

CHEM 106

The Periodic Table and Atoms & Nucleii



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The Periodic Table

View: *The genius of Mendeleev's periodic table*
Lou Serico

View full lesson on [edX.com](https://www.youtube.com/watch?v=fPnwBITSmgU)



TED-Ed
Lessons Worth
Sharing

<https://www.youtube.com/watch?v=fPnwBITSmgU>

Periodic Table (May 2016)

Los Alamos National Lab

<http://periodic.lanl.gov/index.shtml>

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period	1	H	He															
2	Li	Be	B	C	N	O	F	Ne										
3	Na	Mg	Al	Si	P	S	Cl	Ar										
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7	Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og

Lanthanide Series*	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Actinide Series**	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Elements in Song

<http://chemconnections.org/general/movies/leher-elements.swf>

Scientists Name 4 New Elements On The Periodic Table



NPR (National Public Radio)
June 9, 2016
Richard Gonzales

Los Alamos National Laboratory Chemistry Division																	
Periodic Table of the Elements																	
1A	2A	3A	4A	5A	6A	7A	8A	1A	2A	3A	4A	5A	6A	7A	8A	1A	2A
H	He																
Li	Be	B	C	N	O	F	Ne										
Na	Mg	Al	Si	P	S	Cl	Ar										
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og

Los Alamos
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CHEMISTRY

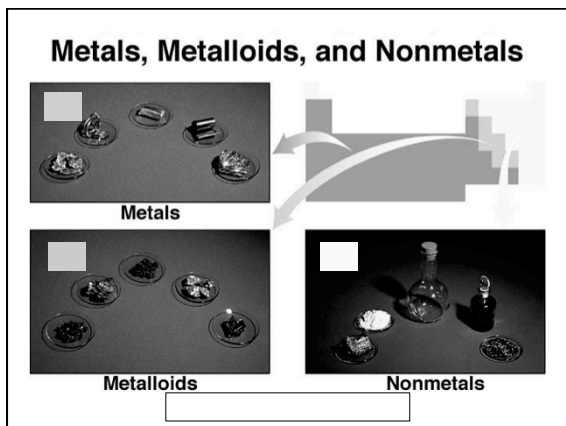
What are the names of 113, 115, 117 and 118?

Los Alamos National Laboratory Chemistry Division																	
Periodic Table of the Elements																	
1A	2A	3A	4A	5A	6A	7A	8A	1A	2A	3A	4A	5A	6A	7A	8A	1A	2A
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Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og

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CHEMISTRY

<http://chemconnections.org/general/chem106/Periodic%20Table-song%20&%20fable.htm>



CHEMISTRY of the Atom

FUNDAMENTAL PARTICLES:

	Mass	Charge	Symbol
Nucleus:			
PROTON	1 amu $1.67 \times 10^{-27} \text{ kg}$	+1	H^+ , H, p
NEUTRON	1 amu $1.67 \times 10^{-27} \text{ kg}$	0	n
ELECTRON	very small $\sim 2000 \times \text{smaller than a proton or neutron}$	-1	e^-

This particle is said to "hold" or "bond" atoms together in molecules.

CHEMISTRY of the Atom

https://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html

CHEMISTRY of the Atom

Atoms (neutral electrostatic charge: # protons = # electrons)

- # Protons = Atomic Number
- Atomic Mass = # Protons + # of Neutrons
- Isotope: same atomic number but different atomic mass (different # of neutrons) eg. hydrogen, deuterium and tritium, or sodium below

QUESTION

Which among the following represent a set of isotopes? Atomic nuclei containing:

- 20 protons and 20 neutrons.
- 21 protons and 19 neutrons.
- 22 neutrons and 18 protons.
- 20 protons and 22 neutrons.
- 21 protons and 20 neutrons.

- a, b, c
- c, d
- a, e
- a, d and b, e
- No isotopes are indicated.

Answer

Which among the following represent a set of isotopes? Atomic nuclei containing:


- 20 protons and 20 neutrons.
- 21 protons and 19 neutrons.
- 22 neutrons and 18 protons.
- 20 protons and 22 neutrons.
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<http://chemconnections.org/general/movies/Radioactivity.MOV>


Nuclear Decay / Radioactivity

- ▶ Unstable nuclei "decay" i.e. they lose particles which lead to other elements and isotopes.
- ▶ The elements and isotopes produced may also be unstable and go through further decay.



