Unit 10 NuclearChem

At the end of this unit, you'll be able to…

Unit Objectives:

- ✓ Predict the stability of an isotope based on the ratio of neutrons and protons in its nucleus.
- ✓ Understand that while most nuclei are stable some are unstable and spontaneously decay emitting radiation.
- ✓ Calculate the initial amount of the fraction remaining, or the half-life of a radioactive isotope, using the half-life equation.
- ✓ Understand the concept of half-life.
- ✓ Differentiate between the following emissions based on mass, charge, ionizing power, and penetrating power:
  - Alpha
  - Beta
  - Positron
  - Gamma
- ✓ Determine the type of decay (alpha, beta, positron, gamma) and write the nuclear equations.
- ✓ Compare and contrast fission and fusion reactions
- ✓ Distinguish between natural and artificial transformations.
- ✓ Complete nuclear equations and predict missing particles from nuclear equations.
- ✓ Understand the change in energy in a nuclear reaction.
- ✓ Be aware of the risks associated with radioactivity.
- ✓ Recognize the beneficial uses and real world application of radioactive isotopes.
  - Radioactive dating
  - Tracing chemical and biological processes
  - Industrial measurement
  - Nuclear power
  - Detection and treatment of diseases

Term	Definition
Alpha particle	A helium nucleus; contains 2 protons and 2 neutrons; has a mass of 4 amu and a charge of +2
Artificial transmutation	occur in stable atoms; need some kind of high energy particles to begin reaction & bombard nucleus
Beta particle	an electron; has a mass of 0 and a charge of -1
Fission	SPLITTING of the nucleus of an atom; LARGER PARTICLE(S) SPLIT into smaller particles
Fusion	LIGHTER NUCLEI are COMBINED to produce heavier nucleus or nuclei
Gamma radiation	Electromagnetic radiation; Similar to xrays; 0 amu; Very dangerous (highly penetrating)
Half-life	the amount of time required for a quantity to fall to half its value as measured at the beginning of the time period
Radioactive tracer	a chemical compound in which one or more atoms have been replaced by a radioisotope
Radioisotope	an UNSTABLE or RADIOACTIVE ISOTOPE of any element
Transmutation	the changing of a nucleus of one element into the nucleus of another element

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Nuclear Chemistry Introduction

Define the terms for #1-5 in **your own words**:

1. Isotope: _____

_____

2. Radioactivity: _____

_____

3. Radioactive decay: _____

_____

4. List and define the two types of nuclear transmutation/transformation:

a. _____

_____

b. _____

_____

5. Gamma emission: _____

6. When a portion of an element sample undergoes radioactive decay,
   a. that portion disappears completely
   b. ½ that portion disappears
   c. that portion changes into another element
   d. that portion changes phase
   e. none of the above occur
7. Fission and fusion are both examples of _____ transmutation.

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Give the correct number of protons, atomic notation, and predict the stability of each isotope.

Element Name	# of protons	# of neutrons	Atomic notation	Stability
Curium	96	151	$^{247}_{96}Cm$	
Carbon		6		
Tin		67		
Silver		64		
Oxygen		8		
Francium		136		
Platinum		117		
Hydrogen		3		
Krypton		48		
Thallium		123		
Barium		81		
Barium		84		
Hydrogen		1		
Hydrogen		2		
Astatine		125		

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Nuclear Reactions

1. State the number of neutrons and protons in each of the following nuclei:

	# protons	# neutrons
$^{2}_{1}H$		
$^{12}_{6}C$		
$^{56}_{26}Fe$		
$^{197}_{79}Au$		

2. The three types of radioactive emissions are called alpha (α), beta (β) and gamma (γ) radiation. Complete the table below with the correct information about each type.

	Charge	Atomic Symbol	Can Be Stopped By
Alpha			
***Beta**			
Gamma			

3. Which of the three radioactive emissions (α, β, γ) best fit the following statements? Write the correct symbol/s on the lines.

   a) These emissions are charged. _____

   b) This emission is the most massive (heaviest). _____

   c) This emission is the most charged. _____

   d) This emission is most dangerous outside of the body. _____

   e) This emission is stopped by thin paper or a few centimeters of air. _____

   f) This emission can travel through paper, but is stopped by aluminum. _____

   g) This emission can travel through fairly thick lead. _____

4. Which type of radiation – alpha, beta, or gamma:
   a. Results in the greatest change in atomic number? Why?

   _____

   b. Results in the least change in atomic number? Why?

