# NUCLEAR CHEMISTRY WORKSHEET

KEY

Name _____ Date _____ Period _____

1) Technetium-99 ($^{99}_{43}Tc$) decays by beta emission to form ruthenium-99 ($^{99}_{44}Ru$).

$^{99}_{43}Tc \rightarrow {}^{0}_{-1}e + {}^{99}_{44}Ru$

2) Phosphorus-32 decays by beta emission to form sulfur-32.

$^{32}_{15}P \rightarrow {}^{0}_{-1}e + {}^{32}_{16}S$

3) Francium-212 ($^{212}_{87}Fr$) decays by alpha emission.

$^{212}_{87}Fr \rightarrow {}^{4}_{2}He + {}^{208}_{85}$

4) Fluorine-18 decays to oxygen-18 by positron emission.

$^{18}_{9}F \rightarrow {}^{0}_{1}e + {}^{18}_{8}O$

5) Sodium-24 decays by beta emission.

$^{24}_{11}Na \rightarrow {}^{0}_{-1}e + {}^{24}_{12}Mg$

6) Krypton-76 absorbs a beta particle to form bromine-76.

$^{76}_{36}Kr + {}^{0}_{-1}e \rightarrow {}^{76}_{35}Br$

7) Aluminum-27 absorbs an alpha particle to form phosphorus-30 and emits a neutron.

$^{27}_{13}Al + {}^{4}_{2}He \rightarrow {}^{30}_{15}P + {}^{1}_{0}n$

8) Nitrogen-14 absorbs an alpha particle to form oxygen-17 and emits a proton.

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

9) When neptunium-239 decays, plutonium-239 is formed and a particle is emitted. (Be sure to include the correct particle in the equation.)

$^{239}_{93}Np \rightarrow {}^{239}_{94}Pu + {}^{0}_{-1}e$

KEY

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10) A particular atom absorbs a neutron to form uranium-236. No particle is emitted

$^{236}_{92}U + {}^{1}_{0}n \rightarrow {}^{237}_{92}U$

Complete the following nuclear equations:

11) $^{14}_{6}C \rightarrow {}^{0}_{-1}e + {}^{14}_{7}N$

12) $^{9}_{4}Be + {}^{4}_{2}He \rightarrow {}^{12}_{6}C + {}^{1}_{0}n$

13) $^{239}_{93}Np \rightarrow {}^{239}_{94}Pu + {}^{0}_{-1}e$

14) $^{4}_{2}He + {}^{238}_{92}U \rightarrow {}^{240}_{94}Pu + {}^{1}_{0}n + {}^{1}_{0}n$

15) $^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{236}_{92}U$

16) $^{13}_{7}N \rightarrow {}^{13}_{6}C + {}^{0}_{+1}e$

17) $^{15}_{7}N + {}^{1}_{1}H \rightarrow {}^{12}_{6}C + {}^{4}_{2}He$

18) $^{6}_{2}He + {}^{1}_{0}n \rightarrow {}^{3}_{1}H + {}^{4}_{2}He$

19) $^{226}_{88}Ra \rightarrow {}^{4}_{2}He + {}^{222}_{86}Rn$

20) $^{18}_{9}F \rightarrow {}^{18}_{10}Ne + {}^{0}_{-1}e$

21) $^{49}_{24}Cr \rightarrow {}^{49}_{23}V + {}^{0}_{+1}e$

22) $^{239}_{94}Pu + {}^{4}_{2}He \rightarrow {}^{241}_{95}Am + {}^{1}_{1}H + {}^{1}_{0}n$

