Weekly Agenda – Week 5 Quarter 4

Foundations Physical Science   Your Name:___________________________

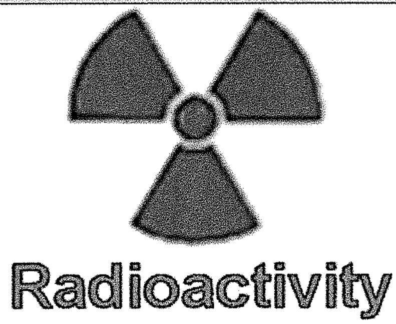
Weekly Learning Outcomes
-I can…   1. Analyze nuclear reactions to identify types of nuclear decay.   2. Form an argument on the advantages or disadvantages of nuclear energy as a power source.   3. Construct and analyze a graph of a radioisotope's half-life.

Date	***Activities***	***What's Due***
Monday 5/7	-Nuclear Chemistry Notes (p.1-4) -Nuclear chemistry practice -Work on TAG Sheets (5-9) *Homework:* *TAG Sheets* + practice (5-9)	
Tuesday 5/8	-Review Nuclear chemistry -Nuclear chemistry webquest (p.10-11) *Homework: Finish webquest* (p.10-11)	
Wednesday 5/9	-Half-Life Lab (p.12-15) *Homework: Finish lab* (p.12-15)	
Thursday 5/10	*-Advisory Schedule* -Review Half-Life lab -Half-life notes -Practice graphing (p.16-21) *Homework: Practice graphing*	
Friday 5/11	-Eyes of Nye: Nuclear Energy (p.21-23) -Chernobyl and Hiroshima *Homework: Flex*	*-TAG Sheets*

FPS – Nuclear reactions notes

Name______________________________ Period__________

Bellwork



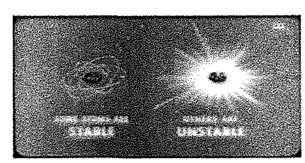
1. Listen to the nuclear decay song, then list 3 things you remember from the song.

2. **Nuclear Radioactivity:**
   a. ______________________ →compose of protons and neutrons
   b. Strong force → causes _________________ and _______________________ to be attracted.
   c. Powerful only when protons and neutrons are closely ________________ together.
   d. Large nucleus is held ____________ tightly than a small nucleus

3. **Nuclear decay** happens when the ____________ ______________ is not large enough to hold the _______________________together.

   a. The nucleus gives off _______________ and ___________________ until they transform into a different isotope or another element.

4. **Isotopes** → atoms with the same number of ______________________, but different number of _____________________.
   Examples: Carbon-14 6 protons, 8 neutrons
   Carbon-12 6 protons, 6 neutrons

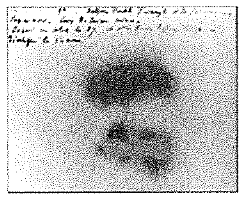


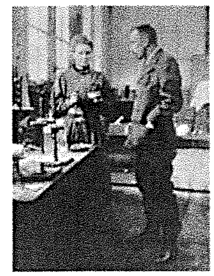
5. An atom's __________________________ will depend on the ratio of protons to neutrons in the nucleus.
   a. A nucleus with either too many or too few neutrons compared to protons is ____

6. POP QUIZ: Explain why nuclear decay occurs.

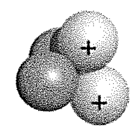
____
____
____
____

7. History:
   a. 1896 – Henri Becquerel discovered radioactivity with ______________
   b. 1898 – Marie Curie discovered radioactivity with ______________ and ______________





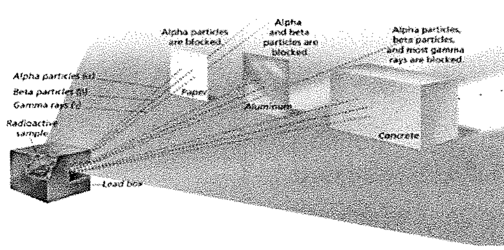
8. **Nuclear radiation –** Particles and energy released from ______________ nucleus. There are 3 types:
   a. ____________ particles
   b. ____________ particles
   c. ____________ rays



9. **Alpha particles →** consist of 2 ____________ and 2 ____________ with a charge of +2. They do not travel far due to ____________ and ____________. Though they are the least penetrating form of radiation, they can cause serious ______________.