   _____

   c. Produces the greatest change in mass number? Why?

   _____

   d. Produces the least change in mass number? Why?

   _____

5. Complete the following nuclear reactions:
   a. $^{226}_{88}Ra \rightarrow$ ☐ $+ \ ^{0}_{-1}e$

   b. $^{209}_{84}Po \rightarrow \ ^{205}_{82}Pb +$ ☐

   c. $^{238}_{92}U \rightarrow$ ☐ $+ \ ^{4}_{2}He$

   d. $^{234}_{90}Th \rightarrow \ ^{234}_{91}Pa +$ ☐

   e. ☐ $+ \ ^{14}_{7}N \rightarrow \ ^{17}_{8}O + \ ^{1}_{1}H$

6. When isotope bismuth-213 emits an alpha particle:
   a. Write out the nuclear equation: ☐

   b. Which is the parent element? _____

   c. Which is the daughter element? _____

   d. Write out the nuclear equation if the isotope, instead, emits a beta particle:

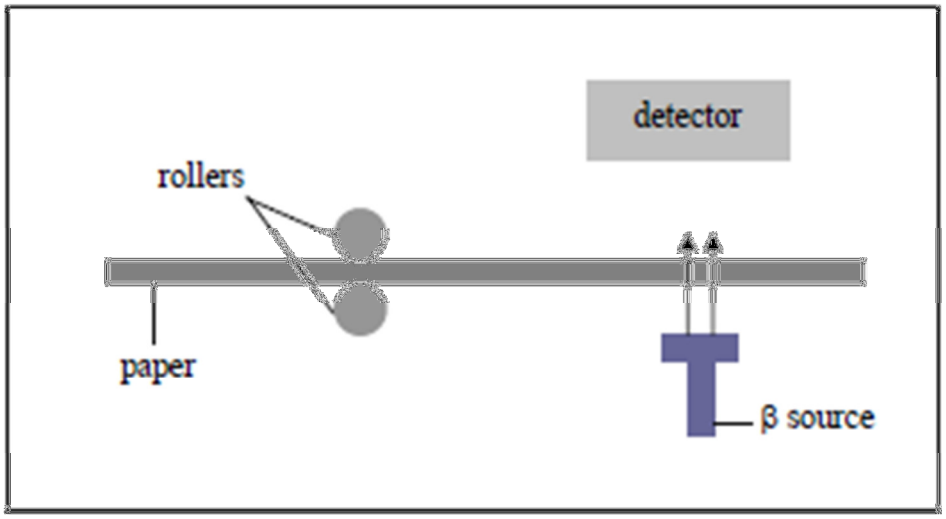
   ☐

7. When $^{218}_{84}Po$ emits a beta particle, it transforms into a new element.
   a. Write out the nuclear equation:

   b. Fill out the chart below:

	Name of the Element	Atomic #	Atomic Mass	# Protons	# Electrons	# Neutrons
Parent Element						
Daughter Element						

8. In a paper-making factory, beta radiation is used to check that the paper being produced is the correct thickness. If the paper gets too thin, the reading on the detector increases causing the rollers to move apart to make the paper thicker. If the paper gets too thick, the reading on the detector goes down causing the rollers to move closer together. A diagram of this set-up is shown below:



Explain why beta radiation is used for this procedure rather than alpha or gamma radiation.

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Nuclear Decay Reactions

							Type of Decay
1)	$^{247}_{96}Cm$	→	$^{243}_{94}Pu$	+	_____		_____
2)	$^{243}_{94}Pu$	→	$^{243}_{95}Am$	+	_____		_____
3)	$^{243}_{95}Am$	→	$^{239}_{93}Np$	+	_____		_____
4)	$^{239}_{93}Np$	→	$^{239}_{92}U$	+	_____		_____
5)	$^{239}_{92}U$	→	$^{235}_{90}Th$	+	_____		_____
6)	$^{235}_{90}Th$	→	$^{235}_{91}Pa$	+	_____		_____
7)	$^{235}_{91}Pa$	→	$^{235}_{90}Th$	+	_____		_____
8)	$^{235}_{90}Th$	→	$^{231}_{88}Ra$	+	_____		_____
9)	$^{231}_{88}Ra$	→	$^{231}_{87}Fr$	+	_____		_____
10)	$^{231}_{87}Fr$	→	$^{227}_{85}At$	+	_____		_____

