Name: _____ **Date:** _____

Chemistry *~ Ms. Hart* **Class:** Anions or Cations

THE URBAN ASSEMBLY SCHOOL FOR CRIMINAL JUSTICE

10.5 - Transmutations, Fission, and Fusion

SPARK

1. Write the full equation for the nuclear decay mechanism that ^{37}K will undergo. Use your reference sheets!

2. Cobalt-60 and iodine-131 are radioactive isotopes that are used in
   1) dating geologic formations
   2) industrial measurements
   3) medical procedures
   4) nuclear power

Objective: SWBAT identify a nuclear reaction as fusion, fission, or one of the decay mechanisms and balance these equations

Sentences

1. A fissure opened in the ice on the lake and the ice-skater fell into the icy water.
2. "A cookie is fissionable!" he stated as he hit it with a hammer, sending crumbs everywhere.
3. Bacteria undergo binary fission to produce two daughter cells from one parent cell.

Define: **Fission**

_____

_____

Sentences:

1. The hot chocolate infused with peppermint candy cane made for a delicious drink.
2. After using a soldering iron to fuse together the two wire ends, the current again was able to flow and the machine was fixed.
3. Having not realized how quickly the glue dried, he was disappointed to discover the papers fused together at a crooked angle.

Define: **Fusion**

_____

_____

MOVIE TIME! Notes:

Look at the following nuclear equations and determine which represent **fusion** and which represent **fission.**

	Fission or Fusion?
$^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{1}H + {}^{1}_{1}p$	
$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\ {}^{1}_{0}n$	
$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{138}_{54}Xe + {}^{95}_{38}Sr + 3\ {}^{1}_{0}n$	
$^{3}_{2}He + {}^{3}_{2}He \rightarrow {}^{4}_{2}He + 2{}^{1}_{1}H$	

Which equation represents a fusion reaction?

1. $^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He}$
2. $^{14}_{6}\mathrm{C} \rightarrow {}^{0}_{-1}\mathrm{e} + {}^{17}_{7}\mathrm{N}$
3. $^{238}_{92}\mathrm{U} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{241}_{94}\mathrm{Pu} + {}^{1}_{0}\mathrm{n}$
4. $^{1}_{0}\mathrm{n} + {}^{27}_{13}\mathrm{Al} \rightarrow {}^{24}_{11}\mathrm{Na} + {}^{4}_{2}\mathrm{He}$

Which equation is an example of artificial transmutation? (hint: which answer is DIFFERENT?)

1. **$^{238}_{92}$U -> $^{4}_{2}$He + $^{234}_{90}$Th**
2. **$^{27}_{13}$AL + $^{4}_{2}$He -> $^{30}_{15}$P + $^{1}_{0}$n**
3. **$^{14}_{6}$C -> $^{14}_{7}$N + $^{0}_{-1}$e**
4. **$^{226}_{88}$Ra -> $^{4}_{2}$He + $^{222}_{86}$Ra**

Writing Nuclear Equations for Fusion and Fission Reactions

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{87}_{35}\mathrm{Br} + {}^{146}_{57}\mathrm{La} + 3\,{}^{1}_{0}\mathrm{n}$$

LEFT side of arrow RIGHT side of arrow

Mass number		
Atomic numbers		

****Note that THREE neutrons are produced in this reaction – not just one.*

TRY this process on your own!

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}n \rightarrow {}^{137}_{52}\mathrm{Te} + \text{\_\_\_\_\_} + 2\,{}^{1}_{0}n$$

LEFT **RIGHT**

Mass number		
Atomic number		

Example Equations:

$^{235}_{92}$ U + $^{1}_{0}$ n →_____ +$^{141}_{56}$ Ba + 3 $^{1}_{0}$ n What is missing?

$^{2}_{1}$H + _____ →$^{4}_{2}$He + $^{1}_{0}$ n What is missing?

PRACTICE:

1. Bombarding a nucleus with high-energy particles that change it from one element into another is called

1. a half-reaction 2. a breeder reaction 3. artificial transmutation 4. natural transmutation

2.Which equation represents a nuclear reaction that is an example of artificial transmutation?

1. $^{43}_{21}\mathrm{Sc} \rightarrow {}^{43}_{20}\mathrm{Ca} + {}^{0}_{+1}\mathrm{e}$ 2. $^{14}_{7}\mathrm{N} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{17}_{8}\mathrm{O} + {}^{1}_{1}\mathrm{H}$ 3. $^{10}_{4}\mathrm{Be} \rightarrow {}^{10}_{5}\mathrm{B} + {}^{0}_{-1}\mathrm{e}$ 4. $^{14}_{6}\mathrm{C} \rightarrow {}^{14}_{7}\mathrm{N} + {}^{0}_{-1}\mathrm{e}$

3. Which nuclear equation represents artificial transmutation?

1. $^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$
2. $^{27}_{13}Al + {}^{4}_{2}He \rightarrow {}^{30}_{15}P + {}^{1}_{0}n$
3. $^{226}_{88}Ra \rightarrow {}^{4}_{2}He + {}^{222}_{86}Rn$
4. $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$

4. Which equation is an example of artificial transmutation?

1. $^{238}_{92}U \rightarrow {}^{4}_{2}He + {}^{234}_{90}Th$
2. $^{27}_{13}Al + {}^{4}_{2}He \rightarrow {}^{30}_{15}P + {}^{1}_{0}n$
3. $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$
4. $^{226}_{88}Ra \rightarrow {}^{4}_{2}He + {}^{222}_{86}Rn$

5.Given the reaction: $^{9}_{4}Be + {}^{1}_{1}H \rightarrow {}^{6}_{3}Li + {}^{4}_{2}He$ Which type of reaction is represented?

