Cr
c. ^{52}Cr
d. ^{53}V
e. ^{54}V

$^{52}_{24}Cr \rightarrow {}^{4}_{2}He + {}^{48}_{22}Ti$

$^{4}_{2}He$	α-particle (alpha)	$^{0}_{0}\gamma$	gamma
$^{0}_{-1}e$	ß-particle (beta), electron	$^{1}_{0}n$	neutron
$^{0}_{+1}e$	positron	$^{1}_{1}H$	proton

13. Plutonium-238 is an ***α* emitter** and a compact heat source. Coupled with a PbTe thermoelectric device, it was once used as a very reliable electrical energy source for cardiac pacemakers. What is the product of the radioactive decay of plutonium-238?

$^{238}Pu \rightarrow \alpha$ particle + ?

$^{238}_{94}Pu \rightarrow {}^{4}_{2}He + {}^{234}_{92}U$

a. thorium-230
b. uranium-234
c. curium-242
d. californium-246
e. plutonium-234

14. Nitrogen-13 decays by **positron emission** to produce _____

$^{13}_{7}N \rightarrow$ positron $^{0}_{+1}$ + ? $^{13}_{+6}C$

a. carbon-13.
b. oxygen-17.
c. boron-11.
d. carbon-14.
e. boron-13.

15. In the initial sequence of thorium-232 decay, an **alpha particle is emitted followed by a beta particle**. What is the product of these two decay steps?

$^{232}_{90}Th \rightarrow {}^{4}_{2}\alpha$ particle + $^{0}_{-1}\beta$ particle + $^{228}_{89}$?

a. radium-228
b. actinium-228
c. thorium-228
d. francium-228
e. The correct answer differs from these possibilities.

$^{4}_{2}He$	α-particle (alpha)	$^{0}_{0}\gamma$	gamma
$^{0}_{-1}e$	ß-particle (beta), electron	$^{1}_{0}n$	neutron
$^{0}_{+1}e$	positron	$^{1}_{1}H$	proton

16. ^{175}Pt spontaneously decays into ^{171}Os. What is another product of this decay?

$^{175}_{78}Pt \rightarrow {}^{171}_{76}Os + ? {}^{4}_{2}He$

a. α particle
b. β particle
c. $_{+1}e$ particle
d. γ ray
e. He atom

17. Which isotope is produced when ^{216}Po decays by **emitting an alpha particle followed by 2 beta particles**?

$^{216}_{84}Po \rightarrow {}^{4}_{2}\alpha$ particle + $2\,{}^{0}_{-1}\beta$ particles + $^{212}_{84}Po$

$^{4}_{2}He$	α-particle (alpha)	$^{0}_{0}\gamma$	gamma
$^{0}_{-1}e$	ß-particle (beta), electron	$^{1}_{0}n$	neutron
$^{0}_{+1}e$	positron	$^{1}_{1}H$	proton

a. ^{210}Po
b. ^{212}Po
c. ^{214}Po
d. ^{218}Po
e. ^{220}Po

18. Cobalt-56 decays by **emitting a positron**. What is the product?

$^{56}_{27}Co \rightarrow {}^{0}_{+1}$positron + ? $^{56}_{26}Fe$

a. cobalt-55
b. cobalt-56
c. nickel-56
d. iron-56
e. iron-55

19. Radon-220 (^{220}Rn) decays to polonium-216. What particle is emitted?

$^{220}_{86}Rn \rightarrow {}^{216}_{84}Po$

a. beta
b. positron
c. neutron
d. alpha
e. gamma

20. Cobalt-60 decays to nickel-60. **What particle is emitted**?

$^{60}_{27}Co \rightarrow {}^{60}_{28}Ni + {}^{0}_{-1}$

$^{60}_{27}Co \rightarrow {}^{60}_{28}Ni$

a. proton
b. neutron
c. electron = beta
d. positron
e. alpha

21. Uranium-238 decays to lead-206 through a series of nuclear reactions. Only α particles and β particles are emitted. **How many α particles are emitted**?

$^{238}_{92}U \rightarrow {}^{206}_{82}Pb + 6\,{}^{0}_{-1}e + 8\,{}^{4}_{2}He$

$92 = 82 + 16 + (-6)$

$^{4}_{2}He$	α-particle (alpha)	$^{0}_{0}\gamma$	gamma
$^{0}_{-1}e$	ß-particle (beta), electron	$^{1}_{0}n$	neutron
$^{0}_{+1}e$	positron	$^{1}_{1}H$	proton

a. 2
b. 4
c. 6
d. 8
e. 10

22. If a nitrogen-14 nuclide captures an alpha particle, a proton is produced along with _____

$^{14}_{7}N + {}^{4}_{2}He \rightarrow {}^{1}_{1}H + {}^{17}_{8}O$

a. neutrons.
b. boron-10.
c. oxygen-17.
d. fluorine-18.
e. carbon-17.