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11) $^{227}_{85}At \rightarrow {}^{227}_{84}Po +$ _____ _____

12) $^{227}_{84}Po \rightarrow {}^{223}_{82}Pb +$ _____ _____

Write **nuclear equations** for each of the following:

1) Alpha decay of $^{231}_{91}Pa$	2) Alpha decay of $^{146}_{62}Sm$
3) Beta decay of $^{223}_{87}Fr$	4) Beta decay of At-198
5) Alpha decay of $^{149}_{62}Sm$	6) Alpha decay of Gd-150
7) Beta decay of $^{165}_{61}Pm$	8) Beta decay of Xe-152
9) Alpha decay of $^{249}_{101}Md$	10) Beta decay of Cs-120

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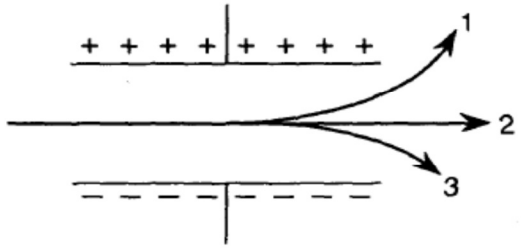
1. An electron has a charge identical to that of
   A) a beta particle B) an alpha particle
   C) a neutron D) a proton

2. A mixture of emanations from radioactive atoms is passed through electrically charged plates, as shown in the diagram below.



   The nuclear emanations 1, 2, and 3 are called, respectively,
   A) gamma, alpha, and beta
   B) gamma, beta, and alpha
   C) alpha, beta, and gamma
   D) beta, gamma, and alpha

3. An alpha particle has the same composition as a
   A) deuterium nucleus B) beryllium nucleus
   C) helium nucleus D) hydrogen nucleus

4. As a radioactive element emits gamma radiation only, the atomic number of the element
   A) decreases B) increases
   C) remains the same

5. Which radioactive emanations have a charge of 2+?
   A) alpha particles B) neutrons
   C) beta particles D) gamma rays

6. When an atom emits a beta particle, the total number of nucleons
   A) decreases B) increases
   C) remains the same

7. Which of these types of radiation has the greatest penetrating power?
   A) alpha B) beta
   C) positron D) gamma

8. Which kind of nuclear radiation has high energy and no mass?
   A) beta B) gamma
   C) neutron D) alpha

9. Which equation represents alpha decay?
   A) ${}^{234}_{90}Th \rightarrow {}^{234}_{91}Pa + X$
   B) ${}^{38}_{19}K \rightarrow {}^{38}_{18}Ar + X$
   C) ${}^{222}_{86}Rn \rightarrow {}^{218}_{84}Po + X$
   D) ${}^{116}_{49}In \rightarrow {}^{116}_{50}Sn + X$

10. Given the equation:
    ${}^{14}_{6}C \rightarrow {}^{14}_{7}N + X$
    Which particle is represented by the letter *X*?
    A) a neutron B) a proton
    C) an alpha particle D) a beta particle

11. Which particle has a negative charge?
    A) a lithium ion B) an aluminum ion
    C) an alpha particle D) a beta particle

12. Which of the following particles has the greatest mass?
    A) an alpha particle B) an electron
    C) a proton D) a beta particle

13. When a beta particle (${}^{0}_{-1}e$) is emitted by the nucleus of an atom, the mass number of the atom
    A) decreases B) increases
    C) remains the same

14. Gamma rays are emanations that have
    A) mass but no charge
    B) charge but no mass
    C) neither mass nor charge
    D) both mass and charge

15. Which of the following particles has the *least* mass?
    A) proton B) beta particle
    C) alpha particle D) neutron

16. Which type of radiation would be attracted to the positive electrode in an electric field?
    A) ${}^{0}_{-1}e$
    B) ${}^{11}H$
    C) ${}_{32}He$
    D) ${}_{10}n$

17. Given the reaction:

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

    This reaction is best described as
    A) beta decay B) fission
    C) alpha decay D) fusion

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Half Live Problems

HALF LIFE PROBLEMS - Use table N & T and show all work...