10. **Beta particles →** ____________ emitted during the decay of a neutron into a proton in an ______________ nucleus. They can travel farther and faster than alpha particles because beta particles are so ____________.

11. **Gamma Rays →** high energy electromagnetic radiation emitted by a nucleus during radioactive decay. They have no __________ and no __________. These rays can penetrate matter deeply, even ______________.



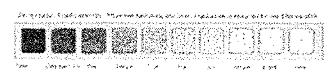
12. A) Writing nuclear equations: **alpha**	B) Writing nuclear equations: **beta**	C) Writing nuclear equations: **gamma**

13. When an atom is ***radioactive,*** it is… ____
____

14. ***Half-life of radioactive isotopes***
a. The length of ________________ it takes _________________ of the atoms of a sample of radioactive isotopes to ___________________.

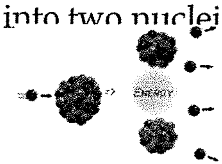
b. Varies from fractions of a __________________ to billions of ______________

c. Do you remember plutonium's half-life? _________________



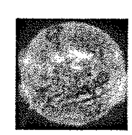
15. ***How can we use radioactive half-lives?***
Can be used to determine the ___________ of old objects, such as
____.

16. ***Nuclear fission*** → the process of ___________________________ a nucleus into two nuclei with smaller masses



17. ***Chain reaction*** → an ongoing series of _____________________ reactions

18. ***Nuclear fusion*** → two nuclei with low masses are _________________________ to form ONE larger _________________
a. Can only happen when nuclei are moving _______________
b. Temperature must be as high as the temperature of a ___________



Complete the review questions and vocab either alone or with one partner!

1. What is the nucleus of an atom composed of?
2. What is a strong force?
3. How are the strong forces between a large nucleus and a small nucleus different?
4. Why does nuclear decay happen?
5. What two things are released during nuclear decay?
6. What is an isotope?
7. Give an example of isotopes of Carbon.
8. What does it mean when a nucleus is unstable or *radioactive?*
9. In what elements did Marie Curie discover radioactivity?
10. What is an alpha particle?
11. What is a beta particle?
12. What is a gamma ray?
13. How are alpha and beta particles different?
14. How are gamma rays different from alpha and beta particles?
15. Which is the most dangerous radiation AND why?

Name ______________________________ Date ____________

Nuclear Decay

The following atoms all undergo alpha particle emission. Write the complete nuclear equation.

$^{210}_{84}\text{Po} \rightarrow$ ________ + ________

$^{238}_{92}\text{U} \rightarrow$ ________ + ________

$^{238}_{90}\text{Th} \rightarrow$ ________ + ________

The following atoms all undergo beta decay. Write the complete nuclear equation.

$^{14}_{6}\text{C} \rightarrow$ ________ + ________

$^{90}_{38}\text{Sr} \rightarrow$ ________ + ________

$^{40}_{19}\text{K} \rightarrow$ ________ + ________

Complete the missing information in the reactions. Then, label the reaction one of the following:

- Alpha Decay
- Beta Decay

_____ $\rightarrow\ ^{14}_{7}\text{N} + ^{0}_{-1}\text{e}$ Type: ______________

$^{238}_{92}\text{U} \rightarrow\ ^{234}_{90}\text{Th} +$ _____ Type: ______________

$^{32}_{15}\text{P} \rightarrow$ _____ $+ ^{0}_{-1}\text{e}$ Type: ______________

$^{244}_{94}\text{Pu} \rightarrow\ ^{4}_{2}\text{He} +$ _____ Type: ______________

FPS – T.A.G. Sheet – Chapter 10

Name______________________________ Period__________

I can…
Define radioactivity. *Construct nuclear equations.*

Section 10.1 page 292

Title of the Section

____

____

Describe any image in the section.

1. What is a radioisotope?

____

____

2. See Figure 3. Fill in the table below.

Characteristics of Nuclear Radiation				
Radiation type	Symbol	Charge	Mass (amu)	Common source

3. What is a beta particle?

____

____

4. How is a gamma ray different from the other two types of decay?

____

____

5. Write the balanced nuclear equation of uranium-238 undergoing alpha decay.

FPS – T.A.G. Sheet – Chapter 10

Name______________________________ Period__________

I can…
Analyze uses of radioactivity.