The Stability of Atomic Nuclei: The Belt of Stability, Recognizing Whether An Isotope is likely to be stable or not, and predicting what it will do if it isn't.

23. What repulsive forces must be overcome for any element other than hydrogen to exist?

a. The repulsion between neutrons and other neutrons.
b. The repulsion between protons and other protons.
c. The repulsion between protons and neutrons.
d. The repulsion between positrons and electrons.
e. The repulsion between neutrons and electrons.

24. All elements with $Z > 83$ are _____

a. Stable and unreactive
b. Radioactive.
c. Likely to decay by β emission.
d. Likely to have neutron/proton rations of less than or equal to 1:1.

25. Light elements with $Z < 20$ generally have a neutron/proton ratios about equal to _____

a. 0.5.
b. 0.8.
c. 1.0.
d. 1.3.
e. 1.5.

See Periodic Table for Help

26. The heaviest stable elements will generally have a neutron/proton ratio about equal to _____

a. 0.5.
b. 0.8.
c. 1.0.
d. 1.5.

See Periodic Table for Help

27. Which one of the following statements is *not* correct?

a. Carbon-10 is unstable because it has too few neutrons.
b. All nuclides with $Z > 83$ decay into nuclides with smaller Z values.
c. Generally, the number of neutrons in a nuclide is equal to or less than the atomic number.
d. As the atomic number increases, the ratio of neutrons to protons in a nuclide increases.

See Periodic Table for Help

28. Which one of the following statements is *not* correct?

a. Oxygen-15 is unstable because it has too few neutrons.
b. Nucleons are held together in a nuclide by the electromagnetic force.
c. All nuclides with $Z > 83$ decay into more stable nuclides with smaller Z values.
d. As the atomic number increases, the ratio of neutrons to protons in a nuclide increases.
e. Generally the number of neutrons in a nuclide equals the number of protons, or nearly so, when the atomic number is small, i.e., $Z < 18$.

29. Which of the following statements is false?

a. U–238 is unstable, as expected based on the "rule of 83"
b. N–16 is unstable and radioactive because its neutron/proton ratio is too high
c. Nuclear reactions often produce large amounts of energy because small amounts of mass are converted into energy (see Einstein's famous equation, $e=mc^2$)
d. All radioactive isotopes decay completely and disappear within a short time (1 year or less)

30. **Predict the decay pathway for ^{90}Sr.** (Strontium-88 is the most abundant stable isotope for Sr.) (Strontium-90 is a particularly hazardous radioactive isotope because, as an alkali earth metal, it will substitute for calcium in bones and teeth.)

a. α emission
b. β emission
c. positron emission
d. γ emission
e. X-ray emission

1. Periodic table: find "actual" n/p ratio
2. Is the nuclide n/p ratio too high?
   *Convert n => p by beta emission
3. Is the nuclide n/p ratio too small? Convert p => n by either electron capture or positron emission
4. Does Z exceed 83? Reduce fast by alpha emission.

Normal This Nuclide n/p

^{88}Sr ^{90}Sn excess

$^{1}_{0}n \rightarrow {}^{1}_{1}p + {}^{0}_{-1}e$

1. Periodic table: find "actual" n/p ratio
2. Is the nuclide n/p ratio too high?
   *Convert n => p by beta emission
3. Is the nuclide n/p ratio too small? Convert p => n by either electron capture or positron emission
4. Does Z exceed 83? Reduce fast by alpha emission

31. Np-237 is most likely to decay by _____

a. gamma emission.
b. beta emission.
c. positron emission.
d. alpha emission.
e. electron capture.

Normal This Nuclide n/p

$^{237}_{93}Np$

32. **What decay pathway is likely for cobalt-60**? (Cobalt-59 is a stable isotope for Co.) (Cobalt-60, on the other hand, is used as a radioactive source approved by the FDA for irradiation of food. This process kills microbes and insects and can delay ripening.)

a. α emission
b. β emission
c. positron emission
d. γ emission
e. X-ray emission

Normal This Nuclide n/p

^{59}Co ^{60}Co too high

$^{1}_{0}n \rightarrow {}^{1}_{1}p + {}^{0}_{-1}e$

33. Nitrogen-12 is most likely to decay by _____

a. gamma emission.
b. beta emission.
c. alpha emission.
d. Either positron emission or electron capture.