1. natural transmutation 2. artificial transmutation 3. Fission 4. fusion

6. Which equation is an example of artificial transmutation?

1. $^{12}_{6}C + {}^{9}_{4}Be \rightarrow {}^{1}_{0}n + {}^{4}_{2}He$
2. $U + 3F_2 \rightarrow UF_6$
3. $Mg(OH)_2 + 2HCl \rightarrow 2H_2O + MgCl_2$
4. $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

7. Which statement explains why nuclear waste materials may pose a problem?
1. They frequently have short half-lives and remain radioactive for brief periods of time.
2. They frequently have short half-lives and remain radioactive for extended periods of time.
3. They frequently have long half-lives and remain radioactive for brief periods of time.
4. They frequently have long half-lives and remain radioactive for extended periods of time.

8. In a nuclear fusion reaction, the mass of the products is
1. less than the mass of the reactants because some of the mass has been converted to energy
2. less than the mass of the reactants because some of the energy has been converted to mass
3. more than the mass of the reactants because some of the mass has been converted to energy
4. more than the mass of the reactants because some of the energy has been converted to mass

9. The amount of energy released from a fission reaction is much greater than the energy released from a chemical reaction because in a fission reaction

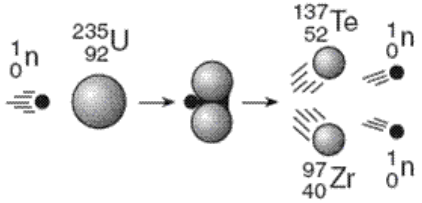
1. mass is converted into energy
2. energy is converted into mass
3. ionic bonds are broken
4. covalent bonds are broken

10. Given the nuclear equation: $^{1}_{1}H + X \rightarrow {}^{6}_{3}Li + {}^{4}_{2}He$

The particle represented by *X* is

1. $^{9}_{4}Li$
2. $^{9}_{4}Be$
3. $^{10}_{5}Be$
4. $^{10}_{6}C$

11. Given the diagram representing a reaction:



Which phrase best describes this type of reaction and the overall energy change that occurs?

1. nuclear, and energy is released
2. nuclear, and energy is absorbed
3. chemical, and energy is released
4. chemical, and energy is absorbed

12. Given the nuclear equation: $^{253}_{99}Es + X \rightarrow {}^{1}_{0}n + {}^{256}_{101}Md$

Which particle is represented by *X*? 1. $^{4}_{2}He$ 2. $^{0}_{-1}e$ 3. $^{1}_{0}n$ 4. $^{0}_{+1}e$

13.Which balanced equation represents nuclear fusion?

1. ${}_{0}^{1}n + {}_{92}^{235}U \rightarrow {}_{56}^{142}Ba + {}_{36}^{91}Kr + 3{}_{0}^{1}n$
2. ${}_{88}^{226}Ra \rightarrow {}_{86}^{222}Rn + {}_{2}^{4}He$
3. ${}_{3}^{6}Li + {}_{0}^{1}n \rightarrow {}_{1}^{3}H + {}_{2}^{4}He$
4. ${}_{1}^{2}H + {}_{1}^{3}H \rightarrow {}_{2}^{4}He + {}_{0}^{1}n$

14. What is a problem commonly associated with nuclear power facilities?

1. A small quantity of energy is produced.
2. Reaction products contribute to acid rain.
3. It is impossible to control nuclear fission.
4. It is difficult to dispose of wastes.

15. Base your answer to this question on the information below.
Hydrocarbons and fissionable nuclei are among the sources used for the production of energy in the United States. A chemical reaction produces much less energy than a nuclear reaction per mole of reactant.

The balanced chemical equation below represents the reaction of one molecule of a hydrocarbon with two molecules of oxygen.

Chemical equation: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 1.48 \times 10^{-18}$ J. The nuclear equation below represents one of the many possible reactions for one fissionable nucleus. In this equation, *X* represents a missing product. Nuclear equation:

$${}_{0}^{1}n + {}_{92}^{235}U \rightarrow {}_{36}^{89}Kr + X + 3{}_{0}^{1}n + 3.36 \times 10^{-11}\ J$$

Write an isotopic notation for the missing product represented by *X* in the nuclear equation.

16. Write the correct notation for the missing product in the equation below?

${}_{92}^{235}U + {}_{0}^{1}n \rightarrow {}_{38}^{92}Sr + \_\_\_\_\_ + 2{}_{0}^{1}n + \text{energy}$

17. Nuclear fission has been used to produce electricity. However, nuclear fusion for electricity production is still under development. The notations of some nuclides used in nuclear reactions are shown in the table below.

Some Nuclides Used in Nuclear Reactions

Reaction	Nuclides
nuclear fission	${}_{92}^{233}U$, ${}_{92}^{235}U$
nuclear fusion	${}_{1}^{1}H$, ${}_{1}^{3}H$

Complete the nuclear equation for the fission of ${}_{92}^{235}U$ by writing the notation of the missing product.

${}_{92}^{235}U + {}_{0}^{1}n \rightarrow {}_{56}^{142}Ba + {}_{36}^{91}Kr + 3 \_\_\_\_\_ + \text{energy}$