Section 10.2 page 298	
Title of the Section ____________________ ____________________	Describe any image in the section.

6. What is a half-life? Can it change?

____

7. Write the formula for half-lives elapsed.

____

____

8. How is radiocarbon dating useful?

____

____

9. All of the isotopes of radon have half-lives shorter than four days, yet radon is still found in nature. Explain why all the radon has not already decayed.

____

____

FPS – T.A.G. Sheet – Chapter 10

Name_______________________________ Period__________

I can…
Define transuranium elements.

Section 10.3 page 303	
Title of the Section ______________________________ ______________________________	Describe any image in the section.

10. How can scientists carry out nuclear reactions in the lab?

____

____

11. If transuranium elements are not found in nature, how do they exist?

____

____

12. What is a quark?

____

____

13. Read the paragraphs under "Particle Accelerators". How are particle detectors used?

____

____

____

____

FPS – T.A.G. Sheet – Chapter 10

Name______________________________ Period__________

I can…
Compare and contrast nuclear forces.

Section 10.4 page 308	
Title of the Section ____________________________________ ____________________________________	Describe any image in the section.

14. What is the strong nuclear force?

____

____

15. What causes a nucleus to be unstable?

____

____

16. What is nuclear fission?

____

____

17. How can mass be converted into energy?

____

____

18. What is a chain reaction?

____

____

19. What is nuclear fusion?

____

____

20. What is plasma?

____

Virtual Lab # **Name:** ______________________

Nuclear Radiation **Date Performed:** ______________________

PURPOSE:

- Explain alpha radiation in terms of alpha particles tunneling out of the nucleus. Watch alpha particles escape from a polonium nucleus, causing radioactive alpha decay.
- Understand the process of beta decay. Watch beta decay occur for a collection of nuclei.
- Begin to gain an understanding of the forces that work to hold an atomic nucleus together (strong nuclear force) and the forces that work to break it apart (Coulomb, i.e. electric charge, force).

PROCEDURE:

Part 1: Alpha decay (http://phet.colorado.edu/en/simulation/alpha-decay **)**

1) Start by opening the PhET model "Alpha Decay". Click on 'Run Now' and when the simulation opens click on the 'Single Atom' Tab.
2) Watch the Polonium-211 atom until it decays. Click 'Reset Nucleus' and watch it again. Repeat this several times.
3) Make at least 3 observations that compare the Polonium nucleus before and after it decays.

4) What has to happen within the nucleus in order for an atom of Polonium-211 to decay?

5) Click the Pause button immediately after a decay so you can look at the particle that comes flying out of the nucleus. What is this particle made of?

6) Why does the mass number change from 211 to 207 after a decay?

7) Why does the Polonium (Po) become Lead (Pb) after a decay? (You may have to look at a Periodic Table to determine this)

8) Now click on 'Multiple Atoms' and quickly empty the Bucket o' Atoms for Polonium-211 by rapidly clicking the 'Add 10' button until the bucket is empty. Watch the atoms decay and watch the Decay Chart across the top. Make observations about what happens. (if this is too hard to count, try 10 atoms first)

Part 2: Beta decay (http://phet.colorado.edu/en/simulation/beta-decay)

9) Start by opening the PhET model "Beta Decay". Click on 'Run Now' and when the simulation opens click on the 'Single Atom' Tab.
10) Watch the Hydrogen-3 atom until it decays. Click 'Reset Nucleus' and watch it again. Repeat this several times.
11) Make at least 3 observations that compare the Hydrogen nucleus before and after it decays.

12) Click the Pause button immediately after a decay so you can look at what comes flying out of the nucleus. Describe this below.

13) Why does the Hydrogen (H) become Helium (He) after a decay? (You may have to look at a Periodic Table to determine this)

14) Why doesn't the mass number change after a decay?

15) Repeat these steps for a Carbon-14 nucleus. Describe the similarities and differences you see

16) Now click on 'Multiple Atoms' and quickly empty the Bucket o' Atoms for Hydrogen-3 by rapidly clicking the 'Add 10' button until the bucket is empty. Watch the atoms decay and watch the Decay Chart across the top. Make observations about what happens. (if this is too hard to count, try 10 atoms first)

Part 3: Gamma radiation (http://missionscience.nasa.gov/ems/12_gammarays.html)

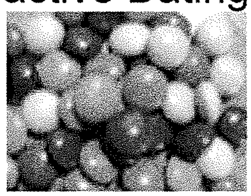
17) What are Gamma rays?