Normal This Nuclide n/p

^{14}N ^{12}N too low

$^{0}_{-1}e + {}^{1}_{1}p \rightarrow {}^{1}_{0}n$ or ${}^{1}_{1}p \rightarrow {}^{1}_{0}n + {}^{0}_{+1}$ positron

e capture

34. **What type of emission is likely for Re-188**? (Rhenium-185 is a stable isotope.) Rhenium-188 is a radioisotope for treatment of cancer.

a. α
b. β
c. positron
d. γ ray
e. X-ray

Normal This Nuclide n/p

^{185}Re ^{188}Re too high

35. Fact: ^{63}Zn is unstable and radioactive. Is its n/p ratio too high or too low? Which process could lead to stability? (Make sure that both parts of the answer are correct.)

a. Its n/p ratio is too low. It could attain stability by either electron capture or positron emission.
b. Its n/p ratio is too low. It could attain stability by beta emission.
c. Its n/p ratio is too high. It could attain stability by electron capture.
d. Its n/p ratio is too high. It could attain stability by beta emission.

Normal This Nuclide n/p

^{65}Zn ^{63}Zn too low

36. Fact: ^{34}P is unstable and radioactive. Is its n/p ratio too high or too low? In that case, which process could lead to stability? (Make sure that both parts of the answer are correct.)

a. Its n/p ratio is too low. It could attain stability by electron capture.
b. Its n/p ratio is too low. It could attain stability by beta emission.
c. Its n/p ratio is too high. It could attain stability by electron capture.
d. Its n/p ratio is too high. It could attain stability by beta emission.
e. Its n/p ratio is too high. It could attain stability by positron emission.

Normal This Nuclide n/p

^{31}P ^{34}P too high

$n \rightarrow p$

37. Which of the following nuclides are most likely to be unstable because they have too many neutrons?

I. carbon-14
II. sodium-24
III. silicon-26
IV. aluminum-27
V. phosphorous-31

few →

^{14}C ^{12}C ^{24}Na ^{23}Na ^{28}Si perfect

1. Periodic table: find "actual" n/p ratio
2. Is the nuclide n/p ratio too high?
   *Convert n => p by beta emission
3. Is the nuclide n/p ratio too small? Convert p => n by either electron capture or positron emission
4. Does Z exceed 83? Reduce fast by alpha emission.

a. only I
b. I and II
c. II and III
d. III, IV, and V
e. all of these

Rates of Radioactive Decay. Nuclear Half Lives and Radioactive Decay Math

$t = (t_{1/2}/0.693) \ln (A_o/A_t)$	$\ln (A_o/A_t) = 0.693 \bullet t / t_{1/2}$

38. A half-life is _____

a. constantly changing.
b. half of the lifetime of an unstable nucleus.
c. the time for one-half of an unstable nuclei to decay.
d. independent of the rate constant for decay.

39. The half-life of a radioactive isotope is 1.0 minute. In an experiment, the number of decay events was monitored in 1-minute intervals over a 5-minute period. Suppose 50 decay events were observed in the first minute. In the second minute, _____ events were observed, and in the 5th minute, _____ events were observed.

a. 50, 50
b. 25, 3
c. 25, 25
d. 50, 100
e. 25, 13

Min (Half/lives)	Events	Percentage
0		100%
1	50	50%
2	25	25%
3	12.5	12.5%
4	6.25	6.25%
5	3.125	3%

40. Uranium-238 decays to form thorium-234 with a half-life of 4.5×10^9 years. How many years will it take for 75% of the uranium-238 to decay?

a. 9.0×10^{10} years
b. 4.5×10^9 years
c. 4.5×10^{10} years
d. 9.0×10^9 years
e. 3.8×10^9 years

(Half/lives)	Percentage
0	100
1	50
2	25
3	
4	

2 half lives

$$\ln (A_o/A_t) = 0.693 \, (t / t_{1/2})$$

$$\ln\left(\frac{100\%}{25\%}\right) = .693 \, \frac{t}{(4.5 \times 10^9)} \qquad t = \frac{4.5 \times 10^9}{.693} \ln\left(\frac{100}{25}\right)$$

41. Tritium, (^3H) is used in glowing "EXIT" signs located where there is no electricity for light bulbs. If the half-life of tritium is 12.26 years, what percentage of the original quantity of the isotope is left in the sign after 18.5 years? (You should be able to both calculate exactly, but also be able to choose from among these options without a calculator.)