23) $^{7}_{3}Li + {}^{7}_{3}Li \rightarrow {}^{4}_{2}He + {}^{10}_{4}Be$

24) $^{3}_{1}H + {}^{2}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$

25) $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$

26) $^{9}_{4}Be + {}^{4}_{2}He \rightarrow {}^{12}_{6}C + {}^{1}_{0}n$

27) $^{14}_{7}N + {}^{4}_{2}He \rightarrow {}^{18}_{8}O + {}^{0}_{+1}e$

28) $^{26}_{12}Mg + {}^{1}_{0}n \rightarrow {}^{27}_{11}Na + {}^{0}_{+1}e$

29) $^{59}_{27}Co + {}^{2}_{1}H \rightarrow {}^{61}_{27}Co + {}^{0}_{+1}e$

30) $^{208}_{84}Po \rightarrow {}^{204}_{82}Pb + {}^{4}_{2}He$

**Nuclear Chemistry Worksheet** KEY **Name:** _____

1. Balance these nuclear equations.

a) $^{35}_{17}Cl + {}^{1}_{0}n \rightarrow {}^{35}_{16}S + {}^{1}_{1}H$

b) $^{229}_{90}Th \rightarrow {}^{4}_{2}He + {}^{225}_{88}Ra$

c) $^{20}_{8}O \rightarrow {}^{20}_{9}F + {}^{0}_{-1}e$

d) $^{54}_{26}Fe + {}^{1}_{0}n \rightarrow {}^{1}_{1}H + {}^{54}_{25}Mn$

e) $^{104}_{47}Ag \rightarrow {}^{0}_{1}e + {}^{104}_{46}Pd$

f) $^{54}_{25}Mn + {}^{0}_{-1}e \rightarrow {}^{54}_{24}Cr$

g) $^{238}_{92}U + {}^{12}_{6}C \rightarrow {}^{246}_{98}Cf + 4\,{}^{1}_{0}n$

h) $^{207}_{83}Bi + {}^{0}_{-1}e \rightarrow {}^{207}_{82}Pb$

2. Write balanced equations for these nuclear reactions.

a) neutron emission by $^{88}Br$

$^{88}_{35}Br \longrightarrow {}^{1}_{0}n + {}^{87}_{35}Br$

b) electron absorption by $^{116}Sb$

$^{116}_{51}Sb + {}^{0}_{-1}e \longrightarrow {}^{116}_{50}Sn$

c) positron emission by $^{184}Hg$

$^{184}_{80}Hg \longrightarrow {}^{0}_{1}e + {}^{184}_{79}Au$

d) alpha emission by $^{229}Th$

$^{229}_{90}Th \longrightarrow {}^{225}_{88}Ra + {}^{4}_{2}He$

e) neutron capture by $^{200}Hg$

$^{200}_{80}Hg + {}^{1}_{0}n \longrightarrow {}^{201}_{80}Hg$

3. Match these statements to one of the choices on the right. They may be used more than once.

B the type of reaction in the sun

A the type of reaction in atomic bombs

A an atomic nucleus is split into 2 roughly equal parts

B requires incredibly high temperatures

A type of reaction in a nuclear power plant

C takes place at room temperature

B 2 very light isotopes come together to form a heavier one

B principal type of reaction in a hydrogen bomb

A) fission

B) fusion

C) cold fusion

Name KEY

## Nuclear Reactions

Fill in the blanks with the appropriate atomic symbols. Make sure you use the law of conservation of mass to solve these problems.

1. $^{37}_{18}Ar + {}^{0}_{-1}e \rightarrow$ $^{37}_{17}Cl$
2. $^{214}_{83}Bi \rightarrow {}^{214}_{84}Po +$ $^{0}_{-1}e$
3. $^{251}_{98}Cf \rightarrow {}^{247}_{96}Cm +$ $^{4}_{2}He$
4. $^{234}_{91}Pa \rightarrow$ $^{234}_{92}U$ $+ {}^{0}_{-1}e$
5. $^{227}_{89}Ac \rightarrow$ $^{227}_{90}Th$ $+ {}^{0}_{-1}e$
6. $^{234}_{91}Pa \rightarrow$ $^{230}_{89}Ac$ $+ {}^{4}_{2}He$
7. $^{42}_{19}K \rightarrow {}^{0}_{-1}e +$ $^{42}_{20}Ca$
8. $^{9}_{4}Be + {}^{4}_{2}He \rightarrow$ $^{13}_{6}C$
9. $^{22}_{11}Na +$ $^{0}_{+1}e$ $\rightarrow {}^{22}_{10}Ne$
10. $^{212}_{83}Bi \rightarrow {}^{4}_{2}He + {}^{208}_{81}Tl$
11. $^{99}_{43}Tc \rightarrow$ $^{99}_{44}Ru$ $+ {}^{0}_{-1}e$
12. $^{239}_{94}Pu \rightarrow$ $^{235}_{92}U$ $+ {}^{4}_{2}He$

13. For #1-12 go back and label each reaction as involving an alpha, beta, or gamma particle. Label also whether it is an example of decay (that particle being given off) or capture (that particle being taken in.)

14. Write the equation for the alpha decay of curium-247

$^{247}_{96}Cm \rightarrow {}^{4}_{2}He + {}^{243}_{94}$

15. Write the equation for the beta capture of manganese-53

$^{53}_{25}Mn + {}^{0}_{-1}e \rightarrow {}^{53}_{24}Cr$

16. Write the equation for the beta decay of sulfur-35

$^{35}_{16}S \rightarrow {}^{0}_{-1}e + {}^{35}_{17}Cl$

17. Write the equation for the beta capture of tellurium-121

$^{121}_{52}Te + {}^{0}_{-1}e \rightarrow {}^{121}_{51}Sb$

18. Write the equation for when gamma radiation is given off by carbon-13.

$^{13}_{7}C \rightarrow {}^{13}_{7}C + {}^{0}_{0}\gamma$

*Identify whether each of the following will undergo alpha decay, beta decay, or beta capture*

19. einsteinium-252 _____
20. strontium-85 _____
21. americium-243 _____
21. krypton-79 _____
22. palladium-109 _____
23. zinc-62 _____

24. What is happening when gamma radiation is given off?

## Nuclear Chemistry Worksheet-

Show "K-U-E-S" where necessary, otherwise answer completely. Work that does not fit in the provided space needs to be completed on your own paper.