18) Where do Gamma rays come from?

19) What are Gamma rays used for?

Half-Life of Candium: Radioactive Dating

Determining Absolute Age

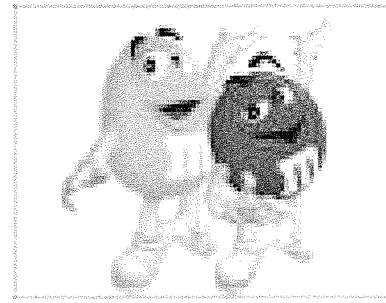


Name:

Period:

Date:

Discussion: Many people have heard the term "half-life" and know that it is related to radioactive elements. Half-life is defined as; "The time required for half of any given amount of a radioactive substance (Parent Atoms) to decay into another substance (Daughter Atoms)". Radioactive decay is a constant process where the unstable radioactive element breaks down to become a more stable element by releasing radioactive particles and radiation. In this lab you will use M&Ms to simulate how atoms radioactively decay and how rocks of different ages have different amounts of radioactive and decayed elements.



Background Information: Testing of radioactive minerals in rocks best determines the **absolute age of the rock**.

In radiometric dating, different isotopes of elements are used depending on the predicted age of the igneous rocks. Potassium/Argon dating is good for rocks 100,000 years old since Potassium 40 has a half-life of 1.3 billion years! Uranium/Lead dating is used for the most ancient rock, since U-238 has a half-life of 4.47 billion years.

By comparing the percentage of an original element (parent atom) to the percentage of the decay element (daughter atom), the age of a rock can be calculated. The ratio of the two atom types is a direct function of its age because when the rock was formed, it had all parent atoms and no daughter atoms.

Procedure: You will be given a sample of a radioactive element known as Candium (M&M's), 50 candies. Radioactive Candium stabilizes into a more stable element Greenium (split peas). **Read the procedure before you start the lab**

1. Place the 50 candies in the cup. The Candium with the "M" side up are the number radioactive **unstable** "undecayed" Candium atoms (the parent atoms) in your igneous rock when it was formed
2. Shake the cup- not too vigorously! Shake the cup for about 7.13 seconds (this represents 713 million years passing). This represents time to decay or one half-life.
3. Carefully pour the Candium atoms onto a paper towel. Remove all the **stable** Candium atoms-those with the "M" side down. Stable Candium atoms are really a new element: Greenium atoms. Replace in the cup these removed stable

Candium atoms (parent atoms) with same number of greenium atoms (daughter atoms).

> The total number of M&M's and peas in your cup must be the same as the number of M&M's you started with (50). Atoms are never lost they just decay from the radioactive atoms (M&Ms) to more stable ones (flipped over M&Ms or peas).

4. Count and record the number of radioactive "undecayed" Candium atoms ('M' side up) remaining. Record in the data table.