a. 0.632%
b. 63.2%
c. 35.1%
d. 1.51%
e. 25.0%

(Half/lives)	Percentage
0	100%
1	50%
2	25%
3	12.5%
4	6.25%
5	3.125%

1 half (12 years) 50% < 18 yrs < 2 halves (24) 25%

$$\ln (A_o/A_t) = 0.693 \, (t / t_{1/2})$$

100 / x ; 18.5 / 12.26

42. Iodine-131 has a half-life of 8.1 days and is used as a tracer for the thyroid gland. If a patient drinks a sodium iodide (NaI) solution containing iodine-131 on a Tuesday, how many days will it take for the concentration of iodine-131 to drop to 5.0% of its initial concentration?

a. 19 days
b. 0.81 day
c. 8.1 days
d. 35 days
e. 4.5 days

$t = (t_{1/2}/0.693) \ln (A_o/A_t)$ — 100% ; 5%

5% in between
4 half = 32.4
+5 half = 40.5

$$t = \frac{8.1}{(.693)} \ln \frac{100}{5} = 35$$

$t = (t_{1/2}/0.693) \ln (A_o/A_t)$	$\ln (A_o/A_t) = 0.693 \bullet t / t_{1/2}$

43. Phosphorus-32 is a radioactive isotope used as a tracer in the liver. How much phosphorus-32 was originally used if there is only 3.50 mg left in a sample after 288 h? (The half-life of phosphorus-32 is 14.3 days.)

a. 1.96 mg
b. 6.26 mg
c. 4.17 mg
d. 7.00 mg
e. 17.9 mg

$\ln (A_o/A_t) = 0.693\ (t / t_{1/2})$

? 3.5 mg 288 h 14.3

$\frac{288\ h}{24\ h / 1\ day} = 12\ days$ $\ln \frac{X}{3.5} = .693\left(\frac{12}{14.3}\right)$

44. Carbon-14 measurements on the linen wrappings from the Book of Isaiah on the Dead Sea Scrolls indicated that the scrolls contained about 79.5% of the carbon-14 found in living tissue. Approximately how old are these scrolls? The half-life of carbon-14 is 5730 years.

a. 570 years
b. 820 years
c. 1300 years
d. 1900 years
e. 4600 years

$t = (t_{1/2}/0.693) \ln (A_o/A_t)$

$t = \frac{5730}{.693} \ln \frac{100}{79.5}$

$= 1897$

45. The half-life of ^{18}F is 109.7 minutes. If radiolabeled Prozac were administered to a patient for a PET scan at 8:00 A.M. on Monday, at what time would its activity reach 10% of the original activity?

a. 9:49 A.M., Monday
b. 9:07 P.M., Friday
c. 10:42 A.M., Tuesday
d. 2:04 P.M., Monday
e. 6:07 P.M., Monday

$t = (t_{1/2}/0.693) \ln (A_o/A_t)$

$t = \frac{(109.7\ min)}{.693} \ln \frac{100}{10} = \frac{365\ min/h}{60\ min}$

2.30 $= 6\ h$

46. The activity of a sample of gas obtained from a basement containing radon-222 was found to be 8 pCi/L. This isotope has a half-life of 3.8 days. If no additional radon-222 entered the basement, how long would it take for the activity to decline to 1 pCi/L?

a. about 4 days
b. a bit more than 10 days
c. about 1 day
d. a bit less than 10 days
e. about 20 days

$t = (t_{1/2}/0.693) \ln (A_o/A_t)$

3.8 8/1

8 → 4 → 2 → 1

3 half lives

$\times 3.8 = 11.4$ days

$= 11.4$ day

47. A 10.00 g sample of wood from an archaeological site produced 3072 β particles in a 10-hour measurement owing to the presence of carbon-14, while a 10.00 g sample of new wood produced 9216 β particles in the same period of time. The half-life of carbon-14 is 5730 years. How old is the wood from the archaeological site?

a. 5730 years
b. 2865 years
c. 4040 years
d. 9080 years
e. The correct answer differs by more than 100 years from the values given in A–D.

$t = (t_{1/2}/0.693) \ln (A_o/A_t)$

$t = \left(\frac{5730}{.693}\right) \ln \frac{9216}{3072}$

Miscellaneous

48. Nuclear fission produces energy because _____

a. neutrons are produced.
b. the total mass of the products is less than that of the reactants.
c. the total mass of the products is more than that of the reactants.
d. it is a very powerful chemical reaction.
e. photons are produced.

49. Which of the following statements is true?

a. Isotopes have the same number of neutrons but have different numbers of protons
b. In order to overcome the repulsion between protons, a strong nuclear force is required to hold a stable nucleus together
c. In order to overcome the repulsion between neutrons, a strong nuclear force is required to hold the nucleus together
d. The higher the number of protons in the nucleus the more stable it will be.
e. none of the above

50. Nuclear fusion produces energy because _____

a. neutrons are produced.
b. the total mass of the products is less than that of the reactants.
c. the total mass of the products is more than that of the reactants.
d. it is a very powerful chemical reaction.
e. photons are produced.