1) A sample of I-131 decays to 1.0 grams in 40 days. What was the mass of the original sample?

2) What is the total number of hours required for Potassium-42 to undergo three half life periods?

3) In 6.20 hours, a 100 gram sample of Ag-112 decays to 25.0 grams. What is the half life of Ag-112?

4) A 2.5 g sample of an isotope of Strontium-90 was formed in a 1960 explosion of an atomic bomb at Johnson Island in the Pacific Test Site. Is what year will only 0.625 grams of the Strontium-90 remain?

5) An 80 g sample of a radioisotope decayed to 10 g after 24 days. What was the total number of grams of the original sample that remained unchanged after the first 8 days?

6) What mass of a 32.0 g sample of ^{32}P will remain after 71.5 days of decay?

7) After 60 days, 10.0 grams of radioactive isotope remains from an original 80.0 g sample. What is the half life of this element?

8) In a nuclear reaction, the particle may be spontaneously released from the nucleus of an atom resulting in the transmutation of the atom into another element. Given the following nuclear reaction:

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + X$$

a) What type of particle is represented by X?

b) According to the Selected Radioisotopes table, what is the half life of C-14?

c) What mass of 10.0 g sample of C-14 remains after 11,460 years have evolved?

9) A radioactive element has a half life of 2 days. What is the fraction of the original sample will remain after six days?

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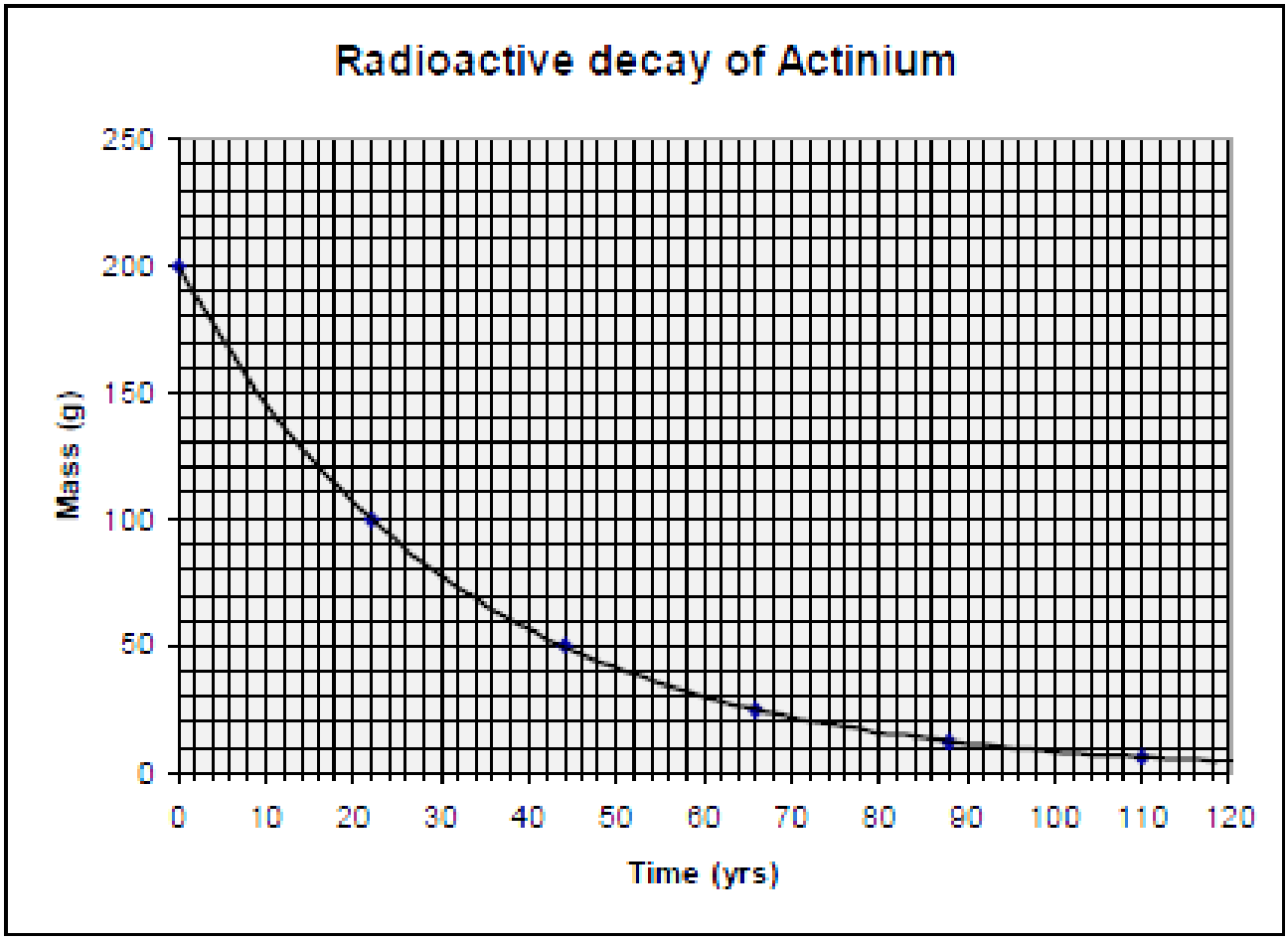
GRAPHING RADIOACTIVE DECAY