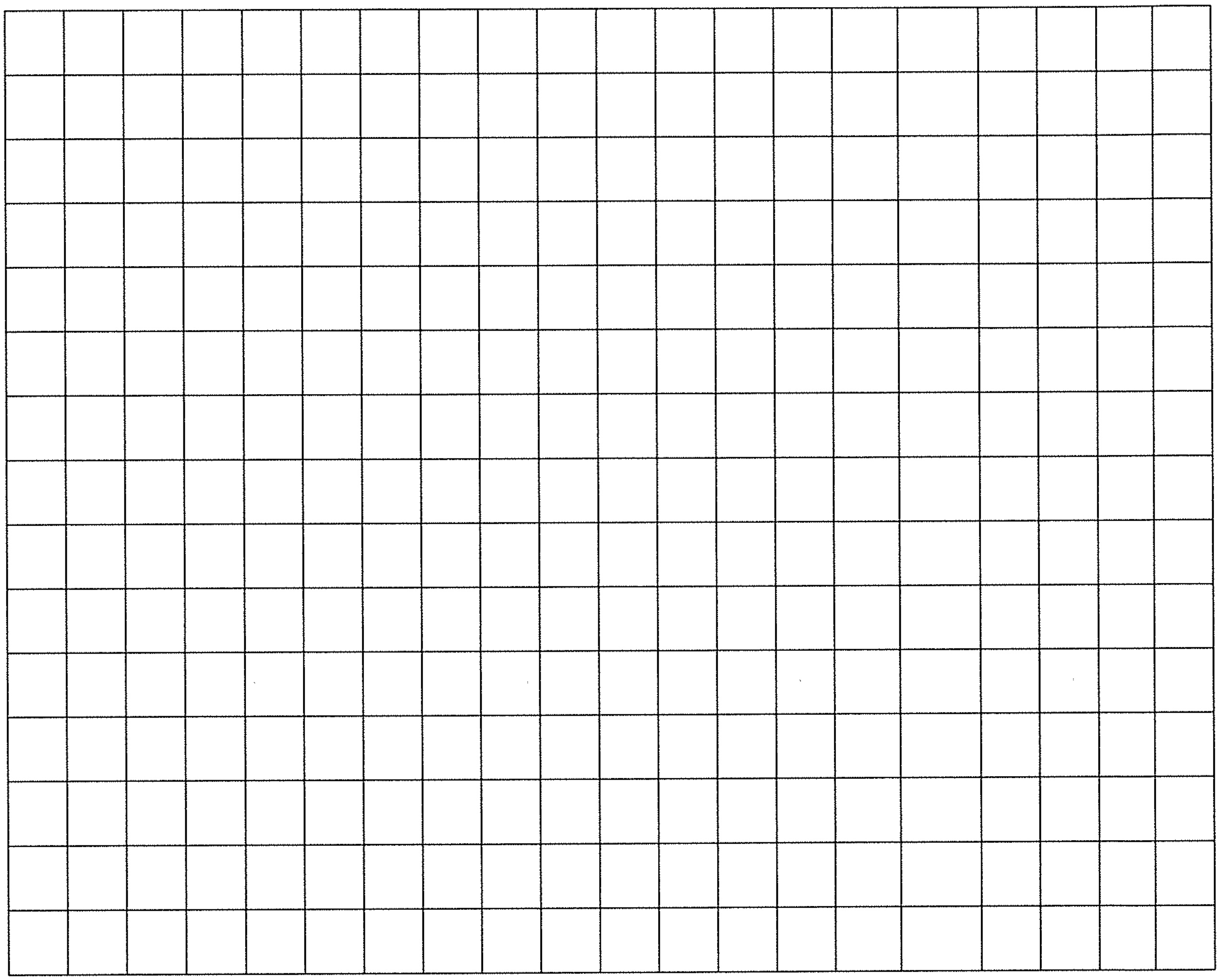
5. Repeat steps 2, 3 and 4 until all the candies "decayed" (flipped 'M' side down) or 10 shakes of the cup-which ever happens first. Do the WHOLE process TWICE!

Data Table

Time (# of shakes) **Half Lives**	Number of "undecayed" radioactive Candium atoms remaining with the "M" side up. "Parent" atoms.	Number of Greenium atoms. The stable "daughter" atoms.	Time (# of shakes) **Half Lives**	Number of "undecayed" radioactive Candium atoms remaining with the "M" side up. "Parent" atoms.	Number of Greenium atoms. The stable "daughter" atoms.
0	50	0	0	50	0
1			1		
2			2		
3			3		
4			4		
5			5		
6			6		
7			7		
8			8		
9			9		
10			10		

Data Analysis

Please use the graph below plot your data of parent and daughter atoms over time passed (millions of years).



Questions

1. The M&M's represent the ________________________.

2. The split peas represent the _________________________ .

3. How much of a radioactive element becomes stable in a half-life?

4. What is the half-life of Candium? (i.e., What number of shakes are necessary to reduce the radioactive members to one-half?)

5. If you started with 100 M&M's, would the half-life change? Please explain.

6. Suppose you had 20 radioactive M & M's. Using your graph determine how many years had passed.

7. After 2,000 million years had passed how many radioactive M & M's would be left? Number of decayed M & M's?

8. Looking at the table of elements used in radioactive dating, identify which element the radioactive M & M's represent.