51. Which type of radiation does the most tissue damage, but only when the emitter is internally ingested?

a. α
b. β
c. γ
d. neutron
e. β^+

52. Which type of radiation has the greatest penetration ability?

a. α
b. β
c. γ
d. neutron
e. β^+

53. Uranium-235 is the fuel in nuclear power plants. When a nucleus of uranium-235 captures a neutron, the nucleus splits into two lighter nuclei and initiates a chain reaction. The chain reaction is driven by the emission of _____

a. protons.
b. neutrons.
c. positrons.
d. β particles.
e. α particles.

54. The purpose of control rods in a fission reactor is to _____

a. cool down the reactor fuel.
b. prevent oxygen from reaching the fuel.
c. absorb neutrons generated in the fission process.
d. absorb the electrons emitted in the fission process.
e. enhance the neutron capture process.

55. Electricity is produced from nuclear reactions by _____

a. capturing the electrons that are emitted.
b. accelerating electrons with rapidly moving protons from the nuclear reaction.
c. a process still not understood by scientists.
d. using the energy to make steam to turn turbines.
e. using the energy to accelerate electrons in wires.

Mass Deficit. Binding Energy: $e=mc^2$ Key equation: $E = \Delta mc^2$ (m in kg, E in J, c = $3x10^8$ m/s)

56. Nuclear fusion produces energy because _____

a. neutrons are produced.
b. the total mass of the products is less than that of the reactants.
c. the total mass of the products is more than that of the reactants.
d. it is a very powerful chemical reaction.
e. photons are produced.

lost mass
missing mass

57. What quantity of energy would be produced **as one atom** of plutonium-238 undergoes alpha decay? The nuclide mass of ^{238}Pu is 238.0495 amu (3.953×10^{-22}g), and the nuclide mass of uranium-234 is 234.0409 amu (3.886×10^{-22} g). Alpha particle mass is 6.64465×10^{-24} g. The speed of light is 2.998×10^8 m/s.

Initial: 3.953×10^{-22}
- Final: $(3.886 \times 10^{-22} + 6.64465 \times 10^{-24}$
$= 5.535 \times 10^{-26}$ g $= 5.535 \times 10^{-29}$ kg

$\Delta m \rightarrow \Delta m$ (kg)

$E = (5.535 \times 10^{-29}\ kg)(3.0 \times 10^8\ m/s)^2$
$= 5.0 \times 10^{-12}$ J per atom
$\times 6 \times 10^{23} = 3.0 \times 10^{12}$ J/mol!!

a. 6.0×10^{-7} J
b. 5.0×10^{-12} J
c. 7.0×10^{-10} J
d. 2.6×10^{-8} J
e. 1.1×10^{-12} J

58. What quantity of energy would be produced as 1.00 g of plutonium-238 undergoes alpha decay? The nuclide mass of ^{238}Pu is 238.0495 amu (3.953×10^{-22}g), and the nuclide mass of uranium-234 is 234.0409 amu (3.886×10^{-22}g). Alpha particle mass is 6.64465×10^{-24} g. The speed of light is 2.998×10^8 m/s.

a. 4.4×10^{10} J
b. 3.5×10^8 J
c. 6.2×10^{-13} J
d. 1.3×10^{10} J
e. 2.7×10^9 J

See #57

$$x\ J = \frac{1.00\ g\ Pu}{238\ g} \left| \frac{1\ mol}{1\ mol} \right| \frac{6.02 \times 10^{23}\ atoms}{1\ atom} \left| \frac{5.0 \times 10^{-12}\ J}{1\ atom} \right. = 1.3 \times 10^{10}\ J$$

Logic 1.0g → mol → atoms → J
.00420 2.53×10^{21} 1.3×10^{10} J

General Chemistry II Jasperse ANSWERS
Nuclear Chemistry. Extra Practice Problems

1. D 2. A 3. C 4. A 5. B 6. D 7. B 8. A 9. D 10. D 11. B 12. C 13. B 14. A 15. B 16. A 17. B 18. D 19. D 20. C 21. D 22. C 23. B 24. B 25. C 26. D 27. C 28. B 29. D 30. B	31. D 32. B 33. D 34. B 35. A 36. D 37. B 38. C 39. B 40. D 41. C 42. D 43. B 44. D 45. D 46. B 47. D 48. B 49. B 50. B 51. A 52. C 53. B 54. C 55. D 56. B 57. B 58. D