

Name: _____

Unit XI: Nuclear Chemistry Test 3.1



The following information may or may not be helpful in answering some or all of the questions on this test.

<u>element</u>	<u>atomic. wt.</u>	<u>mode of decay</u>	<u>halflife</u>
${}^{12}_6\text{C}$	12.000000	stable	
${}^{14}_6\text{C}$		beta	5700 yr.
${}^{197}_{78}\text{Pt}$		beta	20 hrs.
${}^{14}_7\text{N}$	14.00307	stable	
${}^{28}_{14}\text{Si}$	27.97693	stable	
${}^{67}_{31}\text{Ga}$		K-capture	67 hrs.
${}^{198}_{79}\text{Au}$		beta	
${}^{13}_7\text{N}$		positron	10 min
${}^{142}_{58}\text{Ce}$		alpha	5×10^{15} yrs.
${}^{131}_{53}\text{I}$		beta	8 da.
${}^{17}_9\text{F}$		positron	66 sec.
${}^7_4\text{Be}$		K-capture	54 da.

1gram matter= 9.0×10^{20} ergs= 9×10^{13} Joules= 2.26×10^{10} Cal energy from 2.3×10^8 Bananas
 2.3×10^8 miles (as per $E=mc^2$)

Multiple Choice

- ___ 1. Which of the following best describes the operation of a cyclotron? (1) an uncharged particle is accelerated to great speeds by a fast moving current of air which is generated by a voltage of not less than 500 Bev. (2) a charged particle is accelerated by alternating the charge on adjacent Dees, while being subjected to a magnetic force which causes the particle to move in a spiral. (3) a charged particle is accelerated by changing charges in a series of pipes or tubes. (4) an uncharged particle is accelerated by alternating charges on adjacent Dees.
- ___ 2. A gamma ray is a high energy (1) electron; (2) proton; (3) neutron; (4) helium nucleus; (5) light ray.

- ___ 3. Which of the following changes occurs in the nucleus when a positron particle is given off during a nuclear decay process? (1) the production of a proton; (2) the loss of neutron; (3) the loss of a particle containing 2 protons and 2 neutrons; (4) the splitting of a neutron into a proton and an electron; (5) the production of a neutron;
- ___ 4. $^{67}_{31}\text{Ga}$ is used in nuclear medicine to determine blood flow when coronary artery disease is suspected. If after treatment the initial radioactivity of a person's blood is 20,000 counts per minute, how much time would have elapsed in order for the activity to decrease to 4066 counts per minute? (1) 67 hours; (2) 60 hours; (3) 154 hours; (4) 28 days; (5) 56 days.
- ___ 5. Which of the following particles could not be accelerated in a linear accelerator? (1) proton; (2) neutron; (3) helium nucleus; (4) electron; (5) none of the above.
- ___ 6. Chief Indium of the Potawatomi tribe was in the process of preparing a family tree. He lacked only the date of his great, great, great, great, ... , great grandfather's death. Therefore, the chief secured the talents of those two famous detectives Mr. Erbie Terbium and Miss Sally Boron, who after digging in the local Indian burial ground, located a piece of wood from chief Indium's ancestor's grave. This piece of wood had an activity due to $^{14}_6\text{C}$ of 6.0 counts per minute per gram of carbon. What was the approximate time of the Indian death if we assume that the activity of $^{14}_6\text{C}$ was 15.7 counts per minute per gram of carbon at the time of the Indian death. (1) 6900 yrs.; (2) 10500; (3) 11100; (4) 7910.
- ___ 7. The average person has several misconceptions regarding nuclear radiation. Which of the following misconceptions was presented in class? (1) exposure to radiation will always make you radioactive; (2) solar radiation is the most dangerous; (3) radiation is always good for you; (4) man is responsible for all radiation; (5) both 1 and 2; (12) both 1 and 4; (13) both 3 and 4.
- ___ 8. Alpha radiation consists of (1) electrons; (2) protons; (3) boron nuclei; (4) helium nuclei; (5) short wavelength electromagnetic radiation; (12) long wavelength electromagnetic radiation.
- ___ 9. In theory two mols of $^{14}_7\text{N}$ can undergo fusion to produce one mol of $^{28}_{14}\text{Si}$ plus some energy. What would be the mass defect of such a reaction? (1) 28.00614 g; (2) -28.00614 g; (3) 0.01775 g; (4) 0.01511 g. (5) 0.02921 g.
- ___ 10. How much energy would be produced by the reaction in question 9? (1) 0.00 Cal; (2) 6.601×10^8 Cal; (3) 3.619×10^8 Cal; (4) 0.01775 Cal; (5) 0.01775 ergs; (12) 1.598×10^{19} ergs.
- ___ 11. In an experiment with $^{197}_{78}\text{Pt}$ Sam Dysprosium recorded an activity of 500 counts per minute at 5:00 pm Friday. What would the activity of his sample be at 9:00 am the following Monday morning when he resumed his experiment? (1) 450.6; (2) 54.4; (3) 435.3; (4) 94.8; (5) 500.
- ___ 12. $^{131}_{53}\text{I}$ is used to treat and diagnosis some thyroid disorders. If the initial activity of the thyroid after treatment with $^{131}_{53}\text{I}$ is 600 counts per second how many days would have to elapse for the activity of the treated thyroid gland to reach 150 counts per second? (1) 8; (2) 16; (3) 10.6; (4) 12.7.