Elements used in radioactive dating		
Radioactive element	**Half-life (years)**	**Dating range (years)**
carbon-14	5,730	500-50,000
potassium-40	1.3 billion	50,000-4.6 billion
rubidium-87	47 billion	10 million-4.6 billion
thorium-232	14.1 billion	10 million-4.6 billion
uranium-235	713 million	10 million-4.6 billion
uranium-238	4.5 billion	10 million-4.6 billion

9. Can this radioactive element be used to determine the age of humanoid fossils? Why or why not? (Remember from the timeline, humanoids first appeared 5 million years ago).

10. Try multiplying 1/2 X1/2 over and over to determine if you ever get to zero. 1/2 x 1/2 x 1/2 x 1/2 x 1/2 x 1/2 x 1/2 x 1/2 x etc. Will a small amount of the "parent" radioactive element always remain?

NAME ______________________________ DATE ______________

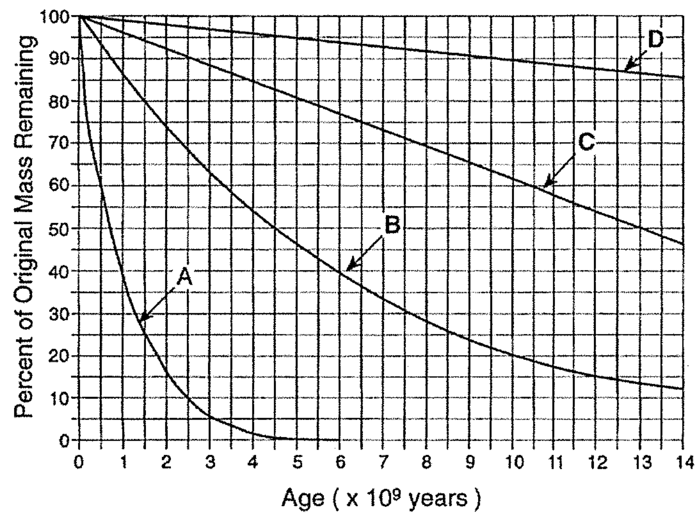
Half-life Practice

1. What is half-life? ______________________________

2. If we start with 400 atoms of a radioactive substance, how many would we have after:
   a. one half-life? __________ c. three half-lives? __________
   b. two half-lives? __________ d. four half-lives? __________

3. If we start with 48 atoms of a radioactive substance, how many would remain after:
   a. one half-life? __________ c. after three half-lives? __________
   b. two half-lives? __________ d. after four half-lives? __________

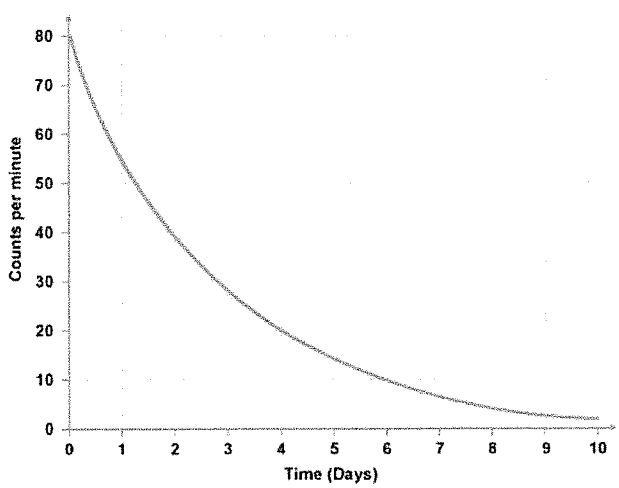
Using the graph to the right, answer the following questions.



4. What is the half-life of each element?

5. Which element has the shortest half-life?

6. Which element is the most unstable? How do you know?



Use the graph on the to answer the following questions.