The graph for the decay of actinium below to answer questions 1-8.



1) What was the original mass of the astatine sample?
2) How many grams of astatine remain after 40 years?
3) What is the half life of astatine?
4) What mass of astatine remains after one half-life?
5) What fraction of astatine remains after one half-life?
6) How many half-lives must astatine go through until only 25% of the original sample mass remains?
7) How many half-lives until only 6.25% remains?
8) How many half-lives will it take for all of the original sample to decay?

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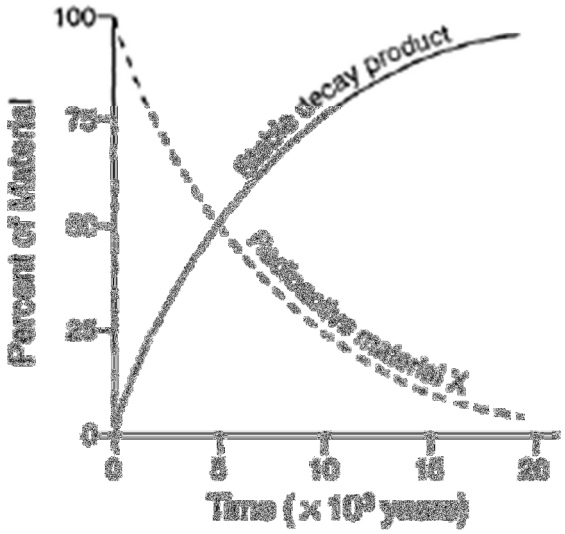
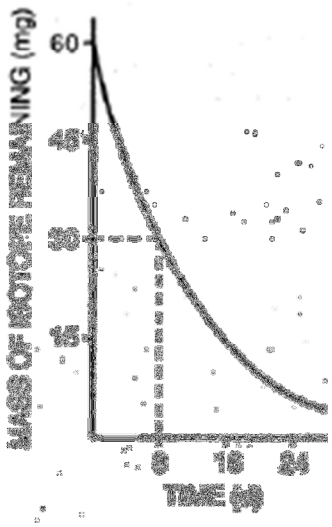
GRAPHING RADIOACTIVE DECAY (continued)

(Fig. A)



(Fig. B)



Use Fig. A below to answer questions 9-13:

9) Compare the rate of decay for radioactive material X to the rate of appearance of the stable decay product.

_____

_____

10) How long does it take for the percentage of stable decay product to equal the percentage of radioactive material X?

11) What is the half-life of radioactive material X?

12) What fraction of radioactive material X exists after 3 half-lives?

13) How long does it take for the amount of radioactive material X to decrease ***by*** 25%?

Use Fig. B below to answer questions 14-17:

14) What is the half-life of this isotope?

15) How many half-lives must pass before only 15 mg of the isotope remains?

16) After 16 days, what fraction of the isotope remains?

17) When the mass of the isotope remaining reaches 45 mg, how many half-lives will have passed?