- ___ 13. Before Dr. Butcher could use $^{35}_{16}\text{S}$ in his medical research laboratory, he had to measure the halflife of this isotope. He delegated the task to Raggedy Ann and Sally Sue, his two assistants, who collected the following data:

<u>time (days)</u>	<u>true activity (cps)</u>	<u>time (days)</u>	<u>activity (cps)</u>
0	2000	80	1050
20	1702	100	893
40	1449	120	760
60	1233	140	647

However, if one just scans the data, both girls should come up with a value very close to (1) 90 days; (2) 70 days; (3) 60 days; (4) 75 days; (5) 86 days.

- ___ 14. Scientists do not understand all of the factors influencing the stability of a nuclei. However, two factors are known to have something to do with the stability of a nucleus. One of these is (1) neutron-proton ratio; (2) number of neutrons cannot exceed 20; (3) number of protons cannot exceed 20 (4) any element with more than 50 electrons is not stable.
- ___ 15. Unstable nuclei with an atomic number less than 20 having a neutron proton ratio that is too low will try to undergo a mode of decay that will result in (1) a proton being converted into a neutron; (2) an electron being lost from the L shell; (3) a neutron being converted into a proton; (4) the emission of a gamma ray to lower the energy of activation.
- ___ 16. An unknown type of radiation was giving a reading on a geiger counter of 2000 counts per second (cps). When a piece of paper was placed between it and the geiger counter the reading dropped to about 50 cps. Based on this observation you could conclude that the radiation was mostly (1) alpha; (2) beta; (3) gamma; (4) X-ray.
- ___ 17. At 9:00:00 AM your lab partner reported an activity of 100,000 counts per second on a sample of $^{21}_{12}\text{Mg}$. At 9:05:00 AM you recorded an activity of 10 counts per minute on that same sample. Which of the following best accounts for this difference. (1) $^{21}_{12}\text{Mg}$ is giving off alpha radiation; (2) $^{21}_{12}\text{Mg}$ is giving off gamma radiation; (3) $^{21}_{12}\text{Mg}$ is giving off neutrino radiation; (4) essentially every radioactive atom in the sample decayed due to the short half life of the isotope.
- ___ 18. Which of the following isotopes would stand the greatest chance of being stable, that is, not being radioactive? (1) $^{13}_5\text{B}$; (2) $^{13}_6\text{C}$; (3) $^{16}_7\text{N}$; (4) $^{18}_8\text{O}$.
- ___ 19. Which of the following is the most penetrating type of radiation? (1) alpha; (2) beta; (3) x-rays; (4) gamma.
- ___ 20. Which of the following is the least penetrating type of radiation? (1) alpha; (2) beta; (3) x-rays; (4) gamma; (5) neutrinos.
- ___ 21. Radiation was discovered by (1) Henri Becquerel; (2) Maria Curie; (3) Pierre Curie; (4) Ernest Rutherford; (5) Albert Einstein.
- ___ 22. Who was one of the first individuals to propose that nuclear fission was responsible for the presence of elements with an atomic number less than 82 (lead) in uranium ore. This individual

also proposed that during fission a few free neutrons would also be produced. (1) Henri Becquerel; (2) Maria Curie; (3) Pierre Curie; (4) Ernest Rutherford; (5) Albert Einstein; (12) Lise Mienter.

Short Answer

1. Write complete balanced nuclear equations for each of the following nuclear processes. Note: remember disintegration modes are listed on page 1.

a) decay of ${}_{79}^{198}\text{Au}$

b) decay of ${}_{58}^{142}\text{Ce}$

c) ${}_{27}^{62}\text{Co}$ + two neutrons yields a single product

d) decay of ${}_{7}^{13}\text{N}$

e) decay of ${}_{4}^{7}\text{Be}$

f) decay of ${}_{9}^{17}\text{F}$

g) ${}_{12}^{24}\text{Mg}$ + ${}_{14}^{30}\text{Si}$ to yield a single product
in a fusion reaction

h) fusion of two ${}_{8}^{16}\text{O}$ nuclei

i) a neutron disintegrates to form a beta particle and another product

j) fission of ${}_{94}^{239}\text{Pu}$ to form two nuclei of ${}_{47}^{117}\text{Ag}$, and neutrons. (Hint: How many neutrons?).

2. The critical mass of plutonium is about 10 pounds. Explain why this mass of plutonium in one spot will cause the entire mass to spontaneously explode.

3. From the data below determine the half-life of $^{32}_{15}\text{P}$ by graphical analysis as done in the laboratory exercise on half-life. Six graphs have already been constructed for you and can be found on the last page of this test. **Indicate on the appropriate graph how you got the half-life of the isotope. This is necessary for any credit!!**

<u>time</u> <u>(days)</u>	<u>reading</u> <u>in</u> <u>counts</u>	<u>duration of</u> <u>each</u> <u>reading (min.)</u>	<u>background</u> <u>reading</u> <u>(counts/min.)</u>	<u>true</u> <u>activity</u> <u>(counts/min.)</u>	<u>log of true</u> <u>activity</u>
0	5224	60	4	1291	3.11
2	4512	36	4	1119	3.05
4	4236	40	4	1049	3.02
6	4052	56	4	999	3.00
8	3696	56	4	910	2.96
10	3068	52	4	754	2.88
12	3084	52	4	758	2.88
14	2524	72	4	613	2.79
16	2344	72	4	568	2.75
18	2224	64	4	540	2.73
20	2016	64	4	488	2.69
22	1820	76	4	436	2.64
24	1632	48	4	396	2.60
26	1568	56	4	378	2.58
28	1296	48	4	312	2.49
30	1184	64	4	280	2.45
32	1156	72	4	271	2.43
34	1028	72	4	239	2.38

Extra Credit

1. It has been said that the earth could have an unlimited supply of energy if we could make use of CH_2O . What is this substance?
2. When a bee flies into your mouth you get your _____?