7. How many atoms are in the original sample size of this radioisotope?

8. How long is the half-life?

9. How many atoms are left after 2 half-lives?

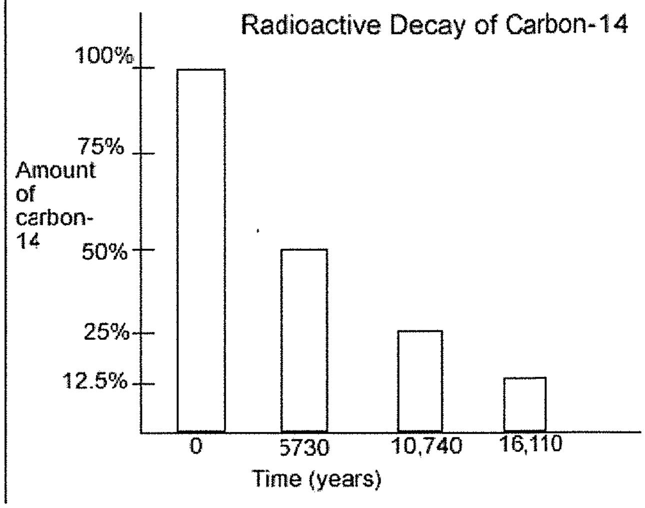
10. Approximately how many days would have to pass for there to be only 2.5 atoms of the sample remaining? How many half-lives?

Use the table on the right to answer the following questions.

11. How long is a half-life for carbon-14?

12. If only 25% of the carbon-14 remains, how old is the material containing the carbon-14?

13. If a sample originally had 120 atoms of carbon-14, how many atoms will remain after 16,110 years?



14. If a sample known to be about 10,740 years old has 400 carbon-14 atoms, how many atoms were in the sample when the organism died?

The table below shows the radioactive decay of a 600 g sample of Iodine-125.

Time (days)	Half-Lives	% of Parent Isotope Remaining	Fraction of Parent Isotope Remaining	Mass (g) of Parent Isotope	Mass (g) of Daughter Isotope
0	0	100%	1/1	600	0
60	1	50%	1/2	300	300
120	2	25%	1/4	150	450
180	3	12.5%	1/8	75	325
240	4	6.25%	1/16	37.5	562.5
300	5	3.125%	1/32	18.75	581.25
360	6	1.56%	1/64	9.4	590.6

15. What **percent** of iodine is left if 5 half-lives have passed? __________

16. What **percent** of iodine-125 has decayed if there are 37.5 grams of the original sample left? __________

17. What is the half-life of Iodine-125? __________

18. What **mass** of the Iodine-125 has decayed after 6 half-lives? __________

19. What **fraction** of the Iodine-125 remains after 300 days have passed? __________

20. How many half-lives would have to pass for there to be only 1.2 grams remaining? __________

21. How many grams of the daughter isotope are there after three half-lives? __________

The table of parent-daughter isotopes shows three different isotope pairs that are used in radioisotope dating. Examine the chart and answer the following questions.

Isotope		Half-Life of Parent (y)	Effective Dating Range (y)
Parent	Daughter		
uranium-235	lead-207	710 million	> 10 million
potassium-40	argon-40	1.3 billion	10 000 to 3 billion
carbon-14	nitrogen-14	5730	up to 50 000

22. Lead-207 is called the daughter of uranium-235. What does this mean?

23. How old is a rock sample that contains uranium-235 and lead-207 in equal amounts?

24. The age of Earth was first established in 1953 when Claire C. Patterson of the California Institute of Technology used a uranium-lead clock to analyze rock. In comparing amounts of uranium-235 with lead-207, he established that about 8 half-lives of uranium-207 had passed <u>since the rock formed</u>. Using this data, estimate the age of Earth.

25. Iodine-131 is a radioactive substance that can be used to treat certain thyroid conditions. It has a **<u>half-life of 8 days</u>**. Your friend with a thyroid condition is given 40 mg of I-131 to drink. Assuming that all the I-131 stays in her body, how much will remain after 4 half-lives?

26. Your mother will soon undergo some medical testing that will require her to swallow a radioactive isotope as a tracer. She is nervous about having a radioactive substance in her body even though the radiologist told her not to worry, as the isotope has a half-life of only 7 minutes. Explain to her what a half-life is, and the significance of the half-life being 7 minutes.

27. Volcanic rocks can be dated using the potassium-40 clock, a dating method based on the decay of the potassium-40 isotope into the daughter isotope argon-40. The age of volcanic rock can be measured by comparing the amount of these two isotopes present in the rock. Below is a table of data on the half-life of potassium-40. Use this information to create a decay curve for both isotopes.