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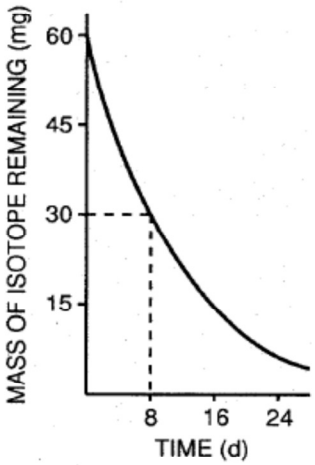
Half Lives

_____1. Which sample will decay *least* over a period of 30 days?

A) 10 g of I-131 B) 10 g of P-32

C) 10 g of Rn-222 D) 10 g of Au-198

_____2. The graph below represents the decay of a radioactive isotope.



Based on Reference Table N, which radioisotope is best represented by the graph?

A) ^{131}I

B) ^{222}Rn

C) ^{198}Au

D) ^{32}P

_____3. A sample of ^{131}I decays to 1.0 gram in 40. days. What was the mass of the original sample?

A) 8.0 g B) 16 g

C) 32 g D) 4.0 g

_____4. What is the number of half-life periods required for a sample of a radioactive material to decay to one-sixteenth its original mass?

A) 8 B) 16

C) 3 D) 4

_____5. In how many days will a 12-gram sample of $^{131}_{53}I$ decay, leaving a total of 1.5 grams of the original isotope?

A) 24 B) 8.0

C) 16 D) 20.

_____6. As a sample of the radioactive isotope ^{131}I decays, its half-life

A) decreases B) increases

C) remains the same

_____7. Given the nuclear reaction:

$$^{9}_{4}\mathrm{Be} + X \rightarrow {}^{12}_{6}\mathrm{C} + {}^{1}_{0}\mathrm{n}$$

What is the identity of particle *X*?

A) alpha particle B) beta particle

C) proton D) neutron

_____8. Given the correctly balanced nuclear equation:

$^{12}_{6}C + {}^{249}_{98}Cf \rightarrow {}^{257}_{104}Unq + 4X$

Which particle is represented by the *X*?

A) $^{1}_{1}H$

B) $^{0}_{-1}e$

C) $^{1}_{0}n$

D) $^{4}_{2}He$

_____9. In the reaction:

$$^{9}_{4}Be + X \rightarrow {}^{6}_{3}Li + {}^{4}_{2}He$$

The *X* represents

A) $^{1}_{0}n$

B) $^{1}_{1}H$

C) $^{0}_{-1}e$

D) $^{0}_{+1}e$

_____10. Given the nuclear reaction:

$$^{32}_{16}S + {}^{1}_{0}n \rightarrow {}^{1}_{1}H + X$$

What does *X* represent in this reaction?

A) $^{32}_{15}P$

B) $^{32}_{16}P$

C) $^{31}_{15}P$

D) $^{31}_{16}P$

_____11. Artificial transmutation is brought about by using accelerated particles to bombard an atom's

A) valence shells

B) nucleus

C) occupied sublevels

D) inner principal energy levels

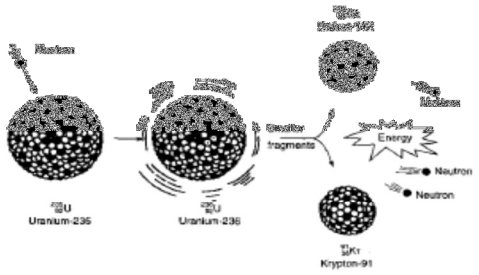
_____12. The nuclear reaction:

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

Is an example of

A) natural transmutation
B) nuclear fission
C) artificial transmutation
D) nuclear fusion

_____13. The diagram below represents a nuclear reaction in which a neutron bombards a heavy nucleus.



Which type of reaction does the diagram illustrate?

A) fission B) fusion
C) alpha decay D) beta decay

_____14. In which reaction is mass converted to energy by the process of fission?

A) $^{2}_{1}H + ^{2}_{1}H \rightarrow ^{4}_{2}He$
B) $^{226}_{88}Ra \rightarrow ^{222}_{86}Ra + ^{4}_{2}He$
C) $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{87}_{35}Br + ^{146}_{57}La + 3^{1}_{0}n$
D) $^{14}_{7}N + ^{1}_{0}n \rightarrow ^{14}_{6}C + ^{1}_{1}H$