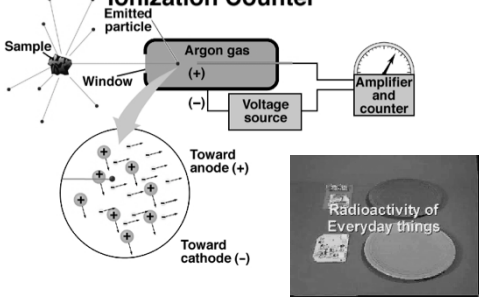
<https://www.youtube.com/watch?v=TJgc28csgV0>

Nuclear Decay / Radioactivity




<http://chemconnections.org/general/movies/radioactivityofeverydayob.mov>

Detection of Radioactivity by an Ionization Counter



<http://www.pbs.org/video/2209769748/>


Radioactive Decay



Nuclear Particles emitted from unstable nuclei

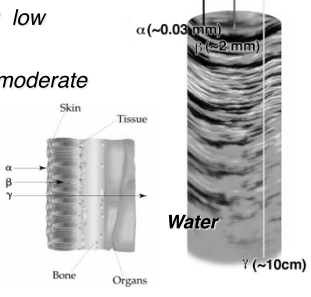
- ▶ **Emitted Particles:**

	Mass	Charge	Symbol
▶ alpha particle	4 amu	+2	${}^4_2\text{He}^{2+}$; $({}^4_2\text{He})$; ${}^4_2\alpha$
▶ beta particle	very small	-1	${}^0_{-1}e$; ${}^0_{-1}\beta$
▶ gamma	very very small	0	γ



Nuclear Penetrating Power

- ▶ alpha particle: low
 ${}^4_2\text{He}^{2+}$; $({}^4_2\text{He})$; ${}^4_2\alpha$
- ▶ beta particle: moderate
 ${}^0_{-1}e$; ${}^0_{-1}\beta$
- ▶ gamma: high
 γ
- ▶ X-rays?




<div>☢</div> Number of Stable Isotopes (Nuclides) Elements 48 through 54		
Element	Atomic Number (Z)	Number of Nuclides
Cd	48	8
In	49	2
Sn	50	10
Sb	51	2
Te	52	8
I	53	1
Xe	54	9

*Magic numbers are 2, 8, 20, 28, 50, or 82 protons or neutrons.
Even numbers of protons and neutrons are more stable than odd.*

<div>☢</div> Distribution of Stable Nuclides			
Protons	Neutrons	Stable Nuclides	%
▶ Even	Even	157	58.8
▶ Even	Odd	53	19.9
▶ Odd	Even	50	18.7
▶ Odd	Odd	7	2.6
Total =		267	100.0%

☢


Medical X-Rays



*First Medical X-Ray (1895)
The ring finger hand of Mrs. Element #111.*

CHEMISTRY of the Atom

- Isotopes vary in their relative natural abundance.
- Periodic Table's atomic mass is a weighted average of all isotopic masses
- The mass of sodium, Na, element #11 is listed as 22.99 amu. Which isotope is naturally present in the larger amount: the isotope with 12 neutrons or with 13 neutrons? (There is a small percentage of the isotope with 11 neutrons.)



QUESTION

Two stable isotopes of an element have isotopic masses of 10.0129 amu and 11.0093 amu. The atomic mass is 10.81. Which isotope is more abundant?

A) There is insufficient information to answer the question.

B) There are equal amounts of each isotope.

C) The isotope with a mass of 10.0129 amu is more abundant.

D) The isotope with a mass of 11.0093 amu is more abundant.

Answer

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CHEMISTRY of the Atom

Atomic Mass of Carbon:

Exact Mass	% Occurrence
12.00000	98.98
13.00335	1.011
14.00	negligible

What is the "weighted" atomic mass?

$$12.00000 \times 98.98/100 + 13.00335 \times 1.011 =$$

CHEMISTRY of the Atom

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14.00	negligible

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$$12.00000 \times 98.98/100 + 13.00335 \times 1.011 =$$

$$11.8776 + 0.13146 = 12.0090$$

12.01

Atomic Symbols

Mass number \rightarrow ^{39}K ← Element Symbol
Atomic number \rightarrow 19

Also written as $^{39}_{19}\text{K}$

CHEMISTRY of the Atom

- Atomic Number = 6 (atom's identity)
- Carbon
- Atomic Mass = 13 (isotope 13)
- 6 protons; # neutrons = 13 - 6
- neutral atom has 6 electrons



QUESTION

The average mass of a carbon atom is 12.011. Assuming you were able to pick up only one carbon unit, the chances that you would randomly get one with a mass of 12.011 is

- 0%.
- 0.011%.
- about 12%.
- 12.011%.
- greater than 50%.

None of the isotopes has an exact mass of 12.011.

Answer

The average mass of a carbon atom is 12.011. Assuming you were able to pick up only one carbon unit, the chances that you would randomly get one with a mass of 12.011 is

- 0%.
- 0.011%.
- about 12%.
- 12.011%.
- greater than 50%.