Table 7.7 The Decay of Potassium-40

Number of Half-lives	Elapsed Time (billions of years)	Amount of Potassium-40 Present	Amount of Argon-40 Present
0	0	1000 g	0
1	1.3	500 g	500 g
2	2.6	250 g	750 g
3	3.9	125 g	875 g
4	5.2	62.5 g	937.5 g

Your graph should have;
Title, x-axis label (# of half-lives), y-axis label (Mass of Isotope), legend.

HALF-LIFE PROBLEMS

Name____ Block ______

1. An isotope of cesium (cesium-137) has a half-life of 30 years. If 1.0 g of cesium-137 disintegrates over a period of 90 years, how many g of cesium-137 would remain?

2. Actinium-226 has a half-life of 29 hours. If 100 mg of actinium-226 disintegrates over a period of 58 hours, how many mg of actinium-226 will remain?

3. Sodium-25 was to be used in an experiment, but it took 3.0 minutes to get the sodium from the reactor to the laboratory. If 5.0 mg of sodium-25 was removed from the reactor, how many mg of sodium-25 were placed in the reaction vessel 3.0 minutes later if the half-life of sodium-25 is 60 seconds?

4. The half-life of isotope X is 2.0 years. How many years would it take for a 4.0 mg sample of X to decay and have only 0.50 mg of it remain?

5. Selenium-83 has a half-life of 25.0 minutes. How many minutes would it take for a 10.0 mg sample to decay and have only 1.25 mg of it remain?

6. The half-life of Po-218 is three minutes. How much of a 2.0 gram sample remains after 15 minutes? Suppose you wanted to buy some of this isotope, and it required half an hour for it reach you. How much should you order if you need to use 0.10 gram of this material?

HALF-LIFE CALCULATIONS

Name ____________________

Half-life is the time required for one-half of a radioactive nuclide to decay (change to another element). It is possible to calculate the amount of a radioactive element that will be left if we know its half-life.

Example: The half-life of Po-214 is 0.001 second. How much of a 10 g sample will be left after 0.003 seconds?

Answer: Calculate the number of half-lives:

$$0.003 \text{ seconds} \times \frac{1 \text{ half-life}}{0.001 \text{ second}} = 3 \text{ half-lives}$$

After 0 half-lives, 10 g are left.
After 1 half-life, 5 g are left.
After 2 half-lives, 2.5 g are left.
After 3 half-lives, 1.25 g are left.

Solve the following problems.

1. The half-life of radon-222 is 3.8 days. How much of a 100 g sample is left after 15.2 days? ____________

2. Carbon-14 has a half-life of 5,730 years. If a sample contains 70 mg originally, how much is left after 17,190 years? ____________

3. How much of a 500 g sample of potassium-42 is left after 62 hours? The half-life of K-42 is 12.4 hours? ____________

4. The half-life of cobalt-60 is 5.26 years. If 50 g are left after 15.8 years, how many grams were in the original sample? ____________

5. The half-life of I-131 is 8.07 days. If 25 g are left after 40.35 days, how many grams were in the original sample? ____________

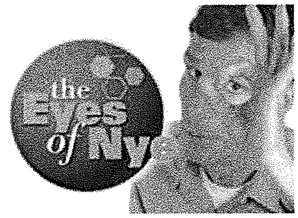
6. If 100 g of Au-198 decays to 6.25 g in 10.8 days, what is the half-life of Au-198? ____________

2

Name: ______________________________ Period: ________________ Date: _________________

The Eyes of Nye

Nuclear Energy



1. What are the three main sections of a nuclear power plant?

2. What starts the nuclear chain reaction?

3. What does fission mean?

4. What two products are formed from the fission of uranium?

5. How much nuclear waste is produced in 60 years of a power plant operating?

6. How much would a coal plant produce?

7. Where are most of the nuclear waste and spent fuel rods currently?

8. What is the estimate for how long it takes nuclear waste to completely decay?

9. What materials are used to shield or block nuclear radiation?

10. Why is Yucca Mountain such an attractive location for nuclear waste storage?

a.

b.

c.

11. What is the half-life of Plutonium, part of nuclear waste?

12. Why was the 10,000 year standard ruled invalid?

13. Give two positive and negative arguments involving the usage of nuclear energy.

14. How much total nuclear waste exists worldwide?

15. What are two other ideas for dealing with nuclear waste?

16. Why can't the nuclear waste be shot into space?

17. Describe **transmutation**.