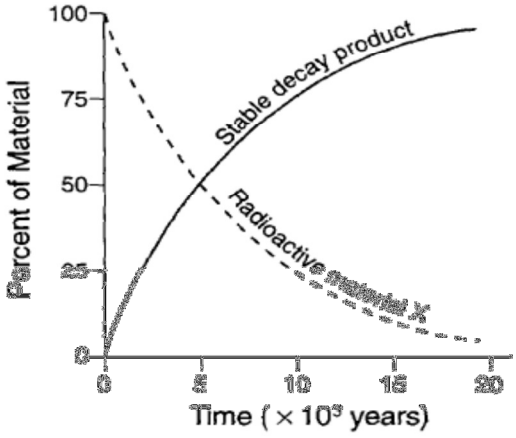
_____15. A radioisotope which is sometimes used by doctors to pinpoint a brain tumor is

A) lead-206 B) carbon-12
C) uranium-238 D) technetium-99

_____16. Which procedure is based on the half-life of a radioisotope?

A) radiating to kill cancer cells
B) dating to determine age
C) accelerating to increase kinetic energy
D) counting to determine a level of radioactivity

Base your answers to questions **17** through **20** on on the graph below. The graph represents the decay of radioactive material *X* into a stable decay product.



_____17. What is the approximate half-life of radioactive material *X*?

A) 10,000 yr B) 5,000 yr
C) 100,000 yr D) 50,000 yr

_____18. Which graph best represents the relative percentages of radioactive material *X* and its stable decay product after 15,000 years?(**The shaded region represents radioactive material while the non-shaded region represents stable decay products.**)

A) 

B) 

C) 

D) 

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_____19. Each of the objects below has different amounts remaining of the original radioactive material *X*. Which object is most likely the oldest?

A)

Rock
10% of the radioactive material remains

B)

Wood
33% of the radioactive material remains

C)

Bone
52% of the radioactive material remains

D)

Shell
41% of the radioactive material remains

_____20. If radioactive material *X* were heated, the length of its half-life period would

A) decrease B) increase

C) remain the same

_____

_____21. Iodine-131 is used for diagnosing thyroid disorders because it is absorbed by the thyroid gland and

A) emits alpha radiation
B) has a very long half-life
C) emits gamma radiation
D) has a very short half-life

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Uses and Risks of Nuclear Energy

1. High levels of radiation can be damaging to body cells, but despite this radiation can be useful in medicine. Describe 2 uses of radioactive isotopes.

   a. _____

   _____

   b. _____

   _____

2. Gamma emitting isotopes can be used to find out if containers or pipes are leaking. An engineer needs to test an underground water pipe for leaks without digging up the sidewalk. The pipe is buried three feet below the sidewalk. Describe what the engineer would do to carry out the task. _____

   _____

   _____

   _____

3. Describe one way in which radioactive materials are useful in the food industry. _____

   _____

4. What types of radiation are most dangerous outside the body? _____

   _____

5. What types of radiation are most dangerous inside the body? _____

   _____

6. Radioactive particles can give a person "radiation sickness."

   a. How could a person develop radiation sickness? _____

   _____

   b. What happens to the body during radiation sickness? _____

   _____

7. How is radioactive waste usually stored? _____

   _____

8. Some radioactive waste materials have a very long half-life. Why is the risk associated with storing these materials greater than those with a shorter half-life? _____

   _____

   _____

9. Explain why an explosion at a nuclear power station is likely to have much further reaching effects than an explosion at a coal-fired power station. _____

   _____

   _____

Name: _____
Teacher: Mr. Roderick

Unit 10 Nuclear Chem Pretest MC

1. [ ] Given the reaction: $^{131}_{53}\mathrm{I} \rightarrow {}^{131}_{54}\mathrm{Xe} + X$

Which particle is represented by *X*?

A. alpha
B. beta
C. neutron
D. proton

2. [ ] Which nuclear reaction is classified as alpha decay?

A. $^{14}_{6}\mathrm{C} \rightarrow {}^{14}_{7}\mathrm{N} + {}^{0}_{-1}\mathrm{e}$
B. $^{42}_{19}\mathrm{K} \rightarrow {}^{42}_{20}\mathrm{Ca} + {}^{0}_{-1}\mathrm{e}$
C. $^{226}_{88}\mathrm{Ra} \rightarrow {}^{222}_{86}\mathrm{Rn} + {}^{4}_{2}\mathrm{He}$
D. $^{3}_{1}\mathrm{H} \rightarrow {}^{0}_{-1}\mathrm{e} + {}^{3}_{2}\mathrm{He}$

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

A. a half-reaction
B. a breeder reaction
C. artificial transmutation
D. natural transmutation

4. [ ] The half-life of a radioactive isotope is 20.0 minutes. What is the total amount of a 1.00-gram sample of this isotope remaining after 1.00 hour?