Solutions

Part A.

$^{256}_{103}\mathbf{Lr} \rightarrow {}^{4}_{2}\mathbf{He} + {}^{252}_{101}\mathbf{Md}$

$^{247}_{95}\mathbf{Am} \rightarrow {}^{0}_{-1}\mathbf{e} + {}^{247}_{96}\mathbf{Cm}$

$^{215}_{89}\mathbf{Ac} \rightarrow {}^{211}_{87}\mathbf{Fr} + {}^{4}_{2}\mathbf{He}$

$^{175}_{93}\mathbf{Np} \rightarrow {}^{4}_{2}\mathbf{He} + {}^{171}_{91}\mathbf{Pa}$

$^{6}_{2}\mathbf{He} \rightarrow {}^{0}_{-1}\mathbf{e} + {}^{6}_{3}\mathbf{Li}$

$^{13}_{5}\mathbf{B} \rightarrow {}^{0}_{-1}\mathbf{e} + {}^{13}_{6}\mathbf{C}$

$^{211}_{79}\mathbf{Au} \rightarrow {}^{0}_{-1}\mathbf{e} + {}^{211}_{80}\mathbf{Hg}$

$^{151}_{67}\mathbf{Ho} \rightarrow {}^{4}_{2}\mathbf{He} + {}^{147}_{65}\mathbf{Tb}$

$^{213}_{83}\mathbf{Bi} + {}^{0}_{-1}\mathbf{e} + {}^{213}_{84}\mathbf{Po}$

$^{148}_{57}\mathbf{La} \rightarrow {}^{4}_{2}\mathbf{He} + {}^{144}_{55}\mathbf{Cs}$

Part B:

11. Decay of polonium-218 by alpha (α) emission.

$^{218}_{84}\mathbf{Po} \rightarrow {}^{4}_{2}\mathbf{He} + {}^{214}_{82}\mathbf{Pb}$

12. Decay of carbon-14 by beta (β-) emission.

$^{14}_{6}\mathbf{C} \rightarrow {}^{0}_{-1}\mathbf{e} + {}^{14}_{7}\mathbf{N}$

13. The alpha decay of radon-198

$^{198}_{86}\mathbf{Rn} \rightarrow {}^{4}_{2}\mathbf{He} + {}^{194}_{84}\mathbf{Po}$

14. The beta (b-) decay of uranium-237

$^{237}_{92}\mathbf{U} \rightarrow {}^{0}_{-1}\mathbf{e} + {}^{237}_{93}\mathbf{Np}$

3

## Nuclear Chemistry Worksheet-

Show "K-U-E-S" where necessary, otherwise answer completely. Work that does not fit in the provided space needs to be completed on your own paper.

### Part A: Completing Nuclear Decay Reactions: 1-10

For each of the atoms listed below, complete the decay reaction by solving for ${}^{A}_{Z}X$ or other missing information. Remember that the mass and protons on each side of the arrow need to equal each other.

${}^{256}_{103}Lr \rightarrow {}^{4}_{2}He + {}^{252}_{101}Md$ ${}^{247}_{95}Am \rightarrow {}^{0}_{-1}e + {}^{247}_{96}Cm$

${}^{215}_{89}Ac \rightarrow {}^{211}_{87}Fr + {}^{4}_{2}He$ ${}^{175}_{93}Np \rightarrow {}^{4}_{2}He + {}^{171}_{91}Pa$

${}^{6}_{2}He \rightarrow {}^{0}_{-1}e + {}^{6}_{3}Li$ ${}^{13}_{5}B \rightarrow {}^{0}_{-1}e + {}^{13}_{6}C$

${}^{211}_{79}Au \rightarrow {}^{0}_{-1}e + {}^{211}_{80}Hg$ ${}^{151}_{67}Ho \rightarrow {}^{4}_{2}He + {}^{147}_{65}Tb$

${}^{A}_{Z}X + {}^{0}_{-1}e + {}^{213}_{84}Po$ ${}^{148}_{57}La \rightarrow {}^{4}_{2}He + {}^{144}_{55}Cs$

### Part B: Writing Nuclear Decay Reactions:

Write equations for the following nuclear decay reactions. Make sure that both mass numbers and atomic numbers are balanced on each side

11. Decay of polonium-218 by alpha (α) emission.

${}^{218}_{84}Po \rightarrow {}^{4}_{2}He + {}^{214}_{82}Pb$

12. Decay of carbon-14 by beta (β-) emission.

${}^{14}_{6}C \rightarrow {}^{0}_{-1}e + {}^{14}_{7}N$

13. The alpha decay of radon-198

${}^{198}_{86}Rn \rightarrow {}^{4}_{2}He + {}^{194}_{84}Po$

14. The beta (β-) decay of uranium-237

${}^{237}_{92}U \rightarrow {}^{0}_{-1}e + {}^{237}_{93}Np$