A. 0.500 g
B. 0.333 g
C. 0.250 g
D. 0.125 g

5. [ ] Gamma rays are emanations that have

A. mass but no charge
B. charge but no mass
C. neither mass nor charge
D. both mass and charge

6. [ ] Which kind of particle, when passed through an electric field, would be attracted to the negative electrode?

A. an alpha particle
B. a beta particle
C. a neutron
D. an electron

7. [ ] Radioisotopes used for medical diagnosis must have

A. long half-lives and be quickly eliminated by the body
B. long half-lives and be slowly eliminated by the body
C. short half-lives and be quickly eliminated by the body
D. short half-lives and be slowly eliminated by the body

8. [ ] Compared to an ordinary chemical reaction, a fission reaction will

A. release smaller amounts of energy
B. release larger amounts of energy
C. absorb smaller amounts of energy
D. absorb larger amounts of energy

9. [ ] In a fusion reaction, reacting nuclei must collide. Collisions between two nuclei are difficult to achieve because the nuclei are

A. both negatively charged and repel each other
B. both positively charged and repel each other
C. oppositely charged and attract each other
D. oppositely charged and repel each other

10. [ ] Which radioactive emanations have a charge of 2+?

A. alpha particles
B. beta particles
C. gamma rays
D. neutrons

11. [ ] Which sample will decay *least* over a period of 30 days? (Refer to Reference Table *N*.)

A. 10 g of Au-198
B. 10 g of I-131
C. 10 g of P-32
D. 10 g of Rn-222

12. [ ] Which statement explains why nuclear waste materials may pose a problem?

A. They frequently have short half-lives and remain radioactive for brief periods of time.
B. They frequently have short half-lives and remain radioactive for extended periods of time.
C. They frequently have long half-lives and remain radioactive for brief periods of time.
D. They frequently have long half-lives and remain radioactive for extended periods of time.

Name: _____
Teacher: Mr. Roderick

Unit 10 Nuclear Chem Pretest CR

Figure 1

Base your answer to the question on the information, the *Reference Tables for Physical Setting/Chemistry*, and your knowledge of chemistry.

Radioactivity and radioactive isotopes have the potential for both benefiting and harming living organisms. One use of radioactive isotopes is in radiation therapy as a treatment for cancer. Cesium-137 is sometimes used in radiation therapy.

A sample of cesium-137 was left in an abandoned clinic in Brazil in 1987. Cesium-137 gives off a blue glow because of its radioactivity. The people who discovered the sample were attracted by the blue glow and had no idea of any danger. Hundreds of people were treated for overexposure to radiation, and four people died.

1. **[Refer to figure 1]**
If 12.5 grams of the original sample of cesium-137 remained after 90.6 years, what was the mass of the original sample?

Answer: [ ] g

Figure 2

Base your answer to the question on the information below.

The radioisotopes carbon-14 and nitrogen-16 are present in a living organism. Carbon-14 is commonly used to date a once-living organism.

2. **[Refer to figure 2]**
Complete the nuclear equation below for the decay of C-14. Include *both* the atomic number and the mass number of the missing particle.

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

Atomic number = [ ]
Mass number = [ ]
Symbol = [ ]

3.

State one possible advantage of using nuclear power instead of burning fossil fuels.

Answer for #3:

4.

State one possible risk of using nuclear power.

Answer for #4:

5.

If animals feed on plants that have taken up Sr-90, the Sr-90 can find its way into their bone structure. Explain one danger to the animals.

Answer for #5:

Figure 3

Given the nuclear equation:

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

6. **[Refer to figure 3]**

State the type of nuclear reaction represented by the equation.

Answer for #6:

7. **[Refer to figure 3]**

The sum of the masses of the products is slightly less than the sum of the masses of the reactants. Explain this loss of mass.

Answer for #7:

8. **[Refer to figure 3]**

This process releases greater energy than an ordinary chemical reaction does. Name another type of nuclear reaction that releases greater energy than an ordinary chemical reaction.

Answer for #8: